US Army Corps of Engineers ®
Omaha District

Fort Peck Dam Test Release

Final Environmental Impact Statement

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Fort Peck Dam Test Release Final Environmental Impact Statement

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Abstract

On February 8, 2019, the United States Army Corps of Engineers (USACE) issued a Notice of Intent to prepare an environmental impact statement for the Fort Peck Dam Test Release EIS (FPDTR-EIS). The public comment period for the Draft EIS was held from March 26, 2021 to May 25, 2021 The FPDTR-EIS is an effort being undertaken in accordance with with the *Final Biological Opinion concerning the Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of the Kansas River Reservoir System, and Implementation of the Missouri River Recovery Management Plan* (2018 BiOp). The purpose of the FPDTR-EIS is to assess the capacity of test flows out of Fort Peck Dam to promote growth and survival of pallid sturgeon (*Scaphirynchus albus*) to free swimming juvenile stage before settling out in the headwaters of Lake Sakakawea. Pallid sturgeon are listed as endangered under the Endangered Species Act of 1973 (ESA).

The document is divided into six chapters. “Chapter 1.0: Purpose and Need” describes why USACE is taking action at this time and what USACE intends to achieve. “Chapter 2.0: Alternatives” presents the approach to developing and screening alternatives and three alternatives examined in detail—two action alternatives and the no-action alternative. The alternatives evaluated provide different approaches to addressing the need for the EIS and meeting pallid sturgeon objectives. “Chapter 3.0: Affected Environment and Environmental Consequences” describes the existing conditions of 14 resource topics including physical, natural, and human consideration resources and the projected impacts to those resources from the three alternatives evaluated. “Chapter 4.0: Implementation of Preferred Alternative” describes how the USACE would implement the preferred alternative under the Fort Peck Adaptive Management Framework. The accompanying Fort Peck Adaptive Management Framework (Appendix H) details the full adaptive management approach for pallid sturgeon in the UMR basin. “Chapter 5.0: Tribal, Agency, and Public Involvement” describes the public involvement process and the Tribal consultation processes that contributed to the development of the FPDTR-EIS. Finally, “Chapter 6.0: Compliance with Other Environmental Laws” describes how the USACE has complied with or will comply with other laws prior to implementing any decision.

The three alternatives considered in this Final FPDTR-EIS include the following: the No Action alternative, as required by the National Environmental Policy Act and based on the current system operation and current implementation of the Missouri River Recovery Program; and Alternatives 1 and 2—test releases from Fort Peck Dam and two variants of each alternative: the flow peaks under “b” variants of each alternative occur one week later and flow peaks under “a” variants occur one week earlier. A full description of the Alternatives is provided in Chapter 2.

The Final FPDTR-EIS evaluates the direct, indirect, and cumulative impacts of the three alternatives. Based on these projected impacts, the ability to meet the action’s purpose, need, and pallid sturgeon objectives, and other decision criteria, USACE has identified the Alternative 1 (and its “a” and “b” variants) test releases as its preferred alternative. Importantly, Alternative 1 would be implemented under the Fort Peck Adaptive Management Framework summarized in Chapter 4.0 of the FPDTR-EIS and detailed within the Fort Peck Dam Adaptive Management Framework (Appendix H).

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EXECUTIVE SUMMARY

The United States Army Corps of Engineers (USACE) has prepared this Environmental Impact Statement (EIS) to evaluate implementing test flow releases at Fort Peck Dam as part of its commitment in the January 19, 2018 amendment to the October 30, 2017 Biological Assessment (BA) for the Operation of the Missouri River Mainstem Reservoir System (System), the Operation and Maintenance of the Bank Stabilization and Navigation Project (BSNP), the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan (MRRMP).

In that BA, USACE proposed to work with the U.S. Fish and Wildlife Service (USFWS) and the Missouri River Recovery Implementation Committee (MRRIC) “to review previous information and information generated since the [2013-2016] Effects Analysis to formulate test flow releases from Fort Peck Dam and an adaptive management (AM) framework for their implementation.” The USFWS relied on this commitment in its 2018 BiOp finding that the USACE’s Proposed Action is “not likely to jeopardize” pallid sturgeon (*Scaphyrinchus albus*) under the Endangered Species Act (ESA).

This EIS describes the formulation of alternative plans to address this need, presents analyses of their predicted benefits and environmental effects, identifies the Preferred Alternative, and discusses uncertainties and implementation considerations.

PURPOSE AND NEED

The purpose of the Fort Peck Test Flows is to evaluate the potential for achieving pallid sturgeon spawning and recruitment on the Upper Missouri River (UMR) using periodic Fort Peck Dam releases that better replicate historical flows and temperatures. The USFWS determined in its 2018 BiOp that USACE’s System Operations in the UMR are potentially impacting the pallid sturgeon’s ability to recruit due to 1) altered water temperatures, 2) altered flow regime, and 3) altered sediment regime and turbidity (USFWS, 2018). No natural recruitment of pallid sturgeon has been documented in either the Yellowstone or Missouri Rivers above Lake Sakakawea, and maintenance of the species currently relies on artificial propagation and stocking.

The MRRMP Science and Adaptive Management Plan (SAMP) envisioned introducing new actions as required to achieve the MRRMP objectives. Flow modifications at Fort Peck Dam were identified as a potential action for avoiding jeopardy to the continued existence of pallid sturgeon on the UMR. Implementing a limited number of test flows under an adaptive management framework allows the USACE to address critical uncertainties, better assess need, and refine potential actions (if needed) to enhance performance relative to the authorized purposes and their ESA obligations. The test flow alternatives would be implemented through a Missouri River Mainstem Reservoir System Master Water Control Manual (Master Manual) deviation request and do not constitute a change to the Master Manual. If the test flows are determined to be successful, an additional impact analysis and public involvement process would be conducted prior to adopting any flow action that would change the Master Manual.

PROJECT AREA

Test flows target the demographic unit of pallid sturgeon found in west-central Montana on the UMR between Fort Peck Dam and Lake Sakakawea and on the lower Yellowstone River. Fort Peck Dam, located at Missouri River Mile (RM) 1772, limits upstream migration of adult pallid sturgeon while the Lake Sakakawea headwaters (approximately RM 1500) limit downstream dispersal of larval pallid sturgeon. The effects of implementing test flows were evaluated from Fort Peck Reservoir downstream to Gavins Point Dam on the South Dakota/Nebraska border at RM 811.

Hydrological modeling for the alternatives was performed on the entire Missouri River system to the Mississippi River confluence. Because no meaningful hydrological differences between any alternative and the No Action Alternative were evident downstream from Gavins Point Dam, human considerations analyses were limited to areas upstream of this point. This encompasses a sequence of river and reservoir segments that includes Fort Peck Dam and Reservoir, Garrison Dam and Lake Sakakawea, Oahe Dam and Lake, Big Bend Dam and Lake Sharpe, Fort Randall Dam and Lake Francis Case, and Gavins Point Dam and Lewis & Clark Lake.

AUTHORITY

USACE has responsibility for the operation and maintenance of the System, including Fort Peck Dam in Montana and five dams and reservoirs on the mainstem of the Missouri River in North Dakota, South Dakota, and Nebraska. USACE operates the System for the

Congressionally authorized project purposes of flood control, navigation, irrigation, hydropower, water supply, water quality, recreation, and fish and wildlife. Authorization for the construction and operation of the projects can be found in the following legislation: the Rivers and Harbors Act of 1935, the Fort Peck Power Act of 1938, and the Flood Control Act of 1944. The operation of the System is guided by the Master Manual.

This study fully addresses the potential impacts of alternatives as required under the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code (USC) 4321 et seq.); Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations (CFR) 1500–1508); and USACE Engineer Regulation (ER) 200-2-2 (33 CFR 230). The alternatives assessed in this EIS would supply a feedback loop of data and information to an AM program that was developed as part of the 2018 MRRMP-EIS (USACE, 2018a).

ALTERNATIVE PLANS

USACE developed two action alternatives (Alternative 1 and Alternative 2) to test hypotheses that flow releases from Fort Peck Dam could attract, retain, and aggregate reproductively ready pallid sturgeon on the UMR, leading to successful spawning, drift, larval development, and recruitment (Figure ES-1). Each action alternative consists of three variants (1, 1a, 1b and 2, 2a, 2b), with the variants reflecting slightly different implementation schedules.

No Action Alternative: The impacts of the No Action Alternative serve as the baseline of comparison for the impacts of the other alternatives. It assumes that no test flow release for pallid sturgeon would occur from Fort Peck Dam. Operations at Fort Peck are assumed to closely follow the Master Manual with no pallid sturgeon test flow.

The detailed specifications of the two Action alternatives are summarized below. They both provide for three to five instances wherein Fort Peck flow releases from April to July better replicate the natural runoff hydrograph than the No Action Alternative and include warmer spillway flows intended to test pallid sturgeon recruitment hypotheses.

- Alternative 1 includes a flow to test the hypothesis that higher flows in April might attract pallid sturgeon into the Missouri River rather than the Yellowstone River, as well as a second release to test the hypothesis that such flows might act as a spawning cue.
- Alternative 2 retains this second, spawning cue-testing flow, but rather than an attraction flow in April, it instead only provides for a more modest flow intended to test the hypothesis that such flows could influence retention of sturgeon already in the Missouri River.

In addition to the spawning cue flows common to both alternatives, authorization of Alternative 1 would permit either attraction or retention flows to be performed, whereas authorization of Alternative 2 would only permit the retention flow.

The range of alternatives was developed considering a suite of planning constraints, including those found in the Master Manual, that were determined during the scoping phase of the study. These constraints were focused on avoiding or minimizing biological and human consideration impacts and were informed by stakeholder input received during scoping and through regular MRRIC engagements. The constraints included additional flood targets Wolf Point, MT. Culbertson, MT, and Williston, ND; limits on the reduction rates of flows; and the provision of a minimum in-river flow measured at the Wolf Point gage.

Alternative 1: Attraction flows would begin on April 16, and the peak flow would be twice as large as the spring release from Fort Peck Dam for the given conditions. For example, the typical early spring release from Fort Peck Dam is approximately 8,000 cfs; therefore, the attraction flow peak would be 16,000 cfs as measured at the Wolf Point gage. Beginning on April 16, spring release flows are increased by 1,700 cfs per day until the peak flow is reached at the Wolf Point gage. The peak flow is held for 3 days and then decreases by 1,300 cfs per day until the retention flow is reached. The retention flow is 1.5 times the Fort Peck Dam early spring release as measured at the Wolf Point gage (12,000 cfs using the above example). The retention flow is held until May 28, when the spawning cue flow regime is initiated.

The spawning cue flow regime for Alternative 1 begins on May 28 and peaks at 3.5 times the Fort Peck Dam spring flow release for the given conditions. Assuming 8,000 cfs as the typical spring flow, this equates to a peak of 28,000 cfs at the Wolf Point gage. Beginning on May 28, the release is increased by 1,100 cfs per day until the peak flow is reached at Wolf Point. The peak is held for 3 days, decreased by 1,000 cfs per day for the next 12 days, then reduced by 3,000 cfs per day until the flow target for drift (8,000 cfs) is reached. The 8,000 cfs drifting flow regime is held until the drift phase is complete (typically by mid-July), when normal operations resume.

Alternative 2: The parameters for Alternative 2 are the same as described for Alternative 1 except that the attraction flow peak is the maximum powerhouse capacity rather than twice the average Fort Peck spring flow in the given year. The maximum flow that can be run through the powerhouse is approximately 14,000 cfs. Any additional release must be made through the spillway and does not generate hydroelectricity. Releases as measured at the Wolf Point gage are held at the powerhouse capacity until the spawning cue release is initiated. The rationale for keeping the releases high through this period – foregoing the inter-flow saddle – is the hypothesis that persistent high flows are needed to retain reproductive adult pallid sturgeon that have been attracted upstream to near the dam.

Both action alternatives incorporate the consideration of variations on these parameters that pertain to the timing of the flow releases. The purpose of the variants was to explore the need for and benefits of flexibility in the timing of these releases depending on the conditions, with ambient temperature being a key consideration. The ‘A’ variants assume flow releases occur one week earlier than the dates described above, whereas the ‘B’ variants assume they occur one week later. The variants are intended to simulate the reality that in any given year, the precise timing of the flow releases may need to adapt to real-time variables, including ambient temperatures, tributary flows, and fish movements. The variants and the base alternatives thus simulate a three-week window of opportunity for such variation to occur.

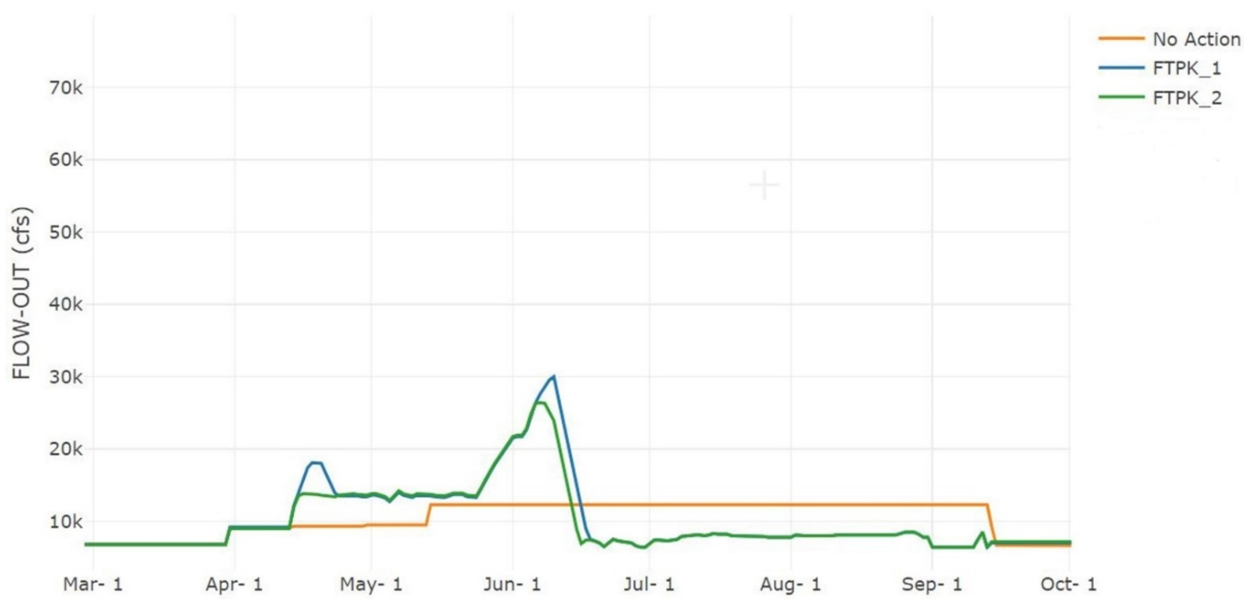

Figure ES-1: Example Hydrograph for Test Flow Alternatives 1 and 2 Compared to No Action (figure generated using 2012 flow data at Fort Peck gage station)

ENVIRONMENTAL CONSIDERATIONS

The term human considerations (HC) is used to address the interests of stakeholders and Tribes. These include the authorized purposes as well as the many other services afforded by the System. A detailed analysis of navigation was not conducted because the modeling demonstrated no discernable flow changes below Gavins Point Dam from the alternatives. The management actions in this EIS that could impact the human environment are related to temporary changes in flow releases from Fort Peck Dam associated with the test flows. The discussion of potential impacts for many resources includes an analysis based on modeling the alternatives over an 82-year hydrologic period of record (1931–2012) (POR) for the Missouri River basin. Pallid sturgeon benefits used an 83-yr period (1930-2012).

Industry-standard models were used to estimate the consequences of the test flows. The USACE Hydrologic Engineering Center (HEC) Reservoir System Simulation (HEC-ResSim) model was used to simulate reservoir operations for each of the alternatives. HEC-ResSim simulated System operation using the “rules” for each of the alternatives assuming the current reservoir System was in place, and the same runoff conditions occurred over the POR. Modifications and additions to these models to serve specific biological and economic analyses are detailed in Appendix D.

Detailed descriptions of predicted effects on environmental endpoints are provided in Section 3 and the Technical Appendices. Summarizing the results for executive purposes is challenging because of the variability involved. The following table provides a description, and in most cases, the percentage change in a measure from that of the No Action. This percentage is typically averaged over years where an attempt is made to release according to the Alternative definitions (referred to as “Full or Partial flow years”), not over the full POR. A full year is when the entire flow release cycle is implemented; a partial year is when the flow sequence is initiated but is cancelled at some point because of a boundary condition (e.g., a flood target). Averaging over test flow years provides a better indication of environmental consequences than averaging over the entire POR, since test flows are possible only about one year in seven.

Following is a summary of the anticipated benefits and adverse effects of the alternatives:

Pallid Sturgeon	• The No Action alternative provides negligible benefit to pallid sturgeon in the reach below Fort Peck Dam in terms of attraction, retention, spawning, and recruitment. • There are modeled benefits to pallid sturgeon from Alternative 1 and 2 and their variations relative to the No Action alternative; modeled spawning frequency for either alternative was four times that for the No Action alternative and retention of larval pallid sturgeon upstream of the lethal anoxic zone was modeled to increase about five-fold. • Overall, the model results show broadly similar benefits to pallid sturgeon retention under each of the action alternatives. Alternative 2 outperforms Alternative 1 in terms of cumulative retention, though subtle differences exist in the variations depending on prevailing weather conditions. • Long-term population growth from natural reproduction in the UMR was modeled to be greater for both action alternatives than for the No Action alternative, although the differences are small, and a declining population is predicted with every alternative.
Piping Plover and Interior Least Tern	• Using methodologies previously developed and reviewed in the MRRMP-EIS, a habitat/population model was used to evaluate the effect of the proposed flow alternatives on the ability to meet the objectives for the piping plover and least tern. These results suggest that there is no statistical difference between the No Action and both the action alternatives, nor is there a meaningful biological difference.
Fish and Wildlife Habitat	• Alternatives 1 and 2 would provide temporary benefits to the riverine ecosystem between Fort Peck Dam and Lake Sakakawea headwaters compared to the No Action Alternative from increased floodplain and side channel connectivity. There would be temporary small adverse and beneficial impacts to reservoir terrestrial habitats and fisheries during test flow years, depending on location and species.
Water Quality	• Under Alternative 1, small temporary increases in water temperature and decreases in dissolved oxygen would occur in April and then again in mid-May to July below the Fort Peck Dam Spillway, which discharges approximately 9 miles downstream of the dam. Negligible to small temporary increases in sediment and turbidity could occur during test flow years below Fort Peck Dam from increased erosion due to higher flows. These impacts would attenuate moving downstream as sediment is added from major tributaries such as the Milk River and Yellowstone River. Effects from introduction of pollutants from increased flows and floodplain connectivity would be negligible, and state and Tribal water quality standards would continue to be met based on negligible to small changes in water quality parameters. • Under Alternative 2, the small temporary increases in water temperature and decreases in dissolved oxygen would occur in mid-May to July below the Fort Peck Dam spillway. Differences to the No Action would otherwise be very similar to those for Alternative 1.
Cultural Resources	• Analysis indicates that many cultural resource sites would continue to experience risks under the No Action Alternative from low and high-water conditions due to fluctuations in the hydrologic and climatic cycles and their associated influence on river hydrology and reservoir storage. Actual impacts, which cannot be determined by modeling, would depend on the specific timing and location of a change in conditions, the physical damage to the site, and the site's cultural significance. • Under Alternative 1 cultural resource sites located below the normal operating elevation of Fort Peck Lake and above the normal operating elevation of Lake Sakakawea would experience an increased risk of impacts relative to the No Action Alternative due to decreasing reservoir elevations at Fort Peck Lake and increasing reservoir elevations at Lake Sakakawea during full and partial flow release years. The greatest increase in

	average annual site-days relative to the No Action Alternative would occur above Lake Sakakawea (+31%) and below Fort Peck Lake (+7%). • Under Alternative 2, cultural resource sites located below the normal operating elevations of Fort Peck Lake and above the normal operating elevations of Lake Sakakawea and Lake Oahe would experience an increased risk of impacts relative to the No Action Alternative due to decreasing reservoir elevation at Fort Peck Lake and increasing reservoir elevation at Lake Sakakawea and Lake Oahe during full and partial flow release years. The greatest increase in annual site-days relative to the No Action Alternative averaged over Full and Partial flow years would occur above Lake Sakakawea (+46%) and below Fort Peck Lake (+18%). • Impacts to cultural resources sites would be minimized by limiting the descending flows of the hydrograph (after the June peak) to no more than a 3,000 cfs per day decrease.
Flood Risk Management	• Under No Action, the Missouri River floodplain from Fort Peck Dam to Gavins Point Dam incurs average annual flood damages of $2.1 million in the modeled POR. However, the magnitude of these impacts varies considerably from year to year because of natural hydrologic cycles, not from the operations that are part of No Action. • Under Alternatives 1 and 2, including their variations, it is expected that flood risk management would experience small, short-term, adverse impacts relative to No Action. These impacts would be due to slight changes in the timing of inundation and minor increases in river stages relative to No Action. Alternative 2 results in slightly higher annual damages ($30k per year) in the Garrison to Oahe reach relative to Alternative 1 when averaged over the POR; it is unclear if this difference is statistically meaningful or if the effects of these two alternatives on flood risk management can be considered equivalent. • Although small on average, there are circumstances when the flood impacts would be greater; full results for every year in the POR are available in Section 3.4.2).
Fort Peck Dam Spillway	• The operation of the Ft Peck spillway would be required to achieve flow releases for the proposed alternatives. Both Alternatives 1 and 2 would peak between 28,000 – 33,000 cfs for 3 days in June. There would be an approximately two-week period in late-May to June when flows would be higher than the Fort Peck powerhouse capacity (14,000 cfs) and releases would occur through the spillway. For comparison, the spillway operated for 140 days in 2011, 175 days in 2018, and 150 days in 2019. The USACE has concerns with spillway slab performance that could be exacerbated with sustained spillway flows and would therefore monitor spillway performance carefully during a test flow. • Installation of equipment and monitoring of the spillway subdrain system, walls, and exit channel will be performed during each spillway use. If issues with the spillway are detected the test flow could be stopped by closing the spillway gates and any necessary repairs could be made before attempting another test flow • If damage to the spillway slabs would occur, repair would likely be extensive and not limited to a single slab or small area due to the high spillway flow velocities and the change in flow hydraulics as a result of slab uplift. If damage occurs, the spillway slab and sub-drain system repairs would be difficult, expensive, and likely constrained by time in order to address dam safety due to loss of spillway operation as quickly as possible.
Hydropower	• Under Alternatives 1 and 2, it is anticipated that overall adverse impacts to Missouri River hydropower would be small compared to the No Action Alternative; however, the modeling results from some test flow years showed large adverse impacts specific to Fort Peck Dam hydropower. • During implementation, the USACE would coordinate with WAPA and test flows could be stopped if test flow year discussions between WAPA and the USACE indicate that extensive hydropower impacts are occurring or anticipated to occur in a given year.
Irrigation	• Irrigation impacts include potential increases in costs associated with damages to irrigation intakes, increases in O&M costs, and reductions in crop productivity. There is

	uncertainty on how each intake would be impacted by the test flows so a range of impacts are provided in the EIS. Modeling indicates that impacts to side-channel intakes could vary with a worst-case of $7.5 million in impacts if 100% of side-channel intakes are not able to irrigate in a test flow year and $307,000 if no side-channel intakes lose the ability to irrigate (See Table 3-85 of the EIS). • During implementation of a test flow, the USACE would monitor irrigation intakes to reduce the uncertainty in forecasted level of impacts to irrigation during test-flow years. Results from monitoring would inform potential additional test-flow releases.
Recreation	• Alternatives 1 and 2 and their variations would cause lower pool levels in Fort Peck Lake during test flow years. Averaged over test flow years only there would be a -2.62% recreation decrease under Alternative 1 and -2.06% reduction under Alternative 2 as modeled at Fort Peck Lake compared to No Action. • Test flows impacts would be minimized by not implementing the flows in years when the minimum Fort Peck pool elevation is below 2227 feet.

PREFERRED ALTERNATIVE

Model results predict that both Alternative 1 and Alternative 2 would benefit pallid sturgeon on the UMR, and while the absolute benefits are uncertain, their modeled performance relative to the No Action Alternative model results is appreciable. The frequency of favorable conditions for spawning was modeled to be 400% greater than No Action for both Alternative 1 and Alternative 2. The model predicts composite retention would be 450% greater for Alternative 1 and 800% greater for Alternative 2, and long-term population growth rates were predicted by the model to be marginally higher for both Alternative 1 (1.6%) and Alternative 2 (0.9%) compared to No Action. The purpose of the action is to create the authority to empirically investigate various hypotheses using test flows; both Alternative 1 and 2 provide that capability while the No Action Alternative does not.

While the modeled direct benefits to pallid sturgeon are greater for Alternative 2 than for Alternative 1, the magnitude of the difference for 3 to 5 test flows would be minor. The primary benefits are associated with the knowledge gained from the hypothesis testing and application of the knowledge gained to future decisions. Relatedly, a key difference is that testing of attraction and holding flows would be constrained under Alternative 2, which is capped at maximum powerhouse capacity during that flow phase. Alternative 1 provides for the possibility of an attraction spill using warmer water from the Fort Peck Dam spillway, enabling experimentation around the value (or lack thereof) of attraction and retention flows in the UMR thus allowing for more flexibility to test hypotheses.

Alternative 2 shows slightly more adverse impacts to hydropower, irrigation, and flood risk management, though the differences are small relative to the wide variation in hydrological conditions across the period of record.

Therefore, Alternative 1 (including variations 1, 1A, and 1B) is identified as the Preferred Alternative in this FPDTR-EIS.

IMPLEMENTATION PLAN

The authority to implement the preferred alternative is inherent in the USACE discretion and authority to operate the System for its purposes under the Flood Control Act of 1944. Implementation of the test flow outlined in the preferred alternative would occur through a Master Manual deviation request that would be coordinated through biannual Missouri River Basin Water Management public meetings. This ensures the test flow is incorporated in the Annual Operating Plan and the public is informed. This EIS serves as the NEPA compliance process for this potential deviation.

The USACE is currently conducting an expert elicitation with scenario analyses to assist with the development of an implementation strategy for the Preferred Alternative. The purpose of the elicitation is to obtain critical input to an implementation plan that would optimize the use of 3 to 5 test flows to assess recruitment hypotheses on the UMR below Fort Peck Dam. The elicitations are employing the alternative description in the EIS along with the best available science and the governance processes in the SAMP to explore the range of plausible scenarios involving test flows. A focus of the effort is to provide clarity for all parties, including stakeholders, on how information will be used in decision-making regarding test flow implementation, adaptation, and determinations of success or failure. The process will document the monitoring, modeling, and analyses needed to provide decision-relevant information, characterize the lines-of-evidence and decision criteria employed to evaluate hypotheses, and describe expected outcomes and contingency plans. This effort will be finalized and incorporated into the test flow monitoring design prior to implementation of a test flow.

COORDINATION WITH TRIBAL NATIONS, AGENCIES, and the PUBLIC

The USACE conducted public scoping meetings at Fort Peck, Montana on February 19, 2019, and Williston, North Dakota on February 20, 2019, to solicit public input in the FPDTR-EIS process. The dates, times, and locations of the public scoping meetings were announced in the Notice of Intent, published in the Federal Register on February 8, 2019, and issued in a press release from the Omaha District Public Affairs Office on February 5, 2019.

Members of the public were invited to submit questions and comments in-person at the scoping meetings, by mail, or email. The comment period was open from February 8, 2019, through March 26, 2019, during which approximately 50 correspondences were received. The content of comments and responses are summarized in the Scoping Summary Report (Appendix G).

Public meetings were also held during the Draft EIS comment period, and comments and responses are included in Appendix G of the Final EIS. Approximately 70 correspondences were received during the public comment period on the Draft EIS which was open from March 26, 2021 to May 25, 2021.

In addition, USACE has coordinated extensively with the Missouri River Recovery Implementation Committee (MRRIC), an interdisciplinary group charged by Congress with making recommendations and providing guidance on a long-term study of the Missouri River and its tributaries and on the existing Missouri River recovery and mitigation plan. The committee was established by the Secretary of the Army in 2008, as authorized by Section 5018 of the 2007 Water Resources Development Act (WRDA). The committee is intended to help guide the prioritization, implementation, monitoring, evaluation, and adaptation of recovery actions while representing a broad array of interests. MRRIC is comprised of nearly 70 representatives of Tribal, local, state, and federal interests throughout the Missouri River Basin. The MRRIC is the primary venue for interacting with MRRP stakeholders, agencies, and Tribes. A list of MRRIC members can be found at https://www.nwo.usace.army.mil/mrrp/mrric/.

MRRIC made several substantive recommendations related to the FPDTR-EIS process in a July 3, 2019 letter transmitting MRRIC consensus recommendations to the USACE and USFWS. The full MRRIC recommendations and USACE responses are provided in Appendix J.

In addition to working with Tribes through the MRRIC process, the USACE sent letters to basin Tribes on February 6, 2019, advising of the purpose of this EIS and inviting them to attend the scoping meetings. At the request of the Fort Peck Tribe, an additional scoping meeting was held in the Tribal Chambers on February 20, 2019. Letters were sent to the Tribes again in July of 2019, offering Government to Government consultation on the EIS process. Another letter was sent to basin Tribes on August 9, 2019, offering consultation under Section 106 of the National Historic Preservation Act. The USACE visited Fort Peck Tribe representatives to tour the Tribe’s two irrigation intake sites on two occasions. These two intakes were included in ground surveys completed in the summer of 2020 and were analyzed in the irrigation impact analysis. The USACE and USFWS also conducted a formal consultation meeting with the Fort Peck Tribes on August 13, 2021.

REMAINING UNCERTAINTIES AND STAKEHOLDER CONCERNS

MRRIC, the MRRP Independent Science Advisory Panel (via a voluntary IEPR), tribes, agencies, stakeholders other than MRRIC, and the public have raised concerns over various aspects of the EIS, including:

- the use of conditions for a 1930/31-2012 Period of Record as the basis for hydrological modeling and derived implications for the Federal endangered species and for impacts to human considerations. This does not take into direct account recent years of extreme high flows, nor climate change that may be responsible for these recent extreme events and could cause future deviations from the historical record. (USACE conducted sensitivity analyses using 2011-2020 flows to partially address this concern).
- the accuracy and reliability of numerical models used to assess the potential effects and impacts of the proposed test releases. Similar concerns were raised over the adequacy of the methods and models for integrating risk and uncertainty when assessing the contribution of test releases to the species management objectives and in characterizing their impacts on human-use considerations. (USACE maintains that all models and modeling techniques used for the study reflect the best standards of professional practice. Moreover, USACE policy requires the use of certified or approved models for all planning studies. All models used for the EIS are certified and have undergone external technical review);
- the need for an effective monitoring program for pallid sturgeon or for the ongoing development of monitoring adequate to pick up a signal of the performance of the test releases that define the preferred alternative. (USACE agrees on the importance of this need and is in the process of developing such a program within budgetary limits);
- the frequency and opportunity for test flow management, which modeling shows could occur only in relatively rare events, a result of the highly constrained nature of operations on the System. More generally, concerns were raised over whether there is sufficient leeway for designing and implementing effective test flows for the pallid sturgeon in the

UMR within a decision-space constrained by the current level of human uses. (USACE concurs that these are risks);

- the degree of net farm income and farm employment losses resulting from potential effects on the side channel irrigation intakes caused by the test flows; because of complexities raised by recent changes in irrigation and by high-flow events, some question whether the magnitude of the damages to these interests have been over-stated, whereas others feel that these damage estimates demonstrate that effects to irrigation interests are potentially unacceptably high; and
- limited data for the purpose of estimating effects on cultural resources.

Sources of uncertainty are identified in the EIS. The ability of the test flows to attract, hold, condition, and aggregate pallid sturgeon such that they successfully spawn immediately below Fort Peck Dam remains a significant uncertainty. While confidence in the ability of the advection/dispersion models to simulate dispersal is high, resulting recruitment is a function of several factors (weather and water temperatures, predation and other sources of mortality, etc.) that are highly variable, difficult to quantify, or otherwise uncertain.

The USACE is working to develop an experimental design with appropriate metrics, criteria, and contingency plans. It is anticipated that three to five test flows might be required to assess the hypotheses, but the schedule and time required cannot be determined because a test flow can only occur when basin storage and runoff conditions meet requirements. Implementation of test flows would employ the MRRP governance described in the SAMP; an intent to proceed with a test flow would be identified in the strategic plan, but actual implementation would occur only when conditions permit, which could be the following year or not until several years later.

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1.0 Purpose and Need

1.1 Introduction

This Environmental Impact Statement (EIS) assesses the potential impacts of a range of test flow release alternatives out of Fort Peck Dam designed to test hypotheses related to recruitment of pallid sturgeon and fulfill the Corps' commitment in the 2018 Biological Opinion (BiOp) to examine test flows from Fort Peck Dam. This Chapter describes the purpose and need for developing test flows out of Fort Peck Dam, the scope of the test flows, and the relevant background information on the Missouri River Mainstem Reservoir System (System), past Endangered Species Act (ESA) consultation associated with the System and Bank Stabilization and Navigation Project (BSNP), the Missouri River Recovery Program (MRRP), and other information relevant to understanding the potential federal actions described in this EIS.

USACE has responsibility for the operation and maintenance of the System, including Fort Peck Dam in Montana and five dams and reservoirs on the mainstem of the Missouri River in North Dakota, South Dakota, and Nebraska. USACE operates the System for the Congressionally authorized project purposes of flood control, navigation, irrigation, hydropower, water supply, water quality, recreation, and fish and wildlife. Authorization for the construction and operation of the projects can be found in the following legislation: the Rivers and Harbors Act of 1935, the Fort Peck Power Act of 1938, and the Flood Control Act of 1944. The operation of the System is guided by the Missouri River Mainstem Reservoir System Master Water Control Manual (Master Manual 2006). Compliance with the ESA is required to continue to operate and maintain the System.

This EIS fully addresses the potential impacts of alternatives as required under the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code (USC) 4321 et seq.); Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations (CFR) 1500–1508); and USACE Engineer Regulation (ER) 200-2-2 (33 CFR 230). The alternatives assessed in this EIS may supply a feedback loop of data and information to an Adaptive Management (AM) program that was developed in 2018 (USACE, 2018a).

1.2 Background

In the January 19, 2018 amendment to the October 30, 2017 Biological Assessment (BA) for the operation of the System, the Operation and Maintenance of the BSNP, the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan (MRRMP), the U.S. Army Corps of Engineers (USACE) proposed to work with the U.S. Fish and Wildlife Service (USFWS) and the Missouri River Recovery Implementation Committee (MRRIC) "to review previous information and information generated since the Effects Analysis to formulate test flow releases from Fort Peck Dam and an adaptive management (AM) framework for their implementation." This commitment was relied on by the USFWS in its 2018 Biological Opinion (BiOp) finding that the USACE's Proposed Action is 'not likely to jeopardize' pallid sturgeon (*Scaphyrinchus albus*) under the Endangered Species Act (ESA).

The USFWS provided direction and guidance for the benefit of pallid sturgeon in the form of a fundamental objective and two sub-objectives (USFWS, 2018). The fundamental objective for pallid sturgeon is to keep actions from jeopardizing their continued existence in the Missouri River. Sub-objectives are to 1) increase recruitment of pallid sturgeon to age-1 and 2) maintain or increase numbers of pallid sturgeon as an interim measure until sufficient and sustained natural recruitment occurs. The Fort Peck AM Framework (provided in Appendix H) was developed to provide a structured process through which substantive decisions regarding the appropriate role of Fort Peck Dam operations and other management actions to support UMR (UMR) pallid sturgeon can be made and may be adjusted over time as new information is obtained. The AM Framework is a collaborative effort led by the Missouri River Recovery Program (MRRP)'s AM Technical Team, with significant contributions from the USFWS and MRRIC working groups, and review and input from pallid sturgeon experts representing regionally appropriate perspectives. In fulfilling the obligation to develop the AM Framework, the USACE is now poised to address actions for developing and evaluating flows out of Fort Peck Dam related to pallid sturgeon recruitment in the UMR from Fort Peck Dam downstream to Lake Sakakawea (Figure 1-1). Test flows target the demographic unit of pallid sturgeon found in west-central Montana on the UMR between Fort Peck Dam and Lake Sakakawea and on the lower Yellowstone River. Fort Peck Dam, located at Missouri River Mile (RM) 1772, limits upstream migration of adult pallid sturgeon while the Lake Sakakawea headwaters (approximately RM 1500) limit downstream dispersal of larval pallid sturgeon. The effects of implementing test flows were evaluated from Fort Peck Lake downstream to Gavins Point Dam on the South Dakota/Nebraska border at RM 811.

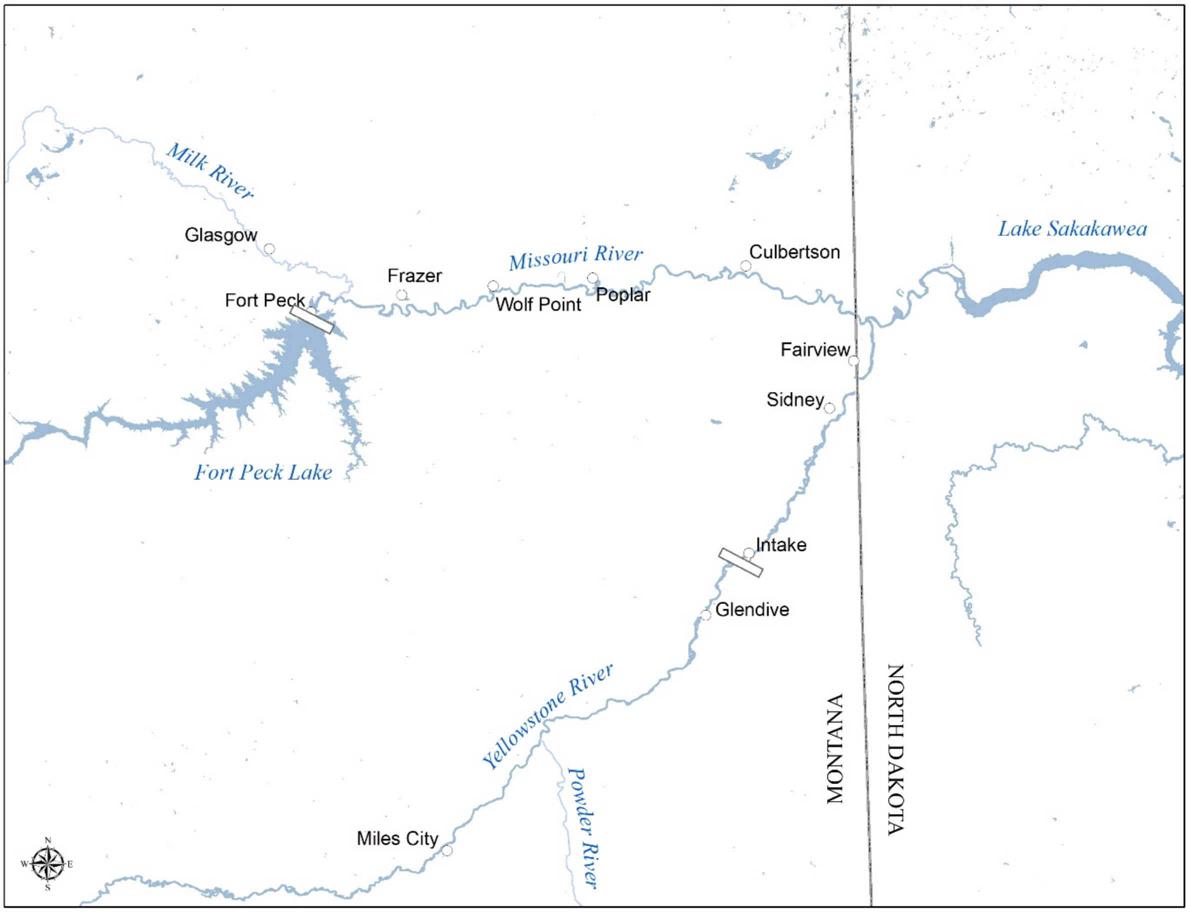


Figure 1-1. UMR from Fort Peck Lake Dam to Lake Sakakawea

The pallid sturgeon is a large, long-lived benthic (i.e., bottom-dwelling) fish that inhabits the turbid, fast-flowing rivers of the Missouri and Mississippi River basins (Figure 1-2). Population declines led the USFWS to list pallid sturgeon as endangered in 1990 under the ESA. USACE reinitiated consultation with the USFWS under the ESA in 2015 as part of the MRRMP-EIS process. A Final BA was submitted to the USFWS on October 30, 2017, and amended on January 19, 2018, and a new Final BiOp was issued by USFWS on April 13, 2018. The preferred alternative identified in the MRRMP-EIS incorporates the Proposed Action from the 2017 BA (as amended) which includes development of test flow releases from Fort Peck Dam. The consultation history for the pallid sturgeon is further summarized in Section 1.7.

Figure 1-2. Upper Missouri River Pallid Sturgeon (photo credit USGS, 2018)

An [2013-2016] Effects Analysis (EA) was performed to compile the best available science and knowledge to date and provide a science-based foundation to evaluate the effects of management actions hypothesized to benefit pallid sturgeon. The EA revised and refined conceptual ecological models for linking management actions to pallid sturgeon population dynamics, and the models comprise a global set of hypotheses and are intended to be used as a foundation for AM of pallid sturgeon populations in the Missouri River (Jacobson et al., 2016). Using the EA as the best available science and knowledge base, the USACE prepared a BA to analyze the effects of its actions for operating the System, concluding that significant knowledge gaps were limiting the ability to determine how ongoing and future management actions may effect pallid sturgeon populations (USACE, 2017). To address uncertainties, a rigorous and progressive Science and Adaptive Management Plan (SAMP) was developed as the most effective, efficient, and accountable way to manage risk to pallid sturgeon and reduce uncertainties around effects of management actions (USACE, 2018).

In their 2018 BiOp, the USFWS considered the existing knowledge base and critical uncertainties about pallid sturgeon, condition of pallid sturgeon in the study area, habitat and flow conditions, and commitment by USACE to implement the SAMP to reduce key uncertainties about how pallid sturgeon will respond to management actions. Based on the analysis in the 2018 BiOp, the USFWS concluded that the action proposed by USACE, including implementing the SAMP, will not jeopardize the continued existence of the pallid sturgeon, piping plover, and interior least tern and will not destroy or adversely modify designated critical habitat for the piping plover (USFWS, 2018). Therefore, this EIS addresses the hypotheses and key uncertainties identified in the SAMP for reducing uncertainty about the effects of test flows from Fort Peck Dam to benefit spawning and recruitment of pallid sturgeon between Fort Peck Dam and Lake Sakakawea.

The present distribution of pallid sturgeon as described in the recovery plan (USFWS, 2014) indicates that wild pallid sturgeon have been documented in the Missouri River between Fort Benton and the headwaters of Fort Peck Reservoir, Montana; downstream from Fort Peck Dam, Montana to the headwaters of Lake Sakakawea, North Dakota; downstream from Garrison Dam, North Dakota to the headwaters of Lake Oahe, South Dakota; from Oahe Dam downstream to within Lake Sharpe, South Dakota; between Fort Randall and Gavins Point Dams, South Dakota and Nebraska; downstream from Gavins Point Dam to St. Louis, Missouri; in the lower Milk and Yellowstone rivers, Montana and North Dakota; the lower James and Big Sioux rivers, South Dakota; the lower Platte and Niobrara rivers, Nebraska; and the lower Kansas River, Kansas.

There is a remnant population of wild, large and fully mature adult pallid sturgeon (158 individuals estimated in 2004; 85-112 individuals estimated in 2016) in the study reach between Fort Peck Dam and Lake Sakakawea that are believed to be survivors since the dams were constructed, and are nearing their life expectancy age. These fish are classified as part of the Great Plains Management Unit (GPMU) population, and have access to the Yellowstone River as the major tributary river in the study reach. The GPMU population is isolated by dams and reservoirs, with little to no evidence of sustainable reproduction and recruitment occurring. While the number of wild pallid sturgeon in the GPMU are declining due to age, 245-249 young hatchery-reared pallid sturgeon have been stocked from 1998 through May of 2016 (USFWS, 2018) as an interim measure to sustain the population. It is estimated that 43,012 of the stocked fish from 1998-2013 were still alive in 2013 and reaching the age of reproductive maturity (94% were between age 3 and 8) when spawning is likely (USACE, 2017). Rotella (2017) updated this population estimate to 16,444 (95% confidence interval (CI), 12,138-20,759) surviving pallid sturgeon through May of 2016. However, Rotella (2017) noted that a shift in sampling gears that likely led to fewer pallid sturgeon recaptures and pit tag loss leading to false negative recapture data may have occurred as a partial explanation for the differing population estimates.

Adult pallid sturgeon are believed to be cued by rising flows in the spring to migrate upstream for spawning. Males and females congregate in spawning habitats and are believed to begin spawning during periods of high flow. Developing[1] pallid sturgeon require 8-14 days of

[1] See Glossary for terms used to describe pallid sturgeon age and development.

downstream drift for growth and development before settling out of the drift and transitioning to a benthic life stage. Drifting larval pallid sturgeon rely on energy derived from their embryonic yolk sac for growth and development, but must transition to external feeding during a critical period for survival as the yolk sac reserve is depleted. If drifting pallid sturgeon reach Lake Sakakawea before sufficient musculoskeletal and fin structure development to support active locomotion and movement for habitat selection, they may settle out into the hypoxic zone (near-bottom sediments of reservoir) and suffer mortality due to lack of oxygen (Bramblett and Scholl, 2015). Model estimates of drift time available for pallid sturgeon in the study reach range from about 6.5 days (Erwin et al., 2018) to 37.4 days (Marotz & Lorang, 2017), suggesting that management of flows may provide opportunity to improve recruitment of pallid sturgeon in the study reach if drift development time is a limiting factor.

1.3 Purpose of the Action

The purpose of the Fort Peck Test Flows is to evaluate the potential for achieving pallid sturgeon spawning and recruitment on the UMR using periodic Fort Peck Dam releases that better replicate historical flows and temperatures. The SAMP envisioned introducing new actions as required to achieve the MRRMP objectives. Flow modifications at Fort Peck Dam were identified as a potential action for avoiding jeopardy to the continued existence of pallid sturgeon on the UMR. Pursuant to the 2018 BiOp, the USACE is evaluating whether flow modifications at Fort Peck can improve pallid sturgeon spawning and recruitment. Implementing a limited number of test flows under an adaptive management framework allows the USACE to address critical uncertainties, better assess need, and refine potential actions (if needed) to enhance performance relative to the authorized purposes and their ESA obligations.

Science and learning is fundamental in the approach recommended by the USFWS in the 2018 BiOp to avoid jeopardizing the continued existence of pallid sturgeon in the Missouri River. Therefore, prioritizing hypotheses related to test flows out of Fork Peck Dam would provide data that informs the AM process and guide the direction of science (i.e., hypothesis testing) as specified in the SAMP and Fort Peck AM Framework to promote learning and to potentially provide benefits to pallid sturgeon. The objectives provided in Section 1.4 further describe the intended purpose of the action.

1.4 Need for the Action

The ESA requires that operation and maintenance of the System do not jeopardize the continued existence of endangered species or result in the destruction or adverse modification of designated critical habitat. Alteration of the ecosystem and loss of habitat due to USACE operation of the System and operation and maintenance of the BSNP have contributed to the ESA listing of the pallid sturgeon. Compliance with the ESA is required to continue to operate the System and operate and maintain the BSNP. In 2004, an estimated 158 wild adult pallid sturgeon were reported to remain in the population from Fort Peck Dam to the headwaters of Lake Sakakawea, including the Yellowstone River (USACE, 2017, p. 133; Klungle & Baxter, 2005). Jaeger et al. (2009) estimated approximately 125 wild adult pallid sturgeon remain within this reach. The remaining wild adults were estimated to be 43-57 years old (i.e., fish spawned before Lake Sakakawea was filled in the 1950s); (USACE, 2017, p. 133; Braaten et al., 2015b). The number of wild fish is slowly declining due to age, but thousands of hatchery-reared fish are reaching the age where spawning is likely. Maintenance of the species currently relies on artificial propagation and stocking.

The USFWS determined in the 2018 BiOp that effects of the USACE's System Operations in the UMR are potentially negatively impacting the pallid sturgeon's ability to recruit due to 1) altered water temperatures, 2) altered flow regime, and 3) altered sediment regime and turbidity as a result of the construction of the water management system and its ongoing operational hydrograph (USFWS, 2018). Currently there is no known natural recruitment in either the Yellowstone or Missouri Rivers above Lake Sakakawea despite evidence of successful spawning.

Pursuant to the 2018 BiOp, there is a need to prioritize hypotheses related to flows out of Fort Peck Dam to determine whether conditions can be developed to benefit pallid sturgeon recruitment. There is also a need to determine if there are hydrograph conditions that can be provided to maximize pallid sturgeon larval drift distance and/or time to promote growth and survival to free swimming juvenile stage before settling out in the headwaters of Lake Sakakawea.

1.5 Objectives and Constraints

The 2018 BiOp provided an overall fundamental objective and two sub-objectives to guide the purpose and need for evaluating flow modification hypotheses to benefit pallid sturgeon, and the Fort Peck AM Framework provided the active link to the 2018 SAMP with oversight to ensure hypotheses are reflecting the best available science and current knowledge. The fundamental objective for pallid sturgeon is to keep actions from jeopardizing the continued existence of the species in the Missouri River. Sub-objectives are to 1) increase recruitment of pallid sturgeon to age-1 and 2) maintain or increase numbers of adult pallid sturgeon as an interim measure until sufficient and sustained natural recruitment occurs.

1.5.1 Objectives

The hypotheses identified in the AM Framework supported by the SAMP (see Section 1.5 below for description of relationships among documents and advancement of hypotheses addressed in this EIS) were formed around pallid sturgeon reproductive behavior and separated into four biologically relevant phases of the hydrograph to address reproduction and recruitment. The hypotheses from the SAMP and AM Framework driving this EIS are driven by questions about spawning cues and drift dynamics. Because reproductively mature pallid sturgeon migrate upstream during spring attracted by increasing flows, the question asked is can spring pulsed flows from Fort Peck Dam synchronize reproductive fish in space and time to increase chances of reproduction and recruitment. This question serves as the basis for a hypothesis in this EIS (labeled H2 in SAMP and AM Framework):

> **Hypothesis** H2: Attractant flow releases at Fort Peck will result in increased reproductive success through increased aggregation and spawning success of adults.

Newly compiled information in the AM Framework (see: Pat Braaten, U.S. Geological Survey, unpublished data) documents consistent movements of fish upstream on the UMR in spring and early summer when discharge on the UMR is approximately twice that of the Yellowstone River. This doubled discharge criterion was used therefore as an estimate of an initial attractant flow. Once attracted upstream, appropriate flows should be designed to retain (or hold) the fish near the spawning area before a second flow cues the aggregation of mature males and females to facilitate spawning. Typical early-spring flows in the UMR are 8,000 cubic feet per second (cfs) followed by a March-April peak flow of 16,000 cfs. The Technical Team working on the AM Framework hypothesized that the attractant pulse would be more effective if moved later in the month of April when it will compete less with the Yellowstone River March-April pulse. The May-June pulse is hypothesized to be important in retaining fish upstream in the UMR and to contribute to a spawning cue. An empirical basis for understanding spawning cues is lacking, including how flow functions with or without associated variation in temperature and turbidity (DeLonay et al 2016, Jacobson et al 2016). Two relevant pieces of information are an apparent water temperature threshold for pallid sturgeon spawning of 16°C (DeLonay et al 2016) and the tendency for fish to spawn on the receding limb of the May-June pulse (Carrie Elliott, U.S. Geological Survey, unpublished data). With respect to the latter, 10 verified pallid sturgeon spawning events on the Yellowstone River have ranged 0 to 24 days post peak, with an average of 12.1 days. The conditions that "cue" spawning, therefore, are hypothesized to be a receding flow when water temperatures are in excess of 16 °C.

Finally, fertilized eggs undergo a period of downstream drift migration with lower flows on the receding limb of the hydrograph to minimize flow velocities and maximize drift time as they develop and grow into larvae (Figure 1-3). The question asked from the SAMP, AM Framework, and finally in this EIS focused on drift dynamics is can flow manipulation from Fort Peck Dam increase probability of successful dispersal of free embryos and retention of exogenously feeding lavae. This question serves as the basis for a hypothesis in this EIS (labeled H2 in SAMP and AM Framework):

> **<u>Hypothesis</u>** H3: Reduction of mainstem Missouri flows from Fort Peck Dam during free-embryo dispersal will decrease mainstem velocities and drift distance thereby decreasing mortality by decreasing number of free embryos transported into headwaters of Lake Sakakawea.

An additional management control to manipulate flow conditions towards improving chances of reproduction and recruitment is use of the emergency spillway to release surface water that is warmer than the releases through the hydropower facility. The question from the SAMP and AM Framework is whether water-temperature manipulations at fort Peck contribute significantly to increased chance of reproduction and recruitment. The question serves as the basis for a hypothesis in this EIS (labeled H5 in SAMP and AM Framework):

> **<u>Hypothesis</u>** H5: Warmer flow releases from Fort Peck Dam will increase growth rates, shorten drift distance, and decrease mortality by decreasing free embryos transported into headwater of Lake Sakakawea.

In summary, the objective of the Fort Peck Dam test flows EIS are to investigate the capacity of Fort Peck Dam flow releases to test these hypotheses that flows will:

- **Attract**: trigger upstream spawning migration and attract pallid sturgeon up the Missouri River,
- **Retain**: hold pallid sturgeon upstream near spawning areas,
- **Aggregate and Spawn**: signal aggregation and spawning of reproductively ready pallid sturgeon,
- **Drift**: provide conditions for survival of drifting larval pallid sturgeon.

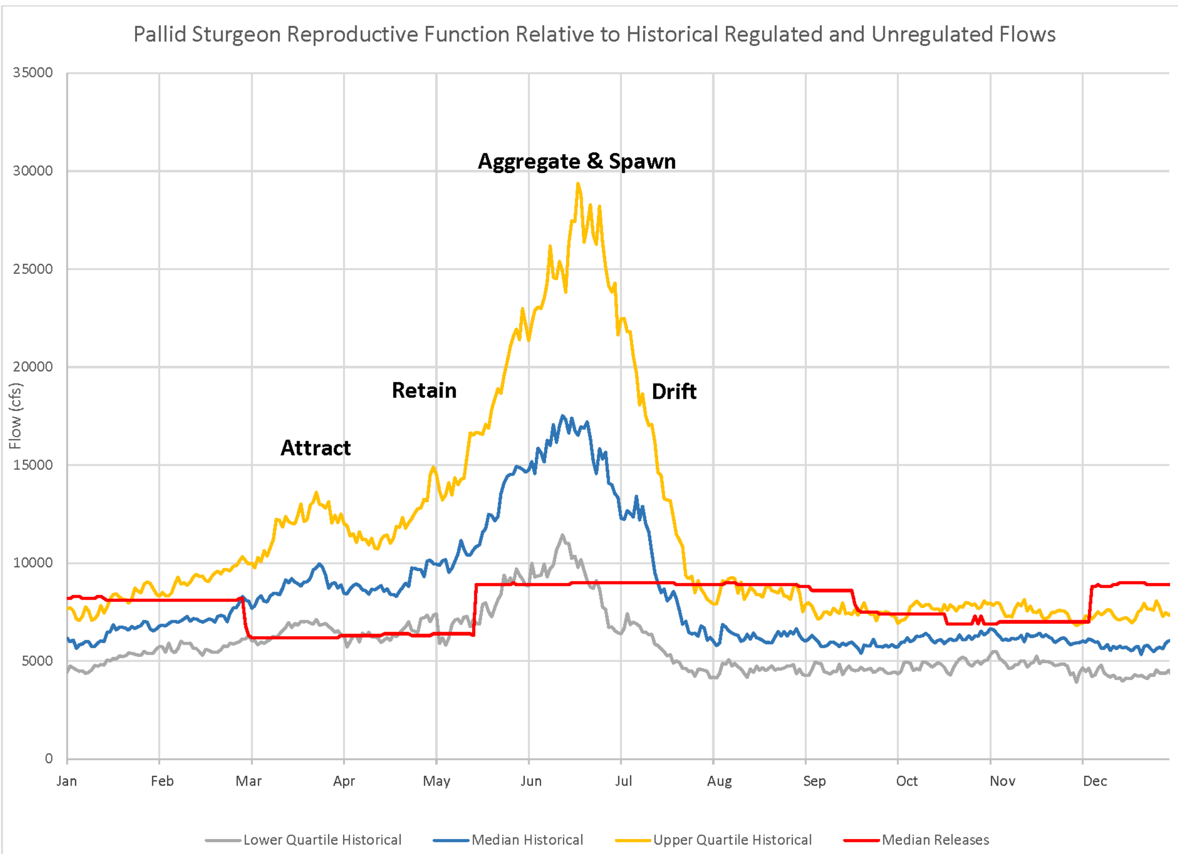


Figure 1-3. Pallid sturgeon reproductive functions relative to historical regulated and unregulated flows at Fort Peck Dam

1.5.2 Constraints

The range of alternatives were developed in light of a suite of planning constraints that were determined during the scoping phase of the study. Constraints help to define the range of or intensity of measures selected to build alternatives, and often reflect sensitive issues or represent critical thresholds to minimize or avoid negatively impacting resources identified as important. The constraints for the Fort Peck Dam test release flows were focused around avoiding or minimizing biological and Human Consideration impacts, and were informed by stakeholder input during several meetings. It should be noted that competing actions and uses of the Missouri River may limit the availability of future management actions for the pallid sturgeon. Although other competing actions and uses may limit future actions for the pallid sturgeon, the agencies believe that adaptive management continues to be the best path forward for endangered species management on the Missouri River – hence the high level of effort the agencies (and MRRIC) have expended in designing a progressive SAMP and the Fort Peck Adaptive Management Framework. Limited implementation, monitoring, and assessment of flow management actions on a test basis under an AM framework provides a useful mechanism to address concerns that my become constraints. The structure of the SAMP and Fort Peck AM Framework allows for revisions of actions, and new actions if those specified are insufficient after they are implemented.

Yellowstone River Fish Passage – Intake Diversion Dam

The BiOp requires the consideration of activities on the Yellowstone River to benefit pallid sturgeon during the planning, design, and implementation of Fort Peck Dam test release flows. Actions at Yellowstone Intake include a bypass channel providing passage at Intake Diversion Dam to protect and restore pallid sturgeon populations. By providing passage at Intake Diversion Dam, approximately 165 river miles of potential spawning and larval drift habitat would become accessible in the Yellowstone River.

Flood Targets

The Master Manual does not contain specific flood limit targets (the estimated discharge when flood damages begin) below Fort Peck (USACE, 2018). Therefore to address concerns raised during scoping, maximum flow and/or stage limits (flood targets) were set at various locations downstream of Fort Peck to avoid potentially increasing flood damages during periods of high flow of a test release (i.e., attract, retain, aggregate and spawn). A 14-day forecast of releases and stream flows will inform decisions during the test flow. The flood targets for flows and stages were modeled with the same criteria for each alternative. The aim of each was to limit and minimize any potential impacts due to flooding based on forecasted in-river flows at the Wolf Point, MT and Culbertson, MT gage stations, and high stages at Williston, ND. The flood target at Wolf Point and Culbertson was set to 35,000 cubic feet per second (cfs). Two flood targets were specified near Williston, ND: an upstream and downstream flood target. A maximum stage of 22.0 feet, which is equal to the National Weather Service (NWS) flood stage at Williston, ND, was used for the upstream flood target. The downstream flood target was a water surface elevation of 1853.5 feet above mean sea level (msl), which was based on a water surface elevation that would not increase seepage risk for the Williston levee. See the Alternatives sections in Chapter 2 of this EIS for further details. A 14-day forecast that would lead to exceeding any of these flood targets would trigger a decision process for determining whether to continue with the test flow, or to shut off all or parts of the test flow resulting in a partial test flow release that addresses zero to four of the hydrograph phase objectives. For example, it would be possible to shut off flow releases during the attraction, retention, and/or spawning phase due to exceeding a flood target yet still implement the drift phase of the flow releases, resulting in a partial test flow release that provides opportunity to evaluate the drift phase of the hydrograph to address the drift objective. Opportunities exist to learn from the drift phase if test flows were shut off earlier the same season due to exceeding constraints. These include experimental actions such as a Drift Study similar to an event conducted during 2019 with experimental release of negatively buoyant particles, colored dye, or actual live larvae provided by a hatchery to mimic drifting sturgeon larvae spawned in the wild. Additional opportunities to learn exist during partial flow years by monitoring and sampling abiotic variables such as water velocity and water temperature to populate drift and growth modeling efforts. Finally, the catch of age-1 (or age 1+t) pallid sturgeon the following year(s) may provide data useful to learning about the partial flow year.

Flow Rate of Change

Rapidly decreasing flow releases have potential to result in damaging stream bank instability. Therefore, the maximum flow release reduction rate of change (ROC) has been limited to 3,000 cfs per day to reduce the potential for bank instability. The limit on ROC will be most relevant during the receding limb of the test flow hydrograph during the larval drift period, however, the limit would apply during any active phase of a test flow. Opportunities exist to learn from the drift phase if test flows were shut off earlier the same season due to exceeding constraints. These include experimental actions such as a Drift Study similar to an event conducted during 2019 with experimental release of negatively buoyant particles, colored dye, or actual live larvae provided by a hatchery to mimic drifting sturgeon larvae spawned in the wild. Additional opportunities to learn exist during partial flow years by monitoring and sampling abiotic variables such as water velocity and water temperature to populate drift and growth modeling efforts. Finally, the catch of age-1 (or age 1+t) pallid sturgeon the following year(s) may provide data useful to learning about the partial flow year.

Minimum Flow Release

A minimum in-river flow of 8,000 cfs measured at the Wolf Point, MT gage (51 miles downstream of the Milk River confluence, see Section 1.6) was established in years that a test flow would be implemented to avoid potential impacts for M&I and irrigation water intakes during the pallid sturgeon larvae drift period and irrigation season. Representatives from Fort Peck Dam's hydropower facility indicated that impacts to power production may occur at a flow release rate of 4,000 cfs, but would not likely occur at 8,000 cfs. Because it is possible that a test flow could be initiated and then stopped (e.g., see flood target constraint above), USACE and representatives from hydropower marketers and users agreed that the target minimum flow would still be 8,000 cfs, but that the minimum flow through Fort Peck Dam for power generation would follow the No Action alternative condition of 6,400 cfs. The 8,000 cfs minimum in-river flow target may also support the pallid sturgeon larval drift goal of maximizing drift time for growth and development because lower minimum flow release targets (e.g., 4,000 cfs) could reduce the opportunity for drifting larval sturgeon to access and utilize channel margin habitat areas which could extend the downstream migration pathway. By concentrating flows in the lowest part of the river channel, extreme lower flow releases during the drift phase could accelerate the downstream migration and effectively shorten the drift phase and reduce the time available for larval sturgeon development before reaching the head waters of Lake Sakakawea.

Therefore, to avoid potential impacts to water intakes and hydropower production, and support opportunity for increased drift time of larval pallid sturgeon, a minimum in-river flow target at the Wolf Point, MT gage was set at 8,000 cfs with a minimum 6,400 cfs discharge from Fort Peck Dam during years that a test flow was initiated and stopped prior to completion. To summarize intended operation to meet minimum flows, when test flow release is at or below the powerhouse capacity (maximum of 14,000 cfs), all flow releases will be through the powerhouse. During the minimum flow period of the alternative, powerhouse releases will be adjusted to provide a minimum of 8,000 cfs at Wolf Point. However, powerhouse releases will not be dropped below 6,400 cfs regardless of the Milk River inflow (unless an extreme event is occurring at which point the alternative test release would be stopped). In some cases, Milk River inflow above 1,600 cfs could result in flows higher than 8,000 cfs at Wolf Point while meeting the 6,400 cfs powerhouse minimum.

1.6 Scope of the Environmental Impact Statement

This EIS assesses the effects of alternatives for implementing test flows from Fort Peck Dam to potentially benefit pallid sturgeon as an action to avoid jeopardizing the continued existence of the species. This document provides the necessary information for the decision maker to fully evaluate a range of alternatives to best meet the purpose and need. It fully addresses the potential impacts of alternatives as required under the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code (USC) 4321 et seq.); Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations (CFR) 1500–1508); and USACE Engineer Regulation (ER) 200-2-2 (33 CFR 230).

The alternatives assessed in this EIS would supply a feedback loop of data and information to an AM program that was developed as part of the 2018 MRRMP-EIS (USACE, 2018a). The MRRMP-EIS is supported by the SAMP (USACE, 2018a) which provides a list of hypotheses to address scientific uncertainty associated with pallid sturgeon. Adaptive management copes with uncertainty through implementation while acknowledging concerns about the effectiveness of the course of action. Progress towards reducing uncertainty can be expected through iterative application of learning and adjustment. Adaptive management leads to a better understanding of the resource or system, which in turn leads to improvements in management decisions and their results over time. Because it is reasonable to anticipate the effectiveness of some actions may be limited due to Human Considerations and constraints (see Section 1.4.2 above), the SAMP and Fort Peck AM Framework is structured to allow revisions of actions or new actions to address insufficient success of actions after they were implemented. Further, if a hypothesis is rejected, the SAMP and Fort Peck AM Framework is networked to use this learned information and proceed towards other learning actions (e.g., test hypotheses) or towards more informed management decisions. Finally, the Fort Peck AM Framework (Appendix H) provides the necessary thread ensuring best available science, and current knowledge directly guides the development and assessment of the alternatives for test flows from Fort Peck Dam. It is important to note that management actions contemplated under the AM Framework are only able to be implemented after the necessary environmental compliance (e.g. NEPA) activities have occurred. This EIS for instance, provides the NEPA compliance only for test flows from Fort Peck Dam as described in Chapter 2.

The two primary and important purposes of the Fort Peck AM Framework were to 1) identify and sequence Level 1 and Level 2 science actions to address hypotheses listed in the SAMP to reduce uncertainty around pallid sturgeon recruitment in the UMR, and 2) assess the broader scope of science activities in the UMR related to pallid sturgeon life history.

The effects of implementing test flows were evaluated from Fort Peck Reservoir in Montana downstream to Gavins Point Dam in South Dakota. Below Gavins Point Dam, the hydrology modeling showed negligible changes. The effects of alternative test flows were modeled based on the 82-year period of record for Missouri River flows, and impact analyses on resources generally considered the potential effects over a 50-year planning horizon.

1.7 Fort Peck Dam and Reservoir

The Fort Peck project is located 19 miles southeast of Glasgow, Montana in McCone, Valley, Garfield, Phillips, Petroleum, and Fergus Counties in northeastern Montana. After closure of the dam in 1937, the resulting reservoir, Fort Peck Lake, began to fill, eventually covering 240,000 acres and storing 17,492,000 acre-feet of water at the maximum normal operating pool (elevation 2246 feet msl). Fort Peck Lake is the fifth largest man-made reservoir in the nation, with a typical length of 135 miles and width ranging from 2 to 5 miles. At maximum operating pool (2250 feet msl), the surface area of the pool covers 246,000 acres. Fort Peck Dam is 4 miles long, and 250 feet high at its highest point. The dam is located approximately 10 miles upstream from the confluence with the Milk River (Figure 1-4), and 1,772 miles upstream from the mouth of the Missouri River at the confluence with the Mississippi River. Fort Peck Dam is the world's oldest and largest hydraulically-filled earthen dam, is listed on the National Historic Register, and is under consideration for National Historic Landmark status. Fort Peck Dam was initially authorized by the 1935 Rivers and Harbors Act, with allowances for the possibility of future hydropower generation. The Fort Peck Act, approved May 18, 1935, authorized the completion of the dam, maintenance and operation of the dam, and hydropower generation. The Flood Control Act of 1944 authorized the construction of Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point dams, and administratively modified the operation of the Fort Peck Dam to incorporate it into the Missouri River main stem reservoir system operations. The main stem reservoir system is authorized for eight purposes including flood control, irrigation, fish and wildlife, navigation, water quality, water supply, recreation, and hydroelectric power. In 1986, the Water Resources Development Act (WRDA) authorized recreation as a specific project purpose at Fort Peck.

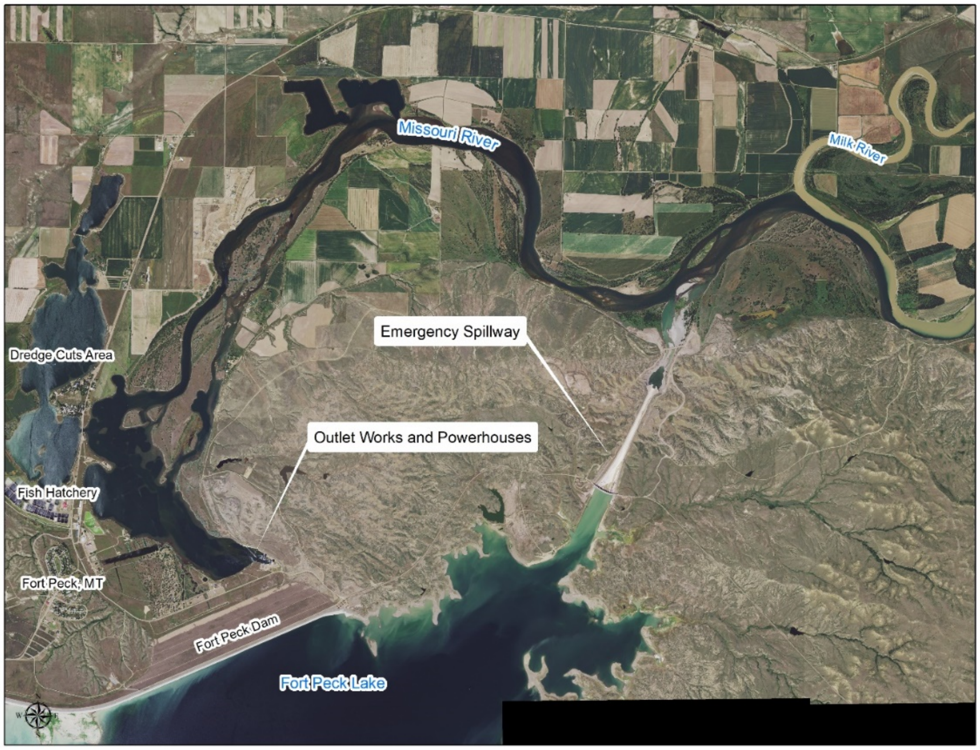


Figure 1-4. Fort Peck Dam area showing outlet works, power house, spillway, fish hatchery, and confluence of Missouri and Milk Rivers

The water intake gate to facilitate hydropower flow releases is located on the bottom of the reservoir immediately upstream from the dam. Flows released through the hydropower operation are hypolimnetic with high nutrient loading, low dissolved oxygen, and cold temperature. These flows support a cold water fishery in the tailrace areas below the dam, and provide appropriate water temperatures for operation of the State Fish Hatchery located immediately downstream of the dam. A secondary form of flow release is through the spillway gates and associated discharge channel. The spillway discharges reservoir surface water that is usually warmer than the flows discharged from the bottom of the reservoir during the spring and summer periods.

1.8 Endangered Species Act

1.8.1 Endangered Species Act Compliance and Consultation History

USACE has a responsibility under the ESA to take actions to ensure that its operation of the Missouri River projects are not likely to jeopardize the continued existence of threatened and endangered species or destroy or adversely modify designated critical habitat. In October of

2017, USACE provided a BA to USFWS pursuant to Section 7(a)(2) of the ESA as part of formal consultation for the Operation and Maintenance of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of the Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan. In January of 2018, USACE provided an amendment to that BA proposing to work with USFWS and MRRIC to review previous information and formulate test flow releases from Fort Peck Dam for the benefit of the pallid sturgeon and an AM framework for their implementation. Based on the Proposed Action described in the BA and its amendment, USFWS issued a 2018 BiOp with a finding that the USACE's Proposed Action is not likely to jeopardize the pallid sturgeon. This EIS is evaluating proposed alternatives for test flows out of Fort Peck Dam, as contemplated in the January 2018 amendment to the BA, for the benefit of pallid surgeon reproduction, in accordance with NEPA.

1.9 Missouri River Recovery Program

1.9.1 Missouri River Recovery Program and the Missouri River Recovery Implementation Committee

The MRRP was established by USACE in 2005 to enable USACE to operate the System in accordance with the Master Manual and to operate and maintain the BSNP to meet their authorized purposes while also complying with the ESA and other federal laws and regulations. The MRRP purpose is also to meet the objectives of the BSNP Fish and Wildlife Mitigation Program. It is the umbrella program that coordinates USACE efforts in the following:

- Compliance with the ESA in operation of its Missouri River Projects;
- Acquiring and developing lands to mitigate for lost habitats as authorized in Section 601(a) of WRDA 1986 and modified by Section 334(a) of WRDA 1999 (collectively known as the BSNP Fish and Wildlife Mitigation Project); and
- Implementation of WRDA 2007 including MRRIC and Section 3176, which allowed USACE to use recovery and mitigation funds in the upper basin states of Montana, Nebraska, North Dakota, and South Dakota.

The MRRP is a comprehensive, multi-district effort that ensures actions taken to meet USACE's legal obligations under the ESA are coordinated, scientifically sound, and cost-effective. Omaha and Kansas City Districts collaborate to use the best engineering and scientific practices, leverage resources and expertise, and share lessons learned across the program. Program aspects involving flow modifications and reservoir levels are coordinated with Northwestern Division's Missouri River Basin Water Management Division.

On July 1, 2008, the Assistant Secretary of the Army for Civil Works provided implementation guidance thereby adopting the MRRIC charter pursuant to congressional authorization set forth in WRDA 2007. The MRRIC makes recommendations and provides guidance to federal agencies on the existing MRRP. The MRRIC is composed of over 70 members representing various interests, Tribes, states, and agencies from within the Missouri River basin. MRRIC is the key basin stakeholder group engaged in the Fort Peck AM Framework process and the overall MRRP. MRRIC involvement in the process is further described in Chapter 5 of this EIS.

2.0 Alternatives

The National Environmental Policy Act requires federal agencies to evaluate and consider a range of alternatives that address the purpose of and need for action. This chapter describes the alternatives development process, modeling tools used in the process, and decision-making rationale used for this EIS. The No Action alternative and two action alternatives that were examined in detail are described. Initial alternatives that were considered but eliminated from detailed analysis are also discussed.

2.1 Alternative Development Process

Alternatives were informed by the current state of pallid sturgeon science as described in the MRRP Science and Adaptive Management Plan (USACE, 2018a), the associated 2018 BiOp (USFWS, 2018), and by the MRRP Pallid Sturgeon Technical Team (Technical Team) activities described below. Alternatives were also shaped by input received through the scoping process for this EIS and through MRRIC engagements. The MRRP Technical Team is a group of USACE, USFWS, USGS, state agency and other experts in pallid sturgeon ecology that provide technical support to the MRRP. It was tasked by the USACE to formulate test flow releases from Fort Peck Dam for pallid sturgeon and an adaptive management framework for their implementation. It was also asked to review information generated since the Effects Analysis and reprioritize Level 1 and Level 2 actions in the UMR as needed to reflect increased priority for a test flow release from Fort Peck Dam. As defined in the SAMP, Level 1 studies are research focused and do not change the System (laboratory studies or field studies under ambient conditions). Level 2 studies would focus on in-river testing of actions at a level sufficient to expect a measurable biological, behavioral, or physiological response in pallid sturgeon, surrogate species, or related habitat response. The test flow alternatives examined in this EIS are considered to be Level 2 actions that would test the efficacy of flow changes at Fort Peck Dam. The Technical Team undertook five primary activities related to this charge, as follows:

1. Design and preliminary analysis of conceptual hydrographs to learn more about hydrologic possibilities and their implications for frequency of occurrence, geophysical differences, and potential impacts to human considerations.

2. Design and populate effects pathway diagrams in order to organize what is known and what is uncertain about cause-effect relationships in a way that helps clarify key uncertainties for technical and communications purposes.
3. Conduct an expert survey to review technical priorities and opportunities for new actions. The survey gathered what a broader array of experts consider, on the weight of current evidence, to be the state of knowledge on limiting factors and biological needs.
4. Consolidate expert views and proposed modifications of Level 1 and Level 2 studies and aggregate the learning into a revised set of proposed studies.
5. Design an adaptive management implementation framework for Level 1 and Level 2 studies.

The Technical Team was tasked with developing hydrographs for testing recruitment of pallid sturgeon to age-1 on the UMR using the best scientific understanding of biological needs of the fish, recognizing that fish passage at Intake Dam on the Yellowstone River is imminent, and that management actions at Fort Peck should complement, but not detract from, potential for successful recruitment from passage at Intake on the Yellowstone River. The Technical Team formulated two hydrographs that could be used to test hypotheses. They are described below in Section 2.3. The conceptual hydrographs developed by the Technical Team were presented to the public during public scoping meetings held in February of 2019 and were ultimately modified based on scoping input and further analysis and assessment to form the alternatives examined in detail in this Draft EIS.

2.2 Models Supporting Alternatives Development and Analysis

The EIS employs two general classes of models; hydrologic, reservoir operations, hydraulics, water quality, and some economic analyses are conducted using industry-standard models developed by the Hydrologic Engineering Center (HEC), and the remaining models were purpose-built by technical experts using data from the Missouri River system. The USACE requires that all models used for planning be approved or certified, which requires robust documentation, testing, and independent review. All models used in the EIS have been approved or certified.

The Missouri River Mainstem Reservoir Simulation (ResSim) and RAS models have gone through extensive review and scrutiny through both a formal USACE review process and independent and public review. The models were approved for modeling operations of the

ResSim and routing flows and calculating corresponding stages (RAS). For ResSim, the criteria laid out in the Master Manual has not changed since implementation of the Missouri River Recovery Management Plan EIS selected alternative. For RAS, the calibration was updated for the Fort Peck test release EIS, but the underlying model components of the models did not change since implementation of the Missouri River Recovery Management Plan EIS selected alternative.

The HEC hydrologic software program suite was chosen based on: capability to model the large, complex river system, widespread use and acceptance both within and outside of the Corps of Engineers (transparency), compatibility with other HEC economic and ecological analysis software, thorough documentation, and availability of long-term technical support. HEC models are considered the industry standard and have widespread global use. All selected HEC models are also on the software list of models that have undergone extensive testing and are approved for use within USACE.

Other models used during this study were developed specifically for use on the Missouri River and parameterized using data from the Missouri River. All models have documentation that describes limitations and uncertainties. The uncertainty associated with the model outputs is not able to be fully quantified at this time. However, the limitations and uncertainties apply equally across the alternatives, permitting a reasonable comparison of the relative performance of alternatives, including the No Action alternative.

2.2.1 Hydrologic Engineering Center – Reservoir System Simulation Model

HEC-ResSim is a reservoir operations model developed by the USACE HEC. The model incorporates user defined rules with other conditions (i.e., inflow, pool elevation, and downstream flows) to determine reservoir outflow. The model also performs downstream hydrologic channel routing. Water managers, as well as water control manuals and other documentation, help in determining the rules necessary to simulate a reservoir within the model. The Missouri River mainstem HEC-ResSim model was developed and used to simulate System operation of historical flows during a period of record (POR) (1931-2012). Flow-related management actions or alternatives that include altering reservoir operations were simulated and compared to a simulation of current operations to assess effectiveness towards meeting species objectives and the effects on natural, social, cultural, and economic resources of interest. HEC-ResSim simulations provided pool elevations and regulated inflows and outflows of each of the mainstem projects for each alternative simulation. These data were used directly as input to impacts assessment models (i.e., HC models) and available HEC-RAS models that estimate inundation and discharges at locations on free-flowing reaches of the Missouri River.

The Missouri River mainstem HEC-ResSim model was simulated using a daily time interval. The modeling includes the mainstem Missouri River reservoirs and extends downstream to target gages on the lower river. This model is described in detail in Appendix D. To assist in providing context for how the proposed alternatives would change current operation, Section 3.2, River Infrastructure and Hydrologic Processes, includes a summary of mainstem System operations focusing on Fort Peck and Garrison Dams.

2.2.2 Hydrologic Engineering Center – River Analysis System Models

HEC-RAS is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels. Common outputs include stage, duration/timing of inundation, water velocities, flow areas/routes, water temperature, and sediment loads. Unsteady flow analysis was chosen as the method of hydraulic modeling due to the need to analyze time series stage and flow data. Both the biological considerations (e.g., seasonal habitat requirements) and the HC (e.g., potential irrigation impacts) are affected by the timing of river flows. HEC-RAS was used to more accurately route discharges from reservoirs and tributaries to points downstream and to simulate impacts of mechanical changes in river channel geometry. These models simulate how proposed alternatives and management actions would impact river stage and discharge over a wide range of basin hydrologic conditions.

Three separate HEC-RAS models were used for the Missouri River between Fort Peck Dam in Montana and Gavins Point Dam in South Dakota:

- **Fort Peck to Garrison Dam**: begins with the regulated outflow from Fort Peck Dam in Montana and extends approximately 382 miles downstream, to just upstream of Garrison Dam on Lake Sakakawea, North Dakota.
- **Garrison Dam to Oahe Dam**: begins with the regulated outflow from Garrison Dam in North Dakota and extends approximately 318 miles downstream to just upstream of Oahe Dam on Lake Oahe, South Dakota.
- **Fort Randall Dam to Gavins Point Dam**: begins with the regulated outflow from Fort Randall Dam in South Dakota and extends 69 miles downstream to just upstream of Gavins Point Dam on Lewis and Clark Lake.

HEC-RAS models were not needed downstream of Gavins Point Dam because the ResSim modeling showed negligible changes below Gavins Point. The purpose of the HEC-RAS models was to create a baseline that closely represents current river conditions and to provide a tool to evaluate potential hydraulic changes resulting from the alternatives. The baseline or existing conditions models were modified to represent a future condition under the No Action and action alternatives. Outputs of the HEC-RAS models were used in concert with other modeling programs such as HEC-Ecosystem Functions Model (HEC-EFM) and HEC-Flood Impact Analysis (HEC-FIA) to perform impacts analysis.

2.2.3 Pallid Sturgeon Modeling

The objectives for pallid sturgeon provide the preferred basis for evaluation of the effects of alternatives on pallid sturgeon. Quantifying each alternative's effect on recruitment to age 1 and on population size of the UMR demographic unit of pallid sturgeon (upper Missouri and Yellowstone Rivers) permits comparison of effects of each alternative to the no action alternative using those metrics.

Figure 2-1 represents the modeling applied to the EIS to generate measures of benefit and impact for each alternative. HEC-ResSim and HEC-RAS models were used to assess the hydrologic and hydraulic effects of alternatives and serve as a basis for all other modeling.

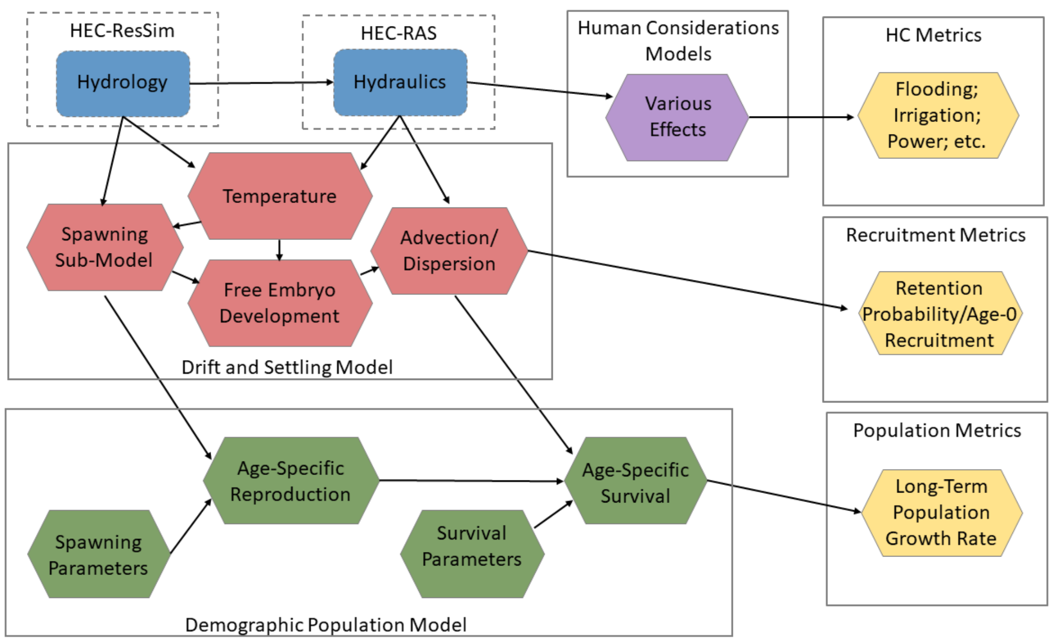


Figure 2-1. Graphical representation of the modeling for the Fort Peck EIS

Benefits to pallid sturgeon were assessed using two connected models:

a) an integrated advection/dispersion and temperature model to estimate the fraction of embryos that would develop to the exogenously feeding stage and be retained in the riverine portion of the Upper Missouri (Fischenich, 2019); and

b) population modeling to assess expected long-term population growth rates given the predicted retention of embryos, and other assumptions about the population (Colvin et al, 2018).

The Drift and Settling Model (DSM) couples an assessment of larval dispersion and temperature-dependent development to determine the proportion of larvae likely to remain upriver of the Lake Sakakawea headwaters, which are lethal to pallid sturgeon larvae due to anoxic conditions at the bed (Bramblett and School, 2015). The primary model output, retention probability, serves as both a useful benefit metric for the EIS and as a critical input to the Population Model, which assesses the effects of alternatives on the long-term population trends for the UMR pallid sturgeon demographic unit.

A key difference from earlier advection and dispersal (A/D) modeling (Fischenich et al., 2018; Erwin et al., 2017) is that the DSM couples one-dimensional A/D computations with hourly water temperatures throughout the system calculated with an energy budget using prevailing weather conditions (air temperature, humidity, cloudiness, pressure, solar radiation and wind speed), water temperatures for the reservoir and tributaries, and release operations. A spawning submodel is applied to determine the likelihood of spawning in a given year based on flow and temperature conditions. A settling submodel is used to determine the distribution of pallid sturgeon larvae at the onset of settling and exogenous feeding. Settling is assumed to occur once thermal exposure thresholds are met using one of two free embryo development models (Braaten, 2012; DeLonay et al 2016). A deterministic, age-structured demographic population model was used to assess the effects to population dynamics of alternative management actions at Fort Peck Dam. Joint spawning and retention probabilities (provided by the DSM) are coupled to pallid sturgeon population dynamics for each year and alternative flow scenario to compute the long-term population growth rate. The long-term population growth rate represents the expected growth rate of a population that consistently experiences the given flow and temperature conditions, and is used as a metric for comparing alternatives.

In addition to providing metrics for comparing Fort Peck flow alternatives, the DSM and population Models can be used to perform sensitivity analyses that inform actions and conditions that improve population growth rates. A detailed description of the pallid sturgeon modeling process and results is provided in Appendix E.

2.2.4 Bird Habitat/Population Modeling

The bird habitat/population models were used to evaluate the potential impacts of flow test alternatives on least tern and piping plover downstream from Fort Peck Dam. The quantitative modeling framework for the bird species includes components of hydrology, riverine and reservoir shoreline habitat and population viability. Buenau et al. (2016) and Fischenich et al. (2018) document the models in detail. Hydrology and reservoir operations were modeled using HEC-ResSim, which routes basin runoff through the Missouri River using specified rules for reservoir operations. These rules were modified to reflect changes to reservoir operations under each alternative. Emergent sandbar habitat (ESH) under varying flow conditions was predicted using a model that relates the deposition and erosion of sand to river flow and existing ESH area. Reservoir shoreline habitat is modeled indirectly. Fledgling production on reservoir shorelines is a function of two hydrological metrics: the vertical extent of exposed shoreline that had been inundated for at least 160 days in the past 2 years and the increase in reservoir elevation during the nesting season. Bird populations are modeled using viability models that account for the number of fledglings produced per pair of adults, annual survival for life stages (juvenile and adult plovers, juvenile young adult, and older adult terns) and dispersal between river segments and regions. They use the output of the habitat models and add inputs to produce fledge ratios (number of fledglings per pair of adults), population sizes, and associated population growth rates for each year and segment simulated. The Population model for plovers is based upon Buenau et al. (2016), updated to reflect the most current demographic rate estimates available.

2.2.5 Human Considerations Modeling

The term human considerations is used to address the interests of stakeholders and Tribes. These include the authorized purposes as well as the many other services afforded by the System. The authorized purposes of the System include: flood risk management, water quality, hydropower, navigation, irrigation, water supply, recreation, and fish and wildlife, all of which are represented in the HC analysis. A detailed analysis of navigation was not conducted because no discernable flow changes below Gavins Point Dam were observed in the modeling results. On the Missouri River, the navigation channel begins downstream of Gavins Point Dam at Ponca, Nebraska and extends to the Mississippi River confluence near St. Louis, Missouri. Input on potentially affected HCs was gathered during the scoping process for the EIS. MRRIC has also provided input on HCs through periodic updates. The list of HCs potentially affected by Fort Peck Test Flow alternatives are described in the Affected Environment and Environmental Consequences Chapter (Chapter 3). HCs to be assessed when evaluating alternatives are rooted in the economic, social, and cultural values associated with the natural resources of the

Missouri River. The models used to evaluate each HC are used in conjunction with the H&H models and are described further in Appendix F.

2.3 Fort Peck Adaptive Management Framework

As part of the charge described in Section 2.1, the Technical Team, supported by a broader group of agency and technical experts (see acknowledgements in the draft Fort Peck AM Framework Appendix H), developed an adaptive management framework. The framework includes a series of Level 1 and Level 2 scientific investigations and experiments that address the critical uncertainties. It also conceptually describes how criteria and mechanisms gained from studies and experimentation could guide decisions about what implementation activities (if any) are warranted, and how they should be structured.

The Fort Peck AM Framework builds on the foundational work in the Effects Analysis and utilizes the processes outlined in the SAMP to provide logical parallel pathways of Level 1 studies and Level 2 experiments that could lead to Level 3 and Level 4 actions in the future if the evidence shows these actions may be warranted. The framework focuses on the issues of flow, temperature and turbidity downstream from Fort Peck Dam, but includes other effect pathways that may be limiting pallid sturgeon recruitment. It emphasizes the need to manage the UMR demographic unit of pallid sturgeon using a systems perspective (i.e. considering the potential for recruitment on either or both the Yellowstone and Missouri Rivers). It also advances an opportunistic strategy wherein the use of passive monitoring and assessment is augmented with focused studies and experiments triggered by advantageous System conditions. Adjustments to the studies, decision criteria, and ultimately management actions over time in response to new knowledge is fully anticipated and is likely necessary for success. Other management actions, for example a separate intake structure, could be evaluated in the future, depending upon the biological results of the test flows and/or effect to the spillway structure.

Recognizing the potential need for management of flows from Fort Peck Dam in order to address pallid sturgeon objectives for the upper river, the amended BA called for the development of a framework to guide the implementation of any flow management actions under adaptive management. This is necessary given the significant uncertainty regarding the causes for recruitment failure in the Missouri River. The framework establishes a logical and systematic series of scientific investigations and experiments that may ultimately lead to the long-term implementation of activities needed to meet species objectives in the Upper Basin. It also conceptually describes how criteria and mechanisms gained from studies and experimentation could guide decisions about what implementation activities are warranted, and how they should be structured. Actions contemplated in this AM framework may require additional NEPA analysis prior to implementation.

The AM Framework outlines two main areas of work to develop a framework. The first concerns the immediate management focus that has been identified in work dating back at least to the EA (Jacobson et al., 2016), which appear in various iterations of the SAMP and, most recently, in the 2018 BiOp. The BiOp notes that effects of the USACE's System Operations in the UMR are potentially negatively impacting the pallid sturgeon's ability to recruit due to altered 1) water temperatures, 2) flow regime, and 3) sediment regime and turbidity as a result of the construction of the water management System and its ongoing operational hydrograph (USFWS, 2018). Effective management actions to address these issues could result from modifying the System operational hydrograph in the Upper River to better replicate aspects of the historical hydrograph. To this end, this framework builds on foundational work to provide logical, parallel pathways of simultaneous Level 1 studies and Level 2 hydrograph modification experiments and actions that together could potentially pave the way to future Level 3 and Level 4 actions if the evidence shows these actions may be warranted. Thus this framework has, as its primary focus, information designed to help:

- Identify / prioritize Level 1 science studies to address key unknowns, focusing on the issues of flow, temperature and turbidity of the Missouri River downstream from Fort Peck Dam.
- Clarify key decisions and sequencing of actions related to implementing Level 2 flow actions to address these issues.
- Describe approaches for implementing a test flow action (e.g., components of the hydrograph to test different hypotheses).
- Summarize monitoring and assessment activities that may be needed to evaluate effectiveness once a test flow action has been implemented and, potentially, to assess effects on human considerations.

2.4 Preliminary Alternatives Formulation

The Technical Team formulated two flow regimes (conceptual hydrographs) to illustrate how hydrograph development might proceed when formulating alternative hydrographs for evaluation in compliance with the 2018 BiOp. These preliminary hydrographs were the starting point for further development of alternatives and most aspects from the initial hydrographs were retained in the refined set of alternatives examined in detail. The Technical Team developed the hydrographs based on the best available science, but acknowledged that additional examination and possible refinement of the conceptual hydrographs was necessary in order to factor in human considerations. Some preliminary analyses of these hydrographs were conducted using HEC ResSim and HEC-RAS modeling similar to how alternatives were evaluated in the MRRMP-EIS (USACE, 2018a). Results of these exploratory analyses were presented to the agencies and the MRRIC Fish and HC Work Groups on May 21, 2018.

The general approach to developing example conceptual hydrographs was to define hypothesized biological functions of the parts of the conceptual hydrographs that would drive flow-release strategies. The functions anticipated for the hydrograph, related to reproductive ecology of the pallid sturgeon, are: 1) attractant flow to motivate pallid sturgeon movement as far upstream as possible to maximize drift (larval dispersal) distance, 2) flows that retain the fish in the upstream reaches, 3) an additional flow to aggregate fish and create a spawning cue, and 4) low flows on the receding limb of the hydrograph to minimize velocities, and therefore, to maximize drift time. Figure 2-2 shows the reproductive functions relative to the historical regulated and unregulated flows at Fort Peck Dam.

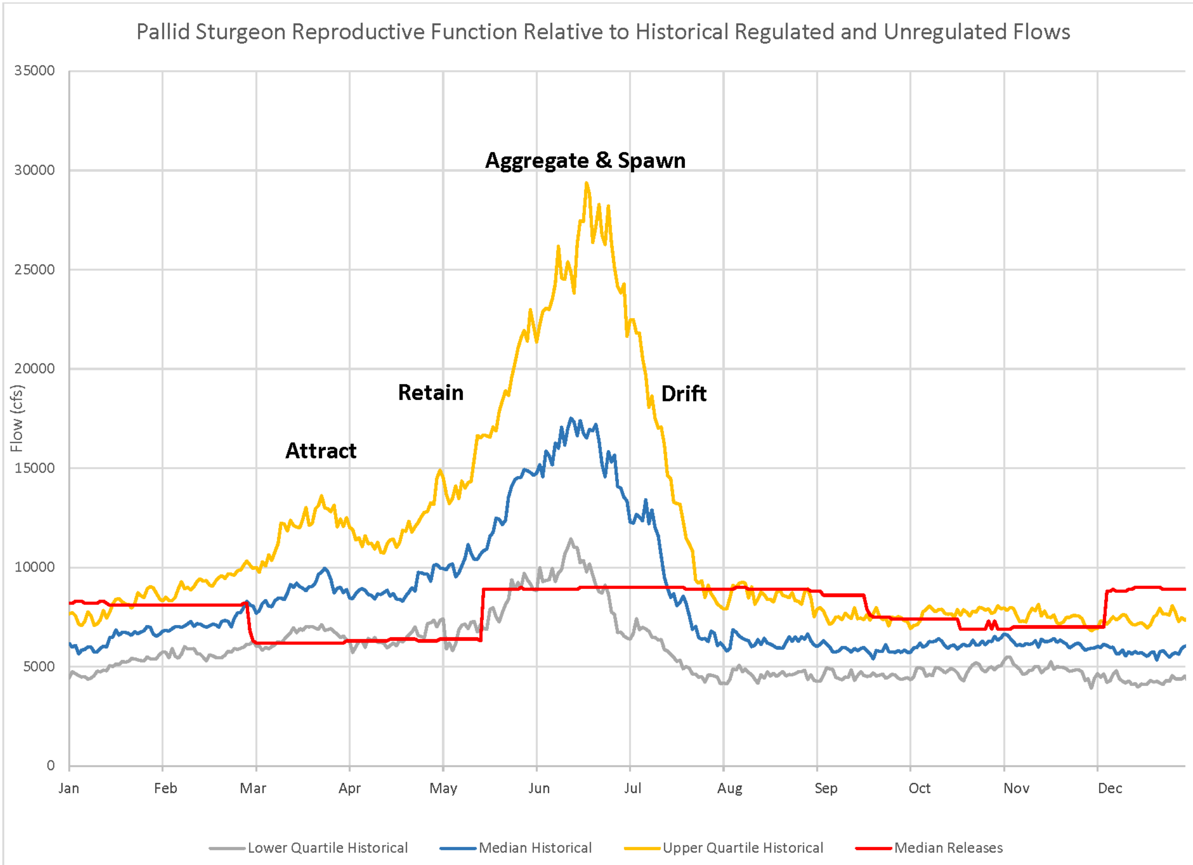


Figure 2-2. Pallid sturgeon reproductive functions relative to historical and unregulated flows at Fort Peck Dam

A fundamental assumption of the conceptual hydrograph design process was that the unregulated flow regime could be used to fill in gaps and detail where current understanding of biological needs was insufficient to parameterize the hydrograph based on hypothesized functions. In this process, the unregulated flow regime is used as a template for constructing low flows, high flows, peaks, timing, and rates of rise and fall. The argument for using elements of the unregulated flow regime is based on the present lack of specific, quantitative understanding of fish responses to elements of the annual hydrograph (Jacobson & Galat, 2008). Without specific, quantitative understanding, the next-best option is to use elements of the natural flow regime that existed as the species evolved. A counter to this assumption is that the system is highly altered (highly fragmented) and many of the fish are hatchery fish. These factors might diminish the value of the natural flow regime in eliciting a behavioral response. For the conceptual hydrographs presented herein, the Technical Team relied on recent information on fish responses to help design parts of the flow regime; and then used the natural flow regime to fill in other components.

Parameters used to describe the hydrographs and employed in their preliminary evaluation using HEC-ResSim and HEC-RAS are provided in Table 2-1.

Table 2-1. Conceptual hydrographs and parameters

Hydrograph Component	Parameter	Conceptual Hydrograph 1	Conceptual Hydrograph 2
Attraction Flow Regime	Minimum Pool Elevation	2225.0 ft	2225.0 ft
	Initiated on	April 16	April 16
	Magnitude	2x Fort Peck spring release	14,000 cfs (max powerhouse release)
	Rate of Increase	1,700 cfs/day	1,700 cfs/day
	Rate of Decrease	1,300 cfs/day for 12 days, then decrease by 3,000 cfs until interim release is reached	1,300 cfs/day for 12 days, then decrease by 3,000 cfs until interim release is reached
	Duration at Peak	3 days	3 days
Retention Flow Regime	Flowrate	1.5x Fort Peck spring release, no downstream constraints	14,000 cfs (max powerhouse release)
Spawning Cue Flow Regime	Minimum Pool Elevation	2225.0 ft	2225.0 ft
	Initiated on	May 28	May 28
	Magnitude	2x Fort Peck spring release	14,000 cfs (max powerhouse release)
	Rate of Increase	1,700 cfs/day	1,700 cfs/day
	Rate of Decrease	1,000 cfs/day for 12 days, then decrease by 3,000 cfs until post-flow release is reached	1,000 cfs/day for 12 days, then decrease by 3,000 cfs until post-flow release is reached
	Duration at Peak	3 days	3 days
Drifting Flow Regime	Flowrate	4,200 cfs; Post-flow release held until Aug 31, No down-stream constraints	Normal operations, No down- stream constraints

Preliminary conceptual hydrograph 1

Newly compiled information (Pat Braaten, U.S. Geological Survey, un-published data) documents consistent movements of fish upstream on the UMR in spring and early summer when discharge on the UMR is approximately twice that of the Yellowstone River. This doubled discharge criterion was used therefore as an estimate of an initial attractant flow (in both conceptual hydrographs). In a departure from the natural flow regime, the Technical Team hypothesized that the attractant flow would be more effective if moved later in the month of April when it may compete less with the Yellowstone River March-April flow.

In the unregulated flow regime, the initial March-April flow is followed by a gradual low flow saddle and then the main May-June peak (Figure 2-3). The May-June flow is hypothesized to be important in retaining fish upstream in the UMR and to contribute to a spawning cue. An empirical basis for understanding spawning cues is lacking, including how flow functions with or without associated variation in temperature and turbidity (DeLonay & others, 2016; Jacobson & others, 2016). Data for 12 documented spawning events on the Yellowstone River and UMR have shown that PS spawned on the descending limb of the runoff hydrograph 11 times. For the EIS, spawning is assumed to occur 3 days after the hydrograph peak, which is sooner than for the Yellowstone River (med = 11 days post peak), but is consistent with the median reduction in flow (35%) from the peak until spawning. As such, the hydrograph reflects best available data and expert elicitation provided additional context (see the Appendix E for additional details).

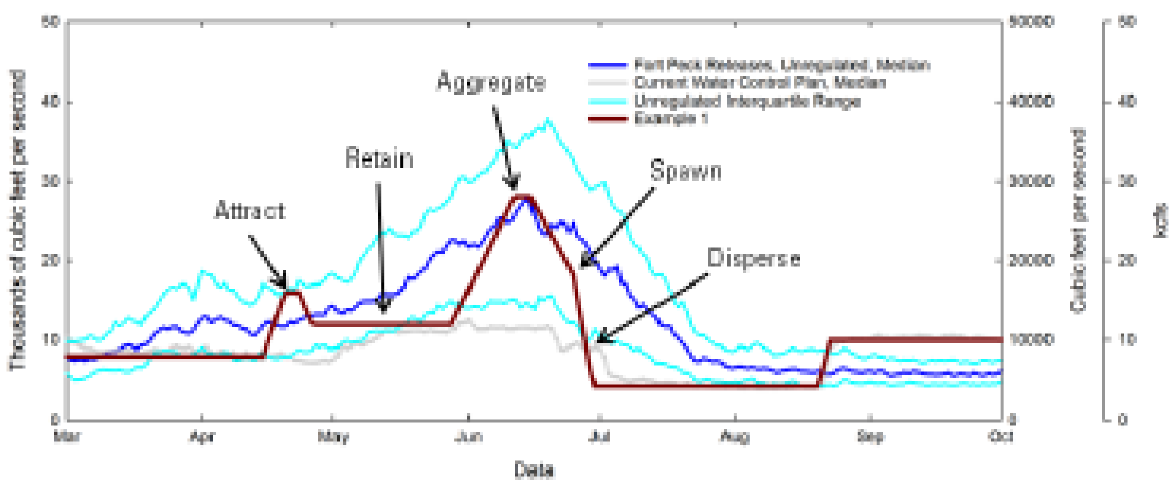


Figure 2-3. Conceptual Hydrograph 1 compared to median and interquartile range of the unregulated flow regime and median of flows based on the current water control plan

In another data and expert elicitation driven variation from the natural flow regime, the Technical Team hypothesized that return to low flows as quickly as possible after spawning would be more effective in minimizing velocities and downstream advection of hatched free embryos. The maximum fall rate to avoid excessive bank erosion is estimated to be 3,000 cfs/day. Both conceptual hydrographs use this recession rate to return to prevailing operations in early July.

The proposed flows for conceptual hydrograph 1 were constructed by using the median rate of rise to bring discharge up to the peak flow magnitudes, after which the peak was held for 3 days (Figure 2-2). The median rate of fall was then applied to bring the discharge back to 1.5 times the base, late-winter flow for the inter-flow saddle. The magnitude of the inter-flow saddle is another potential variable that can be adjusted in the future, but for the initial implementation the 1.5 multiplier was determined by the Technical Team to be a reasonable value for testing. The fall rate after the May-June flow is set to the 50th percentile of the unregulated regime for 12 days (about 1,000 cfs/day); after the 12th day the fall rate is 3,000 cfs/day until return to conventional operations in early July. Operating discharge at the end of the May-June flow will vary depending on system storage and other parameters; however in conceptual hydrograph 1, flow is maintained at 4,200 cfs through August 20 to match median conditions.

A minimum lake level for Fort Peck Reservoir is necessary to provide spillway flows, a condition which may constrain how often spillway releases can contribute to flows.

Preliminary Conceptual hydrograph 2

Conceptual hydrograph 2 follows the same principles, data, and expert elicitation input used in conceptual hydrograph 1, but simplifies the conceptual hydrograph and uses powerhouse flows as a release metric. The attractant flow starts at the same time (April 16) and increases at the same rate as conceptual hydrograph 1, based on early spring flows of 8,000 cfs. The attractant flow is limited to powerhouse capacity, nominally at 14,000 cfs. Moreover, the flows are maintained at powerhouse capacity through the end of May when the May-June flow starts. The rationale for keeping the flows high through this period – foregoing the inter-flow saddle – is the hypothesis that persistent high flows will be needed to hold migrated, reproductive adults upstream near the dam.

The second flow begins on May 28, rises at the rate extracted from the natural flow regime to a peak at double the powerhouse capacity, that is, 28,000 cfs. Discharge over 14,000 cfs comes from the spillway and is presumably warmer than the powerhouse water. Similar to conceptual hydrograph 1, the hypothesis is that the flow of warmer water will help cue reproductive behavior. The peak magnitude is presently arbitrary and could be adjusted through monitoring of fish behavioral responses and adaptive management. Because the added discharge necessarily comes from the spillway, available lake levels will constrain how often and how large this flow can be. Similar to conceptual hydrograph 1, the May-June flow could be initiated in any year when water is available at or above the spillway elevation, but flows might be cut short due to lack of water. The peak is maintained for two days and then discharges decline at rates extracted from the natural flow regime (about 1,000 cfs/day) for 12 days. After 12 days, recession rates are the maximum allowable (3,000 cfs/day) until conventional flow operation is achieved. Low flows at this time of year could be adjusted to minimize velocity and downstream advection of free embryos; conceptual hydrograph 2, as shown in Figure 2-4, uses 4,200 cfs as base discharge from early July to August 20, which is similar to current median conditions.

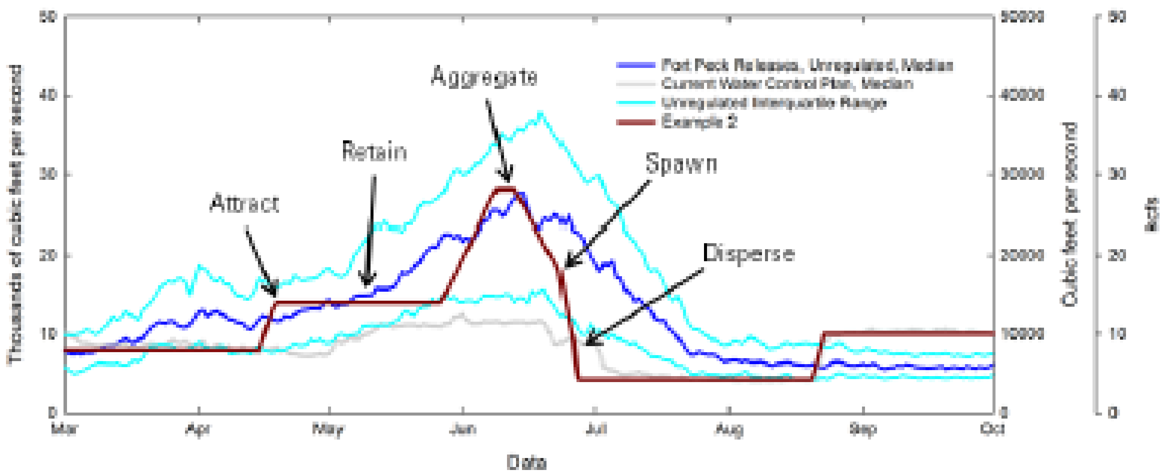


Figure 2-4. Conceptual Hydrograph 2 compared to median and interquartile range of the unregulated flow regime and median of flows based on the current water control plan

2.5 Alternatives Carried Forward for Detailed Evaluation

The two preliminary conceptual hydrographs produced by the Technical Team were modified based on scoping input and additional modeling and assessment. There are two alternatives, each with A and B variants, 1 week earlier and 1 week later. The modified hydrographs represent the two action alternatives and their variations that were carried forward for detailed analysis in this EIS. A scoping summary report is provided as Appendix F. Comments received during scoping related to modification of the conceptual alternatives can be summarized as follows:

- Consider flows with reduced rate of change to reduce the risk of erosion

- Consider a higher low-flow that would have less risk of impacting irrigation intakes
- Consider lower high-flows that would have less risk of damaging irrigation intakes and less chance of increasing flood risk
- Consider flows that would minimize the impact to hydropower (e.g. maximize water moving through generators before putting any water through spillways)

Two action alternatives, each including three variations, were developed to meet the pallid sturgeon objectives and respond to concerns with the initial hydrographs. The functions anticipated for the test flow releases, related to reproductive ecology of the pallid sturgeon are: 1) attractant flow to motivate pallid sturgeon movement as far upstream as possible to maximize drift (larval dispersal) distance 2) retention flow to retain pallid sturgeon in the upstream reaches, 3) a flow pulse to aggregate fish and create a spawning cue, and 4) lower flows on the receeding limb of the hydrograph to minimize velocities, and therefore, to maximize drift time. Each of the alternatives are described below along with a description of the No Action Alternative. A summary table is provided at the end of the section for comparison of alternative parameters. Each alternative description includes an explanation of what factors make it unique from the initial conceptual hydrographs and the other alternatives. Table 2-2 summarizes the different hydrograph components and values associated with each hydrograph parameter for each alternative.

No Action Alternative: The impacts of No Action Alternative serve as the baseline of comparison for the impacts of the other alternatives. It assumes that no test flow release for pallid sturgeon would occur from Fort Peck Dam. Operations at Fort Peck are assumed to closely follow the Master Manual with no pallid sturgeon test flow. When modeling the No Action Alternative, local inflows are adjusted by the difference between the historic and present level depletions to ensure the period-of-record datasets are homogenous and reflect current water use. All modeled flood targets are outlined in the 2018 Master Manual, and reservoir storages are based on current reservoir surveys. All four navigation target locations are used when setting navigation releases and the model balances storage in the upper three reservoirs by March 1. It is assumed that other activities and actions for pallid sturgeon in the Upper Basin would be implemented as described in the MRRMP-EIS and 2018 BiOp and the Lower Yellowstone Intake Diversion Dam Fish Passage EIS (USBR, 2016). These actions include fish bypass construction at Yellowstone Intake, continued propagation and stocking of pallid sturgeon in the UMR, and continued pallid sturgeon science and monitoring activities in the UMR.

Attributes Common to All of the Action Alternatives: There are several differences from the conceptual hydrographs that are common to both action alternatives:

- Target flows for increases and decreases in flow releases are established in the model at Wolf Point rather than for releases from Fort Peck Dam. Establishing targets at Wolf Point, the nearest gage downstream of the dam, rather than measuring releases from Fort Peck Dam, takes into account flows from the Milk River and is intended to give a better estimate of the magnitude of releases needed from Fort Peck Dam in order to achieve downstream objectives.
- During the drifting portion of the flow regime, target flows remain at a minimum of 8,000 cfs until September 1. In comparison, the Fort Peck AM Framework conceptual hydrograph 1 included lower flows to a minimum of 4,200 cfs until September 1 and conceptual hydrograph 2 included a return to normal rebalancing operations which would emphasize refilling Fort Peck Reservoir after the test flow release resulting in low flows below the dam. Changing to a flow of 8,000 cfs was done to reduce the risk of impacting irrigation intakes with lower flows. Additionally, flows that are too low have a chance of concentrating the flow in the main channel which could have the undesired effect of speeding larval drift.
- Under the conceptual hydrographs, the test flows would have been initiated any time the minimum Fort Peck Reservoir elevation was above 2225.0 feet. Limitations during flow regimes are consistent across both of the action alternatives and include:
    - A forecasted Fort Peck to Garrison runoff that is less than the upper quartile range
    - Minimum forecasted Fort Peck Lake pool elevation of 2227.0 feet
    - Flow limit at Wolf Point and Culbertson gages of 35,000 cfs
    - Maximum forecasted Garrison Lake pool elevation of 1850.0 feet
    - Minimum forecasted Williston levee freeboard of 6.4 feet (based on a water surface elevation of 1853.5 feet)
    - Maximum forecasted Williston stage of 22.0 feet (NWS flood stage at Williston).

Alternative 1: System operations under this alternative are based on those described under the No Action Alternative except that it includes a flow release regime from Fort Peck Dam intended to benefit pallid sturgeon.

The Attraction Flow Regime begin on April 16 and the peak flow would be twice as large as the spring release from Fort Peck Dam in the given year. For example, the typical early spring release from Fort Peck Dam is approximately 8,000 cfs; therefore the Attraction Flow Regime peak flow would be 16,000 cfs as measured at the Wolf Point gage. Beginning on April 16, spring release flows are increased by 1,700 cfs per day until the peak flow is reached at the Wolf Point gage. The peak flow is held for 3 days and then decreases by 1,300 cfs per day until the retention flow is reached. The retention flow is 1.5 times the Fort Peck Dam early spring release as measured at the Wolf Point gage, 12,000 cfs using the example. The retention flow is held until May 28 when the Spawning Cue Flow Regime is initiated.

The Spawning Cue Flow Regime under Alternative 1 begins on May 28 and is 3.5 times the Fort Peck Dam spring flow release in the given year. Assuming 8,000 cfs as the typical spring flow, this equates to approximately 28,000 cfs at the peak as measured at the Wolf Point gage. Beginning on May 28, the release is increased by 1,100 cfs per day until the peak flow is reached as measured at the Wolf Point gage. The peak is held for 3 days and then decreases by 1,000 cfs per day for 12 days then decreased by 3,000 cfs per day until the Drifting Flow Regime of 8,000 cfs is reached. The 8,000 cfs Drifting Flow Regime is held until September 1 when releases to balance storage resume.

Variation 1A: This test flow is a variation of Alternative 1. The parameters for 1A are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue Flow Regime is initiated on May 21, rather than May 28. The April 9 initiation date is closer to the timing of the initial flow shown on the unregulated hydrograph. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases. In Alternative 1, the later initiation date of April 16 is designed to enhance the contrast between Missouri River and Yellowstone River discharges by moving the start date approximately two weeks later than the initial flow shown on the unregulated hydrograph.

Variation 1B: This test flow is another variation of Alternative 1. The parameters for 1B are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 23 and the Spawning Cue Flow is initiated on June 4. Similar to the concept described in Variation 1A, the later initiation date is intended to provide contrast in order to explore any differences in forecasted impacts from a later flow initiation date.

Alternative 2: The parameters for Alternative 2 are the same as described for Alternative 1 except that the Attraction Flow Regime peak is 14,000 cfs (the maximum powerhouse capacity) rather than twice the average Fort Peck spring flow in the given year. The maximum amount of flow that can be run through the generators is 14,000 cfs. Any additional flow is run through the spillway and does not generate hydroelectricity. Additionally, releases as measured at Wolf

Point gage are held at 14,000 cfs until the Spawning Cue release is initiated. The rationale for keeping the releases high through this period – foregoing the inter-flow saddle – is the hypothesis that persistent high flows are needed to hold migrated, reproductive adult pallids upstream near the dam.

Variation 2A: This test flow is a variation of Alternative 2. The parameters for Alternative 2A are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue flow would be initiated on May 21, rather than May 28. The difference in timing follows the same reasoning as described for Alternative 1A.

Variation 2B: This test flow is a variation of Alternative 2. The parameters for Alternative 2B are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 23, rather than April 16, and the Spawning Cue flow is initiated on June 4, rather than May 21. The difference in timing follows the same reasoning as described for Alternative 1B.

Table 2-2. Fort Peck test flow alternatives and variations (B variations are 1 week later, A variations are 1 week sooner than their respective base alternatives)

Hydrograph Component	Parameter	Alt 1	Var 1A	Var 1B	Alt 2	Var 2A	Var 2B
Attraction Flow Regime	Date Initiated	April 16	April 9	April 23	April 16	April 9	April 23
	Magnitude	Peak flow is 2x the Spring Release from Fort Peck	Peak flow is 2x the Spring Release from Fort Peck	Peak flow is 2x the Spring Release from Fort Peck	Peak flow is 14,000 cfs (max powerhouse release)	Peak flow is 14,000 cfs (max powerhouse release)	Peak flow is 14,000 cfs (max powerhouse release)
	Rate of Increase	Wolf Point flows increase by 1,700 cfs per day until peak flow reached	Wolf Point flows increase by 1,700 cfs per day unitl peak flow reached	Wolf Point flows increase by 1,700 cfs per day unitl peak flow reached	Wolf Point flows increase by 1,700 cfs per day unitl peak flow reached	Wolf Point flows increase by 1,700 cfs per day unitl peak flow reached	Wolf Point flows increase by 1,700 cfs per day unitl peak flow reached
	Rate of Decrease	Wolf Point flows decrease by 1,300 cfs per day until retention flow is reached	Wolf Point flows decrease by 1,300 cfs per day until retention flow is reached	Wolf Point flows decrease by 1,300 cfs per day until retention flow is reached	Wolf Point flows decrease by 1,300 cfs per day until retention flow is reached	Wolf Point flows decrease by 1,300 cfs per day until retention flow is reached	Wolf Point flows decrease by 1,300 cfs per day until retention flow is reached
	Duration at Peak	3 days	3 days	3 days	3 days	3 days	3 days

Retention Flow Regime	Flowrate	Wolf Point flows remain at 1.5x the spring release from Fort Peck	Wolf Point flows remain at 1.5x the spring release from Fort Peck	Wolf Point flows remain at 1.5x the spring release from Fort Peck	Wolf Point flows remain at 14,000 cfs	Wolf Point flows remain at 14,000 cfs	Wolf Point flows remain at 14,000 cfs
Spawning Cue Flow Regime	Date Initiated	May 28	May 21	June 4	May 28	May 21	June 4
	Magnitude	Peak Flow is 3.5 x Fort Peck spring release	Peak flow is 3.5 x Fort Peck spring release	Peak flow is 3.5 x Fort Peck spring release	Peak flow is 28,000 cfs (2x assumed max powerplant release)	Peak flow is 28,000 cfs (2x assumed max powerplant release)	Peak flow is 28,000 cfs (2x assumed max powerplant release)
	Rate of Increase	Wolf Point flows increase by 1,100 cfs per day until peak flow is reached	Wolf Point flows increase by 1,100 cfs per day until peak flow is reached	Wolf Point flows increase by 1,100 cfs per day until peak flow is reached	Wolf Point flows increase by 1,100 cfs per day until peak flow is reached	Wolf Point flows increase by 1,100 cfs per day until peak flow is reached	Wolf Point flows increase by 1,100 cfs per day until peak flow is reached
	Rate of Decrease	Wolf Point flows decrease by 1,000 cfs for 12 days then decrease by 3,000 cfs until 8,000 cfs is reached.	Wolf Point flows decrease by 1,000 cfs for 12 days then decrease by 3,000 cfs until 8,000 cfs is reached.	Wolf Point flows decrease by 1,000 cfs for 12 days then decrease by 3,000 cfs until 8,000 cfs is reached.	Wolf Point flows decrease by 1,000 cfs for 12 days then decrease by 3,000 cfs until 8,000 cfs is reached.	Wolf Point flows decrease by 1,000 cfs for 12 days then decrease by 3,000 cfs until 8,000 cfs is reached.	Wolf Point flows decrease by 1,000 cfs for 12 days then decrease by 3,000 cfs until 8,000 cfs is reached.
	Duration at Peak	3 days	3 days	3 days	3 days	3 days	3 days
Drifting Flow Regime	Flowrate	Wolf Point flows remain at 8,000 cfs until Sept. 1	Wolf Point flows remain at 8,000 cfs until Sept. 1	Wolf Point flows remain at 8,000 cfs until Sept. 1	Wolf Point flows remain at 8,000 cfs until Sept. 1	Wolf Point flows remain at 8,000 cfs until Sept. 1	Wolf Point flows remain at 8,000 cfs until Sept. 1
Limitations During Flow Regimes	Forecasted Fort Peck to Garrison runoff	Less than upper quartile	Less than upper quartile	Less than upper quartile	Less than upper quartile	Less than upper quartile	Less than upper quartile
	Minimum Forecasted	2227.0 ft.	2227.0 ft.	2227.0 ft.	2227.0 ft.	2227.0 ft.	2227.0 ft.

	Fort Peck Elevation						
	Flow limit at Wolf Point and Culbertson	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs
	Maximum Forecasted Garrison Pool	1850 ft.	1850 ft.	1850 ft.	1850 ft.	1850 ft.	1850 ft.
	Minimum forecasted Williston levee freeboard	6.38 ft.	6.38 ft.	6.38 ft.	6.38 ft.	6.38 ft.	6.38 ft.
	Maximum forecasted Williston stage	22.0 ft.	22.0 ft.	22.0 ft.	22.0 ft.	22.0 ft.	22.0 ft.

2.6 Comparison of Alternatives

The potential impacts associated with each of the alternatives have been assessed and the findings are discussed in detail in Chapter 3.0 and further described in technical reports provided in Appendix F.

This section provides an overview of the analysis and then summarizes the differences between alternatives; discusses how the alternatives are different hydrologically; discusses some of the implications of these differences for endangered species and HCs in terms of relative benefits and adverse impacts compared with the No Action Alternative.

Collectively, these evaluations provide the rationale for the identification of a preferred alternative for the FPDTR-EIS, which is further described in Section 2.7.

2.6.1 Summary Consequence Table

Table 2-3 summarizes the average annual consequences of implementing each of the alternatives. Although absolute values provide important context, it is more relevant for decision-makers to consider the estimated differences between each of the action alternatives and No Action. Table 2-3 shows the differences in the performance of Alternatives 1 and 2 and their variants in relation to the No Action Alternative. These differences are discussed further in Chapter 3 and in full detail in the accompanying technical reports available in Appendix F.

Table 2-3. Summary of environmental consequence of the alternatives

Summary of Environmental Consequences			Comparison to No Action					
			Alternative 1			Alternative 2		
Account	Metric	No Action	Base Alt 1	Variant 1A	Variant 1B	Base Alt 2	Variant 2A	Variant 2B
River Infrastructure and Hydrologic Processes								
Other	Impacts to hydrology	Same or similar to existing conditions. Hydrologic conditions include the wide range of natural flows and System operations by USACE in response to these flows.	Temporarily higher river levels below Fort Peck, lower reservoir elevations in Fort Peck Lake, and higher reservoir elevations in Lake Sakakawea. Impacts might be large in some locations but overall would be small to negligible particularly because of its limited occurrence.	Overall, the one week timing differences is not likely significant. The alternatives may have different levels of impacts during the flow implementation due to downstream inflows. Differences may occur that are locally large.	See 1, 1A	See 1, 1A	See 1, 1A	See 1, 1A
Other	Impacts to geomorphology	Aggradation and degradation trends would continue in river reaches and reservoir bank erosion trends would continue.	Temporary impacts for any of the alternatives could occur such as localized degradation and aggradation; impacts might be large in some locations but overall would be small to negligible particularly because of its limited occurrence.	Overall, the one week timing differences is not likely significant for geomorphic processes. The alternatives may have different levels of impacts during the flow implementation due to downstream inflows.	See 1, 1A	See 1, 1A	See 1, 1A	See 1, 1A

Summary of Environmental Consequences			Comparison to No Action					
			Alternative 1			Alternative 2		
Account	Metric	No Action	Base Alt 1	Variant 1A	Variant 1B	Base Alt 2	Variant 2A	Variant 2B
Other	Impacts to river infrastructure	Under the No Action Alternative operations and maintenance activities on river infrastructure are expected to occur at the same level as existing conditions.	In summary, if a Fort Peck flow alternative were implemented, the Fort Peck Dam spillway and bank structures in the upper river would have increased operating and maintenance costs. The Fort Peck Dam spillway would require additional monitoring equipment and may require modification to address any operation risk. Negligible to minor for any of the alternatives.	Same as Alt 1	Same as Alt 1	Same as Alt 1	Same as Alt 1	Same as Alt 1
Pallid Sturgeon								
EQ	Pallid Sturgeon Spawning Frequency and Larval Retention	The No Action Alternative provides negligible benefit to pallid sturgeon in the reach below Fort Peck Dam in terms of attraction, retention, spawning, and recruitment.	Potential benefit to pallid sturgeon from Alternatives 1 and 2 and their variations relative to the No Action Alternative. The spawning frequency for either alternative was modeled to be approximately four	See Alternative 1 Description	See Alternative 1 Description	See Alternative 1 Description	See Alternative 1 Description	See Alternative 1 Description

Summary of Environmental Consequences			Comparison to No Action					
			Alternative 1			Alternative 2		
Account	Metric	No Action	Base Alt 1	Variant 1A	Variant 1B	Base Alt 2	Variant 2A	Variant 2B
			times that of the No Action and retention of larval pallid sturgeon was modeled to increase about five-fold.					
EQ	Pallid Sturgeon Population Growth Rate	The No Action Alternative provides negligible benefit to pallid sturgeon in the reach below Fort Peck Dam in terms of growth rate.	Predicted population growth rates are marginally higher compared to the No Action Alternative for both Alternatives 1 and 2 and their variations	See Alternative 1 Description	See Alternative 1 Description	See Alternative 1 Description	See Alternative 1 Description	See Alternative 1 Description
Piping Plover and Least Tern (numbers reported in absolute values)								
EQ	Northern Region Quasi-extinction probability -lower is better	0.131	0.133	0.129	0.135	0.141	0.14	0.143
EQ	Southern Region Northern Region Quasi-extinction probability -lower is better	0.214	0.219	0.221	0.216	0.207	0.216	0.215
Fish and Wildlife								
EQ	Riverine terrestrial and aquatic habitat	Negligible change to riverine aquatic and terrestrial habitat from the existing conditions as described in the	Overall, there would be temporary large benefits to the riverine ecosystem between Fort Peck Dam and the Lake	Same as Alt 1	Same as Alt 1	Same as Alt 1	Same as Alt 1	Same as Alt 1

Summary of Environmental Consequences			Comparison to No Action					
			Alternative 1			Alternative 2		
Account	Metric	No Action	Base Alt 1	Variant 1A	Variant 1B	Base Alt 2	Variant 2A	Variant 2B
		Affected Environment.	Sakakawea headwaters compared to the No Action Alternative from increased floodplain and side channel connectivity.					
EQ	Reservoir terrestrial and aquatic habitat	Negligible change to reservoir aquatic and terrestrial habitat from the existing conditions as described in the Affected Environment.	There would be temporary small adverse and beneficial impacts to reservoir terrestrial habitats and fisheries during test flow years depending on location and species	Same as Alt 1	Same as Alt 1	Same as Alt 1	Same as Alt 1	Same as Alt 1
Water Quality								
EQ	Water quality parameters (e.g., temperature, dissolved oxygen, and nitrogen and phosphorus)	Overall, under the No Action Alternative it is anticipated that impacts to water quality parameters would result in the same or similar water quality conditions as described in the Affected Environment section because operation of the System would be	Negligible to small temporary increases in sediment and turbidity could occur during test flow years. Small increases in temperature and decreases in dissolved oxygen below Fort Peck spillway in some years. No to negligible change in pollutants.	Same as Alt 1	Same as Alt 1	Same as Alt 1	Same as Alt 1	Same as Alt 1

Summary of Environmental Consequences			Comparison to No Action					
			Alternative 1			Alternative 2		
Account	Metric	No Action	Base Alt 1	Variant 1A	Variant 1B	Base Alt 2	Variant 2A	Variant 2B
		the same or similar.						
Cultural Resources (numbers reported are for test flow years relative to No Action)								
EQ	% difference in site days impacted - Fort Peck Lake (above) -lower is better	NA	0.00%	-0.00%	0.00%	0.00%	-2.9%	0.00%
EQ	% difference in site days impacted – Fort Peck Lake (below) -lower is better	NA	6.7%	6.3%	4.8%	12.5%	18.2%	10.6%
EQ	% difference in site days impacted - Lake Sakakawea (above) -lower is better	NA	30.6%	16.9%	25.2%	28.5%	46.2%	30.9%
EQ	% difference in site days impacted – Lake Sakakawea (below) -lower is better	NA	-5.0%	-2.3%	-3.2%	-5.6%	-7.2%	-5.9%
EQ	% difference in site days impacted - Lake Oahe (above) -lower is better	NA	-1.3%	2.8%	4.1%	4.5%	-1.3%	-24.9%
EQ	% difference in site days impacted - Lake Oahe (below) -lower is better	NA	0.00%	0.7%	0.3%	-0.3%	0.0%	-1.3%
Flood Risk Management (numbers reported are for test flow years relative to No Action)								

Summary of Environmental Consequences			Comparison to No Action					
			Alternative 1			Alternative 2		
Account	Metric	No Action	Base Alt 1	Variant 1A	Variant 1B	Base Alt 2	Variant 2A	Variant 2B
NED	Largest Damage Decrease $/yr, Fort Peck to Garrison -lower is better	NA	-62,045	-73,868	-3,720	-54,769	-59,457	-52,808
NED	Largest Damage Increase $/yr, Fort Peck to Garrison -lower is better	NA	290,464	137,324	165,028	194,462	189,051	224,428
NED	Largest Damage Decrease $/yr, Garrison to Oahe -lower is better	NA	-3,468	-296	-87	-268	-781	-284
NED	Largest Damage Increase $/yr, Garrison to Oahe -lower is better	NA	47	487	406	37	125,655	1
NED	Largest Damage Decrease $/yr, Fort Randall to Gavins Point -lower is better	NA	-26,095	-16,468	-12,068	-14,494	-13,369	-18,585
NED	Largest Damage Increase $/yr, Fort Randall to Gavins Point -lower is better	NA	12,789	30,164	1,239	5,861	31,371	150
Hydropower (numbers reported are for test flow years relative to No Action)								
NED	Missouri River System Average Annual Generaion Value. $/yr	NA	-164,000	-352,000	-102,000	-210,000	-298,000	-18,000

Summary of Environmental Consequences			Comparison to No Action					
			Alternative 1			Alternative 2		
Account	Metric	No Action	Base Alt 1	Variant 1A	Variant 1B	Base Alt 2	Variant 2A	Variant 2B
	-higher is better							
NED	Fort Peck Only. Average Annual Generation Value $/yr -higher is better	NA	--378,000	-391,000	-201,000	-410,000	-575,000	-258,000
Irrigation (numbers reported are for test flow years relative to No Action)								
NED	Lower Intake Thresholds – Average Annual Net Farm Income -higher is better	n/a	-$2,122,145	-$1,933,496	-$2,247,606	-$821,621	-$2,156,846	-$2,809,054
RED	Lower Intake Thresholds (jobs) -higher is better	768	-4	-5	-5	-3	-6	-8
NED	Upper Intake Thresholds Average Annual Net Farm Income– side channel intakes -higher is better	n/a	-$7,500,000 [a]	-$7,500,000 [a]	-$7,500,000 [a]	-$7,500,000 [a]	-$7,500,000 [a]	-$7,500,000 [a]
RED	Upper Intake Thresholds (annual jobs) – side channel intakes -higher is better	121	-80	-80	-80	-80	-80	-80
NED	Upper Intake Thresholds – main channel intakes O&M -lower is better	n/a	$895,155	$594,371	$760,387	$1,024,487	$1,121,915	$1,017,989

Summary of Environmental Consequences			Comparison to No Action					
			Alternative 1			Alternative 2		
Account	Metric	No Action	Base Alt 1	Variant 1A	Variant 1B	Base Alt 2	Variant 2A	Variant 2B
Recreation (numbers reported are for test flow years relative to No Action)								
NED	Fort Peck Lake Percent Change in Average Annual Recreation NED Benefits $/yr recreation value -higher is better	NA	-2.62%	-1.23%	-2.23%	-2.06%	-2.17%	-3.68%
NED	Lake Sakakawea Percent Change in Average Annual Recreation NED Benefits $/yr -higher is better	NA	0.36%	0.11%	0.28%	.46%	.56%	.52%
NED	Lake Oahe Percent Change in Average Annual Recreation NED Benefits $/yr	NA	-0.01%	-0.04%	-0.10%	0.05%	-0.03%	0.10%
RED	Average employment (jobs) (Upper three reservoirs) -higher is better	NA	-1	-2	-2	0	1	-1
RED	Average employment (jobs) (Fort Peck Lake) -higher is better	NA	-5	-2	-5	-2	-4	-7
Thermal Power (numbers reported are for test flow years compared to No Action)								
NED	Annual average NED $/yr -higher is better	NA	565,000	301,000	60,000	20,000	68,000	70,000

Summary of Environmental Consequences			Comparison to No Action					
			Alternative 1			Alternative 2		
Account	Metric	No Action	Base Alt 1	Variant 1A	Variant 1B	Base Alt 2	Variant 2A	Variant 2B
Water Supply (numbers reported are for test flow years relative to No Action)								
NED	Percent Change in costs from No Action Alternative	NA	-0.33%	-0.13%	-0.17%	-0.25%	-0.79%	-0.62%
Environmental Justice (relative to No Action)								
OSE	Disproportionate adverse impacts on any potential populations of concern	Not expected to have disproportionate adverse impacts on environmental justice populations.	Not expected to have disproportionate adverse impacts on environmental justice populations	Not expected to have disproportionate adverse impacts on environmental justice populations	Not expected to have disproportionate adverse impacts on environmental justice populations	Not expected to have disproportionate adverse impacts on environmental justice populations	Not expected to have disproportionate adverse impacts on environmental justice populations	Not expected to have disproportionate adverse impacts on environmental justice populations

a $7.5 million is the estimated impact if 100% of side channel irrigation intakes experienced crop loss. See Table 3-85 for the range of potential impacts with values ranging from -307,000 to -7.5 million depending on percentage of intakes experiencing crop losses.

2.6.1.1 No Action (Current System Operation and Current MRRP Implementation)

Summary of Characteristics and Features

The No Action Alternative is a continuation of the current operation of the System and also management actions being used to comply with the 2018 BiOp other than those specifically relating to the provision of test flows under evaluation in this process (USFWS, 2018). Although referred to as “No Action” because it is the default reference case under NEPA, the No Action alternative could be referred to as no change in direction from existing System operation and implementation of MRRP in this reach.

Evaluation Discussion

Pallid sturgeon modelling (see Appendix E for details of methods and assumptions) suggests that the No Action Alternative provides negligible benefit to pallid sturgeon in the reach below Fort Peck Dam in terms of attraction, retention, spawning, and recruitment.

The No Action Alternative does not meet the Purpose and Need of the EIS as described in Chapter 1 as it does not specifically provide for test flows for pallid sturgeon. Because of this, it has generally lower adverse impacts across the board of human considerations than Alternatives 1 and 2, though this is not the case for every interest (for example, both action alternatives typically maintain Lake Sakakawea 2-3 feet higher than the No Action during the summer, which is predicted to increase recreation visitation there).

The acceptability of No Action would likely be based on the perceived value of allowing test flow releases from Fort Peck as part of the adaptive management of that species under the 2018 BiOp. Given that USACE must comply with the ESA to continue to operate the System and maintain and operate the BSNP, in selecting a preferred alternative, the USACE must consider the potential value of the test flows to pallid sturgeon against the impacts to other interests.

2.6.1.2 Alternative 1 (including Variant 1A and Variant 1B)

Summary of Characteristics and Features

Alternative 1 has the features described in Table 2-2.

Over the period of record, the main hydrological differences of Alternative 1 relative to No Action include:

- Higher flows from Fort Peck in approximately 20-25% percent of years during mid-April (plus and minus one week for the two variants) attraction flow releases are attempted. Some of these involve spills, which typically result in combined generator and spill outflows of up to approximately 20,000 cfs, and others do not.
- Higher flows from Fort Peck in these same years during mid-May to early June (plus and minus one week for the two variants) when spawning flow releases are attempted. All of these involve spills, some of which briefly bring combined generator and spill outflows above 30,000 cfs.
- In these same years, flows from Fort Peck after the releases and the spawning release (early June to mid-September, plus and minus one week for the variants) are typically between 0% and 50% lower than under the No Action, and function both to slow the drift phase and to allow for reservoir storage rebalancing.

Balance of Beneficial and Adverse Effects

The net benefits of Alternative 1 compared to No Action mainly relate to potential benefits for pallid sturgeon. Both Alternative 1 and 2 and their variants were modeled to benefit pallid sturgeon on the UMR, and while the absolute benefits are uncertain, their performance relative to the No Action Alternative appears to be appreciable. The frequency of favorable conditions for spawning is modeled to be 400% greater than No Action for Both Alternative 1 and Alternative 2. Alternative 1 and its variants are modeled to have a 450% greater retention rate than the No Action Alternative and a population growth rate that is modeled to be 1.6% higher.

Because Alternative 1 provides for the possibility of an attraction spill in April, it enables adaptive management experimentation around the value (or lack thereof) associated with this operation in influencing the attraction and retention of pallid sturgeon in the Missouri River.

There are no expected net effects on the piping plover and least tern.

Benefits to other interests are limited:

- Benefits to recreation in Lake Sakakawea can be seen in the base Alternative 1 and its A and B variants, within the range 0.04% to 0.16% change from No Action averaged over 82 data years. Net improvements (<1% relative to No Action) are also seen in Lake Sakakawea Cultural Resource site protection.

- There would be a temporary unquantified benefit to aquatic ecosystem between Fort Peck Dam and Lake Sakakawea from increased side-channel and floodplain connectivity.
- Impacts to water supply from Alternative 1 and its variants are positive but are less than 0.1% relative to No Action when averaged over 82 years; when averaged in flow years, these impacts are less than 0.8%.

Adverse impacts are seen in most of the other interests:

- When averaged over the 82-year period of record, most adverse impacts of Alternative 1 are less than 5%, the single exception being cultural resource sites that could be affected by higher elevations in Lake Sakakawea.
- Flood Risk Management damages from Alternative 1 and its variants in the Fort Peck to Garrison reach are between 1.25% to 4% higher than No Action when averaged over 82 years. In full or partial flow years, this range increases to being a 3.9% to 11.8% impact above No Action, approximately $15,000 to $45,000 per flow release event. These damages are almost entirely to agriculture rather than to infrastructure.
- The test flow releases would increase the likelihood that the Fort Peck spillway could be damaged because of increased use of the spillway.
- Although overall hydropower system adverse impacts from Alternative 1 relative to No Action are limited to less than 0.1% (when averaged over 82 years) or 0.2% (when averaged only in flow years), at Fort Peck, average hydropower system value in partial or full release years would change between -$730,000 and -$890,000 (-1.76% to -1.97%) relative to No Action.
- When averaged over 82 data years, adverse impacts to irrigation net income is in the 2.9% to 4.0% range for Alternative 1 and its variants. High flows could result in moderate adverse impacts to irrigation intakes in Montana, with side channel intakes being at greater risk of sedimentation and other high flow related issues.
- Impacts to thermal power from Alternative 1 and its variants are less than 0.05% relative to No Action when averaged over 82 years; when averaged in flow years, these impacts are less than 0.12%.
- In contrast to the noted benefits to recreation at Lake Sakakawea, impacts to Fort Peck recreation are adverse. Averaged over 82 years, adverse impacts are in the 0.6% to 1.3% range, or 1.3% to 2.7% when averaged only in flow years.
- Cultural resource impacts differ across the three reservoirs and between sites above the normal range of operations and those that are below. Numerically, the largest

number of site-days of impact in the No Action alternative are around Lake Oahe, though relatively few are affected differently by Alternative 1 and its variants.

Evaluation Discussion

Because Alternative 1 provides for the possibility of an attraction spill in April, it enables adaptive management experimentation around the value (or lack thereof) associated with this operation in influencing the attraction and retention of fish in the Missouri River. Of the three versions of Alternative 1, Variant 1A appears to have the least impacts to human considerations other than irrigation. Overall, Alternative 1 shows less impacts to human considerations than Alternative 2 although impacts can vary depending on the year and overall impacts are driven by only a handful of years. Alternative 1 offers the ability to test the April attraction spill, and modeling results predict a similar level of pallid sturgeon benefits as Alternative 2.

2.6.1.3 Alternative 2

Summary of Characteristics and Features

Alternative 2 has the features described in Table 2-2.

Over the period of record, the main hydrological differences of Alternative 2 relative to No Action include:

- Higher flows from Fort Peck in approximately 20-25% percent of years during mid-April (plus and minus one week for the two variants) attraction flow releases are attempted. In contrast to Alternative 1, none of these involve spills.
- Higher flows from Fort Peck in these same years during mid-May to early June (plus and minus one week for the two variants) when spawning flow releases are attempted. All of these involve spills, some of which briefly bring combined generator and spill outflows above 30,000 cfs.
- In these same years, flows from Fort Peck after the releases and the spawning release (early June to mid-September, plus and minus one week for the variants) are typically between 0% and 50% lower than under the No Action, and function both to slow the drift phase and to allow for reservoir storage rebalancing.

Balance of Beneficial and Adverse Effects

The net benefits of Alternative 2 compared to No Action mainly relate to potential benefits for pallid sturgeon. The frequency of favorable conditions for spawning was modeled to be

400% greater than No Action and retention was modeled to be approximately 800% greater under Alternative 2 and its variants. The long-term population growth rate under Alternative 2 was modeled to be 0.9% higher than No Action.

Although Alternative 2 provides for the possibility of an attraction flow in April, it does not prescribe spilling of warmer water to augment this. Relative to Alternative 1, this may limit somewhat the learning about attraction and retention flows.

As with Alternative 1, benefits to other interests are limited:

- Benefits to recreation in Lake Sakakawea can be seen in the base Alternative 2 and its A and B variants, within the range 0.19% to 0.26% change from No Action averaged over 82 data years. Net improvements (<1% relative to No Action) are also seen in Lake Sakakawea Cultural Resource site protection.
- There would be a temporary unquantified benefit to aquatic ecosystem between Fort Peck Dam and Lake Sakakawea from increased side-channel and floodplain connectivity.
- As with Alternative 1, impacts to water supply from Alternative 2 and its variants are positive but similarly are less than 0.1% relative to No Action when averaged over 82 years; when averaged in flow years, these benefits are less than 0.8%.

Adverse impacts are seen in most of the other interests:

- Flood Risk Management damages from Alternative 2 and its variants in the Fort Peck to Garrison reach are between 2.7% to 4% higher than No Action when averaged over 82 years. In full or partial flow years, this range increases to being an 8.9% to 11.4% impact above No Action, approximately $34,200 to $44,100 per flow release event. These damages are almost entirely to agriculture rather than to infrastructure.
- As with Alternative 1, the test flow releases would increase the likelihood that the Fort Peck spillway could be damaged because of increased use of the spillway.
- When averaged over 82 data years, adverse impacts to irrigation net income in is in the 2.4% to 6.7% range for Alternative 2 and its variants. As with Alternative 1, high flows could result in moderate adverse impacts to irrigation intakes in Montana, with side channel intakes being at greater risk of sedimentation and other high flow related issues.
- Although overall hydropower system adverse impacts from Alternative 1 relative to No Action are limited to less than 0.1% (when averaged over 82 years) or 0.2% (when averaged only in flow years), at Fort Peck, annual average hydropower

system value in partial or full release years would change between -$768,000 and -$1,227,000 (-1.68% to -2.70%) relative to No Action.

- When averaged over 82 data years, adverse impacts to irrigation net income in Montana is in the 2.6% to 7.2% range for Alternative 2 and its variants, or 6% to 14% when averaged only in flow years (equating to approximately $610,000 to $1,440,000 per release event).
- Impacts to thermal power from Alternative 2 and its variants are less than 0.01% relative to No Action when averaged over 82 years; when averaged in flow years, these impacts are less than 0.08%.
- In contrast to the noted benefits to recreation at Lake Sakakawea, impacts to Fort Peck recreation are adverse. Averaged over 82 years, adverse impacts are in the 0.9% to 2.0% range, or 2.1% to 3.7% when averaged only in flow years.
- As with Alternative 1, cultural resource impacts differ across the three reservoirs and between sites above the normal range of operations and those that are below. Numerically, the largest number of site-days of impact in the No Action alternative are around Lake Oahe, though relatively few are affected differently by Alternative 2 and its variants.

Evaluation Discussion

While the modeling predicts that direct benefits to pallid sturgeon are greater for Alternative 2 than for Alternative 1, the magnitude of the difference for 3 to 5 test flows would be minor. The primary benefits are associated with the potential knowledge gained from the hypothesis testing and application of the knowledge gained to future decisions. Relatedly, a key difference is that testing of attraction and holding flows would be constrained under Alternative 2, which is capped at maximum powerhouse capacity during that flow phase. Alternative 1 provides for the possibility of an attraction spill using warmer water from the Fort Peck Dam spillway, enabling experimentation around the value (or lack thereof) of attraction and retention flows in the UMR and more fully meeting the requirements of the 2018 Biological Opinion.

Alternative 2 shows slightly more adverse impacts to hydropower, irrigation, and flood risk management, though the differences are small relative to the wide variation in hydrological conditions across the period of record.

2.7 Identification of the Preferred Alternative

The "preferred alternative" is the alternative which the USACE believes would fulfill its mission and responsibilities, giving consideration to economic, environmental, technical, and other factors. NEPA regulations (40 CFR Section 1502.14) require the section of the EIS on alternatives to "identify the agency's preferred alternative if one or more exists, in the draft statement, and identify such alternative in the final statement. The USACE considered comments from other agencies, Tribes, stakeholders, and the public during the public comment period in determining the preferred alternative.

The preferred alternative is to implement Alternative 1 including the ability to implement variants 1a and 1b which would occur one week sooner or later respectively. Alternative 1 is the preferred alternative because it allows for more flexibility in testing within an adaptive management framework, generally has less overall HC impacts than Alternative 2, and has a similar level of potential pallid sturgeon benefits as modeled.

The authority to implement the preferred alternative is inherent in the USACE discretion and authority to operate the System for all of its purposes under the Flood Control Act of 1944. Implementation of the test flow outlined in the preferred alternative would occur through a Master Manual deviation request that would be coordinated through Missouri River Basin Water Management biannual public meetings. This ensures the test flow is incorporated in the Annual Operating Plan and the public is informed. This EIS serves as the NEPA compliance process for this potential Master Manual deviation. The test flows do not constitute a change to the Master Manual. Another NEPA process and additional analysis would be needed if flow changes were to be adopted as part of System operations described in the Master Manual.

3.0 Affected Environment and Environmental Consequences

3.1 Introduction

This chapter presents both the affected environment and environmental consequences, as required by NEPA. This chapter is organized by resource topic with the status of the affected environment and the impacts of each alternative described within each resource section. The affected environment sections provide a description of different aspects of the human environment that may be affected by the alternatives. The environmental consequences sections provide a description of the impact assessment methodologies, direct and indirect impacts, and how these impacts might change based on climate change. Resource impacts specific to the Tribes are discussed within each applicable resource section. Cumulative impacts are described at the end of each resource topic. This Draft EIS was prepared under the 1978 CEQ NEPA regulations because the Notice of Intent for the EIS was issued in February of 2019, prior to the effective date of new CEQ NEPA regulations that went into effect on September 14, 2020.

Adverse environmental effects which cannot be avoided, the relationship between short-term uses of the environment and long-term productivity, and any irreversible or irretrievable commitments of resources are presented in separate sections at the end of the chapter.

CEQ Regulations Implementing NEPA defines the following impact categories:

- **Direct Impacts**: caused by an action included in a plan alternative and occurring at the same time and place.
- **Indirect Impacts**: caused by an action included in a plan alternative, but would occur later in time or further removed in distance.
- **Cumulative Impacts**: caused from incremental impact of an action added to other past, present, and reasonably foreseeable future actions.

Impacts are described as either *beneficial* or *adverse*. Beneficial impacts result in a positive change in the condition of the resource when compared to the No Action alternative. Adverse impacts result in a negative change in the condition of the resources when compared to the No Action alternative. Impacts are also described in terms of duration. *Temporary* or *short-term* impacts would persist for the duration of the management action and/or occur for a limited time after implementation of the management action. Temporary impacts can be re-occurring such as in the case of flow actions that occur at different intervals over time. *Long-term* impacts would be permanent or continuous over the period of analysis.

Finally, impacts are described in relation to their significance. The CEQ regulations require consideration of both context and intensity when determining the significance of an impact on a resource. Context means considering the extent of the impact such as in a national, regional, or local setting. The following factors can be considered in determining the severity of impact (40 CFR 1508.27):

- Impacts that may be both beneficial and adverse. A significant effect may exist even if the federal agency believes that on balance the effect will be beneficial.
- The degree to which the action affects public health or safety.
- Unique characteristics of the geographic area, such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
- The degree to which possible effects on the human environment are uncertain or involve unique or unknown risks.
- The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
- Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or breaking it down into small component parts.
- The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historic resources.
- The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act.
- Whether the action threatens a violation of federal, state, or local law or requirements imposed for the protection of the environment.

The following descriptors are used in the body of this chapter for consistency in describing impact intensity in relation to significance.

- **No or Negligible Impact**: The action would result in no impact or the impact would not change the resource condition in a perceptible way. Negligible is defined as of such little consequences as to not require additional consideration or mitigation.
- **Small Impact**: The effect to the resource would be perceptible; however, not severe and unlikely to result in an overall change in resource character.
- **Moderate Impact**: The effect to the resource would be perceptible and may be severe in some cases, but the overall character of the resource would not change.
- **Large Impact**: The effect to the resource would be perceptible and may be severe. The effect would likely result in an overall change in resource character.

The rationale for why an impact is considered to fall under one of the preceding intensity descriptors is included in each resource section. Statements of significance are supported by text describing the context and intensity of the impact and are summarized in the "Conclusion" section under each resource topic.

3.1.1 Impact Assessment Methodology

The management actions in this EIS that could impact the human environment are related to changes in reservoir System releases from Fort Peck Dam. The discussion of potential impacts for many resources includes an analysis based on the results of modeling the alternatives over an 82-year hydrologic period of record (1931–2012) for the Missouri River basin.

The USACE HEC-ResSim model was used to simulate reservoir operations for each of the alternatives (Figure 3-1). HEC-ResSim simulated System operation using the "rules" for each of the alternatives assuming the current reservoir System was in place for the entire POR and the same runoff conditions that occurred over the POR. The runoff conditions for the POR were adjusted to account for the current level of depletions. The outputs from HEC-ResSim are reservoir releases and elevations for each of the reservoirs for each of the alternatives. The outputs are labeled in terms of data simulation years (1931, 1932…2012). Thus, the 1945 output is the result of simulating how the System would be operated under each of the alternatives if the water that entered the river in 1945 (adjusted for depletions) were to occur again.

The USACE HEC-RAS model uses the outputs of HEC-ResSim to calculate river flow and water surface elevations of the Missouri River that were routed down the Missouri River Mainstem. The HEC-RAS model geometry and calibration were generally representative of 2012 conditions and revised to reflect the potential extent of early life stage pallid sturgeon habitat for each alternative. It was assumed this revised geometry was in place every year of the POR.

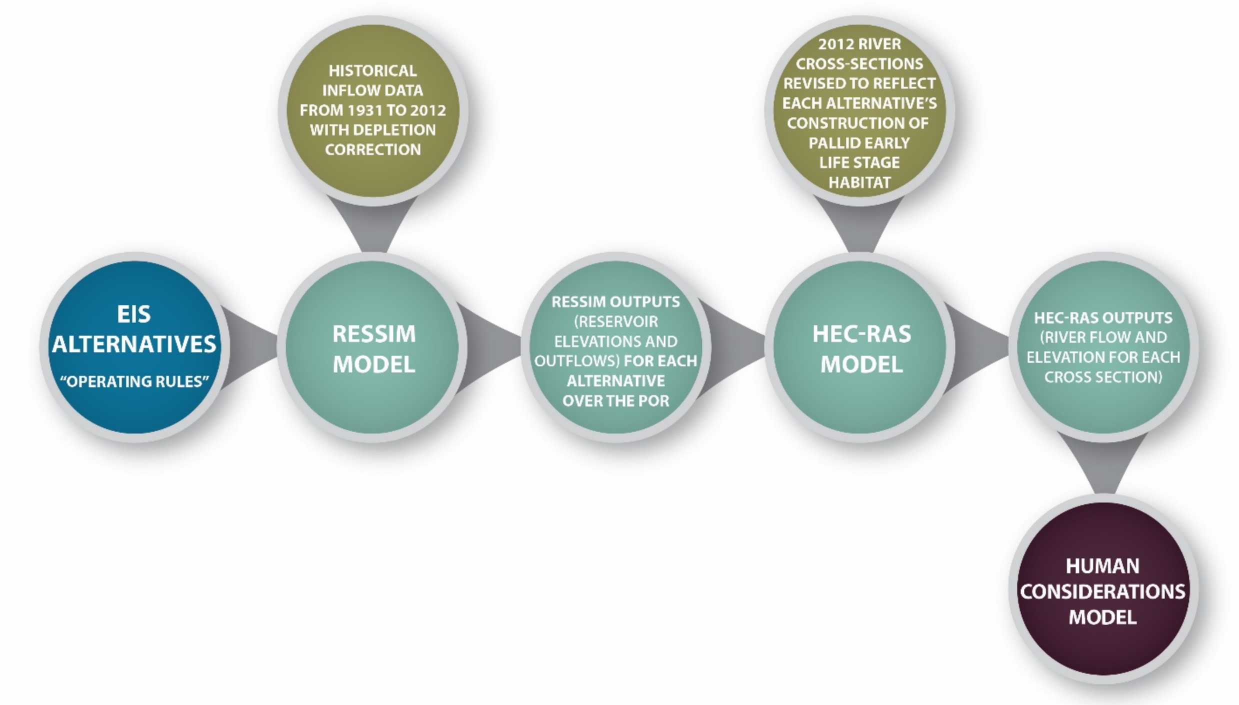


Figure 3-1. Model outputs for the Fort Peck Dam Test Release EIS

One might expect the modeling output for the No Action Alternative (which reflects existing operation of the System and current implementation of MRRP actions) from either HEC-ResSim or HEC-RAS to match actual observed conditions. However, this is not the case. The following is a description of the primary reasons why the modeled outputs for the No Action Alternative do not match what actually occurred in the past.

- **Operational Differences**: The No Action Alternative is a simulation of how the System is currently operated, including current MRRP actions, but does not and cannot take into account the numerous minor adjustments to basic rules that USACE actually makes to reasonably address critical short-term situations (e.g., increase releases for water supply, reducing releases for ice jams, etc.). In addition to the short-term changes, the basic operational rules have changed throughout the POR. For example, drought conservation criteria have been changed as recently as 2004 and were included in simulating operation for the entire POR.
- **River Geometry Changes**: The bed profile of the Missouri River is constantly changing: eroding ("degrading") in some places and accumulating ("aggrading") in others. Long-term stage trends not associated with the management actions included in the alternatives are known to be occurring in many locations under existing operation. For the purposes of comparing the effects of the alternatives, the models were developed with the best available survey data and calibrated to the 2012 condition. This geometry was assumed for each year of the POR.

- **Depletions**: All historic POR runoff levels were adjusted for consumptive water use to the current level of depletions. Depletions consist of water use by irrigation, municipal, evaporation, etc. This assumes the current 2012 level of water use projected from 1931 including evaporation from the Mainstem reservoirs.

Therefore, modeling results of the No Action Alternative do not reflect actual past or future conditions but serve as a reasonable basis or "baseline" for comparing the impacts of the action alternatives on resources.

The POR is characterized by substantial variability in hydrologic conditions, which includes periods of drought (e.g., 1930s) and high runoff (e.g., 1997, 2011). This hydrologic variability results in substantial changes to resources and uses over the POR with all the alternatives, including the No Action Alternative. These changes are not associated with the species management actions included in the alternatives, and therefore the following impact analyses are focused on comparing the difference the action alternatives have on resources compared to the No Action Alternative. The "rules" governing System operation during periods of drought and high runoff for the action alternatives are generally the same as current System operation under the No Action Alternative. Therefore, the effects of the action alternatives on reservoir elevations and releases are relatively small compared to the variation caused by the extreme hydrologic events in the POR. For additional details describing the HEC-ResSim or HEC-RAS modeling, refer to the technical reports available on the MRRP website at https://www.nwo.usace.army.mil/MRRP/.

The outputs of the modeled alternatives are the result of very prescriptive modeling rules that attempt to simulate how management actions might be implemented in order to compare the effects of the alternatives with the variation in hydrology over the POR. In actual operation under active adaptive management, management actions would be implemented on a basis that is more flexible and responsive to on-the-ground conditions that cannot be modeled.

3.1.2 "Human Considerations" and USACE Planning Accounts

Effects to human considerations (refer to Section 2.4.5) can be categorized into the "accounts" established in USACE planning policy to facilitate evaluation and display of the effects of alternative plans. These accounts are: national economic development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE). These accounts encompass the effects of the alternative plans as required by NEPA. The EQ account shows effects on ecological, cultural, and aesthetic attributes of natural and cultural resources that cannot be measured in monetary terms. The OSE account shows urban and community impacts on life, health, and safety. The NED account shows effects on the national economy. The RED account shows the regional incidence of NED effects, income transfers, and employment effects (U.S. Water Resources Council, 1983). Additional resource topics, other than those categorized as human considerations, were identified and are presented in this chapter.

3.1.3 Cumulative Impacts

The CEQ regulations for implementing NEPA require an assessment of cumulative impacts in the decision-making process. This section describes the methods for identification of cumulative actions and presents the results of the cumulative impact analysis. CEQ defines a cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7).

The cumulative action identification and analysis methods are based on the policy guidance and methodology originally developed by CEQ (1997) and an analysis of current case law. Cumulative impacts were determined by adding the impacts of the alternatives being considered with other past, present, and reasonably foreseeable future actions. A process based on four primary steps was employed to assess the cumulative impacts of the alternatives.

Step 1: Identify Affected Resources

In this step, each resource affected by any of the alternatives is identified. Cumulative impacts were considered for each resource identified in this chapter.

Step 2: Establish Boundaries (Geographic and Temporal)

In identifying past, present, and reasonably foreseeable actions to consider in the cumulative impact analysis, affected resource-specific spatial and temporal boundaries were identified. The spatial boundary is where impacts to the affected resource could occur from the proposed alternatives and therefore where past, present, and reasonably foreseeable future actions could contribute to cumulative impacts to the affected resource. This boundary is defined by the affected resource and may be a different size than the proposed project area.

The temporal boundary describes how far into the past and forward into the future actions should be considered in the impact analysis. The temporal boundary is guided by CEQ guidance on considering past action and a rule of reason for identifying future actions. For each resource topic, the geographic and temporal boundaries were identified. For all resource topics, the consideration of past actions is reflected in the existing condition. A default future temporal boundary of 50 years from the baseline condition was used as an initial timeframe; however, the impacts are based on their likelihood of occurring and whether they can be reasonably predicted.

Step 3: Identify the Cumulative Action Scenario

In this step, past, present, and reasonably foreseeable future actions to be included in the impact analysis for each specific affected resource were identified. These actions fall within the spatial and temporal boundaries established in Step 2. Table 3-1 lists cumulative actions considered in the analysis and which resources could be affected by the action. For a description of the cumulative actions considered see Appendix C: Cumulative Actions Descriptions.

Table 3-1. Cumulative Actions and Affected Resources

	Type			Affected Resources														
Cumulative Action	Past	Present	Reasonably Foreseeable	Hydrogeomorphology	River Infrastructure and Dam Safety	Pallid Sturgeon	Flood Risk Management	Hydropower	Irrigation	Thermal Power	Water Supply	Water Quality and Temperature	Recreation	Fish and Wildlife	Other Project Purposes	Cultural Resources	Tribal Interests	Environmental Justice
Missouri River Mainstem Reservoir System Construction	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Missouri River Recovery Mgmt Plan Implementation		X	X			X								X				
Missouri River Depletions for Agricultural, Municipal, and Industrial Use	X	X	X	X		X	X	X	X	X	X	X	X	X				X
Oil/Natural Gas Production	X	X	X			X					X	X		X		X	X	X
Groundwater Withdrawal	X	X	X	X					X		X	X	X	X				X
Urbanization and Development	X	X	X	X		X	X	X		X	X	X	X	X		X	X	X

Cumulative Action	Past	Present	Reasonably Foreseeable	Hydrogeomorphology	River Infrastructure and Dam Safety	Pallid Sturgeon	Flood Risk Management	Hydropower	Irrigation	Thermal Power	Water Supply	Water Quality and Temperature	Recreation	Fish and Wildlife	Other Project Purposes	Cultural Resources	Tribal Interests	Environmental Justice
Crop Production	X	X	X									X		X				
Fishery Stocking and Management	X	X	X			X							X	X				
Transportation and Utility Corridor Development	X	X	X			X	X	X						X		X	X	
Management of USACE Project Properties	X	X	X										X	X				
USFWS National Wildlife Refuge System Management	X	X	X			X							X	X				
Water Quality Management Programs	X	X	X			X						X	X	X			X	
Tribal Programs and Actions	X	X	X											X				
State Fish and Wildlife Management	X	X	X			X							X	X				
Yellowstone Intake Diversion Dam Modification	X	X	X			X								X				
Climate Change	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Step 4: Analyze Cumulative Impacts

For each resource, the actions identified in Step 3 are analyzed in combination with the impacts of the alternatives being evaluated. This analysis describes the overall cumulative impact related to each resource and the contribution to this cumulative impact of each alternative being evaluated. Cumulative impact analyses are presented for each resource in Chapter 3.

3.2 River Infrastructure and Hydrologic Processes

The flow of the mainstem Missouri River is influenced by precipitation and seasonal snowmelt that occurs throughout the basin, as well as flow regulation from mainstem and tributary dams. This section is an abbreviated description specifically focused on the Fort Peck Dam to Garrison Dam reach of the Missouri River. A thorough description of the Missouri River basin affected environment is contained within the *Missouri River Recovery Management Plan and Environmental Impact Statement*, Section 3.2, Volume 2 (USACE, 2018a).

3.2.1 Affected Environment

3.2.1.1 Basin Overview

The Missouri River is the longest river in the United States, draining one-sixth of the country. The river extends 2,341 miles from Three Forks, Montana at the confluence of the Jefferson, Madison, and Gallatin Rivers, to the confluence with the Mississippi River at St. Louis, Missouri. USACE and many other federal, state, and local agencies have constructed numerous water resource development projects within the Missouri River basin.

The Missouri River watershed covers an area of 529,350 square miles. The broad range in latitude, longitude, and elevation of the river basin and its location near the geographical center of the North American continent results in a wide variation of climatic conditions. Average annual precipitation ranges from as little as 8 inches in the northern Great Plains to as much as 40 inches in the higher elevations of the Rocky Mountains and in the southeastern portion of the basin.

The flows of the Missouri River have been altered by the numerous USACE projects with construction starting as early as the 1800s. Primary alterations include dams and reservoirs, flow regulation, channelization, and bank stabilization. Channelization has altered the river cross section and increased the depth and flow velocity within the river channel compared to the pre-channelization river. The stabilized channel, levees, and riverbed degradation (lowering) have reduced both the connection of the river with the floodplain and the amount of groundwater recharge in the remaining floodplain. In river segments with a degraded riverbed, the groundwater table has dropped.

River flows are made up of base and peak flows. Base flow consists of groundwater discharge and the drainage of soil moisture from the surrounding watershed of the Missouri River and its numerous tributaries. Unregulated peak flow consists of distinct flows of higher discharge as a result of large rainstorms and snow melting periods in spring and early summer. The magnitude, frequency, timing, duration, and rates of change of river flows affect the geomorphology, chemistry, human uses, and biological processes in the Missouri River.

Total annual runoff from the Missouri River varies considerably from year to year because of large variations in precipitation. The median runoff at Sioux City is 25 MAF—about 29 percent of this runoff enters above Fort Peck Dam, 42 percent enters between Fort Peck and Garrison Dams, 10 percent enters between Garrison and Oahe Dams, 3 percent enters between Oahe and Fort Randall Dams, 7 percent enters between Fort Randall and Gavins Point Dams, and 9 percent enters between Gavins Point and Sioux City. There are no additional mainstem dams controlling discharge between Gavins Point Dam and the confluence of the Missouri River with the Mississippi River. Some minor regulation that affects mainstem Missouri River flows may occur as a result of tributary reservoir operation such as the Kansas River basin. Refer to the Missouri River Management Plan EIS (USACE, 2018a) for further information.

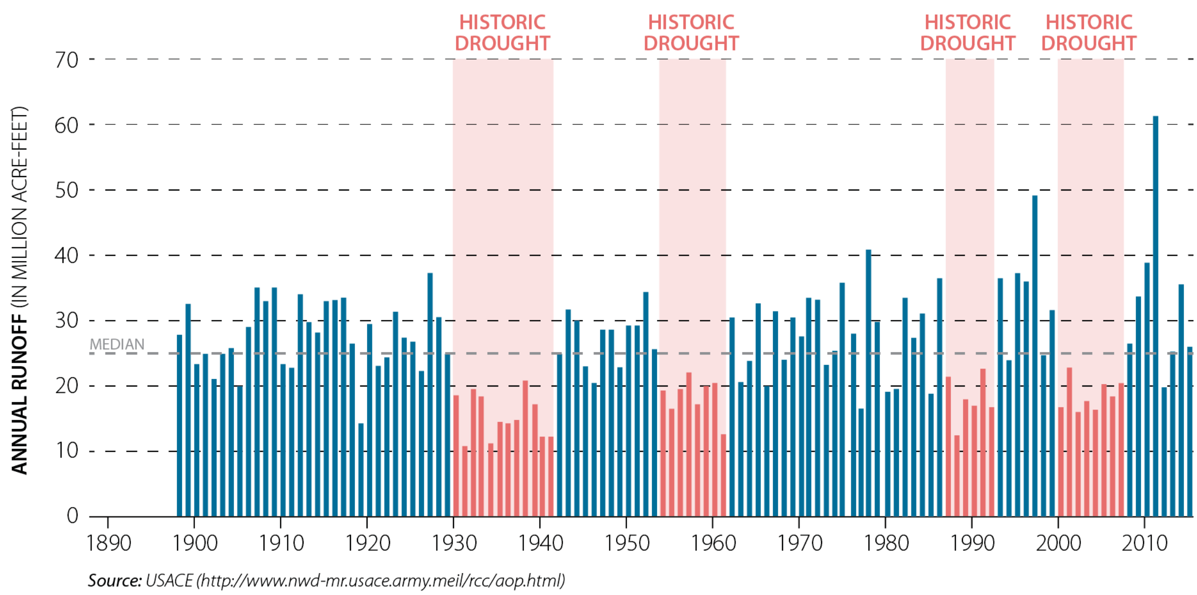


Figure 3-2. Annual runoff in the Missouri River upstream of Sioux City, Iowa (1898-2015) (USACE, n.d.)

Total annual runoff into the Missouri River varies considerably from year to year because of large variations in basin conditions and precipitation. Runoff into, and downstream from the System varies in terms of geographic distribution and seasonal fluctuation. Annual runoff, as measured above Sioux City (Figure 3-2) with adjustments for depletions, varied from 10.7 MAF to 61.0 MAF during the period of record (1898-2019). The average annual runoff at Sioux City is nearly 26 MAF – about 28 percent of this runoff enters above Fort Peck Dam, 42 percent enters between Fort Peck and Garrison Dams, 10 percent enters between Garrison and Oahe Dams, 4 percent enters between Oahe and Fort Randall Dams, 7 percent enters between Fort Randall and Gavins Point Dams, and 9 percent enters between Gavins Point and Sioux City. There are no additional mainstem dams controlling discharge between Gavins Point Dam and the confluence of the Missouri River with the Mississippi River.

In the period of record, the basin has experienced four periods of significant drought, including the 12-year drought from 1930-1941, the 8-year drought from 1954 to 1961, the 6-year drought that began in 1987 and ended abruptly with the flood of 1993, and the most recent 8-year drought that began in 2000 and ended in 2007. During the 2000-2007 drought, the System storage reached its historic low of 33.9 MAF, which made it the longest and most impactful drought since the System first filled in 1967. The record runoff of 61.0 MAF occurred in 2011. Four of the top six highest runoff years have occurred during the period from 2010 to 2019. Runoff in the lower river (from Sioux City to St. Louis) averages about 44 MAF (1967 through 2017), which accounts for 63 percent of the runoff in the basin.

Climate, upstream tributary depletions, and construction of reservoirs on the Mainstem and tributaries alter streamflows and affect basin runoff. Depletions and evaporation also affect runoff.

Groundwater and surface water evaporate in warm weather periods, primarily from April through October (USACE, 2006a). The average annual evaporation rate in the reservoirs of the Missouri River basin is less than 2 feet in the western Rocky Mountains and more than 6 feet in the plains area of western Kansas. Evaporation from the Mainstem reservoirs averages 3 feet annually. The description of the affected environment includes the major USACE actions in the basin and the ongoing water resource processes associated with those actions.

3.2.1.2 USACE Missouri River Mainstem Reservoir System

The Missouri River reservoir system (System) on the Mainstem consists of six dam and reservoir (lake) projects. USACE constructed, operates, and maintains these projects to serve congressionally-authorized project purposes of flood control, navigation, irrigation, hydropower, water supply, water quality, recreation, and fish and wildlife. Based on the most recent survey information at each project (collected between 2007 and 2012), the System has the capacity to store 72.4 MAF of water, which makes it the largest reservoir system in North America. To achieve these multipurpose benefits, the System is operated in a hydrologically and electrically integrated manner. It is noted that all reservoir elevations listed below are in feet based on the National Geodetic Vertical Datum of 1929 (NGVD 29).

- **Fort Peck Lake (Fort Peck Dam)**: The reservoir is 134 miles long and has a storage capacity of 18.5 MAF. Operating pool elevations range from a minimum of 2,160 feet to a maximum of 2,250 feet. Before 2011, the record flow release from Fort Peck Dam was 35,000 cfs (1975). In mid-June 2011, a record flow of 65,900 cfs was released. The shoreline of the reservoir is 1,520 miles long (with pool elevation at base of flood control).
- **Lake Sakakawea (Garrison Dam)**: The reservoir is 178 miles long and has a storage capacity of 23.5 MAF. Before 2011, the record flow release from Garrison Dam was 65,000 cfs (1975). In mid-June 2011, a record flow of 150,600 cfs was released. The shoreline of the reservoir is 1,340 miles long.
- **Lake Oahe (Oahe Dam)**: The reservoir is 231 miles long and has a storage capacity of 23.0 MAF. Operating pool elevations range from a minimum of 1,540 feet to a maximum of 1,620 feet. Before 2011, the record flow release from Oahe Dam was 59,000 cfs (1997). In mid-June 2011, a record flow of 160,300 cfs was released. The shoreline of the reservoir is 2,250 miles long.
- **Lake Sharpe (Big Bend Dam)**: The reservoir is 80 miles long and has a storage capacity of 1.8 MAF. Operating pool elevations range from a minimum of 1,415 feet to a maximum of 1,423 feet. Before 2011, the record flow release from Big Bend Dam was 74,000 cfs (1997). In mid-June 2011, a record flow of 166,300 cfs was released. The shoreline of the reservoir is 200 miles long.
- **Lake Francis Case (Fort Randall Dam)**: The reservoir is 107 miles long and has a storage capacity of 5.3 MAF. Operating pool elevations range from a minimum of 1,320 feet to a maximum of 1,375 feet. Before 2011, the record flow release from Fort Randall Dam was 67,000 cfs (1997). In late July 2011, a record flow of 160,000 cfs was released. The shoreline of the reservoir is 540 miles long.
- **Lewis and Clark Lake (Gavins Point Dam)**: The reservoir is 25 miles long and has a storage capacity of 0.4 MAF. Before 2011, the record flow release from Gavins Point Dam was 70,000 cfs (1997). In mid-June 2011, a record flow of 160,200 cfs was released. The shoreline of the reservoir is 90 miles long.

Released water from the lowest dam in the System, Gavins Point Dam, flows down the lower river, which includes the Missouri River BSNP, from Sioux City, Iowa, to St. Louis, Missouri.

3.2.1.2.1 Mainstem System Reservoir Storage

The combined storage capacity of all six Mainstem reservoirs is about three times the annual runoff in the basin above Sioux City, Iowa. The storage capacity of the System and each reservoir is divided into four storage zones for regulation purposes (Figure 3-3):

- **Permanent Pool**: Designed for sediment storage, minimum fisheries, and minimum hydropower heads.
- **Carryover Multiple Use**: Designed to serve all project purposes, although at reduced levels through a severe drought such as the drought in the 1930s.
- **Annual Flood Control and Multiple Use**: This zone is the preferred operating zone. Ideally, the System storage is at the base of this zone at the start of the spring runoff season. Spring and summer runoff is captured in this zone reducing flood risk between and below the Mainstem dams. The stored water is metered out through the remainder of the year to serve the other project purposes, returning the reservoirs to the base of this zone by the start of the next runoff season.
- **Exclusive Flood Control**: This zone is used only during extreme floods, and evacuation is initiated as soon as downstream conditions permit.

The total water volume in System storage gradually increased during the 1950s as the reservoirs filled and reached the base of the System's annual flood control zone for the first time in 1967. The reservoir filling period and subsequent System operation has dramatically altered stream flows within the basin.

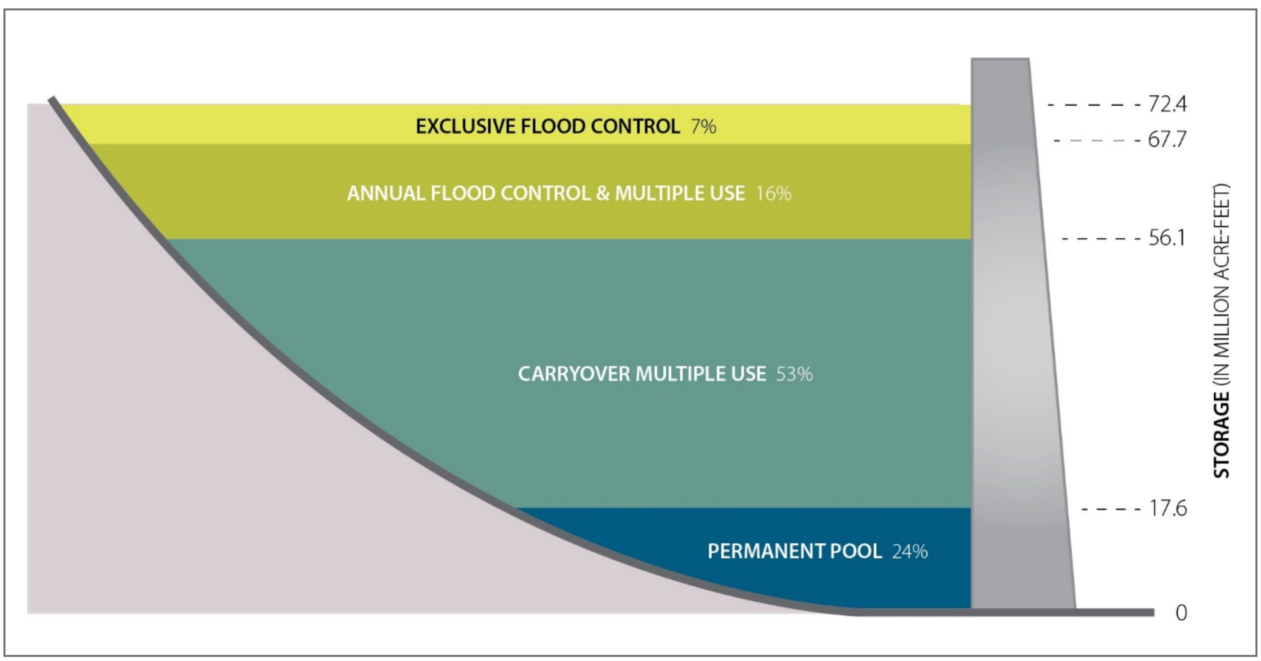


Figure 3-3. Missouri River Mainstem System storage zones and allocations (USACE, 2015a)

3.2.1.2.2 Mainstem Reservoir System Operation

The Master Manual records the basic water control plan and objectives for the integrated operation of the Mainstem reservoirs. The reservoir elevations and flow releases vary throughout the year as a result of reservoir operations that follow the Master Manual. The typical reservoir operation cycle for flood control, hydropower, navigation, water supply, irrigation, recreation, water quality, and fish and wildlife is shown in Figure 3-4.

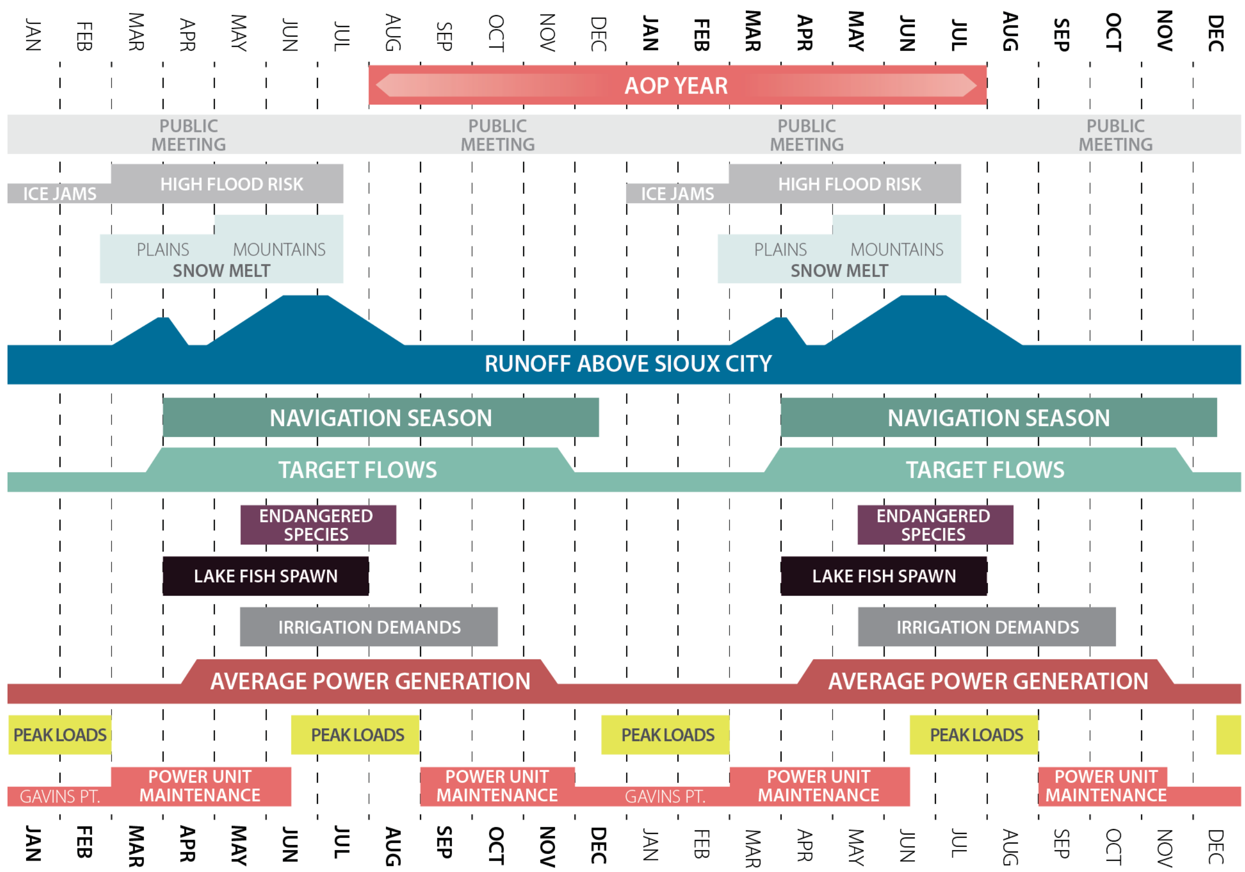


Figure 3-4. Typical system operation cycle

The Master Manual describes the water control plan for the System, which consists of the water control criteria for the management of the System for the full spectrum of anticipated runoff conditions that could be expected to occur. Annual water management plans (Annual Operating Plans, or AOPs) are prepared each year, based on the water control criteria contained in the Master Manual, to detail reservoir regulation of the System for the current operating year.

Because the System is so large, it can respond to extreme conditions of longer than one-year in duration. The AOP document also provides an outlook for planning purposes in future years (USACE, 2018b).

For a portion of some years, deviations may be made from the specific technical criteria stated in the Master Manual to allow the USACE to respond to conditions or emergencies that were not anticipated when developing the rule curves that are in the master manual. In such circumstances, the AOP will explain the deviation from the specific technical criteria and the rationale for that deviation related to the operational objectives or applicable statutory and regulatory requirements (USACE, 2018b). All deviations from the current water control plan will be coordinated and approved by the USACE Northwestern Division Commander. Deviations are presented to the public through press releases and World Wide Web dissemination. Minor changes to the AOP that are within the Master Manual guidance are accomplished by the Missouri River Basin Water Management Division.

Basin interests can anticipate continued public involvement in the water control management process and any significant water control plan revisions in the future will be processed in accordance with ER 1110-2-240.

3.2.1.3 Missouri River Channel and Floodplain

Historically, the Missouri River channel and floodplain geometry varied widely. The width of the main channel ranged from roughly 1,000 to 10,000 feet during normal flow periods and 25,000 to 35,000 feet during floods (Schneiders, 1999), resulting in a wide floodplain. The channel geometry continuously changed as varying flows and sediment loads in the river resulted in frequent erosion, deposition, degradation (i.e., lowering of the channel bed), and aggradation (i.e., raising of the channel bed); the formation of sandbars, mudflats, chutes, pools, log jams, whirl pools, and backwaters; and the development of meanders and cut-off channels (e.g., Skalag et al., 2013). The thalweg (i.e., primary flow channel) was narrow and highly variable in both location and depth. Most of these changes occurred during flood events.

The Missouri River channel and floodplain has been widely affected by the reservoirs, bank stabilization, infrastructure (e.g. roads, railroads, bridges, etc.), and many other works within the Missouri River valley. Missouri River main stem dam construction created an alternating system of open river reaches and reservoir pools. Degradation reaches located downstream of each dam are subject to scour, bank failure, and channel widening with generally lowering river stages over time. Aggradation reaches located in the reservoir pool headwaters are subject to sediment deposition resulting in an increase in river stages over time. Between the Missouri

River dams and the downstream reservoir pools, the boundary between degradation and aggradation reaches is somewhat ambiguous and may move several miles upstream or downstream depending on pool levels, stream flows, sediment loads, and other factors. Aggradation and degradation are further discussed in Section 3.2.1.13 Geomorphological Processes.

3.2.1.3.1 Reservoir Pool

The reservoir pools formed by dam construction are extremely large and cover hundreds of miles. The pools are not particularly noteworthy when discussing stage trends. However, reservoir pool location is an important factor in delta location. Prolonged drought, high runoff volume flow years, reservoir operations, and other factors all combine to affect pool levels. Evaluation of aggradation rates and stage trends within the delta reaches should consider that fluctuating pool levels were a factor in observed values.

3.2.1.3.2 Channel Capacity

Channel capacity refers to the flow conveyed by the Missouri River main channel that is near the top of bank such that all flow is contained within the channel without significant floodplain ponding or conveyance. Channel capacity has been affected by the ongoing processes of degradation and aggradation. The inter-reservoir reaches are bounded by a dam and degradation reach on the upstream end, and an aggradation reach near the reservoir delta headwaters on the downstream end.

The frequency of channel capacity exceedance in several reaches was compared with the HEC-RAS model for each of the inter-reservoir reaches and the reach downstream of Gavins Point Dam (USACE, 2018b). Releases exceeding channel capacity in the Garrison and Fort Randall reaches are of particular concern due to limited channel capacity in those reaches (approximately 35,000 cfs). Regardless of downstream tributary flows, a reservoir release equal to or greater than the channel capacity would cause some level of impact to adjacent property.

Flows and the capacity of the river channel have potential impacts such as flooding within each reach, as discussed further in Section 3.2.2.20, Flood Risk Management and Dam Safety. A tabulation of the previously determined inter-reservoir reach length and estimated channel capacity is provided in Table 3-2 (USACE, 2018b).

Table 3-2. Inter-reservoir reaches in the UMR and channel capacity

Inter-Reservoir Reach (at normal reservoir elevations)	Distance (river miles, approximate)	Channel Capacity [a] (kcfs, estimate)	Largest City along the Reach
Fort Peck Dam to Lake Sakakawea	204	35–40	Williston, North Dakota
Garrison Dam to Bismarck	75	55–60	Bismarck, North Dakota
Downstream of Bismarck to Lake Oahe	18	35–40	–
Oahe Dam to Lake Sharpe	17	(not available) [d]	Pierre, South Dakota
Big Bend Dam to Lake Francis Case (There is no inter-reservoir reach.)	NA	NA	NA
Fort Randall Dam to Lewis and Clark Lake [b]	52	35–40	Springfield, South Dakota
Gavins Point Dam to Rulo, Nebraska [c] (Lower River Reach)	313	80 to 85	Omaha, Nebraska

a The channel capacity estimate is based on an evaluation of hydraulic model results. The estimated channel capacity refers to the flow level at which significant water levels exceed bank elevations (may represent ponding water and not necessarily flow through connectivity). Values vary considerably within the reach and may change over time. Flow value is total flow at the specified location and includes both upstream reservoir releases and downstream inflows.

b Includes Fort Randall Dam to upstream of Niobrara River confluence (35 river miles), and upstream of Niobrara River confluence to headwaters of Lewis and Clark Lake (17 miles).

c This reach is not an "inter-reservoir reach" but it is a lower river reach that includes the somewhat natural condition, commonly referred to as the recreational river, for the first 60 river miles downstream of Gavins Point Dam (although significant degradation has occurred downstream of the dam). The reach also includes the upper 240 miles of the navigation channel from Sioux City, Iowa to Rulo, Nebraska. This reach includes the Nebraska City gage which was used in the channel capacity exceedance analysis (USACE, 2018; Section 3.12.)

d There is not a hydraulic model for this river reach. No channel capacity was estimated.

3.2.1.3.3 Bank Stabilization and Channelization Projects

The Missouri River is channelized in the lower river, downstream of Ponca, Nebraska, and unchannelized between Gavins Point Dam and Ponca and within the inter-reservoir reaches upstream of Gavins Point Dam (Table 3-2). Stabilization projects in the upper river inter-reservoir reaches have been comparatively small in magnitude. Stabilization along the Missouri River is typically constructed for the purposes of infrastructure protection, including irrigation intakes, and for general bank stabilization to limit bank erosion and loss of private lands.

A previous study, *Bank Stabilization Cumulative Impact Technical Analysis, Ft Peck, Garrison, Fort Randall, and Gavins Point Study Reaches (USACE, 2008)*, stated that the Fort Peck Dam to Lake Sakakawea reach has little to no bank stabilization while the Garrison Dam to Lake Oahe reach has about 29 percent of all bank stabilized. The Missouri River navigation reach extends from the mouth of the Big Sioux River just above Sioux City, Iowa, to the confluence with the Mississippi River near St. Louis, MO, for a distance of 735 river miles. The BSNP responsibilities include the operation and maintenance of 5,000 to 8,000 dikes, revetments, and additional structures between Omaha and Kansas City District. Construction of the BSNP was declared complete in 1980.

3.2.1.3.4 Large Wood and Snag Removal

The prevalence of large wood on the Missouri River has been noted in historic references including the Journals of Lewis and Clark (DeVoto, 1997). An 1881 report to Congress noted that the “cavings of the banks precipitates into the river countless trees” (Secretary of War, 1881).

USACE conducted Missouri River snag removal for navigation purposes starting in the 1800s. Wood structures and river snags provide biological diversity and also contribute to channel habitat diversity by altering depth, velocity, and sediment processes. Refer to the National Large Wood Manual (Bureau of Reclamation & USACE, 2016) for further information regarding the role of wood in fluvial aquatic and riparian ecosystems.

3.2.1.3.5 Fort Peck Reach Geometry

The Missouri River from Fort Peck Dam flows in an easterly direction for over 200 miles as an unchannelized river before entering the headwaters of Garrison reservoir downstream of Williston, ND. Major tributaries include the Milk, Poplar, Redwater, and Yellowstone Rivers. The Yellowstone River enters the Missouri River just upstream of the Garrison reservoir delta and influences only a short segment of the Fort Peck reach.

Major tributary streams entering the Missouri River on the north side of the valley between Fort Peck Dam and the Yellowstone River include the Milk River, Little Porcupine Creek, Wolf Creek, Poplar River, and Big Muddy Creek. The main tributaries entering from the south include Prairie Elk Creek and Redwater Creek along with numerous other smaller tributaries. The most important tributary in this reach is the Yellowstone River. The other tributaries are minor with a total contribution to the river flow in this reach that is generally less than about five percent.

The channel in this reach exhibits a meandering pattern with occasional straight reaches. The channel width ranges from about 450 feet to nearly 3,000 feet with an average width of about 1,000 feet. The energy slope for the Fort Peck reach, calculated from the HEC-RAS analysis, ranges from about 0.0003 to 0.0005 feet/feet. Bank heights in this reach generally range from about 10 feet to over 40 feet with an average bank height of about 20 feet (Biedenharn et al., 2001). Channel characteristics of this river reach include many sandbars, islands and side channels. Abandoned channels and several oxbow lakes remain in the floodplain. Upstream of Brockton, MT (River Mile (RM) 1660), the floodplain is about four miles wide and is bordered by rolling grasslands, dryland crops and rangelands. Downstream from this point, the floodplain narrows to a one-mile wide valley. The configuration of the uplands on the south side of the river is very broken and in several places badland topography exists. The valley width is relatively uniform, two to three miles wide, and is well entrenched in the terrain of the Montana prairies. The river flows through this valley in broad sweeping meanders alternately crossing the valley from side to side. Although the meandering pattern is well developed throughout the reach, several straight segments of river channel are also encountered.

The bottomland through which the river flows possesses a topography that clearly defines the different flow levels and the intricate channel courses the river has assumed throughout recent times. It is characterized by several distinct terraces which rise one above the other to a maximum height of approximately 10 feet above the present high water level of the river. The uppermost terrace defines the maximum stage of valley aggradation which occurred after the retreat of the last glacial ice-sheet from the region. The surface of this high terrace is uniformly level in a trans-valley profile and has a slope of approximately 1.3 to 1.5 feet per mile in a longitudinal direction. Generally, this terrace is devoid of tree or shrub growth and since the materials of which the terrace is composed consist of fine grained sands and silts, it is readily susceptible to the erosive action of the river in instances where the river impinges directly against this terrace. The younger terraces, which mark various stages of valley degradation during recent times, are generally covered with dense growths of cottonwood trees and willows. The lowest terrace consists of a maze of accretion deposits and small islands which have their surface only a few feet above the present high water surface of the regulated river (USACE, 2013a).

Since Fort Peck Dam entraps all upstream contributed sediment, the downstream river remains relatively free of suspended sediment until the Milk River confluence, which enters the Missouri River about 10 miles downstream of the dam, and other tributaries introduce their individual load contributions into the Missouri River (USACE, 2018b).

Bed material in the reach is predominately sand. Outcrops of gravel, cobbles, and dense clay are occasionally observed. As is often typical of rivers downstream of sediment trapping reservoirs, bed material tends to be coarser in the reach immediately downstream of the dam (Simon et al., 1999).

3.2.1.3.6 Fort Peck Aggradation and Degradation

Within the Fort Peck Dam to Lake Sakakawea reach, degradation extends from the dam downstream until tapering off between Brockton and Culbertson, MT. The Lake Sakakawea aggradation influence reach is generally considered to extend from Lake Sakakawea to upstream of the Yellowstone River confluence.

The degradation reach downstream of Fort Peck Dam has relatively high bank heights with greater channel capacity. A typical plan view and cross section within the Fort Peck degradation reach is shown in Figure 3-5. The figure includes an illustration of the inundation area at two flows as well as a cross section illustrating the main channel and floodplain. Refer to the *HEC-RAS Modeling Alternatives Report* (Appendix D) and the previous Management Plan EIS (USACE, 2018a) for further information.

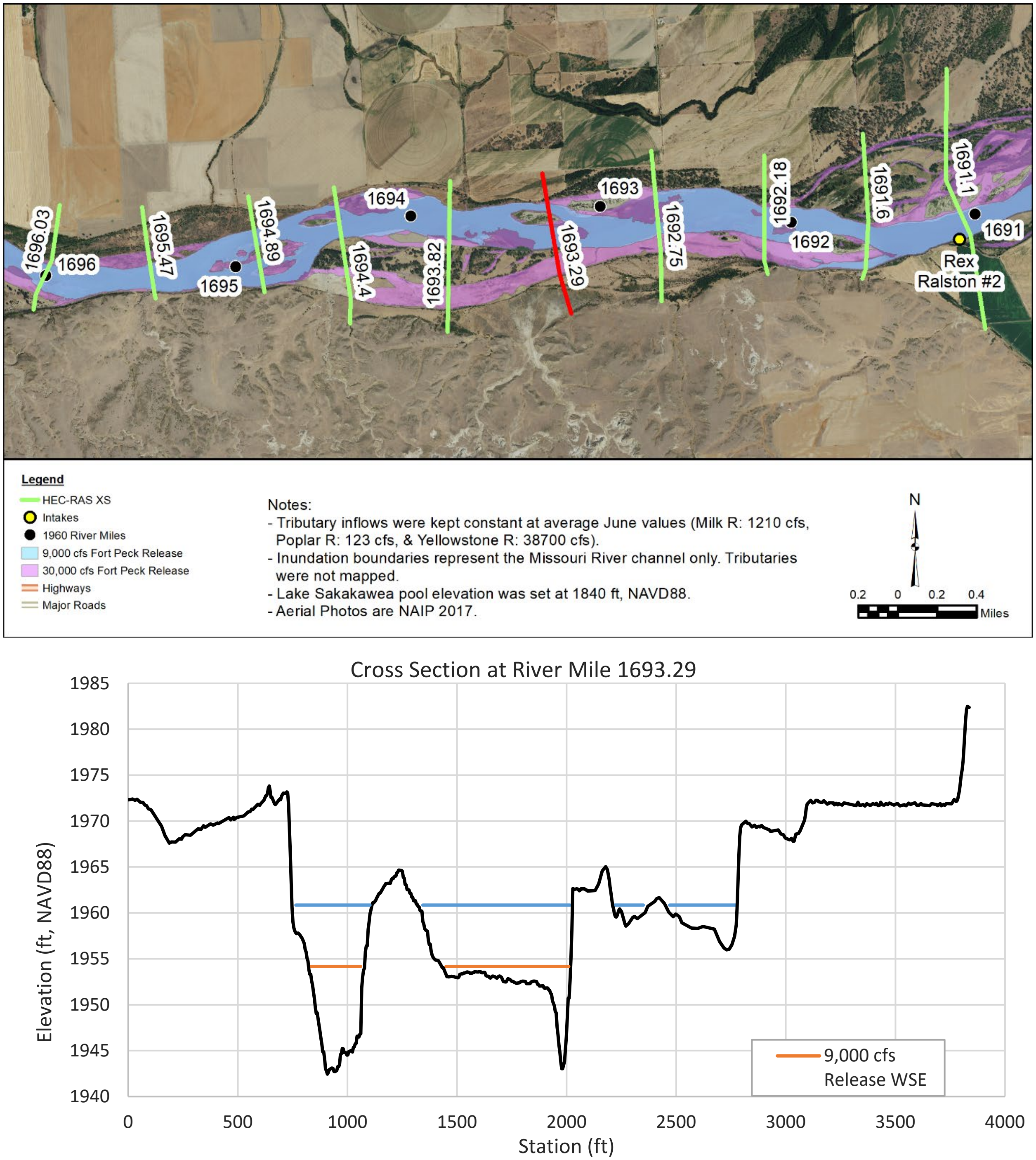


Figure 3-5. Missouri River plan view and typical cross section within the degradation reach

The aggradation reach in the Lake Sakakawea headwaters has lower bank heights and a wide floodplain. A typical plan view and cross section within the Fort Peck aggradation reach is shown in Figure 3-6. The figure includes an illustration of the inundation area at two flows as well as a cross section illustrating the main channel and floodplain. Refer to the *HEC-RAS Modeling Alternatives Report* (Appendix D) for further information.

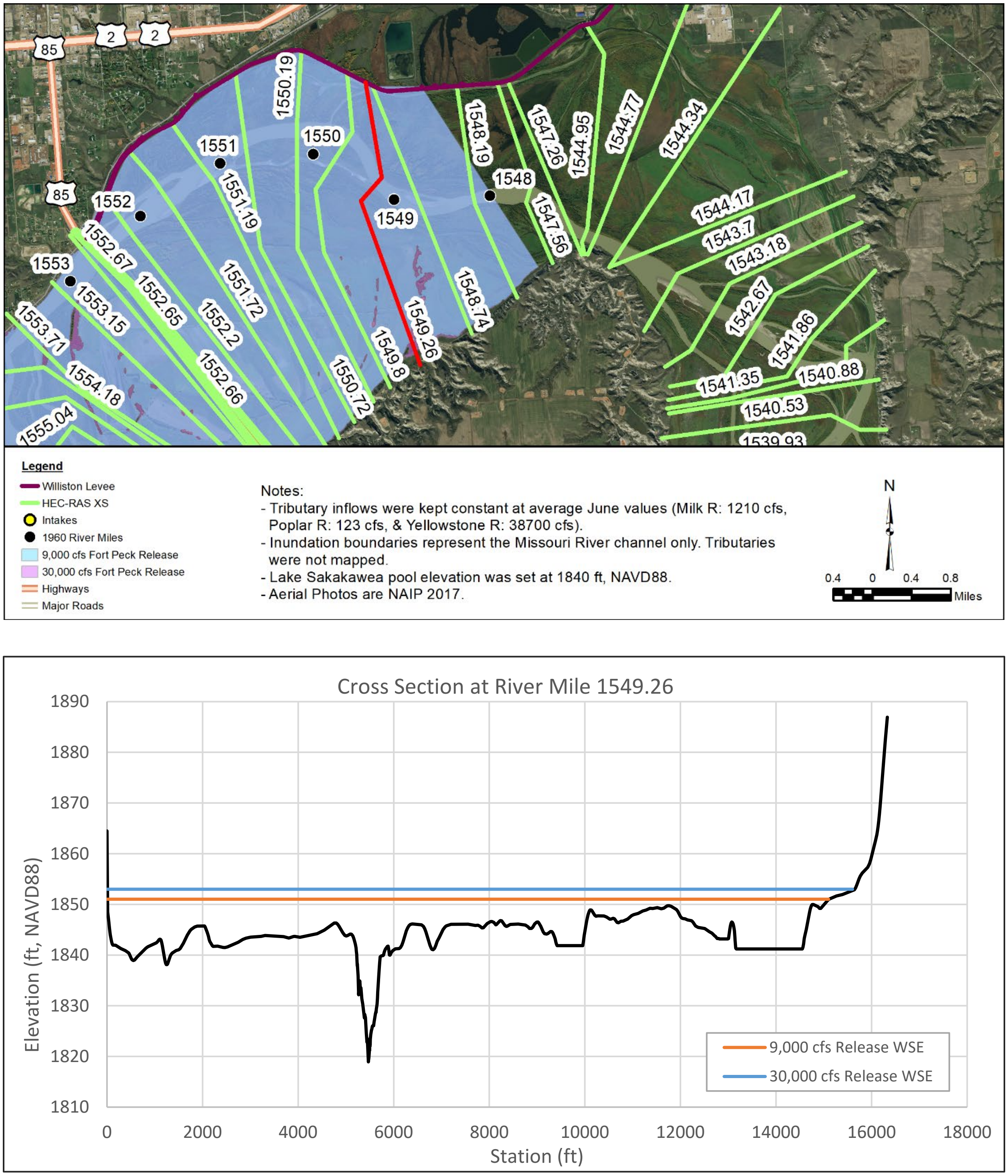


Figure 3-6. Missouri River plan view and typical cross section within the aggradation reach

3.2.1.4 Geomorphological Processes

Sediment is an integral part of geomorphological processes and important for building and sustaining habitats in a river system. The amount, size, type, and location of sediments in the river system affect the species of plants and animals occupying the various river habitats. Although sediment is trapped in the upper river by the reservoirs, the Missouri River continues to be a large source of sediment to the Mississippi River. Refer to the Missouri River Management Plan EIS (USACE, 2018a) for further information.

The six Mainstem reservoirs are located in the Great Plains portion of the Missouri River basin, where the slope is generally gentle and the bedrock is generally composed of shales and sandstones. The land surface consists of a mixture of glacial material, river deposits, and wind-blown sediment. Soils consist of a mixture of clay, silt, sand, and gravel. As a result of these unconsolidated materials, shorelines and the bottoms of the reservoirs and river reaches are highly erodible.

Sediment is transported by the river either as suspended sediment in the water column or as bedload along the channel floor. The suspended sediment load in the river is directly related to the turbidity of the water, which affects the types and densities of aquatic organisms. Bedload consists of coarser-grained sediment particles (sand and gravel), which can either be suspended for short periods of time or are rolling along the riverbed, depending on the flow velocity. Bedforms in the river include sandbars that change over time through flow-driven erosion and deposition processes.

Primary geomorphological processes that are relevant for the proposed management actions consist of channel degradation and bank erosion, reservoir sediment deposition and aggradation, sandbar erosion and deposition occurring within the river channel and in reservoir deltas, reservoir shoreline erosion, and ice dynamics.

An extreme event such as the one seen in 2011 results in significant sediment movement with corresponding observed stage changes in the aggradation and degradation reaches that greatly exceed long-term averages at many locations. Following an extreme flow event, most locations with large stage changes also experience some rebound over the next several years during a more normal flow regime.

3.2.1.4.1 Degradation and Bank Erosion Overview

Sediments carried by the UMR and its tributaries are deposited in the upper ends of the reservoirs. As a result, the river channel downstream of the dams deepens (degrades) as sediment that erodes from the channel floor is not replenished with sediment from upstream sources (e.g., USACE, 2014a). While degrading, the riverbed experiences progressive armoring. Armoring is the gradual loss of finer sediment particles and the buildup of progressively larger sediment grain sizes, such as gravel and cobbles. The channel bed at the mouths of tributaries entering a degraded reach of the Mainstem Missouri River may also degrade (i.e., head cutting). In some stretches of the river, the degradation rates have decreased substantially since the response to upstream reservoir construction, while in other stretches degradation continues to shape the river as it seeks its dynamic equilibrium. The term "degradation reach" refers to the area of general erosion of the channel bed and banks over a substantial distance downstream of each dam.

Multiple degradation impacts result from the lower river water levels and material removal. Typical impacts include damage to infrastructure such as water intakes and bridge piers, confined flows for future events which further concentrates main channel energy, reduced floodplain connectivity which affects the ecosystem, and lower groundwater levels which may adversely impact wetland areas and reduce the yield of such bottomland crops as corn and alfalfa.

Degradation and head cutting have led to increased erosion, aquatic habitat degradation, reduced fish access up some of the affected tributaries, and increased public expenditures to maintain infrastructure. Unprotected riverbanks along the Missouri River are also being eroded, but at a reduced rate in the absence of historic flood flows. Without overbank and sediment-laden flows, new high banks are not formed in the reaches immediately below the dams. Fewer flood flows have also led to less erosion of sandbars.

- **Fort Peck Dam to Lake Sakakawea**: Although most of the bed degradation below Fort Peck Dam occurred before 1966, some degradation continues in the upper and center portions of the 204-mile reach, causing some streambank erosion (USACE, 2004). Degradation below the dam (RM 1772) occurs at differing degrees to about RM 1650. Downstream of RM 1650, minor degradation has occurred during recent high flow events. The width of the river channel has not increased much as a result of streambank erosion. Streambank erosion rates for the entire reach were about 97 acres per year from 1975 to 1983 (USACE, 2004).
- **Garrison Dam to Lake Oahe**: Degradation of the riverbed below Garrison Dam (RM 1390) occurs primarily in the upper 35 miles of the 87-mile reach, although degradation rates began to level off around 1983 (USACE, 2004; USACE, 2012a). The riverbed below the dam degraded about 5 feet between 1950 and 1975, but further degradation is unlikely to occur, except during high-flow periods. The riverbed 25 to 50 miles below the

dam continues to degrade, but the rate of degradation also decreased after 1975. Since 1960, erosion of the streambed in this area has lowered the riverbed by approximately 4 feet. The channel widths for the first 20 miles below Garrison Dam have remained fairly constant, with the exception of the mouth of the Knife River (RM 1378) where sediment deposits have been decreasing the Missouri River channel width. Downstream of the Knife River confluence, the Missouri River channel is widening. Streambank erosion rates were 48 acres per year from 1978 to 1982 for the 93-mile reach.

- **Oahe Dam to Lake Sharpe**: This reach is relatively stable because of the short distance of open water and implementation of protective measures.
- **Fort Randall Dam to Lewis and Clark Lake**: From 1953 to 1997, the riverbed downstream of the dam degraded from RM 880 to RM 860 by up to 6 feet and the channel widened, although the rate of erosion decreased over this period (USACE, 2004). Streambank erosion since closure of the dam in 1953 has averaged about 40 acres per year.
- **Missouri River from Gavins Point Dam to Ponca, Nebraska**: Since 1955, erosion of the riverbed and streambank has been gradual (USACE, 2004). Degradation has been highest (about 10 feet) in the reach immediately below the dam, although the rate of riverbed erosion has diminished since 1980. Post-dam streambank erosion rates between 1956 and 2011 have averaged 120 acres per year, but have declined somewhat since 1975. Streambank erosion rates are higher during high flow events.
- **Missouri River from Ponca, Nebraska to St. Louis, Missouri**: Within this reach, degradation of the river channel continues down to the confluence with the Platte River near Omaha, Nebraska. Sediment supplied by the Platte River adds to stabilization of the river channel, although channel degradation still occurs in some reaches of the river between the Platte River confluence and the mouth of the Missouri River near St. Louis. Sand and aggregate mining contributes to degradation in the approximately 500-mile long reach between Rulo, Nebraska, and St. Louis, Missouri (USACE, 2017b). The large volume of material mined within approximately 50-miles of Kansas City, MO resulted in degradation of the riverbed by up to 7 feet between 1990 and 2005 (USACE, 2017b). Degradation may also occur over the short term as a result of specific hydrologic conditions in the river.

Streambank erosion rates in the lower Missouri River are lower than in the upper river because of extensive bank stabilization measures. Within the lower Missouri River, the primary geomorphic influence is the navigation channel which contains, in comparison to the historic river, fewer sandbars and side channels. Floodplain levees along much of the lower river have reduced overbank flooding, thereby decreasing water flows to old sloughs and chutes.

3.2.1.4.2 Bank Erosion Fort Peck Dam to Lake Sakakawea

Numerous studies of Missouri River bank erosion downstream of Fort Peck Dam have been conducted (ND & MT, 1991; Simon et al., 1999; USACE, 2008; USACE, 2018b). Bank erosion is typically described as a function of stream bed lowering, soil type, soil drainage, ice effects, and site river flow conditions. A study conducted by the U.S. Department of Agriculture (USDA) (Simon et al., 1999) concluded that important issues affecting streambank erosion along the Missouri River in the study reach are pore-water pressure effects from sustained high flows, ice-related effects, and the direct effects of an ice cover. Ice effects are particularly significant in channel-bed shifting and, therefore, the silting of pump sites along the river. A further study (Collison et al., 2002) concluded that the effects of an elevated flow release followed by a period of low flow is likely to have a detrimental effect on bank stability. They identified bank erosion impacts by both rapid drawdown and toe erosion during the sustained high flow levels. The different studies present many conclusions regarding bank erosion causes and future Missouri River bank erosion trends that are conflicting in some cases. A typical location along the Missouri River illustrating bank erosion is shown in Figure 3-7.

Figure 3-7. Typical Missouri River bank erosion sites (near RM 1680, 90 river miles downstream of Fort Peck Dam

3.2.1.4.3 Reservoir Sediment Deposition and Aggradation

The aggradation reach occurs when river flows enter the ponded or slack water area of a reservoir. As a result, flow velocity decreases and sediment particles begin to fall out of transport. The coarsest sediments deposit first continuing downstream, until all fractions have deposited in a progressively finer distribution, building a delta throughout the reservoir headwaters. The delta grows in both the downstream and upstream direction. The delta location also shifts with pool levels due to the interaction between river flow velocity, reservoir pool depth, and sediment transport. Aggradation causes an upward shift of the river stage-flow relationship (the river flows at a higher stage for the same flow).

The large Mainstem reservoirs capture and store the sediment load carried by the Missouri River upstream of Gavins Point Dam. A combined total of approximately 100,000 acre-feet of sediment enters the six Mainstem reservoirs annually (USACE, 2018b). Sediment is supplied by natural basin processes, intermittent erosion of the riverbanks and channel bars during flood events, and long-term trends such as channel bed lowering and erosion in degrading river and tributary segments. As of 2012, sedimentation reduced the originally available total storage capacity in the Mainstem Reservoir System by approximately 5 percent. Sedimentation rates have not been uniform between the reservoirs, with the highest rate occurring in Lewis and Clark Lake (formed by Gavins Point Dam), which has lost over 26 percent of storage volume as of 2011. However, the storage volume in Lewis and Clark Lake provides very minor System flood control capacity.

The effects of the alternatives on sedimentological and geomorphological processes in reservoir System deltas from flow releases would be small compared to the natural variability in river flows and sediment input; therefore, a detailed evaluation of variation between sediment processes for the various alternatives within the Mainstem Reservoir System deltas, including Lewis and Clark Lake, was not conducted.

Sediment is deposited slightly below the prevailing reservoir water level as flows enter the reservoir delta. Since this location shifts annually as pool levels vary, the delta formation process is intermittent and variable. Most of the loss to the capacity of the permanent pool zones throughout the System occurred during the filling period before 1967 (see Figure 3-3). Since then, the loss has been occurring primarily in the carryover multiple use zone.

Sedimentation has resulted in large deltas at the head of the reservoirs. Although these deltas continue to grow, the useful life of the three largest reservoirs, Fort Peck, Garrison, and Oahe, is at least several hundred years because of their large storage volume. However, the growing deltas have posed problems at many of the reservoirs. Sediment accumulation within the channel (aggradation) has resulted in elevated surface water and groundwater elevations at the head of Lake Sakakawea, Lake Oahe, and Lewis and Clark Lake. Higher channel beds also result in lateral shifts of the thalweg, leading to bank erosion.

Aggradation impacts due to the deposition of sediment along with higher water levels include effects to water quality, recreation, ground water levels, non-project lands, and power generation. The growing deltas have blocked boat ramps and cut off some reservoir arms. Boat ramps and fish spawning and rearing habitat are often concentrated in reservoir arms. Changes in reservoir elevations also lead to changes in sediment deposition patterns within the reservoirs. When reservoir elevations are lower, sediment is eroded from the deltas and is deposited farther downstream in the reservoir. With subsequent higher storage, sediment is again deposited farther upstream nearer to the head of the reservoir.

- **Fort Peck Dam to Lake Sakakawea**: Aggradation of the riverbed and in the Lake Sakakawea delta has caused a backwater impact between the reservoir and the mouth of the Yellowstone River that has resulted in flooding. USACE built levees in this reach to protect the City of Williston, ND and nearby agricultural lands.
- **Garrison Dam to Lake Oahe**: At the time Garrison Dam was constructed, the open water channel capacity at the City of Bismarck, ND, was approximately 90,000 cfs for a stage of 13 feet; however, aggradation decreased the channel capacity to approximately 50,000 cfs for the same stage by 1997 after 42 years of reservoir operation (USACE, 2006a). This trend was temporarily decreased in 2011 when high flows scoured out the channel.
- **Fort Randall Dam to Lewis and Clark Lake**: A relatively large loss of channel capacity has occurred in the river reach downstream of Fort Randall, in part because of the sediments from the Niobrara River deposited at its mouth, and because of aggradation in the Missouri River (USACE, 2006a). Refer to the previous Missouri River Management Plan EIS (USACE, 2018a) for further information.
- **Gavins Point Dam to St. Louis**. As stated above, sediment supplied by the Platte River and other tributaries adds to stabilization of the river channel. Aggradation of the river channel may occur locally, as well as on a short-term basis as a result of specific hydrologic conditions. Aggradation has also occurred locally on the floodplain, although specific causes and the persistence of aggraded sections are not well understood.

3.2.1.4.4 Stage Trends on the Missouri River

The measurement, evaluation, and reporting of changes to the geomorphology and the associated stage of the Missouri River from Montana to the Mississippi River have been performed routinely by the Corps of Engineers at irregular intervals since the dam construction era. Stage trends were affected by the record discharges from all six main stem dams in 2011 (USACE, 2012a).

Trends in river stages have been measured in tailwater locations (immediately downstream of dams that affect power generation), degradation reaches downstream of each dam, aggradation reaches in the headwaters of each reservoir, and the navigation channel. To summarize stage trend terminology and trends:

- Degradation reaches within the open river reach downstream of the dam are subject to scour, generally resulting in a lowering of the river stages over time.
- Due to the downstream reservoir pool level and limited length of open river reach, the degradation reach downstream of both Oahe and Big Bend Dams are short and stage trends in those reaches are minor or not measurable.
- Aggradation within the delta headwater locations are subject to sediment deposition, resulting in an increase in river stages within the delta and upstream over time.
- Reservoir pool levels impact both the location and magnitude of deposition in the aggradation zones.
- Certain locations along the navigation channel have been subject to various influences that have led to increases or decreases in stages over time (USACE, 2012a).

3.2.1.4.5 Sandbar Erosion and Deposition

The formation of sandbars is common in rivers with high sediment loads such as the Missouri River. Sandbars form within the river channel as well as in the delta of the river flowing into the reservoirs. Sandbars are as dynamic, as the flow and sediment transport that builds them. Their formation and changes over time are affected by variables such as channel width, streamflow, sediment load in the river, grain size, vegetation, and man-made infrastructure. In the managed system of the Missouri River, sandbars form and change both naturally and as a result of deliberate management actions as discussed in various sections within Chapter 2 (see also Fischenich et al., 2014).

The river downstream from Wolf Point, MT is characterized as depositional with numerous shifting sand bars. Despite depositional characteristics, several gravel bars occur in this reach. For example, Gardner and Stewart (1987) identified 14 gravel areas between Wolf Point and

Nohly varying in length from 61 m to 183 m (200 - 600 yards). Liebelt (1996) similarly identified gravel and cobble areas near Nohly. A detailed analysis of sandbar location and migration rate has not been performed although field observations support the conclusion that bar movement does occur and is a function of the river flow rate. A typical sandbar location along the Missouri River downstream of Fort Peck Dam is shown in Figure 3-8.

Figure 3-8. Typical Missouri River sandbar (near RM 1690, 80 river miles downstream of Fort Peck Dam)

3.2.1.4.6 Geomorphic Trends – Fort Peck to Culbertson

A study, *Missouri River Fort Peck Project Downstream Channel and Sediment Trends Study, USACE 2013,* was conducted to evaluate trends in the degradation reach downstream of Fort Peck Dam, roughly defined as Fort Peck Dam to Culbertson, using data collected by USACE since Fort Peck Dam closure in 1937. The study report documents historical channel and sediment data for the Missouri River degradation reach below Fort Peck Dam (USACE, 2013a). Analysis used sediment trend data collected between 1936 and 2012 for the 175-mile reach of the Missouri River downstream of the Fort Peck Dam in Montana. Study results determined degradation in the river bed and overbanks and bank erosion since the closure of Fort Peck Dam in 1937.

The data analyzed were primarily cross-section geometry from numerous field surveys conducted from 1936 to 2012 on 47 sediment ranges located in the reach. Sediment samples at the ranges were also collected for the survey years 1960, 1966, 1973, 1978, and 1984. Water surface profiles for selected years, which were calculated independently, were compared to determine overall elevation trends in the reach. The survey data were used to establish various river characteristics, which indicate how the channel has changed over time in terms of bed elevation, top width, and degradation or aggradation at individual sediment ranges. Trend analysis conclusions for the primary processes evaluated, water surface elevation change, stage trends, bed material, and bank erosion rates, are provided in the following sections:

Water Surface Profiles

Adjusted water surface profiles for three discharges (10,000 cfs, 20,000 cfs, and 30,000 cfs) were analyzed.

- Overall, the water surface profiles have decreased between 1950 and 2012. However, the decrease has not been steady over the entire period or study reach. Decreases occurred from 1950 to 1966 and 1975 to 1984, while increases occurred from 1966 to 1975, and 1984 to 1995. The largest decreases occurred from 1995 to 2012, as a result of the high flow years of 1996-97 and the extreme flows of 2011.
- From 1950 to 2012 at the 10,000 cfs flow, the reach average decrease was 2.4 feet, of which 1.3 feet (or 54%) occurred in the 1995 to 2012 period. At 20,000 cfs, the 1950 to 2012 reach average decrease was 3.1 feet, of which 2.3 feet (or 74%) occurred in the 1995 to 2012 period. At 30,000 cfs, the 1950 to 2012 reach average decrease was 3.4 feet. However, for this flow, the water surface profile decreased 4.6 feet in the 1995 to 2012 period, which more than offset the significant increase (3.5 feet) observed in the 1984 to 1995 period. A summary of the average change in water surface elevation (feet) for the entire study reach is shown below for each adjusted water surface profile in Table 3-3.

Table 3-3. Average change in water surface elevation within the Fort Peck degradation reach

Adjusted Flow	1950 to 1958	1958 to 1966	1966 to 1975	1975 to 1984	1984 to 1995	1995 to 2012	1950 to 2012
10,000 cfs	-0.8	+0.2	-0.2	-0.7	+0.4	-1.3	-2.4
20,000 cfs	-0.6	-0.9	+0.8	-0.8	+0.7	-2.3	-3.1
30,000 cfs	-0.4	-1.8	+0.4	-0.7	+3.5	-4.6	-3.4

Stage Trends – Degradation Reach

A stage-trend analysis was performed at stream gage locations along the study reach: West Frazer Pump Plant (RM 1751.33, approximately 18 miles downstream of Fort Peck Dam), Wolf

Point (RM 1701.31, 68 miles downstream of the dam), and Culbertson (RM 1620.76, 148 miles downstream of the dam).

- Significant stage fluctuations were seen at the West Frazer gage, particularly for the higher flows. This gage is located 10 miles downstream of the Milk River confluence and 11 miles below the Fort Peck spillway. Trends are likely influenced by both sediment-laden Milk River flows and extreme events with spillway discharge. Overall, from 1950 to 2011 there is a downward stage trend, with decreases of 2.4 feet (10,000 cfs), 2.8 feet (20,000 cfs), and 2.6 feet (30,000 cfs). The 2011 event did not appear to have a major impact at the West Frazer gage.
- At the Wolf Point gage, there is a downward stage trend from 1950 to 2011, with decreases of 3.0 feet for the 10,000 cfs flow, 4.5 feet for the 20,000 cfs flow, and 5.3 feet for the 30,000 cfs flow. The Wolf Point gage experienced larger decreases in stage than at the other two gages, and less fluctuation than the West Frazer gage. While data between 1985 and 2011 were limited for the higher flows, the 2011 event appeared to cause a decrease in stage at this gage.
- For the Culbertson gage, from 1950 to 2011, there are decreases of 1.1 feet at 10,000 cfs, 2.0 feet at 20,000 cfs, and 2.7 feet at 30,000 cfs. Overall, the Culbertson gage station experienced smaller decreases in stage than the Wolf Point gage and smaller (or similar) decreases compared to the West Frazer gage. However, of the three gages, Culbertson had the most significant decrease in stage from the 2011 event compared to previous periods.

A summary of the change in stage (feet) between 1950 and 2011 is provided below in Table 3-4.

Table 3-4. Stage trend summary at available gage stations within the Fort Peck degradation reach

Flow	West Frazer (RM 1751.33)	Wolf Point RM 1701.31	Culbertson RM 1620.76
10,000 cfs	-2.4	-3.0	-1.1
20,000 cfs	-2.8	-4.5	-2.0
30,000 cfs	-2.6	-5.3	-2.7

Bed Material

Overall, bed material near the dam is coarser and more varied, with a median bed material size ranging from 0.2 mm to 13 mm. Downstream of RM 1720, the bed becomes uniformly finer, with the median bed material size remaining relatively consistent at 0.2 mm for all years, except for 1978. These bed samples indicate the most recently deposited or exposed sediments at the sampling location at the time of the sample, and do not necessarily represent the bed material loads for the river. It should also be noted that no bed material data has been collected since 1984; therefore, recent trends seen in the water surface profiles and gage trends would also likely be reflected in changes to bed material size.

Bank Erosion Rates

Bank erosion rates were determined from Fort Peck Dam to the Yellowstone River using data from 1975, 1983, and 1990. There was an observed increase in the erosion rate for the 1983 to 1990 period compared with the 1975 to 1983 period. The average total annual erosion rate from 1975 to 1983 was approximately 88 acres per year, while the erosion rate from 1983 to 1990 was 127 acres per year. Using an average bank height of 15 to 20 feet, bank erosion rates are approximately 1-2 ac-ft/river mile/yr. Erosion rates for other periods were not determined due to limited data availability.

A previous study, *Bank Stabilization Cumulative Impact Technical Analysis, Ft Peck, Garrison, Fort Randall, and Gavins Point Study Reaches* (USACE, 2008), determined a total bank and channel erosion rate of 13 ac-ft/river mile/year for the Fort Peck Dam to Lake Sakakawea reach using the most recent available data set from 1978 to 1994. The bank erosion rates determined in the two studies illustrate the high uncertainty in this type of analysis.

3.2.1.4.7 Aggradation Trends Downstream of Culbertson to Lake Sakakawea

An aggradation study (USACE, 2014) developed an estimated 50-yr future water surface level for a range of Lake Sakakawea and Missouri River flow conditions. This study determined an increase in the future condition water surface levels due to aggradation. Water level rise rates downstream of the Yellowstone River were estimated to be in the range of 0.1 to 0.2 ft/yr. A stage trend analysis was also performed at the Williston, ND, USGS gage station using available data as shown in Figure 3-9. Geomorphic trends in the Williston vicinity are further discussed in Section 3.2.6 Flood Risk Management and Dam Safety.

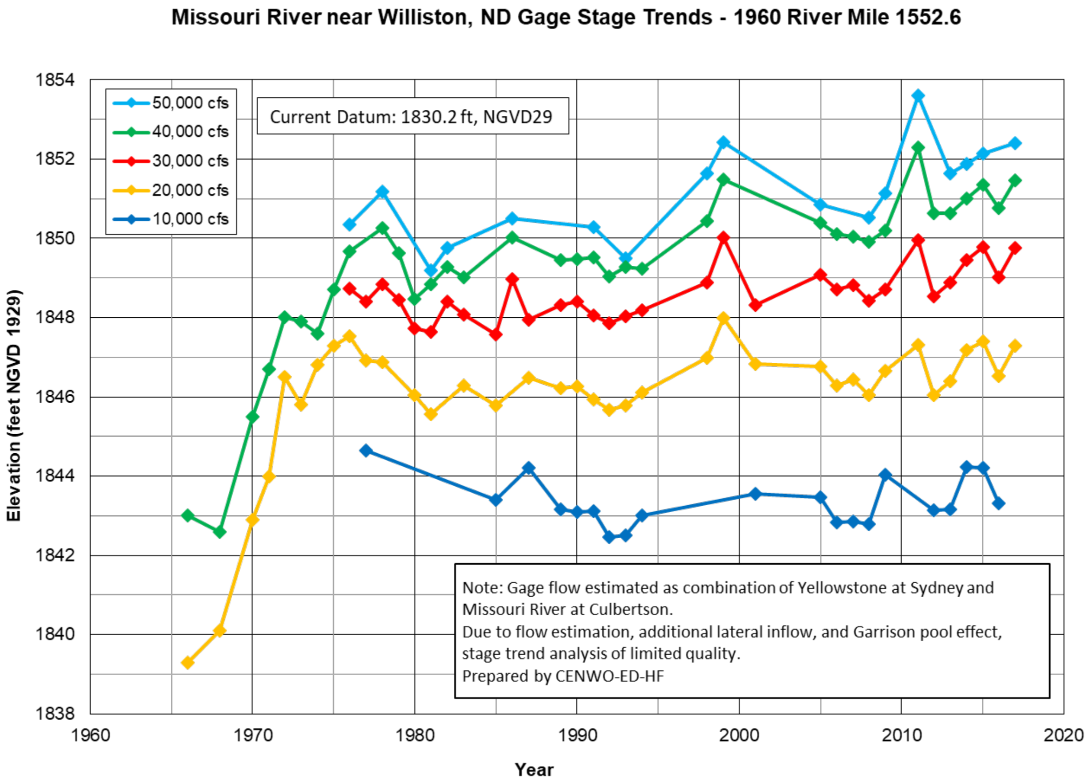


Figure 3-9. Williston, ND USGS gage stage trends

3.2.1.4.8 Reservoir Shoreline Erosion

The shoreline near the top of the reservoirs tends to be highly erodible silty, wind-blown soils of the plains, particularly along Lakes Sakakawea and Oahe. In addition, wave and ice actions lead to accelerated erosion in the form of slumping cut-banks. The cut-banks are continually slumping into the reservoirs at rates as high as 20 feet per year. At such rates, protective vegetation does not have sufficient opportunity to take root and reduce further erosion.

Bank erosion rates are affected by seasonal and annual water-level fluctuations as a result of reservoir regulation. Generally, the erosion rates are much higher at higher reservoir elevations. However, some shoreline segments with more consolidated and coarser-grained material experience lower erosion rates. For example, high gravel or cobble content in the soil results in armoring at the toe of the cut banks and reduced erosion rates. Lower water elevation exposes silt deposits; subsequent drying causes hardened soils that do not revegetate. Lower water elevations also allow waves to erode shorelines and terraces that were previously protected by higher reservoir elevations. Erosion during lower reservoir elevations may further undermine cut-banks and possibly lead to larger slides or bank cave-ins (USACE, 2004).

Long-term shoreline erosion rates in most areas have decreased substantially since dam closures. However, erosion of the reservoir shorelines is expected to continue to some extent throughout the life of the projects. The majority of eroded material usually remains immediately offshore, forming a flat beach slope. As a result, the perimeters of the reservoirs are slowly becoming shallower and wider. In some cases, sediment moves along shore in the direction of the prevailing wind or current and collects in deeper channels of tributary arms. Some reservoir arms are filling and being cut off by these reservoir sediments and collapsing cut-banks. Erosion of shorelines adversely affects recreation facilities and numerous historic and cultural properties. The thousands of miles of shorelines in the reservoirs remain largely unprotected because the costs of protection are high.

3.2.1.4.9 Ice Dynamics

River ice dynamics refer to the pattern of ice formation, breakup, and movement on the Missouri River. Aspects of ice dynamics, such as the time and duration of ice formation and the location and size of ice cover, play a role in physical and biological processes. Moving ice sheets can scour riverbanks and shallow parts of the channel and disturb shoreline vegetation. When ice forms on the river during extreme low-flow conditions, it can limit oxygen supply to the covered waters. Ice jams interfere with river flows and can cause temporary, localized flooding (upstream) and flow depletion (downstream), and their break-up can cause temporary, localized high-flow events. Ice jams can also affect water supply. Ice dynamics within reservoirs can result in reservoir bank damage and accelerated erosion rates. Altering reservoir levels, combined with delta location, are factors in the location and severity of spring ice jams and breakup processes. Alteration of river ice dynamics therefore can disturb a river ecosystem.

USACE operates the Mainstem reservoir releases in winter to minimize problems with ice; however, sometimes problems cannot be averted. The potential for ice cover and resulting problems at any given location along the Missouri River is a function of cold weather intensity and flow discharge. River ice is more prevalent in the upper river, but it is also a factor in the lower river. Mainstem dam releases are adjusted to consider ice conditions; minimum releases from Gavins Point Dam are 3,000 cfs higher during the winter (December through February) than during any non-navigation periods before and after to adequately serve water supply intakes downstream.

Although ice-induced flooding can occur anywhere along the Missouri River, ice dynamics is of heightened concern for the Bismarck-Mandan area in North Dakota. At the beginning of winter when ice cover is forming, river stage usually rises several feet in a short period of time.

During the ice-out period, there is a high risk of ice jams and river stages can fluctuate drastically with little to no warning. Typically, USACE would temporarily reduce releases from Garrison Dam to prevent ice-induced flooding during freeze-in and ice-out periods as conditions permit.

3.2.1.4.10 2020 Site Stability Observations

During irrigation intake site surveys conducted by USACE in the Summer of 2020, observations were also made to support a qualitative stability assessment. The survey team member briefly evaluated the surrounding area of the pump intake to identify indicators about the pump site's streambank stability. These indicators, such as streambank mass wasting or sandbar formation, were documented with photos and brief notes at each site. While most sites were stable enough to support reliable pumping operations, several recurring indicators spoke to the susceptibility of the site to bank erosion and sandbar movement.

Site conditions were assessed by looking for the presence of river process indicators that are often associated with stability. Erosion was a common indicator throughout the surveyed river reach, as multiple sites had varying degrees of streambank and vegetated coverage. Pump intakes near the main channel often had more undercutting of the streambank toe and prevalence of mass wasting. Pump intakes near side channels generally were subjected to smaller flows and exhibited greater vegetation coverage and less streambank erosion. However, this was not always the case. Similarly, due to the prevalence of mass wasting throughout the reach, floating debris was observed at the time of the survey and/or documented as a concern by the landowner.

The presence of sandbars at or near the pump sites also highlighted the river's sediment movement potential. Several sites had sandbars adjacent or near the pumps, or visible from the site. While no exact sediment analysis was done at each site during the course of these surveys, the visual prevalence of silt and sand sediment types indicates bank vulnerability to rapid drawdown due to pore-water pressure buildup following sustained high flows.

Figure 3-10 presents the total number of visual citations of these indicators at the surveyed pump sites. For example, erosion was observed at nearly all sites. The results suggest that multiple instability indicators were present at each of the pump sites, and their combined contributions should be considered when evaluating site stability.

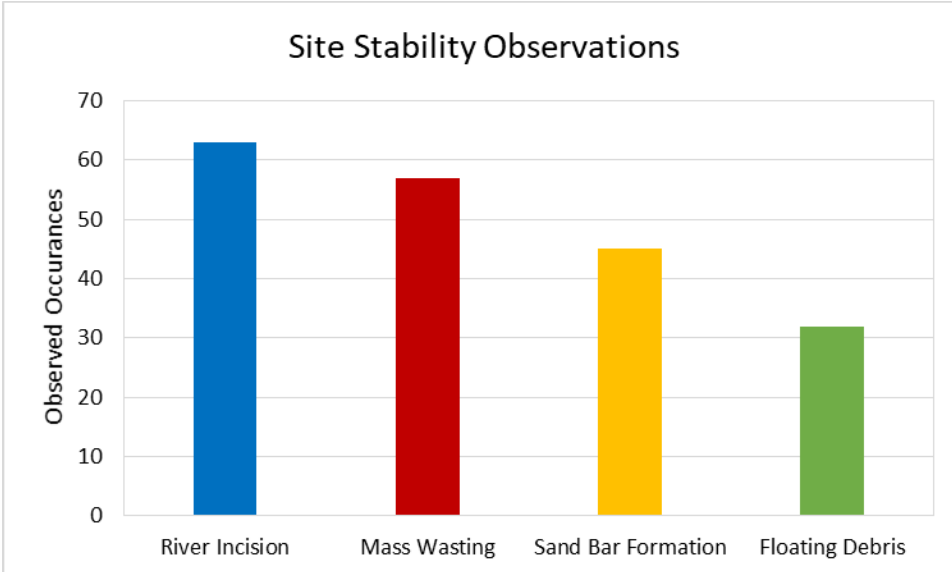


Figure 3-10. Presence of Streambank Stability Indicators at Surveyed Irrigation Pump Sites

The bank steepness at each site was classified as either vertical, steep, or not steep. Results for all sites are shown in Figure 3-11. Nearly half of all sites have vertical banks.

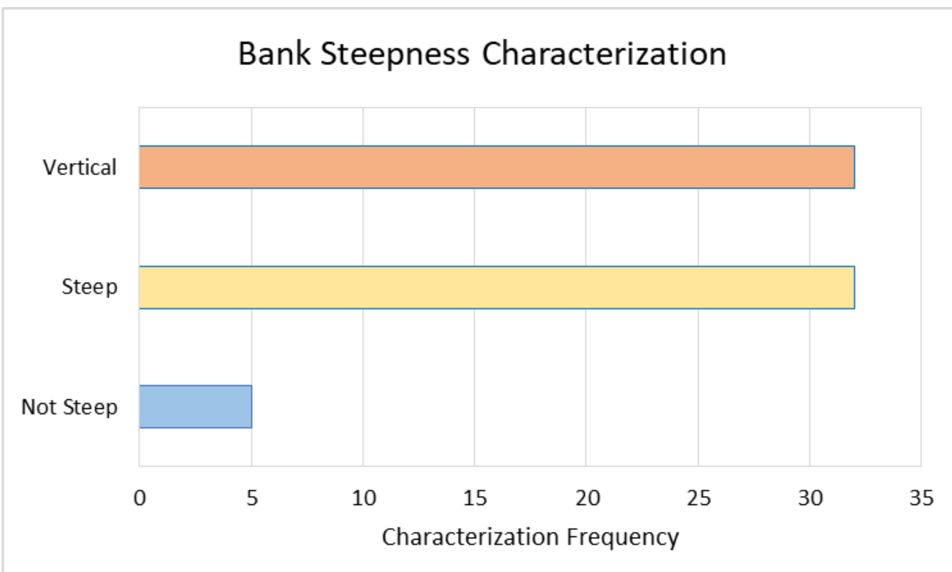


Figure 3-11. Observations of Stream SteepnessGroundwater

Groundwater elevation is a key factor in the composition and spatial distribution of vegetation communities and their associated fauna across the floodplain. Groundwater in the alluvial sediments of the floodplain, also referred to as the alluvial aquifer, supplies water to floodplain plant and wetland communities (e.g., cottonwood floodplain forests), particularly during dry, late summer periods. The elevations of the groundwater table in the alluvial aquifer vary in response to factors such as river stage, precipitation, and evapotranspiration. These elevations are also affected by human activities such as groundwater pumping, intentional drainage of floodplain soils, and alterations to the shape and hydrology of the Mainstem and side channels of the river.

- **Inter-Reservoir Reaches in the Upper River**: Within the degradation reach downstream of each dam, lower riverbed elevation lowers the local groundwater table, which affects vegetation and side channels. Within the reservoir delta deposition zones (aggradation areas), groundwater levels are generally rising and can affect vegetation, including crop yields in farmlands around the delta. Areas in the vicinity of the reservoir pool experience fluctuating groundwater levels because the reservoir elevation typically varies seasonally.
- **Lower River**: Groundwater tables generally rise and fall with the stage in the river. Many floodplain wetlands and riparian communities are sensitive even to small changes in groundwater table elevations. As a consequence of navigation channel construction and the formation of accretion lands from that process, combined with bed degradation, levee construction, and other local water resource projects, drainage has improved on the floodplain and accreted lands have been developed for agricultural purposes. Along the channelized river, relatively few oxbow lakes and isolated backwaters remain (compared to the historic channel prior to navigation channel construction). These areas are passively maintained by groundwater seepage or surface inflow, or actively maintained by pumping of groundwater or surface water. Although still important resources, the separation of these isolated oxbows and backwaters from the river channel has reduced their functional value as habitat.

3.2.1.5 Flood Risk Management and Dam Safety

The Mainstem Reservoir System provides flood control storage volume (USACE, 2018b) and is operated to reduce the risk of flood damage in the reaches downstream from the dams. Regulation of individual reservoirs is coordinated to reduce the risk of damaging releases from a particular reservoir. The usual reservoir operation is to store flood inflows, which generally extend from March through July, and to release them during the remainder of the year. Most of these releases are made before December. Winter releases are restricted due to the formation of ice bridges and the associated higher river stages. The objective is to have reservoir levels lowered to the bottom of the annual flood control and multiple use zone by March 1 of each year. Upstream from Gavins Point Dam, releases from Garrison Dam are reduced during periods of ice formation until an ice cover is formed, after which releases can be gradually increased. Minimal ice problems exist directly downstream from Big Bend Dam due to its proximity to Lake Francis Case.

3.2.1.5.1 Dam Safety and Fort Peck Spillway

The document *Ft Peck Dam, Spillway Test Flow Proposed Repairs and Modifications*, Omaha District, Sep 2019, describes the spillway and operating concerns. Fort Peck Dam spillway is located about three miles east of the main embankment right abutment. The primary function of the spillway is to release surplus water from the reservoir to prevent overtopping and possible failure of the dam. The Fort Peck outlet works does not function as originally intended. Control of flow through the outlet works with the cylinder gates (ring gates) proved to be unreliable and revealed many operational problems that resulted in high maintenance costs. It was last operated at a maximum flow rate of approximately 20,000 CFS in the 1970's according to an NWO Report entitled, "Ft. Peck Spillway Damage/Operation Scenario July 1997". According to current operating practice, all releases that are greater than powerhouse capacity are released through the emergency spillway.

The spillway was not designed to be used for regular releases. During periods of prolonged drought, the spillway crest elevation will be above the lake elevation and spillway releases are not possible. Using the Fort Peck annual pool probability relationship presented in the *Hydrologic Statistics Technical Report* (USACE, 2013b), the spillway crest elevation is exceeded about 65 to 70% of the time annually. Pool levels vary monthly. Normal releases are through the powerplant which has a maximum release capacity of about 14,000 to 16,000 cfs depending on pool elevation and other factors.

Spillway Structure. The spillway consists of an approach channel, a reinforced concrete gate structure, a reinforced concrete-lined discharge channel, a concrete cutoff structure at the end of the discharge channel and an unlined channel to the Missouri River.

Gate Structure. The spillway crest elevation is 2225 feet local project datum (LPD). The reinforced concrete gate structure is 820 feet long and set on a curved line. It consists of 17 piers between which are 16 electrically operated vertical lift steel gates, each 25 feet high and 40 feet wide. The piers support a highway bridge, a service bridge, walkways, and a gate operation platform.

Discharge Channel. The 5,030-foot concrete-lined discharge channel varies in width from 800 feet at the gate structure to 130 feet at the downstream end. There is a sub-drain system which was designed to relieve uplift pressures beneath the discharge channel slab. The channel terminates at elevation 2011.0 feet LPD with a cutoff wall.

Cutoff Wall Structure. The cutoff wall structure is located at the end of the spillway discharge channel and was constructed using cellular concrete. The wall extends to a depth 70 feet below the original spillway channel invert to elevation 1941.0 feet LPD, and also includes wing walls. The main section of the cutoff structure which spans the channel is 229 feet wide. The wing walls extend 260 feet at an angle of 45 degrees.

Roller Compacted Concrete (RCC) Plunge Pool. An RCC plunge pool structure was constructed immediately downstream of the cutoff wall structure after the 2011 high water event to improve the stability of the existing cutoff structure. A significant portion of the scour hole was filled with RCC and tieback anchors were installed through the existing cutoff wall. In addition, training walls were installed to facilitate placement of backfill to support the existing cutoff structure wing walls and to help divert erosive flow away from the cutoff structure. This resulted in the creation of a 350-foot long RCC apron at the downstream end of the cutoff structure that was anchored into the underlying Bearpaw shale foundation and covered with a 2-foot thick reinforced concrete cap.

Downstream Unlined Channel. Downstream of the spillway discharge channel and cutoff structure, an unlined discharge channel continues for a length of approximately 2,700 feet to the Missouri River. Channel excavation consisted of a bottom width of 130 feet, side slopes of 2H on 1V, and a flat gradient at an elevation of 2010 feet LPD. After exiting the shale bluff, a 12-foot wide pilot channel was excavated through the river floodplain to the Missouri River. Following construction, spillway flows have significantly altered the channel cross-section. Sustained spillway operation is projected to continue to erode the spillway discharge channel within the weathered Bearpaw shale.

Previous Spillway Operations. The spillway at Fort Peck has been used to evacuate flood pool when flows above the powerhouse capacity are required. The System had filled and was fully operational in 1967 (USACE, 2018b). Since that time, flood releases to supplement the powerhouse has been necessary on multiple occasions. In 2011, Fort Peck Dam was subjected to large inflows and resulting high pools that required spillway operation for approximately 4 months at record discharge rates, with a peak discharge of 52,000 cfs. Operation details since 1967 are provided in Table 3-5 and illustrated in Figure 3-12. Operations prior to 1980 include a combination of spillway and outlet releases. Since operations now avoid using the outlet works, the historic releases from both the spillway and outlet works were combined to indicate the frequency when flows in addition to powerhouse capacity were needed to manage reservoir pool levels.

Table 3-5. Fort Peck summary of historic operations

Number of Years in Period (1967-2019)	Number Years Operated*	% Years Operated*	Total Days Operated*
59	9	15%	886

* Does not include test flow periods of operation with spillway flow less than 1000 cfs; tabulated values are from the combined historic operations of spillway and outlet works.

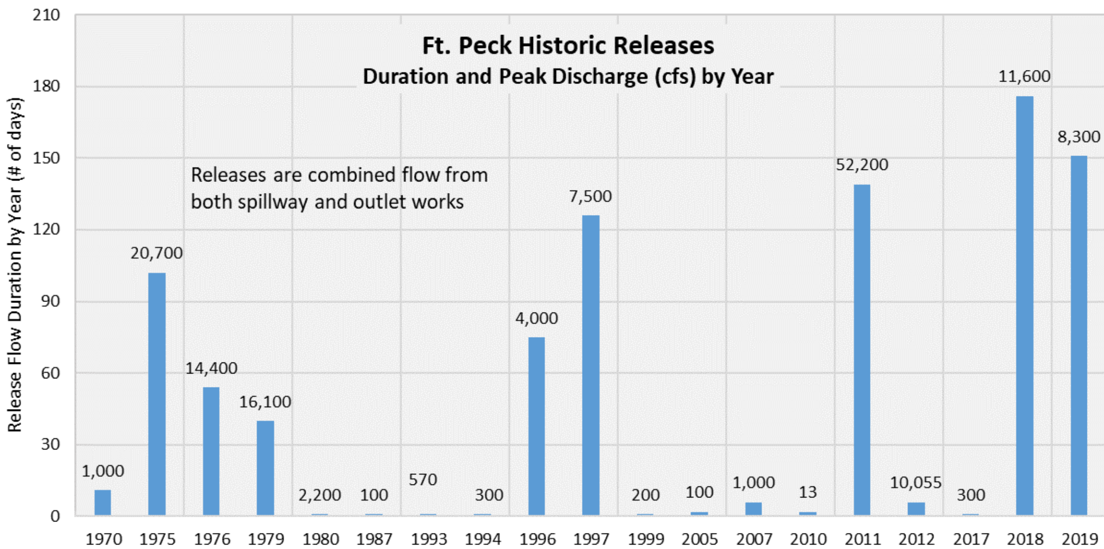


Figure 3-12. Fort Peck operations summary since 1967 with non-powerhouse flow releases

As shown in Figure 3-12 there have been 8 years since 1967 with sustained releases above powerhouse capacity that were longer than 30 days.

During the flood of 2011, the spillway was used for 140 days and released up to 52,000 cfs of water. In 2018, the spillway was used for approximately 175 days with a peak discharge of 11,600 cfs. In 2019, the spillway was used again for approximately 150 days with a peak discharge of 8,300 cfs. With the exception of continued plunge pool erosion, the spillway performed well. The spillway is currently estimated to be able to pass up to 85,000 CFS before significant damage would occur. The 2019 periodic inspection report noted concrete damage in the spillway. The report notes that previously repaired concrete spalls were observed. Some were holding up well, but many were cracked from irregular repair shape, restrained drying shrinkage, and/or incompatibility of repair materials with existing concrete.

2011 Flood Damage and Repairs. Following the 2011 sustained high flows, substantial repairs were required. Repairs were authorized to return the spillway to pre-flood conditions, and did not increase the reliability of the spillway or return it to pristine conditions. Repairs of the spillway structure included welding repairs to the gates, removal and replacement of specified spillway drainage structures, and repair of vent pipes that support the spillway sub-drain system. Flow releases created a large scour hole downstream of the spillway exit. The scour hole exposed much of the cutoff structure supporting the spillway discharge channel. There was less than 30 feet of embedment remaining of the original 70 feet. Repairs were performed to stabilize the cutoff structure by constructing an RCC-lined plunge pool. This work was completed in 2016. Approximate repair cost total was $52M.

Discharge Channel and Spillway Slab Stability Concerns. Design Memorandum No. MFP-109 Spillway Rehabilitation, dated September 1966, discusses differential movements in certain areas of the Fort Peck Spillway concrete-lined discharge channel. The differential movement became apparent before the end of construction and has continued up to the present time. A portion of the spillway channel was filled in 1970 with excavated material from the side slopes in an attempt to halt the movement of the downstream spillway chute and to arrest the rebound within the concrete channel. The fill was washed out during the 1975 spillway releases.

Studies were conducted in 1997 and 2000 (USACE, 2019a) to evaluate the spillway slab performance. These studies identified that changes in the spillway profile geometry due to existing domes in the chute slab do not cause large scale cavitation problems. However, vertical offsets or rotational deformations accompanying the dome formation may cause failure of the water stop and precipitate a structural failure due to uplift. Offsets at the joints may cause some local cavitation damage. Slab instability will result in the lower portion of the chute if the drains do not have the required efficiency to relieve uplift conditions.

A semi-quantitative risk assessment was conducted by USACE in 2014 and again in July 2021. These assessments concluded that the emergency spillway structure was designed with a high level of redundancy resulting in a remote likelihood of failure. However, the emergency spillway at Fort Peck is the last line of defense in preventing catastrophic failure. A proper functioning spillway sub-drain system is vital to the stability and performance of the spillway. The spillway gates were rehabilitated in 2014 and flaws referenced in a 2021 memo were addressed. Operational gate testing in 2019 did not reveal any new issues. It should be noted the 2014 SQRA was conducted prior to the Oroville spillway incident in California. Post Oroville, USACE and other dam owners have reconsidered their approaches to examining spillway risks.

Current Condition. An inspection was conducted in 2019 (USACE, 2019a) with pertinent details as follows:

> Spillway Discharge Channel and Walls - As documented in previous inspection reports, the spillway slab has experienced significant rebound between Station 34+00 and Station 41+00. Maximum rebound is on the order of 2½ feet. Joint separation is common. Exposed dowels, which are losing section due to exposure (rust), and key separation between adjacent joints are common. Surface scaling, spalling at joints and cracks within the slabs are also common.
>
> Sub-drain System - The spillway sub-drain system, which was designed to relieve uplift pressures beneath the slab, remains in disrepair with known segments of collapsed, displaced or cracked pipe.
>
> Plunge Pool - The recently completed RCC training walls within the plunge pool were observed from the end of each spillway access road. No issues were noted with the concrete. Continued erosion/scour of the cut bank slopes adjacent to and downstream of the concrete training walls was noted. Future discharges within the spillway could potentially lead to additional erosion and slope failures without riprap protection.

Provided below is a summary of spillway recommendations developed as a result of the 2019 Periodic Inspection (USACE, 2019a) and discussions with Operations Division staff stationed at Fort Peck Dam:

- Installation of new infrastructure to provide access to the spillway sub-drain system in order to perform a comprehensive inspection of the drain and provide access for repairs.
- Perform spillway chute concrete maintenance and spall repair.
- Perform a geotechnical investigation of both spillway abutments and install survey monitoring points to aid in evaluating/monitoring abutment wall movement.

- Erosion was noted immediately upstream of the riprap placed along the left abutment approach wall. The area measured approximately 50 feet wide. Riprap and bedding should be added to this area to prevent further erosion.
- The area of significant spalling that has exposed rebar in the spillway chute slab at the exit of the chute for Gate #4 should be prepared prior to spillway releases to prevent section loss of the rebar.
- Install instrumentation to monitor flows in the under slab drainage system. In 2019, a flow meter was installed, however, project personnel have no way to monitor it while the spillway is in operation. A readout box mounted on top of the west spillway wall is needed to monitor sub-drain flows.

The recommended actions have not been completed at this time. Funding for these actions must compete with other USACE Operation and Maintenance priorities with an unknown outcome. No funding has been identified in the immediate future. **Summary.** The USACE has concerns with spillway slab performance that could be exacerbated with sustained spillway flow. The risk of potential slab damage will likely be a function of both spillway flow and duration. Past spillway repair expenses and the recommended repair items illustrate concerns with future spillway performance.

If damage to the spillway slabs would occur, repair would likely be extensive and not limited to a single slab or small area due to the high spillway flow velocities and the change in flow hydraulics as a result of slab uplift. The spillway slab and sub-drain system repairs would be difficult, expensive, and likely constrained by time in order to address dam safety due to loss of spillway operation as quickly as possible. Depending on damage extent and allowable repair time period, repair cost is estimated to be in the range of $20 to $40M. The test flow releases would increase the likelihood these repairs would be needed because they increase the use of the spillway. Physical monitoring during a test flow would include monitoring of the spillway as described in Section 3.2.2.11.

3.2.1.5.2 Reservoir System

Operation of the reservoirs for flood risk management must account for highly variable flows from numerous tributaries. During any flood season, the existence of upstream tributary storage reduces Mainstem flood volumes to some extent. Normally, the natural crest flows on the

Mainstem reservoirs will also be reduced by the existence of tributary reservoir storage, provided significant runoff contributing to the crest flows originates above the tributary projects.

The flow release magnitude for each alternative exceeds the power plant capacity at both Fort Peck and Garrison projects. Past operations experience has shown that using the spillway or flood tunnels to release flow for a prolonged period results in the need for additional maintenance of these features and adds cost to operating the System. Long-term reliability of flow release features (spillway and/or flood tunnel) may also be affected. Finally, minor changes in dam safety risk from the use of additional release mechanisms and pool levels may occur. These risks have not been quantified at this time and would require a risk-based analysis to evaluate changes in operation frequency and pool probability.

3.2.1.5.3 River Floodplain and Channel Capacity

The river floodplain downstream of Fort Peck Dam has variable levels of protection. In general, the channel capacity is higher near the dam and decreases with downstream distance. Within the reach downstream of the Yellowstone River in the aggradation zone of Lake Sakakawea, channel capacity is much lower.

The HEC-RAS Alternatives Analysis (Appendix D) evaluated channel capacity to provide an indication of reaches susceptible to flooding and if any of the alternatives may alter flood risk. Within selected model reaches, the minimum flow that exceeded bank elevations was determined at a representative area. Within the Fort Peck reach, the minimum channel capacity identified within the Fort Peck reach was 35,000 to 40,000 cfs in the area downstream of the Yellowstone River.

3.2.1.5.4 Levees

Levees also play a role in flood risk management along the Missouri River. Federal agricultural levee construction in accordance with the 1941 and 1944 Flood Control Acts began in 1947. Most existing federal levees are in the reach located between Omaha and Kansas City, MO. A federal levee was also constructed in the vicinity of Williston, ND as a portion of the Garrison project. Only the Williston Levee would potentially be affected by the test flow alternatives. The levees help manage flood risk to localities during the most severe flood events of record. In other reaches, especially between Sioux City and the mouth of the Missouri River, local interests have built many miles of levees, consisting of about 500 non-federal levee units through this reach of the river (USACE, 2004a). Most of these levees are inadequate to withstand major floods, but generally provide flood risk management for events in the 5 percent to 20 percent annual chance of exceedance event (5-year to 20-year).

3.2.1.5.5 Levee at Williston, ND

The Williston Levee System (WLS) construction was completed in 1961 and is a component of the Garrison Dam and Reservoir Project. The WLS is federally owned, operated and maintained. The USACE original levee design documentation (USACE, 1954) states the purpose of the project is the protection of low lying portions of the City of Williston and facilities of the Great Northern Railway against damages from floods in the backwater reach of Garrison Reservoir. The original levee design was based on an estimated river level that considered inflow, backwater effect from Lake Sakakawea, and aggradation (Missouri River flows enter the pool and sediments deposit to form the delta). The original design (USACE, 1954) was not based on a specific frequency flood event (i.e. 100-year or 500-year). The levee was constructed at elevation of 1862 feet NGVD 29 at the Little Muddy Creek confluence and 1863 feet NGVD 29 near Hwy 85 to provide 3 feet of freeboard during reservoir operations. The original levee construction elevation included an allowance for 5 feet of water level raise to accommodate Missouri River aggradation due to the effects of the Lake Sakakawea pool backwater effects in the Williston vicinity. Assessment of water levels for the base condition and alternatives was performed with the HEC-RAS model as described in the *HEC-RAS Modeling Alternatives Report* (Appendix D). A schematic of the WLS and the HEC-RAS model cross sections are shown in Figure 3-13.

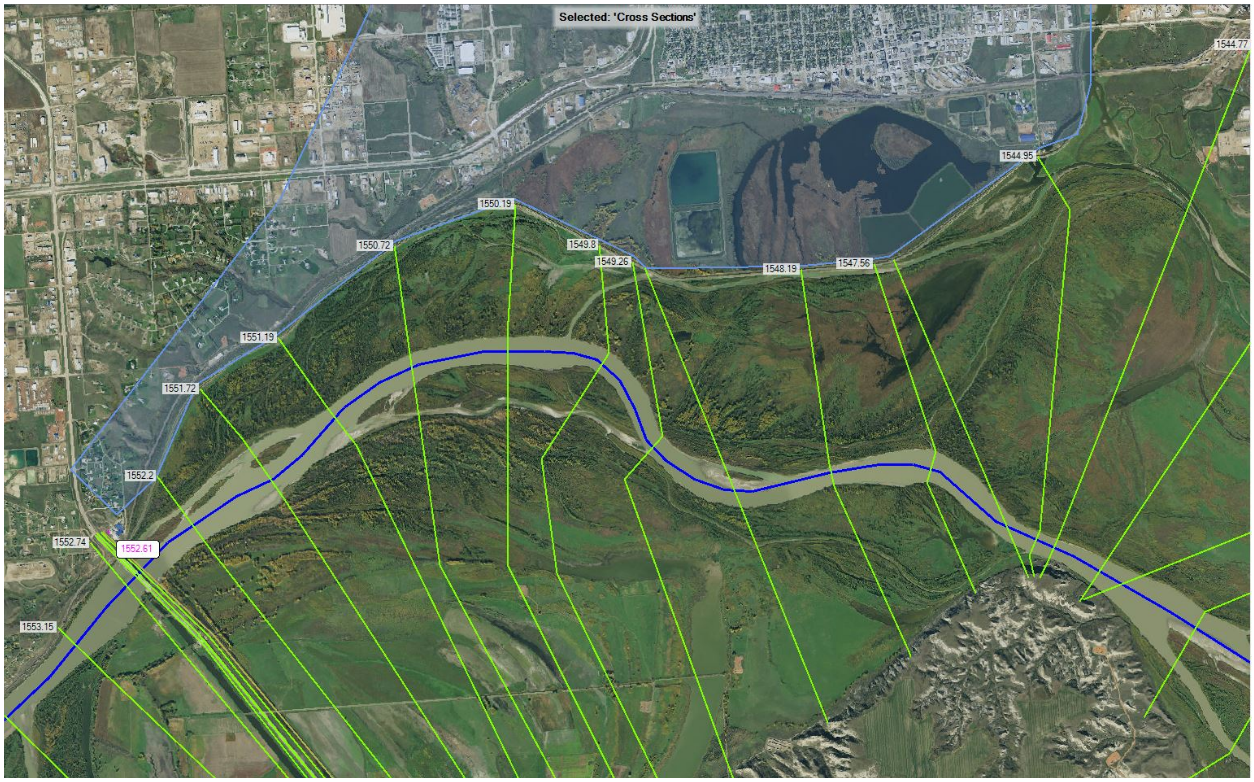


Figure 3-13. Williston, ND levee system schematic

The original levee design (USACE, 1954) recognized that a levee raise would be required to offset future sediment deposition and meet Garrison Project operation needs. The design estimated a need for a future levee raise of 8 feet at Hwy 85 and 6 feet at Little Muddy Creek, as well as two new short span levees and additional relief wells.

An aggradation study (USACE, 2014a) developed an estimated 50-year future water surface level for a range of Lake Sakakawea and Missouri River flow conditions. Information from that study provides estimated future aggradation Missouri River water levels in the Williston, ND, vicinity. The aggradation study used a HEC-RAS model to compute profiles for a 2012 current condition calibrated model, a 50-year future condition with aggradation estimated water levels (USACE, 2014a), and 2011 event observed water levels. Computed profiles are shown in Figure 3-14.

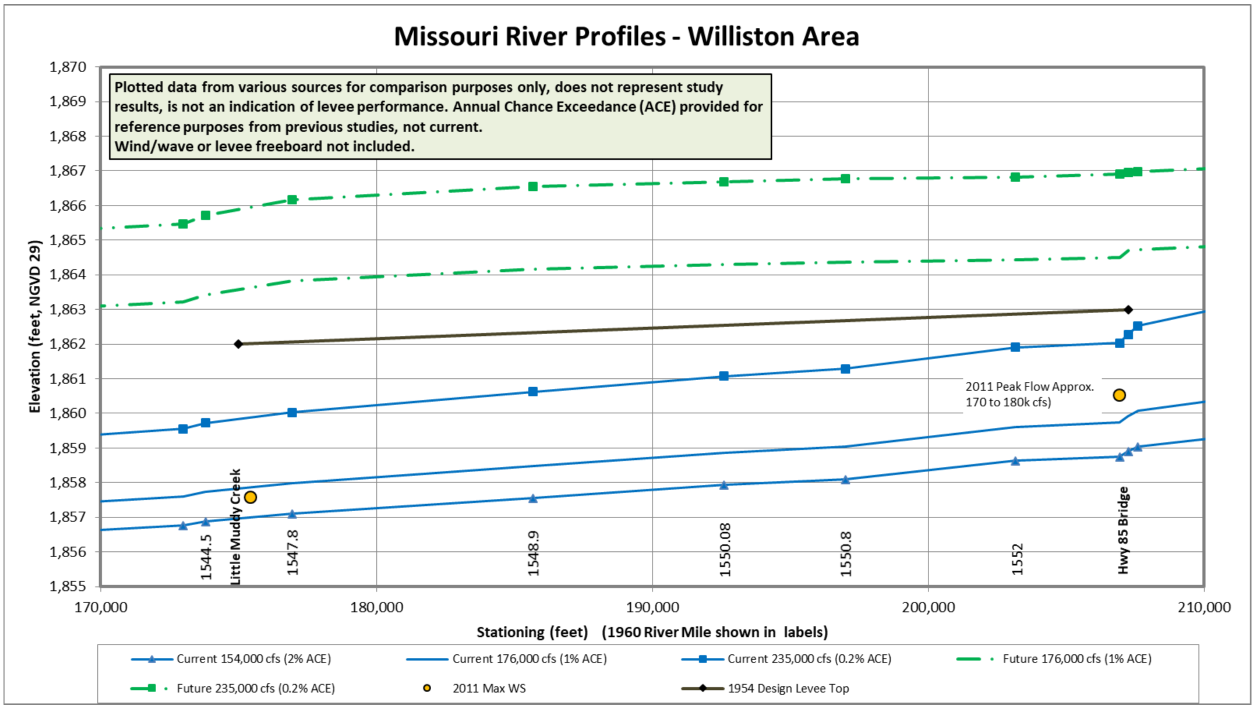


Figure 3-14. Comparison of Missouri River profiles at Williston, ND

Performance of the WLS was considered to develop alternative constraint criteria. The Omaha District Dam Safety office developed criteria based on observations during recent events with high Missouri River water levels. Dam Safety identified the following performance-based risks/requirements for the WLS as:

a) Loading (both elevation/stage and duration) shall not appreciably increase risk.
b) Loading (including contributions from tributaries) shall not exceed the post 2011 maximum elevation set in March 2019 (1858.4 feet NGVD 29 referencing National Oceanic and Atmospheric Agency (NOAA) Gage WLTN8); performance above this elevation is uncertain and therefore risks are not well characterized.
c) Under existing conditions, acceptable levee performance is expected/substantiated for loadings up to elevation 1856.0 NGVD 29 (summer 2018 flood event). However, foundation distress (boil activity) has been observed in the relief well channel at elevations approaching 1858.4 NGVD 29 (March 2019). Based on loading duration, this condition is not expected to threaten the integrity of the levee and/or its foundation but loading above elevation 1856.0 should be avoided to minimize risk.

d) Increased monitoring and surveillance of the WLS is prescribed for elevations exceeding 1854.0 NGVD 29. Target elevations above 1854.0 places additional demand on already constrained Engineering Division resources (both funding and staffing) to perform surveillance activities.

3.2.1.5.6 Williston Gage and Flood Impacts

The Williston gage (USGS 06330000) is at RM 1552.6, located about 100 feet downstream of the Hwy 85 bridge on the right descending (south) bank. The gage datum is 1831.84 feet, North American Vertical Datum of 1988 (NAVD88). The NWS flood stages and impacts at the Williston, ND, gage are shown in Table 3-6. Gage level flood impacts provide an additional source of information regarding alternative constraints.

Table 3-6. Williston, ND NWS flood stages and impacts

Stage	Elevation (ft, NAVD88)	Flood Categories	Flood Impacts
33	1864.84		Levees surrounding Williston are likely to be topped without additional measures taken to temporarily raise the flood protection levels.
32.5	1864.34		Missouri River begins to overtop small stretch of levee near Highway 85 bridge and Williston Water Treatment Plant.
30.75	1862.59		Missouri River begins to cover Highway 85 south of Williston.
30.5	1862.34		At 30.5 ft, water is near the top of Highway 58 in areas between Fairview and Trenton.
30	1861.84		Water covers portions of 13th Avenue East and 11th Avenue East along the Little Muddy River.
28	1859.84		Water backing up into the Little Muddy River begins to cover 54th Street Northwest on the east side of Williston.
26	1857.84	Major	
24	1855.84	Moderate	Water begins to cover oil well location south of Williston. Wildlife management areas are flooded. City of Williston does not flood.
22	1853.84	Flood Stage	Low-lying farmland and access roads to oil well sites near Trenton are flooded. City of Williston does not flood.
20	1851.84	Action Stage	Ditches in the vicinity of the river will fill and wildlife management lands along the south banks will begin to flood.

3.2.1.5.7 Flow and Pool Constraints at Williston, ND Gage

The Williston gage flood levels and the previously described geotechnical levee constraints were evaluated in comparison to model computed flow levels. The resulting table provides levels at which inflows and downstream pool levels are estimated by the model to infringe on the established constraints. The results can be used as a guide for alternative screening to limit impacts. Table 3-7 presents model results for various combinations of total flow and downstream Lake Sakakawea pool levels. Shading is provided to highlight combinations above the Action Stage elevation of 1851.84 NAVD 88, the Flood Stage elevation of 1853.84, and the geotechnical levee constraint elevation of 1855.31 (NAVD 88).

Table 3-7. Williston, ND gage water surface elevation constraints

Model Computed Water Surface Elevation at RM 1552.61 Downstream of Hwy 85									
Lake Sakakawea Pool Elevation									
NGVD 29	1837.5	1840	1842	1844	1846	1848	1850	1852	1854
NAVD 88	1838.81	1841.31	1843.31	1845.31	1847.31	1849.31	1851.31	1853.31	1855.31
Q Total	Model Computed Water Surface Elevation (NAVD 88)								
30,000	1850.05	1850.03	1850.05	1850.04	1850.35	1851.26	1852.46	1853.97	1855.71
40,000	1851.45	1851.45	1851.46	1851.51	1851.73	1852.37	1853.13	1854.43	1856.02
50,000	1852.9	1852.91	1852.91	1852.95	1852.92	1853.16	1853.95	1854.98	1856.4
60,000	1853.5	1853.51	1853.54	1853.53	1853.73	1854.08	1854.62	1855.56	1856.76
70,000	1854.53	1854.54	1854.56	1854.62	1854.67	1854.7	1855.29	1856.15	
80,000	1855.05	1855.06	1855.08	1855.12	1855.25	1855.52	1856.02		
90,000	1855.92	1855.92	1855.94	1855.98	1856.08				
Q Total is thetotal river flow at Williston (cfs)									

3.2.1.5.8 Reservoir Flood Risk Management

The Missouri River Reservoir System as currently operated provides substantial flood damage reduction and benefits to the entire basin. Study alternatives include modifying operations of the Missouri River Reservoir System with increased reservoir releases during select periods for species habitat benefits. The current HEC-ResSim and HEC-RAS analysis shows the potential for negative impacts to flood risk management for alternatives that include changes in reservoir flow releases. The current study methodology, which employs an 82-year period of record, is suitable for alternative comparison and providing an indication of change in flood risk associated with a flow test. The test flow alternatives would be implemented through a Master Manual deviation request and do not constitute a change to the Missouri River Master Manual. If the test flows are determined to be successful, an additional impact analysis and public involvement process would be conducted prior to adopting any flow action that would change the Master Manual.

3.2.1.6 Water Supply and Irrigation Intakes

The Fort Peck Dam to Lake Sakakawea reach includes water supply intakes for both agricultural irrigation and municipal water supply purposes.

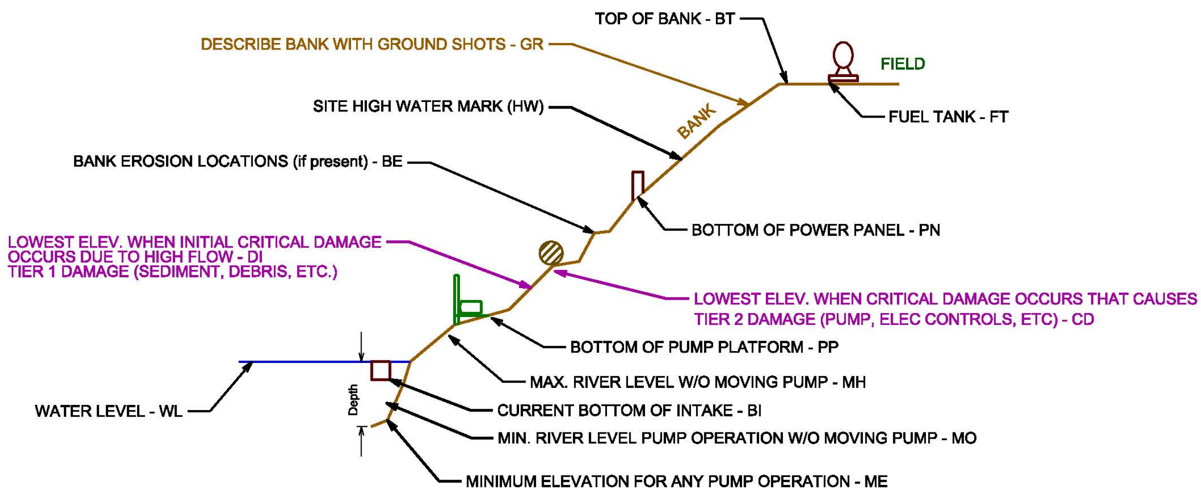
3.2.1.6.1 Municipal Intakes

The water supply Affected Environment section (Section 3.7.1) includes a description of municipal intakes within the study area. Tribal intakes are discussed in Section 3.7.2.

3.2.1.6.2 Agricultural Intakes

There are numerous irrigation intakes that operate along the Missouri River for the purposes of agricultural water supply in the river reach from Fort Peck Dam to Lake Sakakawea. Intake types consist of both fixed and portable.

An inventory of pumps and intakes on the Missouri River between Fort Peck Dam and the North Dakota border was previously performed by the Roosevelt County Conservation District with a final report prepared in 2002 (Roosevelt County Conservation, 2002). New data was collected at a number of intakes in the summer of 2020 by USACE in July and the USFWS / Montana Fish Wildlife and Parks (MTFWP) in August. At each site, easting, northing, and elevation (XYZ) data points were collected to determine the pump site characteristics and potential damage levels for high flow events. Participating landowners were present and identified site-specific critical features such as electrical panels, pump operating levels, and shared concerns about possible impacts from alternatives. A schematic of typical survey data collected from the pump inventory is shown in Figure 3-15.



TYPICAL IRRIGATION PUMP SECTION

Not To Scale

Sketch element order and relationship is site specific. Some sketch elements may not exist at a site. Other site critical features that are not shown in the sketch should be surveyed using a custom survey code or note for new elements. Examples of new elements include rock riprap location, multiple pumps, and similar.

Figure 3-15. Irrigation Intake Survey Schematic

An example of a typical irrigation pump intake is shown in Figure 3-16.

Figure 3-16. Typical pump intake located near RM 1760

The 2020 pump inventory also provided information and critical levels for low flow and high flow impacts based on individual site characteristics. Higher river levels and associated river processes may affect operation or damage one or more components of the intake (sandbar deposition, flooding of electrical panel, operating pump, and similar). Damage levels were defined in the field based on input from the local owner / operator of the intake as described in Table 3-8. Elevations for the Tier 1 and 2 levels were surveyed in 2020.

Table 3-8. Irrigation Intake Damage Level Descriptor

Damage Level	Description
Tier 1	Lowest river level at which debris/sediment deposition typically begins to significantly affect pump operation. This elevation is qualitative and relies on owner / operator input.
Tier 2	The lowest site elevation when critical damage occurs at the pump site to a fixed feature (pump, electrical panel, other supporting equipment). Tier 2 is a higher elevation and damage level than Tier 1).

Irrigation intakes in the reach are located either on the main channel or in a side channel connection. The results of the 2020 survey were used to determine the number of intakes located on the main channel and on side channels. Side channels were assigned for both naturally occurring side channels (perhaps around a sandbar or island) and constructed channels (perpendicular to river flow, for intake use). Examples of side channel locations are shown in Figure 3-17.

Figure 3-17. Example of Irrigation Intake Located on Side Channel

The 2020 July and August surveys collected data at a representative number of intakes along the Missouri River from Fort Peck Dam to Lake Sakakawea. The number of intakes in current operation is difficult to determine with certainty. Input from Montana water users indicate that the 119 sites surveyed in 2020 is a high percentage of the total number of active irrigation intake sites. This number is slightly less than the 2002 pump inventory that listed 143 active pumps but is significantly less than the total number of permitted intakes collected from the Montana and North Dakota water rights database. Assessment of the 143 sites in the 2002 report reduced this by number by one to a total of 142 sites. A detailed inventory including a float trip on the Missouri River along with aerial photo collection and assessment was not performed. For the purposes of this analysis, the 142 pump sites cataloged in the report prepared by Roosevelt County (2002) was adopted as the number of active irrigation intakes within Montana. The number of surveyed intakes and the total number of intakes is summarized in Table 3-9. Refer to Appendix D for a full description of the 2020 irrigation intake survey.

Table 3-9. Surveyed and Total Number of Intakes Summary

Intake Database / Survey	No. Intakes MT	No. Intakes ND	Total
Montana Water Users Database	--	--	365
North Dakota Water Users Database	--	--	30
All Database Sites Combined (Montana and North Dakota)	--	--	395
Surveyed Sites – July 2020	62	7	69
Surveyed Sites – Aug 2020	50	0	50
Total Site Surveyed	112	7	119
Number of Surveyed Sites with Data Sufficient for RAS Modeling			98*
Percentage of Surveyed Sites Used in Modeling			82%
Estimated Number of Operating Intakes in MT	142+		

* Not all sites had sufficient survey data for RAS evaluation. 98 reflects the sites used in the RAS modeling of the 119 surveyed.
+ Number of sites estimated from evaluation of the Roosevelt County Report (2002)

3.2.1.7 Climate Change

A qualitative climate change assessment for the FTPTR-EIS was performed by USACE in accordance with *Engineering and Construction Bulletin (ECB) 2018-14: Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects* (USACE, 2018d). The objective of this climate change assessment is to provide a qualitative analysis of existing literature, data trends, climate projections, and to discuss potential impacts to climatic variables of interest. Previously, the MRRMP-EIS conducted a climate change analysis that pertained to the Missouri River basin for a range of alternatives (USACE, 2016a). The MRRMP-EIS analysis followed previous guidance (USACE, 2016a).

The study region for this analysis consists of the upper Missouri River basin, located primarily within the states of MT, WY, and ND. Study area drainage basins contribute inflow to the USACE operated Fort Peck and Garrison Dams. Refer to Appendix D for a full description of the climate change assessment.

Primary considerations with respect to establishing an appropriate scope for the FTDTR-EIS climate change analysis are summarized as:

- The test flows that are being considered are not a permanent change to the water control plan. The test flows will be conducted over a short period (with respect to climate change analysis) of the next 5-15 years while USACE climate guidance considers a much longer time frame (typical lifetime analysis period of 100 years into the future).
- After test flows following the FTPTR-EIS are completed, USACE would reassess to determine if the test flow should become permanent. Prior to adopting a permanent Fort Peck flow release, a new climate assessment would need to be completed that would include evaluation of a longer period that would address many factors including the effects of climate change.
- It is likely that the test flow biologic and physical monitoring will result in significant changes to the desired Fort Peck operations to optimize release objectives and limit impacts. Any conclusions regarding climate change FTPTR-EIS that could be derived at this time have a high degree of uncertainty.
- Neither the No Action nor any of the alternatives has a significant flow difference such that total annual volume is virtually identical for all cases.

The current climate assessment concluded that the area contributing to and containing the Missouri River reach where flow increases are planned is ***not likely to be impacted by additional flood risk due to climate change in the near-term.***

Refer to Appendix D for detailed information regarding the conducted climate change analysis. Results of the analysis are summarized in the Environmental Consequences (section 3.2.2.10) with specific detail following within each Affected Environment section.

Table 3-10. Summary of Influence of Climate Change on Alternatives

<table>
<tr><th>Climate Change Variable</th><th>No Action</th><th>Risk Assessment</th><th>All Alternatives</th></tr>
<tr><td>Increased Air Temperature</td><td>During the summer, low river levels could have water quality issues if water temperatures increase</td><td>Low Risk</td><td rowspan="6">Pertaining to climate change analysis:

No significant variation is expected from No Action for any alternative due to climate change

1) The test flows will be conducted over a short period of the next 5-15 years

2) Neither the No Action nor any of the alternatives have a significant flow difference and total annual volume is virtually identical

3) A long-term climate change assessment did not illustrate a meaningful difference nor provide information on alternative formulation that could alter FTDTR-EIS vulnerabilities to climate change.</td></tr>
<tr><td>Increased Spring Precipitation and Streamflow</td><td>Ft Peck and Garrison operations may be constrained by higher pool levels and inflows</td><td>Low Risk</td></tr>
<tr><td>Earlier Snowmelt Date and Decreased Snow Accumulation Season Duration</td><td>System storage may rise earlier in the year; this could affect Ft Peck and Garrison operations due to higher pool levels earlier in the season</td><td>Low Risk</td></tr>
<tr><td>Increased Sedimentation</td><td>Decreased System storage may lead to decreased frequency of all releases (assuming release requirements remain the same and sedimentation is not addressed); loss of storage may affect System flood risk management operations</td><td>Low Risk</td></tr>
<tr><td>Decreased Peak Snow Water Equivalent</td><td>Forecasting may become less accurate since runoff from precipitation is more difficult to forecast than snowpack; less accurate forecasts may result in an increased risk of System operations (i.e., lower reservoir elevations, higher releases, lower storage levels) due to runoff uncertainty</td><td>Low Risk</td></tr>
<tr><td>More Sporadic Floods and Droughts</td><td>Accuracy of downstream forecasting may decrease, resulting in more frequent flood impacts caused by releases
Has a greater potential to affect System storage with releases if more droughts</td><td>Low Risk</td></tr>
</table>

	occur		

3.2.2 Environmental Consequences

This section assesses the impacts of the alternatives on the hydrology, geomorphology, river infrastructure, water supply and irrigation intakes, flood risk and dam safety, and climate change. The impact assessment was in part based on hydrologic modeling for the POR using HEC-ResSim and HEC-RAS models, as described in Section 3.1, Introduction. Human considerations analysis generally used hydrologic modeling results to compare between alternatives.

A thorough description of the Missouri River basin affected environment consequences is contained within the *Missouri River Recovery Management Plan and Environmental Impact Statement*, Section 3.2, Volume 2 (USACE, 2018a).

3.2.2.1 Current Conditions

The environmental consequences assessment reflects conditions based on the current storage volume in the six reservoirs along the UMR and the current geometry of the Missouri River riverbed (referred to as “year 0” conditions). Over time, these two variables will continue to change as follows: Continued sediment supply over time will gradually reduce the storage volume in the reservoirs of the UMR, and continue to cause aggradation in the reservoir headwaters and delta areas. Sediment captured by the reservoirs will not be available to replenish sediment eroded downstream of the dams, resulting in continued degradation of the riverbed in respective downstream reaches. Sand and aggregate mining in the lower Missouri River is expected to further contribute to degradation of the riverbed.

However, unlike the previously conducted management plan EIS (USACE, 2018), for the purposes of the Fort Peck Dam Test Release Flow EIS, no geomorphic changes were incorporated in a future condition analysis. The primary ongoing geomorphic processes in the Fort Peck Dam to Lake Sakakawea reach consists of sediment accumulation in the reservoirs, aggradation upstream of the reservoirs, and degradation downstream of the dams. These large-scale processes were assumed to be similar with minor change for the base and all alternative conditions.

3.2.2.2 Datums Employed

All HEC-ResSim models are constructed using the NGVD 29 datum. Use of the 1929 vertical datum was used for consistency with reported reservoir elevations within the Master Manual and operating decisions. All HEC-RAS models are constructed based on the NAVD 88 vertical datum to match current practice along the Missouri River for reporting river flow elevation. Use of two vertical datums within the study area was necessitated by the need to present results in a meaningful manner to the various stakeholder groups. Human consideration evaluations were performed in the appropriate datum for each individual resource.

The conversion between NGVD 29 to NAVD 88 varies by geographic location. The variable elevation difference between the two datums is provided in Tables 3-11.

Table 3-11. Conversion of datums discussed in the EIS

Minimum and Maximum Operating Pool Elevations in Reservoirs		
Location	**Pool Range (NGVD 29)**	**Conversion from NGVD 29 to NAVD 88 (ft)**
Fort Peck Lake	2,160 to 2,250	+2.07
Lake Sakakawea	1,775 to 1,854	+1.31
Lake Oahe	1,540 to 1,620	+1.23
Lake Sharpe	1,415 to 1,423	+1.07
Lake Francis Case	1,320 to 1,375	+0.98
Lewis and Clarke Lake	1,204.5 to 1,210	+0.67

USGS Gages along the Missouri River		
Location	**Conversion from NAVD 88 to NGVD 29 (ft)**	**Gage Datum (NAVD 88)**
Williston, North Dakota	-1.64	1,831.8
Bismarck, North Dakota	-1.34	1,619.6
Sioux City, Iowa	-0.55	1,060.00
Omaha, Nebraska	-0.39	948.97
Nebraska City, Nebraska	-0.35	905.61
Kansas City, Missouri	-0.28	706.68
St. Louis, Missouri	-0.05	379.58

3.2.2.3 Summary of Environmental Consequences

Table 3-12 summarizes the impacts of each alternative relative to river infrastructure and hydrologic processes. Over the long term and considering the hydrologic variability in the POR, the action alternatives would be expected to have small to negligible, adverse impacts on the hydrology, geomorphology, river infrastructure, and groundwater relative to the No Action Alternative.

However, impacts could be large locally and would be dependent on variables such as the site-specific channel configuration at the time of flow releases and other hydraulic features.

Examples of local impacts could be damage of individual riverine infrastructure components, shoreline erosion, or aggradation.

Table 3-12. Summary of environmental consequences for river infrastructure and hydrologic processes

Alternative	Impacts on River Infrastructure and Hydrologic Processes*
No Action	Hydrologic conditions include the wide range of natural flows and System operations by USACE in response to these flows. Changing flows would affect river infrastructure, geomorphic processes, irrigation intakes, groundwater levels, and potentially flood risk management. Continued degradation of river channel and bank erosion in the reaches below dams as a result of a lack of resupply of sediment (because it is trapped behind the dams). Continued aggradation of the riverbed upstream of reservoirs as a result of redeposition of eroded sediment from the degrading part of the Mainstem and its banks and the influx of sediment from tributaries along the reach. There is also streambank erosion and rising river levels in the aggrading delta within the reservoir headwaters. Continued erosion of reservoir shorelines. Small increase in average elevations of upper three reservoirs (1–2 feet over 15 years) because of sediment deposition.
Action Alternatives*	Higher stream flows, water levels, and associated geomorphic processes during the flow period. Overall, small, temporary, and long-term impacts on the river system from releases, including changes in reservoir elevations and shoreline erosion in the upper three reservoirs, and degradation and aggradation rates (and associated future water levels) in the inter-reservoir reaches from Fort Peck Dam to Lake Sakakawea and from Garrison Dam to Lake Oahe. Locally, impacts could be large. Small, temporary, and long-term impacts on irrigation intakes in the open river reach from Fort Peck Dam to Lake Sakakawea and from Garrison Dam to Lake Oahe. Locally, impacts could be large. Small, temporary, and long-term impacts on riverine infrastructure and groundwater elevations. Locally, impacts could be large. Small, temporary, and long-term impacts on geomorphic processes in the inter-reservoir reach from Fort Peck Dam to Lake Sakakawea and from Garrison Dam to Lake Oahe. Negligible impacts, both temporary and long-term, from releases in any of the reaches downstream of Oahe Dam to the mouth because reservoir releases are nearly the same and flow differences from the No Action are negligible.
Alternative 1, 1A, 1B**	The one week timing differences between Alternative 1, 1A, and 1B is not likely significant for geomorphic processes. The alternatives may have different levels of impacts during the flow implementation due to downstream inflows. Differences may occur that are locally large.
Alternative 2, 2A, 2B**	Alternative 2, 2A, and 2B have a slightly higher peak and flow volume than Alternative 1, 1A, and 1B; therefore the 2, 2A, and 2B alternatives are likely to have a greater level of impacts to HC considerations. The one week timing differences between Alternative 2, 2A, and 2B is not likely significant for geomorphic processes. The alternatives may have different levels of impacts during the flow implementation due to downstream inflows. Differences may occur that are locally large.
* Impacts listed for all action Alternatives are compared to No Action. ** Impacts listed contrasted with other alternatives.	

3.2.2.4 Impacts on Hydrology

3.2.2.4.1 Assessment Method

Hydrologic impacts of releases under the various action alternatives in the river and reservoirs were analyzed using the statistical 90th, 50th, and 10th percentiles of the POR. These statistical measures indicate the value below which a given percentage of observations in a group of observations falls. For example, the 90th percentile of a daily reservoir elevation reflects the elevation below which 90 percent of the elevations occur; only 10 percent of the elevations would be higher.

Thus, the 90th percentile may be used as a proxy for “wet period” conditions. A “period” could be a year or several years long, affecting storage and flow conditions. For “dry period” conditions, the 10th percentile may be used as a proxy. Finally, the 50th percentile is the reservoir elevation that may be used as a proxy for “average” conditions, where 50 percent of the elevations are higher and 50 percent of the elevations are lower. Similar definitions also apply to percentiles used for flow and stage in the river.

Releases were also assessed for individual simulated years from the POR to illustrate potential impacts on reservoirs and river reaches for specific action alternatives. These years were selected because they reflect when a release was simulated due to the “rules” governing the release within an alternative. Whether and to what extent a release was simulated for a specific year was dependent on these “rules” and in many years of the POR no release would occur. For example, the extent or magnitude of the releases are dependent on System storage levels and are reduced or curtailed if storage levels fall below certain levels specified in the “rules” for that alternative. Therefore, river flow and reservoir elevations resulting from releases change depending on hydrologic conditions in the larger Missouri River watershed. Specifically, the years used for illustration purposes reflect when the full extent of a release would occur compared to the base condition. Impacts are assessed for flow (measured in cfs) and stage (measured in feet) for various locations. Flow is relevant because it affects erosion and deposition rates in the river. Stage allows for an assessment of impacts to resources and uses, which are driven by water surface elevations. The analysis is limited to an 82-year POR; consequently, the number of years with flow conditions that would trigger releases under the various action alternatives is limited and statistically small. The limited data set necessitates monitoring of impacts under any implemented action alternative and adaptive management.

3.2.2.4.2 Hydrologic Impacts

The frequencies of when full and partial releases would occur under the various alternatives based on the POR are listed in Table 3-13. Partial implementation occurs when the Fort Peck releases are stopped in response to one or more of the test criteria.

- Under Alternative 1, the spawning cue release would be fully implemented (in March and June) in 11 years and partially implemented in 11 years.
- Under Alternative 1A, the spawning cue release would be fully implemented (in March and June) in 16 years and partially implemented in 6 years.
- Under Alternative 1B, the spawning cue release would be fully implemented (in March and June) in 9 years and partially implemented in 16 years.
- Under Alternative 2, the spawning cue release would be fully implemented (in March and June) in 10 years and partially implemented in 10 years.
- Under Alternative 2A, the spawning cue release would be fully implemented (in March and June) in 15 years and partially implemented in 5 years.
- Under Alternative 2B, the spawning cue release would be fully implemented (in March and June) in 9 years and partially implemented in 16 years.
- Expressed in terms of percentage of occurrence for each alternative, full releases with all flow components would occur 13 percent, 19 percent, 11 percent, 12 percent, 18 percent, and 11 percent of the time under Alternatives 1, 1A, 1B, 2, 2A, and 2B, respectively.
- Expressed in terms of percentage of occurrence for each alternative, partial releases when the flow is stopped during the process would occur 13 percent, 7percent, 19 percent, 12 percent, 6 percent, and 19 percent of the time under Alternatives 1, 1A, 1B, 2, 2A, and 2B, respectively.

Impacts under wet, average, and dry period conditions (90th, 50th, and 10th percentile, respectively) are presented together for the six alternatives to demonstrate similarities and differences. However, hydrologic conditions during individual years could result in specific changes under individual alternatives. For example, during extreme droughts (i.e., in the 1930s) and peak flow events (i.e., the spring and summer of 2011), reservoir operating rules (USACE, 2006) would prevent flow releases under the Alternatives from contributing to the effects of these extreme conditions. Graphics pertaining to this discussion are provided in Appendix D, Figures D-12 to D-19. Additional graphics comparing year 0 flows and reservoir pool elevations, and stages in the Missouri River are presented in Figures D-20 to D-30 in Appendix D.

Table 3-13. Summary of releases simulated for alternatives over POR

Alternative	Frequency during 83-year Period of Record (1930-2012)		
	Eliminated[1]	Partial Completion[2]	Full Completion[3]
Alt 1	61	11	11
Alt 1a	61	6	16
Alt 1b	58	16	9
Alt 2	63	10	10
Alt 2a	63	5	15
Alt 2b	58	16	9

[1] Eliminated: flow regime is not initiated
[2] Partial Completion: flow regime is cancelled prior to peak spawning cue flow being held for 3 days
[3] Full Completion: peak spawning cue flow is held for 3 days

3.2.2.4.3 Conclusions

Overall, negligible to minor long-term impacts would occur on river hydrology for any of the alternatives compared to no-action. This is due to the small number of occurrences which results in minor to negligible changes to river flows and reservoir elevations over a long implementation period. Temporary impacts for any of the alternatives could occur such as localized degradation and aggradation; local impacts might be large in some locations but overall would be small to negligible.

3.2.2.5 Impacts on Riverine Infrastructure

3.2.2.5.1 Assessment Method

Impacts on riverine infrastructure were assessed qualitatively because impacts are largely flow driven. The analysis considered that increased flows could result in increased geomorphic processes such as bank erosion, elevated river levels, and similar type impacts.

3.2.2.5.2 Riverine Infrastructure Impacts

The constant forces of flowing water acting on the riverine infrastructure privately built would continue to require maintenance under all alternatives. Alternatives that result in additional flow variability, with increased flow velocity and more frequent overtopping of channel structures, would result in higher maintenance requirements. Locally, the type of maintenance required would depend in part on local hydrologic conditions and the condition of individual infrastructure components. Flow releases could result in temporary and localized impacts on riverine infrastructure as follows:

- **Reservoir Dams**: The flow release magnitude will result in flows that exceed the Fort Peck Dam power plant capacity. Past operations experience has shown that using the Fort Peck Dam spillway or flood tunnels to release flow for a prolonged period results in the need for additional maintenance of these features and adds cost to operating the System. Long-term reliability of flow release features (spillway and/or flood tunnel) may also be affected. Finally, changes in dam safety risk from the use of additional release mechanisms and pool levels may occur. These risks have not been quantified at this time and would require a risk-based analysis to evaluate changes in operation frequency and pool probability.
- **Bank Stabilization Structures in Inter-Reservoir Reaches in the Upper River**: Very few federally-constructed bank stabilization projects were built in the Fort Peck Dam to Lake Sakakawea reach. Privately-constructed stabilization features were built for the purpose of stabilizing banks near infrastructure such as irrigation intakes and as general bank stabilization purposes to limit bank erosion and loss of private lands. Downstream of Garrison Dam, bank stabilization structures were built under various authorities in the 1960s and 1970s. These structures consist mostly of rock structures and are managed by local authorities. Some of these structures are currently in poor condition. Increased flow velocity and more frequent overtopping would result in higher wear and tear on these structures. Structures may also erode in degrading river reaches and be buried in areas of aggradation. Generally, impacts on these structures would be localized and associated with individual flow releases. Overall, long-term impacts under any of the alternatives are small, considering the wide range of natural and system-controlled variability in flows and geomorphological processes.
- **Lower Missouri River Structures and Navigation Channel**: Since flow releases downstream of Gavins Point Dam are not altered, no impact to riverine infrastructure is anticipated.

In summary, if a Fort Peck flow alternative was implemented, the Fort Peck Dam spillway and bank structures in the upper river would have increased operating and maintenance costs. The Fort Peck Dam spillway would require additional monitoring equipment and may require modification to address any operational risk. The bank structures are usually maintained at a level a few feet above the normal water level. Long-term flows with more bank structure overtopping would result in additional maintenance needs. Similarly, long-term risk of bank structure failure, especially for those structures in poor condition that have not been maintained adequately, would also increase. Costs and risks to Fort Peck Dam spillway and river stabilization structures have not been quantified.

3.2.2.5.3 Conclusions

Overall, conclusions of impacts to riverine infrastructure for each of the alternatives are included in Table 3-8. Changing flows would affect river infrastructure locally in the upper river with no change downstream of Gavins Point Dam due to the absence of any flow change; therefore, impacts to river infrastructure are likely to be negligible to minor for any of the alternatives.

3.2.2.6 Impacts on Geomorphology

3.2.2.6.1 Assessment Method

The primary geomorphological processes associated with the proposed alternatives consist of degradation and streambank erosion, reservoir sediment deposition and capacity loss, aggradation rates, shoreline erosion in reservoirs, and ice dynamics.

Each geomorphological issue was assessed by reviewing existing documents, data, and other relevant information. The assessment considered temporary impacts from individual releases under the various alternatives and long-term impacts on a time scale of multiple decades:

- Temporary impacts are impacts that exceed conditions under No Action and may occur locally or over larger distances for the period of an individual release.
- Long-term impacts are impacts that, on balance, alter geomorphological conditions in the river and reservoirs beyond what would be expected under No Action. The analysis considers the fact that the total volume of water passing through the river system remains unchanged, although the action alternatives would alter the timing and flow rates of the releases. The analysis also considers that peak flow events result in comparatively higher sediment erosion and transport rates than normal or especially low flows. Therefore, high flow releases can cause additional erosion in the river and along streambanks, and subsequent redeposition of mobilized sediment in aggrading reaches.

3.2.2.6.2 Geomorphology Impacts

None of the proposed management actions would change the total volume of water transported through the river system over the long term; only the timing of flow releases and flow rates would be altered and some dominant peak flows may be introduced by high releases. The total volume of sediment entering the river system from the watershed would also largely remain unchanged, although the dynamics of the altered flow release patterns may result in additional localized erosion or sediment deposition within the river or reservoirs. This altered pattern may also affect the frequency of ice jam formation in the upper river.

A full description of potential geomorphic impacts due to a change in flow releases from the mainstem reservoir system is described in the Management Plan EIS (USACE, 2018a) *Section 3.2.2.4 Impacts on Geomorphology from the Alternatives*. Geomorphic impacts from the Fort Peck flow release alternatives would be lesser than those discussed for those alternatives since the flow change magnitude decreases downstream of Garrison and is a negligible change downstream of Oahe Dam.

Existing geomorphological processes and trends would continue, consisting primarily of degradation and bank erosion, reservoir sediment deposition and aggradation, shoreline erosion in reservoirs, and ice dynamics. Continued degradation in the lower Missouri River would be caused by sediment trapped behind dams as well as by continued sand and aggregate mining downstream of Rulo, Nebraska, which lowers the riverbed and the stage of the river over time.

Future aggradation and degradation trends have a similar effect on all the alternatives. Modeling performed for the previous EIS (USACE, 2018a) indicated that the action alternatives would not significantly contribute to aggradation or degradation. Impacts from the primary geomorphological processes are discussed in more detail below.

Degradation and Bank Erosion: Degradation refers to the lowering of the riverbed as a result of erosion coupled with a lack of resupply of sediment from upstream sources because sediments are trapped by the dams. Degradation causes impacts such as erosion of streambanks and the riverbed, erosion around river infrastructure and recreational boating facilities, lowering of the groundwater table in the floodplain, and potential conversion of some wetland areas to upland. Streambank failure rates are a function of multiple factors, including high flows and the repetitive wetting/drying of bank materials.

Flow release changes could cause temporary and localized degradation and bank erosion impacts. Overall, long-term impacts related to flow releases from additional degradation and streambank erosion are expected to be small, although they could be large locally from individual releases or from accelerated degradation rates. The largest potential impact would occur in the reach from Fort Peck Dam to Lake Sakakawea followed by the reach from Garrison Dam to Lake Oahe. Downstream of Lake Oahe, the degree of flow change is small and degradation impacts are also expected to be small.

Additional degradation and bank erosion during the alternative flow test could result in elevated sediment transport. This could impact geomorphic issues such as increased sandbar movement rates and localized areas of deposition. These changes are expected to be minor and temporary. Increased sediment movement could result in additional intake maintenance needs in years with alternative flow releases.

Mechanical ESH construction would not occur in the Fort Peck to Lake Sakakawea reach, and therefore, no impacts from these actions would occur.

Reservoir Sediment Deposition and Aggradation: Aggradation of the riverbed could cause impacts such as flooding, conversion of cropland to wetlands, higher groundwater elevations, and shoaling around infrastructure for recreational boating—all of which would affect private property. The specific locations for aggradation would vary from year to year and would have to be modeled; such detail is currently not available but would be addressed through monitoring and adaptive management under any implemented alternative. The sediment supply from the Yellowstone River would be unaffected by the proposed management actions.

Small impacts within the Lake Sakakawea and Lake Oahe headwaters would occur from year to year in the aggrading locations during higher flow release periods compared to the No Action for all alternatives. This would result in temporary and localized variability in sediment aggradation (deposition) in some areas and riverbed degradation (increasing the channel capacity) in other areas. Considering that long-term additional degradation and streambank erosion could occur in the Fort Peck and Garrison downstream channel reaches, additional aggradation in the reservoir headwater and the delta would be expected within Lake Sakakawea and Lake Oahe. Over the long term, additional aggradation would be small in this reach, although long-term impacts could be large locally.

Shoreline Erosion in Reservoirs: Generally, shoreline erosion rates in the reservoirs are much higher at higher reservoir elevations. Overall, the elevation in the upper three reservoirs would be expected to increase slightly over time for No Action and all alternatives as a result of future sediment deposition. Elevation changes as a result of the proposed management actions would be small, resulting in negligible changes that are both temporary and long-term shoreline erosion impacts.

Elevations in the three large upper reservoirs (Fort Peck Lake, Lake Sakakawea, and Lake Oahe) are more variable because they are used for flood risk management (i.e., reducing the variability in natural flows). Lake Francis Case also experiences annual elevation variation. Flow modifications would temporarily alter the elevations in the reservoirs and hence expose the shorelines to altered patterns of erosion and sediment redeposition. Specifically, added fluctuations from the action alternatives could result in additional shoreline erosion as a result of the wetting and drying cycle. These patterns would vary from year to year because they are dependent on meteorological conditions. These conditions include natural precipitation in the watershed that affects overall reservoir elevations and wind that affects wave height and direction.

The reservoir elevations are most likely to be affected within Fort Peck Lake and Lake Sakakawea. In individual years, differences in reservoir elevations are likely to be less than approximately 10 feet. The less frequent (10^{th} percentile) higher pool levels, as previously discussed in Section 3.2.12 Impacts on Hydrology, increase by less than 1 foot for the various alternatives in both reservoirs. Almost no change from the No Action alternative occurs in the other reservoirs. In addition, the operating ranges of 90 feet (Fort Peck Lake), 79 feet (Lake Sakakawea), and 80 feet (Lake Oahe) are substantially larger than the variability in reservoir elevation that would result from the alternatives.

Therefore, temporary and long-term impacts on shoreline erosion and sediment redeposition would be small and would vary along the shoreline from year to year because the overall reservoir elevations (and thus the overall sediment erosion and redeposition patterns) are driven primarily by natural precipitation. While shoreline erosion impacts could be large locally due to factors such as bank material type, prevailing wind direction, and ice dynamics, the action alternatives would not add significant risk to incur additional impacts.

Ice Dynamics: Release modifications may result in localized changes in the pattern of regular ice formation that would occur. For example, sand bars or local deposition areas created by flow releases could result in local ice jams that could erode the shoreline or result in flooding. Aggraded areas in the upper delta within reservoirs could result in ice jams forming farther upriver, potentially causing flooding in upriver communities. However, temporary and long-term impacts are expected to be small and would be highly dependent on meteorological conditions in any particular year. Standard operations of the Mainstem Reservoir System by USACE include measures to minimize impacts from annual ice formations.

Volume Comparison

A comparison of the flow volume for the period during the test-flow (the months of May and June) was performed for the No Action alternative and the six action alternatives for three locations: Wolf Point, Culbertson, and Williston. Only years when there was either a full test-flow or partial test-flow were compared. A summary table of the averages was prepared to illustrate the differences between alternatives as shown in Table 3-14.

Table 3-14. Average Test-Flow Volume Percent Change Between Alternatives and No Action

	Test-Flow Average Volume Change					
	Difference between Alt and No Action (percent)					
	Alt 1	Alt 1A	Alt 1B	Alt 2	Alt 2A	Alt 2B
Wolf Point Full Avg	**49%**	**26%**	**49%**	**64%**	**51%**	**77%**
Partial Avg	**12%**	**-1%**	**16%**	**18%**	**7%**	**26%**
Culbertson Full Avg	**50%**	**27%**	**51%**	**65%**	**53%**	**80%**
Partial Avg	**14%**	**0%**	**18%**	**19%**	**9%**	**27%**
Williston Full Avg	**20%**	**10%**	**19%**	**26%**	**20%**	**31%**
Partial Avg	**5%**	**0%**	**7%**	**6%**	**3%**	**9%**

Results illustrate very large average volume change for all alternatives. Alternative 1A and Alternative 2A have less change. However, it is not possible to determine if this difference is statistically significant or due to the small sample size. The large volume change during the test-flow period indicates that geomorphic processes may be aggravated by alternatives that are associated with river and flow energy such as bank erosion, sandbar movement, degradation, and aggradation.

Qualitative Stability Evaluation: Using the July 2020 survey site observations, a qualitative stability rating was created to estimate stability at each site with the objective to reflect the risk of geomorphic process impacts on intake operation occurring due to a high flow event. Three categories of stability were developed consisting of stable, intermediate, and unstable.

Table 3-15 outlines the various visual indicators used to estimate site stability within each category.

Table 3-15. Qualitative Streambank Stability Indices and Associated Site Observations

Stability Rating	Associated Visual Observations
Stable	-Not steep to steep streambank(s) -Little to no mass wasting present throughout visible reach -No undercut or fallen debris observed

	-Significant vegetative cover on streambanks -Pump site more likely to be a side channel than on the main channel
Intermediate	-Steep to vertical streambank(s) -Mass wasting observed in small to moderate segments of visible reach -Sparse undercut and fallen debris observed -Low to moderate vegetative cover on streambanks
Unstable	-Vertical streambank(s) -Mass wasting present throughout large segments of visible reach -Several undercut and fallen trees throughout area -Little to no vegetative cover on streambanks -Pump site more likely to be the main channel than on a side channel

Using the stated visual indicators, a qualitative rating was assigned to each site. Of the sites with 2020 available data, roughly 10% of the sites were considered stable, 70% were considered to have intermediate stability, and 20% were considered unstable. The intermediate sites often had one or more stability risk factors and may have moderate risk of erosion and pump site impacts during a single event. The unstable sites often had steep to vertical streambanks, little to no vegetative cover, and continuous observations of mass wasting throughout the reach, both upstream and downstream of the pump intake. The unstable sites would likely pose a higher risk of pump site and farming operation impacts during a single event.

The assigned site stability ratings reflect the results of a qualitative assessment that was based on a rapid assessment of observed site conditions during the July and August 2020 site visits. Assigned site stability ratings are suitable only for use as a qualitative indicator on a large group basis of all pump intake sites and do not reflect any type of computational or geomorphic analysis.

The stability relationship for the surveyed sites could be extrapolated to all irrigation intake sites to develop a qualitative estimate of potential impact as a result of alternative flow releases. For the extrapolation, the number of MT intakes is the most appropriate. North Dakota sites are affected by different geomorphic processes that were not included in the qualitative stability evaluation. Table 3-16 provides a summary of the intake stability ratings.

Table 3-16. Summary of Site Stability Ratings

	Number of Intakes	Number of Sites Within Each Category		
		Stable (23% of Sites)	Intermediate Stability (54% of Sites)	Unstable (23% of Sites)

Surveyed Intake Sites with Stability Information	119	28	63	28
Estimated Number of MT Sites from 2002 Inventory	142	33	76	33
Montana Permitted Sites	365	86	193	86

3.2.2.6.3 Conclusions

Continued degradation of the river channel and bank erosion in the reaches below the dams as a result of sediment trapping within the reservoirs will continue. Continued aggradation of the riverbed upstream of reservoirs within the delta area would occur under all alternatives as a result of redeposition of eroded sediment from the degrading reaches of the Mainstem and its banks and the influx of sediment from tributaries. Streambank erosion in aggrading river reaches and erosion of reservoir shorelines would also continue.

Geomorphic changes will be the largest within the Fort Peck Dam to Lake Sakakawea reach followed by the Garrison Dam to Lake Oahe reach. Changes downstream of Oahe Dam are not expected due to the very little change in river flows and reservoir elevations. As a result of the flow release and reservoir elevation changes, small, temporary, and long-term impacts would occur to degradation, bank erosion, sediment transport, and geomorphic processes. Small, temporary, and long-term impacts to shoreline erosion in the upper three reservoirs and degradation and aggradation in the inter-reservoir reaches would also occur. A qualitative stability analysis using data collected at irrigation intakes in 2020 determined that a large proportion of all intakes have ongoing stability issues that may be aggravated by elevated alternative flow releases. Therefore, as a result of the flow release changes, temporary and long-term geomorphic impacts would occur. The bank erosion, degradation, and geomorphic process change impacts could be large and adverse locally within the Fort Peck to Garrison Dam reach.

3.2.2.7 Impacts on Groundwater

3.2.2.7.1 Assessment Method

Impacts on groundwater were also assessed qualitatively because they are largely a function of stage in the river. In general, prolonged periods of higher stages would result in higher groundwater elevations; lower stages would result in lower groundwater elevations.

3.2.2.7.2 Groundwater Impacts

Groundwater elevations in the floodplain and upland areas adjacent to the river are primarily affected by stage in the river. On a shorter time scale (a season to a few years), the river stage varies because of flow rate. On a longer time scale, the river stage is affected also by a decrease or increase of the river channel elevation from degradation or aggradation, respectively. Over the long term, higher groundwater elevations as a result of a higher river stage, for example, could gradually convert upland (including cropland) to wetland areas or could increase soil moisture levels in cropland areas. Conversely, lower groundwater elevations over the long term could drain wetland areas and convert them into upland areas.

Existing effects on groundwater in the floodplain and areas adjacent to the river from System operation and ongoing geomorphic processes within the aggradation and degradation reaches would continue. Groundwater levels would rise or fall with prolonged periods of high or low flows, respectively.

Higher river stages during elevated flow releases as well as lower river stages during low summer flows would have temporary impacts on groundwater elevations. Alternative increased flow releases could cause local impacts in the Fort Peck Dam to Lake Sakakawea reach and within the Garrison Dam to Lake Oahe reach. Releases will likely exceed channel capacity in the upper reservoir delta regions. The elevated river stages during such releases could result in higher groundwater levels, potentially causing damage to property.

Considering the effects on river stage from natural variability in precipitation and the short duration of high flow release, the long-term impact on groundwater elevations would likely be small, but could be large locally.

3.2.2.7.3 Conclusions

Overall, changing flows would affect groundwater levels locally. Impacts to groundwater would occur during the elevated flow release period. Impacts will be largest in low lying areas within the reach downstream of Culbertson, MT, thru the delta to Lake Sakakawea due to the lower channel capacity in that area.

3.2.2.8 Flood Risk Management and Dam Safety

3.2.2.8.1 Assessment Method

The impact assessment was in part based on flow analysis for the POR using HEC-ResSim and HEC-RAS models, as described in Section 3.1, Introduction. The impacts of releases under the various action alternatives in the river and reservoirs were analyzed using the selected statistical parameters. Impacts are assessed for flow (measured in cfs) and stage (measured in feet) for various locations.

3.2.2.8.2 Channel Capacity

River flow levels and flood risk will be elevated during the higher flow period. Flood risk will be affected by localized precipitation events and tributary inflows. Model results determined a maximum stage increase of approximately 0.3 feet between the No Action and alternative conditions (Appendix D). However, the POR modeling approach contains a limited number of event combinations. The risk that increased flow releases from Fort Peck Dam would combine with rapidly rising downstream tributary inflow to create elevated risk for high stages at the Williston, ND, levee has not been fully evaluated as described in *Section 3.4 Flood Risk Management*. For reference, the estimated channel capacity of the Missouri River is estimated to be about 60 to 70 kcfs from Fort Peck to Wolf Point, about 40 to 50 kcfs from Wolf Point to RM 1604 (20 miles upstream of the Yellowstone River), and about 35 to 40 kcfs from RM 1604 to Williston. It should be noted that the evaluation is based on the RAS model output of river stages for the entire POR.

3.2.2.8.3 Williston Gage and Flood Impacts

Impacts to Williston, ND, area flood damage was examined with model results compared to the gage Action Stage elevation of 1851.84 NAVD 88, the Flood Stage elevation of 1853.84, and the Geotech levee constraint elevation of 1855.31 (NAVD 88). Model results determined a stage increase of approximately 0.1 foot between the No Action and alternative conditions (Appendix D). However, the POR modeling approach contains a limited number of event combinations. The risk that increased flow releases from Fort Peck Dam would combine with rapidly rising downstream tributary inflow to create elevated risk for high stages at the Williston, ND, levee has not been fully evaluated as described in *Section 3.4 Flood Risk Management*.

3.2.2.8.4 Fort Peck Spillway

The operation of the Fort Peck spillway would be required to achieve flow releases for the proposed alternatives. Spillway operation has occurred previously to evacuate storage volume when discharge greater than the powerhouse release capacity was needed. The historic period from 1967 through 2019 resulted in 9 years of operation (15% of the total number of 59 years) for a total of 886 days and a maximum discharge of 52,000 cfs (refer to section 3.2.6.7 Dam Safety and Fort Peck Spillway for details).

The spillway reinforced concrete gate structure is 820 feet long and set on a curved line. It consists of seventeen piers between which are sixteen electrically operated riveted/ welded stone vertical lift steel gates. The spillway crest elevation is 2225 local project datum (LPD). Each gate is approximately 25 feet high and 40 feet wide. Gates were fabricated and installed in 1935. Gates are operated by chain hoists connected to hoist motors on the bridge above the spillway. The piers support a highway bridge, a service bridge, walkways, and a gate operation platform.

Gate openings to provide the desired flow are dependent on the Fort Peck Lake elevation. In general, gate openings will be restricted to avoid small openings of less than 0.5 feet, to minimize the number of gates that are opened, to limit the number of gate operations during the test, and to provide a reasonably well distribution of flow between the gates. For reference purposes, for a pool elevation of 2250, the discharge through a single gate with one foot opening would be 1,040 CFS, or if all 16 gates were opened one foot, the total spillway discharge would be 16,640 CFS. Observations and monitoring during the test may be used to alter gate openings.An evaluation was conducted of spillway operation for the No Action and alternative conditions. This evaluation was conducted using the period of record (POR) simulation from 1930 to 2012 over a total of 83 years. Since the period of record simulation is for the 2012 water development condition, the results do not resemble the historic spillway operation. Comparison of the No Action and alternative condition provide information pertaining to the change in spillway operations that would occur to achieve the desired test flow alternative flow peak and duration for the periods (refer to section 2.5 Alternatives Carried Forward for Detailed Evaluation for details). Spillway flow release is necessary for each test flow alternative whenever powerhouse capacity is exceeded.

Using the 1930 – 2012 POR simulation, the total number of years that spillway operation is required, the total number of days of spillway operation, and the total flow volume was compared for each alternative to the No Action. Results are provided in Table 3-17.

Table 3-17. Spillway Operation Alternative Summary Comparison to No Action

Alt	Number Years Operated[1]	% Years Operated[1]	Total Days Operated[1]	Operation Days % Change	Rank[2]	Total Flow Volume (ac-ft/yr)	Volume % Change	Rank [2]
No Action	15	18%	1,269			44,965		
Alt 1	31	37%	1,654	30%	1	56,936	27%	2
Alt 1A	30	36%	1,494	18%	6	56,001	25%	4
Alt 1B	33	40%	1,620	28%	2	53,194	18%	6

Alt 2	30	36%	1,550	22%	4	56,996	27%	2
Alt 2A	30	36%	1,608	27%	3	60,962	36%	1
Alt 2B	35	42%	1,536	21%	5	54,694	22%	5

1 Summary of total number of years and days of spillway operation from the 1930 to 2012 POR simulation, not historic data

2 Rank order for % change from No Action, 1 largest change to 6 smallest change

The Operation Days change from No Action Days of operation and volume change are all significant. Since they do not change consistently, the rank order provides an indication of which alternative may have the largest potential risk for spillway damage. Using the rank order metric, Alternative 1, which ranks 1 and 2 in these categories, has the greatest degree of change from No Action.

The data in the above table can also be visualized by days of spillway operation for each alternative as shown in Figure 3-18. This stacked bar chart visually displays the number of days of spillway operation by decade for the No Action and each alternative. For the No Action and all alternatives, the decade of 1970 – 1979 has the most days of spillway operation.

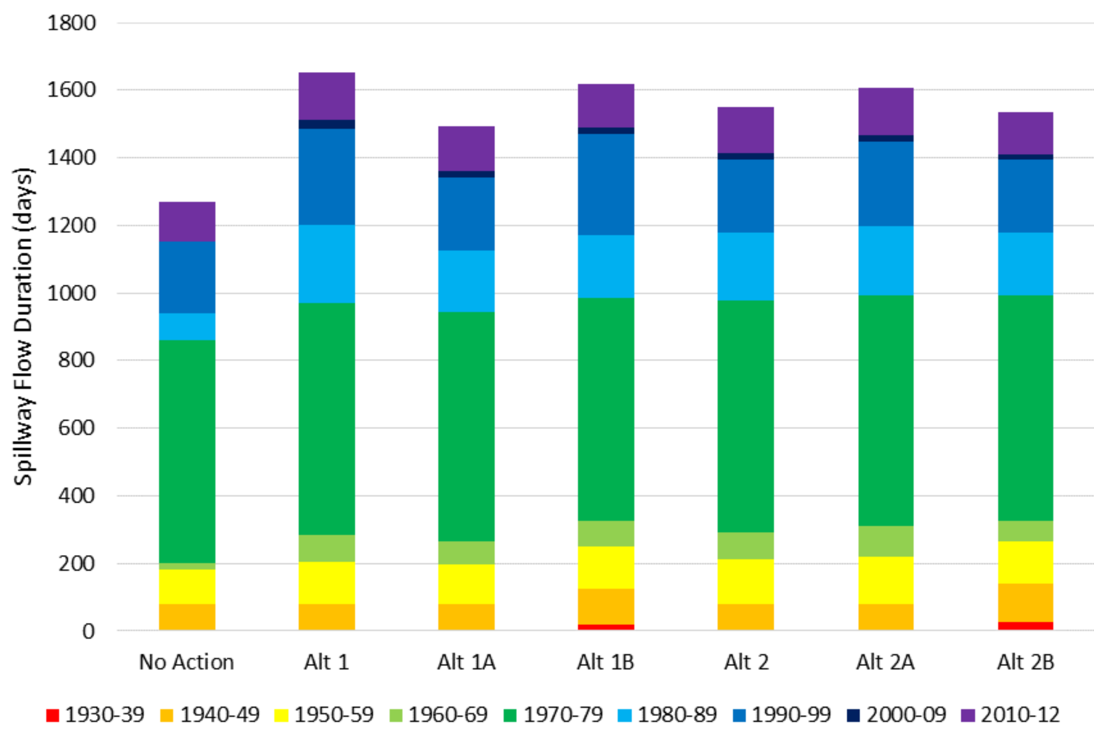


Figure 3-18. Spillway Operation Days for each Alternative by Decade

The change in spillway flow days compared to the no action for each alternative and by year during the 1930-2012 POR is shown in Figure 3-19. Most increases are in the range of 10 to 30 days for any given year.

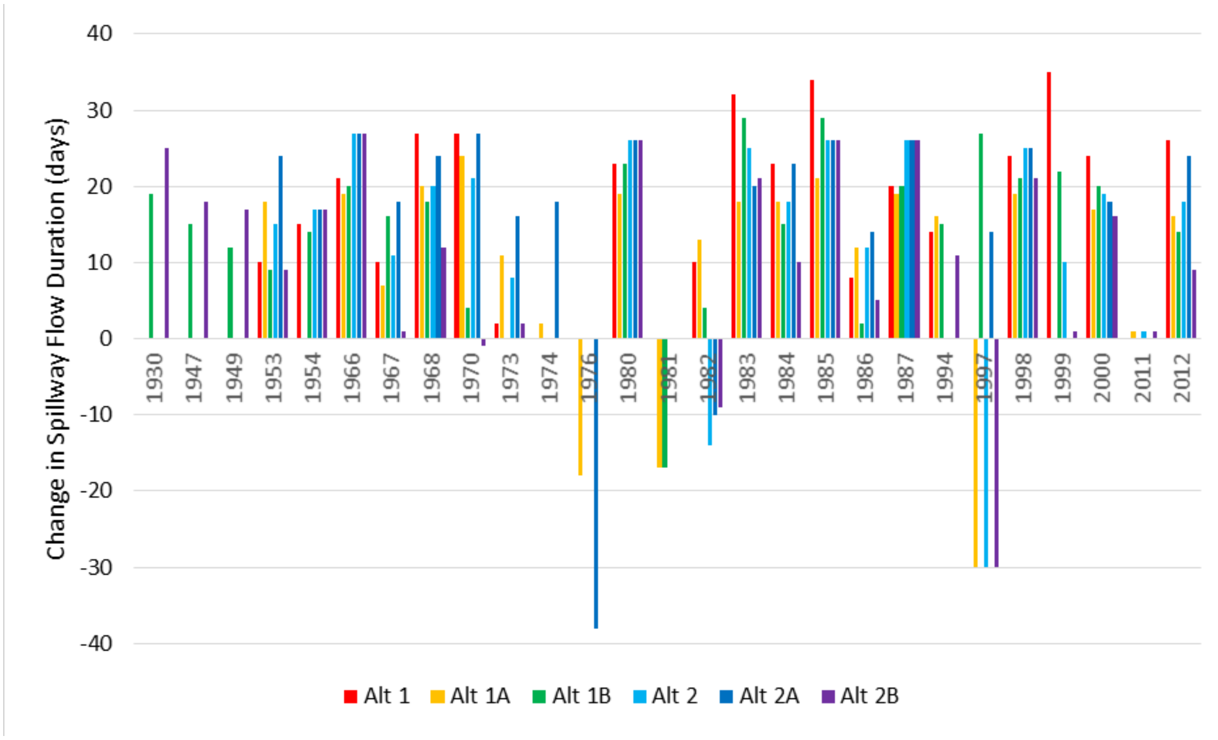


Figure 3-19. Spillway Flow Duration Change for each Alternative Relative to No Action

The change in spillway peak flow compared to the no action for each alternative and by year during the 1930-2012 POR is shown in Figure 3-20. Most increases are in the range of 10,000 to 15,000 cfs for any given year.

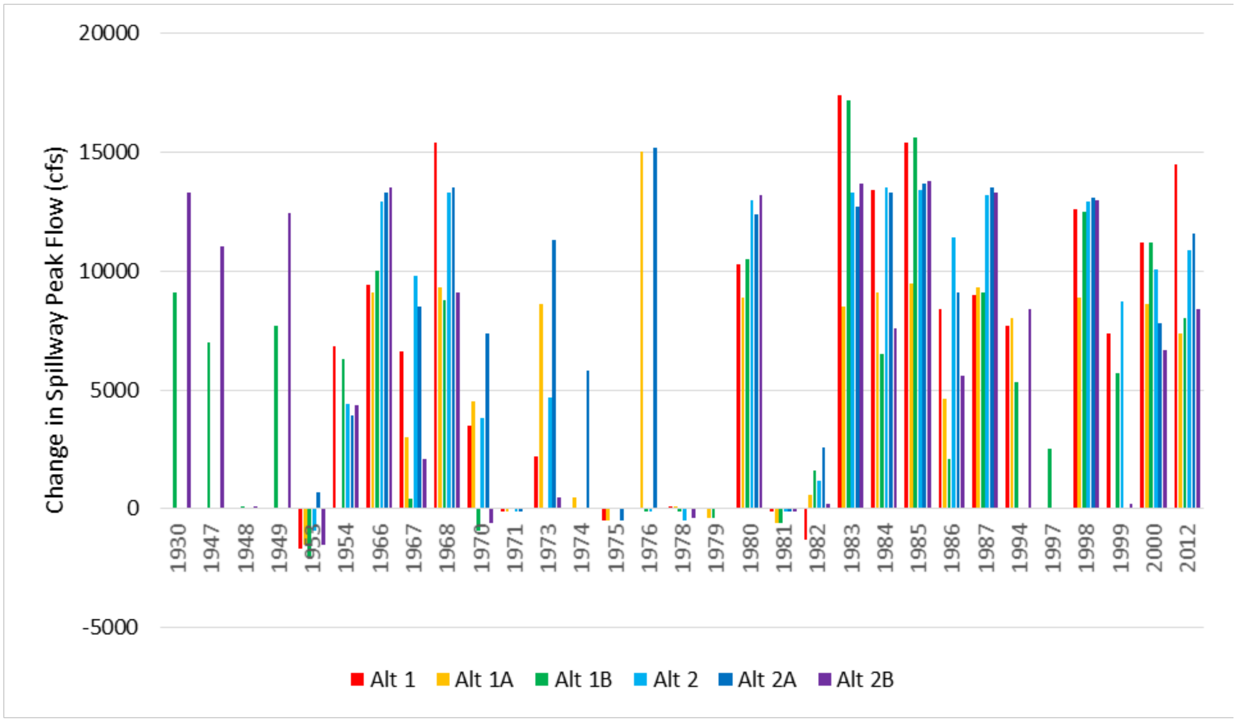


Figure 3-20. Spillway Peak Flow Change for each Alternative Relative to No Action

Increased frequency of Fort Peck spillway operation could provide additional risk to the spillway reliability, damage spillway features, and affect spillway operation and maintenance costs. Each alternative results in a large change in the number of days of spillway operation, the spillway flow volume, and the spillway peak flow.

- Compared to no action, the number of years with spillway operation are about double for each alternative.
- The increase in days of operation ranges from 18% to 30% and the increase in spillway total volume ranges from 18 to 36%.
- Comparing the alternatives, it is not clear that any are preferred to reduce spillway operation damage risk.
- The timing change between the A and B alternatives does not result in a consistent variation between the alternative 1 and 2. While the magnitude of change in flow duration and operation may not be large, using ranked order alternative 1 does appear to have the greatest potential to increase spillway damage risk.

- The Draft 2021 SQRA report found that, with intervention (e.g. closing the spillway gates and stopping the test flow), the test flows should not increase the annual likelihood of failure of the spillway at Fort Peck Dam. Dam Safety risk would not be changed significantly for Fort Peck Dam as a result of the proposed test flows if monitoring is conducted.

- Daily monitoring and observation of the spillway conditions during the test releases was a key assumption for the Draft 2021 SQRA. If, for some reason, personnel would not be available to monitor the releases daily for any change in spillway performance or signs of distress, the test release should not be conducted and / or rescheduled for a time when daily observation by project personnel is possible.
- The operation of the Ft Peck spillway would be required to achieve flow releases for the proposed alternatives. Both Alternatives 1 and 2 would peak between 28,000 – 33,000 cfs for 3 days in June. There would be an approximately two-week period in late-May to June when flows would be higher than the Fort Peck powerhouse capacity (14,000 cfs) and releases would occur through the spillway. For comparison, the spillway operated for 140 days in 2011, 175 days in 2018, and 150 days in 2019.
- The USACE has concerns with spillway slab performance that could be exacerbated with sustained spillway flows and would therefore monitor spillway performance carefully during a test flow. Installation of equipment and monitoring of the spillway subdrain system, walls, and exit channel will be performed during each spillway use. If issues with the spillway are detected the test flow could be stopped by closing the spillway gates and any necessary repairs could be made before attempting another test flow.

3.2.2.8.5 Flood Risk Management

The Missouri River Reservoir System as currently operated provides substantial flood damage reduction and benefits to the entire basin. Study alternatives include modifying operations of the Missouri River Reservoir System with increased reservoir releases during select periods for species habitat benefits. The current HEC-ResSim and HEC-RAS analysis shows the potential for negative impacts to flood risk management for alternatives that include changes in reservoir flow releases. The current study methodology, which employs an 82-year period of record, is suitable for alternative comparison and providing an indication of change in flood risk associated with a flow test. Prior to implementing any management action that changes the water control plan, a complex analysis and public involvement process would be conducted that would address all impacts.

3.2.2.8.6 Conclusions

Overall, changing flows has the potential to affect flood risk management, the Williston levee and gage derived flood impacts, and Fort Peck spillway operation and maintenance. As a result of the flow release changes, small, temporary, and long-term impacts have the potential to occur to flood risk management and dam safety since analysis is limited to the combination of events that occur within the POR as previously described. The POR analysis results indicate that for the past limited number of event combinations when the flow releases were altered, the proposed alternatives did not cause significant impacts to flood risk management because these flooding effects are mostly a result of the natural hydrologic cycles of precipitation and snow pack.

The spillway concrete-lined discharge channel has concerns with spillway slab performance that will be exacerbated with sustained spillway flow. The POR results show a significant increase in spillway operation. Increased frequency of Fort Peck spillway operation could provide additional risk to the spillway reliability, damage spillway features, or affect long-term spillway operation and maintenance costs. Each alternative results in a significant change in the number of days of spillway operation, the spillway flow volume, and the spillway peak flow.

- Compared to no action, the number of years with spillway operation are about double for each alternative.
- The increase in days of operation ranges from 18% to 30% and the increase in spillway total volume ranges from 18 to 36%.
- Comparing the alternatives, it is not clear that any are preferred to reduce spillway operation damage risk.
- Fort Peck spillway experienced significant damage dure to flow releases in 2011. Repairs were conducted as previously described. Spillway slab concerns were noted in a 2019 inspection report (USACE 2019a). These recommended repairs have not yet been performed.
- If damage to the spillway slabs would occur, repair would likely be extensive and not limited to a single slab or small area due to the high spillway flow velocities and the change in flow hydraulics as a result of slab uplift. The spillway slab and sub-drain system repairs would be difficult, expensive, and likely constrained by time in order to address dam safety due to loss of spillway operation as quickly as possible. Depending on damage extent and allowable repair time period, repair cost is estimated to be in the range of $20 to $40M. The test flow releases would increase the likelihood these repairs would be needed because they increase the use of the spillway.
- The risk of spillway slab damage in the future is likely cumulative and related to both spillway operation frequency and flow.

- While the magnitude of change in flow duration and operation may not be large, using ranked order alternative 1 does appear to have the greatest potential to increase spillway damage risk.

3.2.2.9 Water Supply and Irrigation Intakes

3.2.2.9.1 Assessment Method

The 2020 intake data survey (see Appendix D) that provided location information and critical levels for low flow and high flow was used with the calibrated HEC-RAS model and the POR analysis to assess potential alternative impacts. Other impacts on water supply and irrigation intakes were assessed qualitatively for those that are largely a function of site-specific factors including river flow velocity, turbidity, and intake structure geometry as described in the geomorphic impact section.

3.2.2.9.2 Water Supply and Irrigation Intake Impacts

Potential impacts to intake operation that were examined are categorized as:

- Low River Levels – River level is below the intake such that water withdrawal is no longer possible. Low water levels may increase day-to-day operating costs, or, in extreme cases, lead to capital costs for intake modification, location of an alternative water source, or even shutdowns.
- Fluctuating River Levels – Changes in river flows require frequent adjustment and affect the cost of operating intake facilities.
- Tier 1 and Tier 2 River Levels – Higher river levels and associated river processes may affect operation or damage one or more components of the intake (sandbar deposition, flooding of electrical panel, operating pump, and similar).
- Geomorphic Impacts – Processes that increase sandbar migration and bank erosion rates may damage the intake such that flow withdrawal is not possible or requires material removal.

Low River Levels:

Estimates for a minimum Missouri River water surface level required for intake operation were available for sites with available data that were surveyed in 2020. Similar to the methodology used to estimate the Tier 1 and Tier 2 flows, the RAS model was used to derive a flow equivalent to the estimated minimum operating elevation collected during the site surveys.

The evaluation determined several factors that affected reliability of the intake low flow operation.

- Data was available for only 51 of the intake sites and may not be representative of all sites.
- RAS model accuracy at flows in this range is limited as river elevations can be affected by local geometry that is not reflected in the RAS model widely spaced across sections.
- The stage-flow relationship is non-linear in many locations which reduces accuracy of the interpolation based methodology.
- The minimum operating elevation could not be directly surveyed during the site visit in 2020. The elevation was estimated by the site operator as the number of feet below the site river level. At some locations, a flow estimate was provided by the operator rather than an elevation.
- Intake owners often indicated that the minimum intake operating elevation could be lowered by several feet by moving the intake to a nearby location. Intake movement was not included in the evaluation.
- River flow correlates with total flow at the site and includes Fort Peck release and all downstream tributary inflows.
- Locations downstream of the Yellowstone River were not included in the analysis.
- Data includes several outliers with flow estimates above 10,000 cfs that are likely suspect accuracy. River flow at the time of survey was in that range and all intakes were capable of operating.

Results determined that the average river flow at each site required for operation was about 7,200 cfs. Of the 51 sites evaluated, 17 (33%) had a minimum flow necessary for intake operation of 8,000 cfs or greater. Results are summarized in Table 3-18. A plot illustrating the distribution of the minimum river flow required for intake operation by river mile is shown in Table 3-21.

Table 3-18. Minimum Flow for Intake Operation Evaluation Summary

Statistic	Result
Number Sites	51
Average Minimum Operating Flow (cfs)	7,186
Minimum Flow (cfs)	4,000*
Maximum Flow (cfs)	13,952

25th Percentile Flow (cfs)	5,386
75th Percentile Flow (cfs)	8,642
Number Of Sites with Minimum Flow for Operation Greater than 8,000 cfs	17
% Surveyed Sites with Minimum Operating Flow Greater than 8,000 cfs	33%
* Minimum flow not estimated lower than 4,000 cfs	

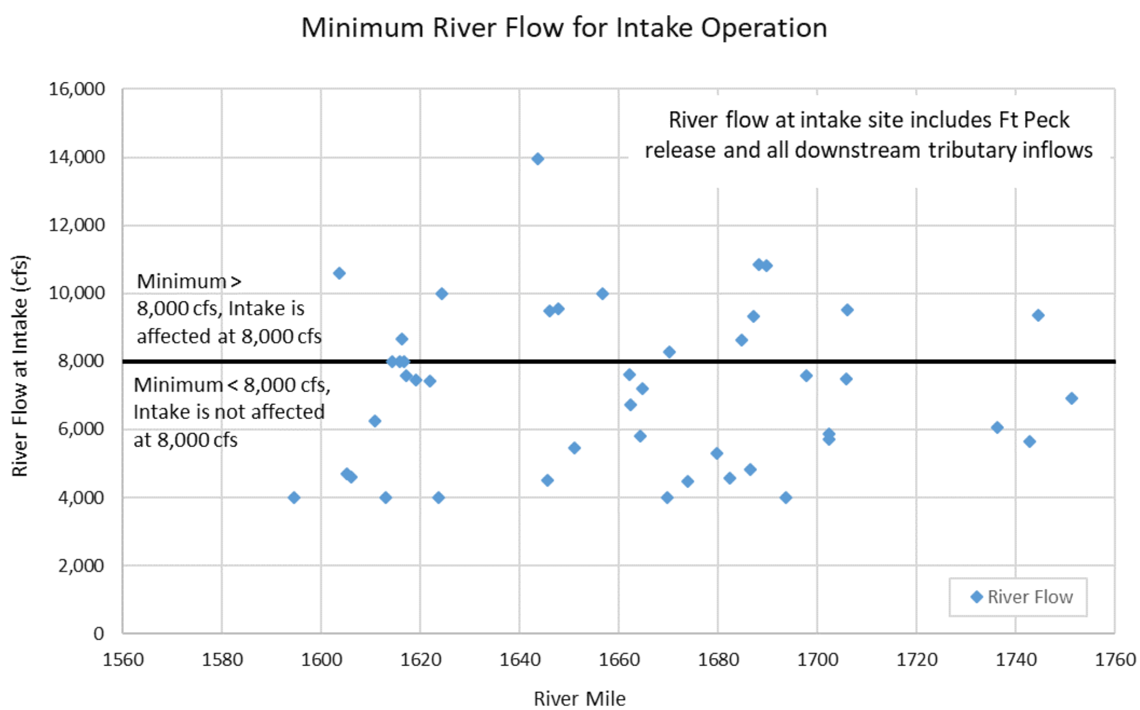


Figure 3-21. Minimum River Flow Estimated for Intake Operation by River Mile

Tier 1 and Tier 2 Evaluation:

RAS model results were combined with 2020 intake survey data to identify Tier 1 and Tier 2 flow levels with a summary results provided in Table 3-19. A detailed table of irrigation intake information and analysis results is provided in Appendix D. Results show that a little over half of the intakes could be impacted with the test-flow peak flow exceeding the Tier 1 flow at 53% of the intake locations.

Table 3-19. Irrigation Intakes Summary Statistics

Statistic	Tier 1	Tier 2
Number Sites Included in Analysis	57	64
Average Flow (cfs)	31,279	56,823
Minimum Flow (cfs)	13,177	22,316
Maximum Flow (cfs)	71,760	85,000*
25th Percentile Flow (cfs)	23,313	34,834
75th Percentile Flow (cfs)	36,654	85,000
Number Sites Tier Flow Less than 25,000 cfs	19	5
Percent of Sites Tier Flow Less than 25,000 cfs	33%	8%
Number Sites Tier Flow Less than 30,000 cfs	30	11
Percent of Sites Tier Flow Less than 30,000 cfs	53%	17%
* Note: Tier 2 flow is capped at a maximum of 85,000 cfs. Actual flow may be higher at some sites.		

Figure 3-22 illustrates the cumulative distribution by Tier 1 and Tier 2 flows for all sites surveyed in 2020.

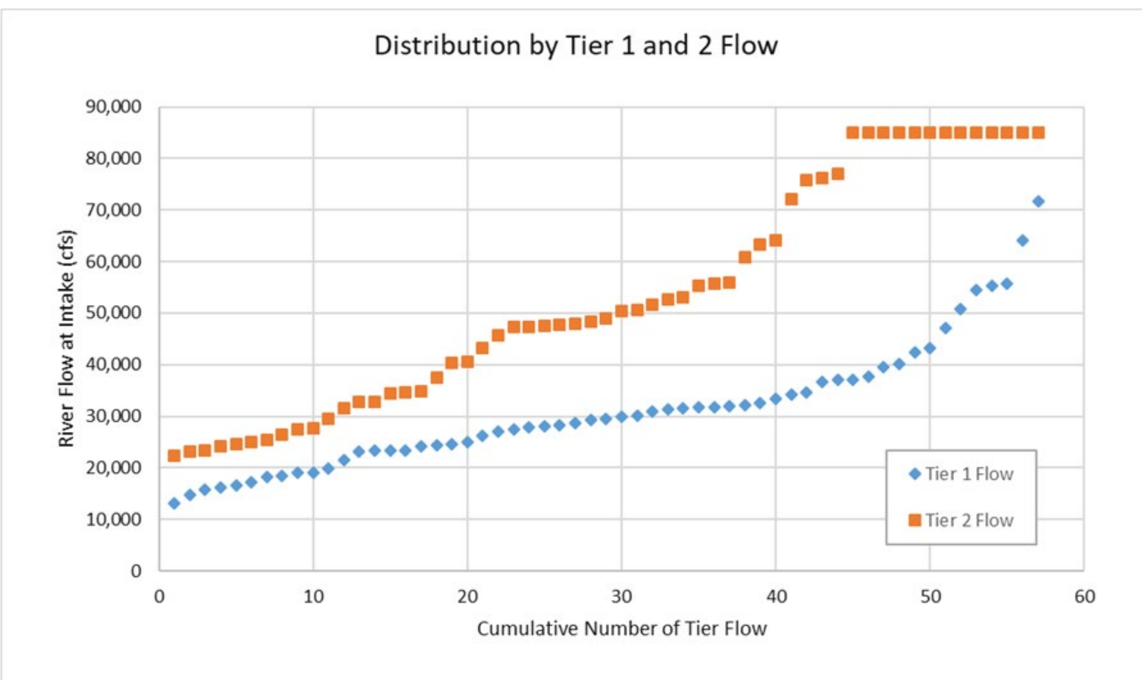


Figure 3-22. Cumulative Distribution by Tier 1 and Tier 2 Flows

Side Channel Connection Intakes:

Side channel locations are susceptible to channel siltation and deposition. The larger gradation size material (fine sands) within the Missouri River sediment load is typically 2 to 3 feet below the river water level. Observations indicate that this sediment often deposits in the form of bars across side channel connections. If this occurs, sediment removal would be required in order to operate the intake. Sediment removal would be complicated by the saturated soil conditions and likely high volume of sediment. Operation of mechanical equipment on top of the deposited bar material may not be possible until water levels recede and drying occurs. This could be a significant time period. Location information was available for all of the 2020 surveys by USACE and MT FWP except for one, leaving a total of 118 sites. For Montana only, the total number of side channel intakes was classified as 24 of 111 sites or approximately 21.6%. Using the 2002 survey total number of sites, this number could be extrapolated to all intake Montana sites to provide an estimate of potential impacts as shown in Table 3-20.

Table 3-20. Side Channel Connection Intakes

	Number of Intakes	Side Channel Connection	Side Channel Connection %
Located MT Sites (2020 survey inventory)	111	24	21.6%
Estimated MT Operating Sites (from 2002 inventory)	142	31	
All Permitted Intake Sites in Montana and North Dakota	395	78	

3.2.2.9.3 Conclusions

There are a large number of intakes affected by the Missouri River within the Fort Peck Dam to Lake Sakakawea reach. Flow change alternatives are likely to have impacts on geomorphic processes including sandbar migration and bank erosion. Fluctuating river levels will also occur due to the alternative implementation. These factors may affect intake operation and contribute to increased maintenance needs. High river levels during the alternative peak flows would impact a portion of the pump stations as identified in the Tier 1 and Tier 2 evaluation. Intakes located on side channels may be affected by sandbar movement and deposition as a result of alternative peak flows. Low river levels may affect the ability to operate the intake. Therefore, as a result of the flow release changes, temporary and long-term impacts would occur to a likely large number of water supply intakes. Intake impacts may be locally large and adverse.

3.2.2.10 Climate Change

A climate change analysis was performed for the FTPTR-EIS with details provided in Appendix D. Potential risk results for the FTPTR-EIS are summarized in the following sections.

3.2.2.10.1 Potential Risk Summary

A literature review of regional climate change related research relevant to the Missouri River basin was conducted and it was found that future climate trends will likely consist of increased temperatures and precipitation. Increased precipitation may result in higher streamflow for some periods, while increased temperatures will likely result in earlier spring snowmelt, decreased snowmelt season duration, and decreased peak snowmelt flows. Increased air temperatures could also have impacts on water temperatures and water quality, which could be exacerbated by low summer flows. Rainfall events will likely become even more sporadic for the entire Missouri River basin. Large rain events will likely become more frequent and interspersed by longer relatively dry periods. Extremes in climate will likely also magnify periods of wet or dry weather, resulting in longer, more severe droughts, and larger more extensive flooding.

An assessment of trends and nonstationarities in observed annual peak streamflow records was conducted for three locations within the study area using the USACE Nonstationarity Detection and Climate Change Hydrology Assessment Tools (NSD & CHAT, respectively). An evaluation of projected, annual maximum mean monthly climate changed hydrology analyzed at a HUC-04 watershed scale was generated for the five HUC-04 watersheds located between Fort Peck Dam and Garrison Dam using the CHAT. A screening level climate change vulnerability assessment was conducted using the USACE Vulnerability Assessment Tool (VA Tool) for the same five HUC04 watersheds analyzed using the CHAT. The vulnerability assessment was conducted for the ecosystem restoration and flood risk management business lines.

- The area contributing to and containing the Missouri River reach where flow increases are planned is not likely to be impacted in an operationally significant way by climate change in the near-term. While the screening level vulnerability assessment, literature reviewed and HUC-04 based analysis of trends in projected, climate changed hydrology specific to the study area indicate possible increases in flood risk and added stress to ecosystem function with time, there is no evidence within observed streamflow records recorded in the study area that flood risk is increasing (no increasing trends/shifts in statistical properties indicating an increase in mean). More detail can be found in Appendix D.

- If the test flow is deemed effective for pallid sturgeon recruitment, the climate change adaptation plan should be revisited. With additional years of gaged data, and innovations in climate change science and modeling methods further insight into how climate change may impact the study area might be obtained. The adaptation management plan should reflect these possible changes in risk due to climate change.
- It is recommended the area continue to be monitored for changing hydroclimatic trends. Additional resilience measures should be considered if changes at the site become statistically significant, when the final long-term plan is selected, and/or if new actionable science related to climate change and relevant to the study area becomes available.

3.2.2.10.2 Potential Risks Related to the Affected Environment

Climate change potential risks were evaluated by resource topic to support the affected environment and environmental consequences analysis. The evaluation considered six climate change variables that are expected to have an impact on flow change alternatives: increased air temperature; increased precipitation and stream flow; decreased peak snow water equivalent; earlier snowmelt date and decreased snow accumulation season duration; increased sedimentation; and increased irregularity of floods and droughts. While the climate change assessment highlighted many likely impacts, assessment did not illustrate a meaningful difference between the No Action and any alternative. Hydrologic processes are summarized in the following paragraphs with specific resource impacts in subsequent sections of Chapter 3.

Hydrology: Flow releases may increase in frequency if System storage rises earlier in the year because a greater proportion of the precipitation in the mountains is expected to fall as rain. In that case, flow release alternatives from Fort Peck Dam may have less frequency of operation if downstream constraints occur more often. Conversely, early evacuation of System storage coupled with more frequent droughts in summer could result in less frequent flow releases. Forecasting calendar year runoff could become less accurate because forecasting runoff based on precipitation may become much more difficult than forecasting runoff based on snowmelt. In addition, climate change could result in lower service levels in the second half of the navigation season if runoff falls as rain in late winter while the System is being evacuated to provide spring runoff storage volume.

Geomorphology*:* Higher natural annual flows and a higher number of peak flow events would likely result in higher sediment erosion rates in the Missouri River watershed. As a result, the Mainstem and tributaries would carry larger volumes of sediment. Rates of degradation, streambank erosion, and aggradation would increase in the inter-reservoir reaches; degradation and streambank erosion would increase in the active degradation reaches. In addition, geomorphological impacts from the release changes would mirror the changes in hydrology. Specifically, more frequent and longer flow releases would result in an incremental increase in geomorphological impacts during that period within the reaches affected by elevated flow. Higher air temperatures and higher sporadic flood flows would also affect ice dynamics, resulting in altered flooding patterns from ice jams.

Riverine Infrastructure: Higher natural annual flow rates and more frequent peak flows would increase the impacts (i.e., erosion, wear and tear from frequent overtopping, burial) on river infrastructure. Riverine infrastructure impacts from release changes would also mirror the changes in hydrology. Rainfall events are likely to become even more sporadic for the study area. Large rain events are likely to become more frequent and interspersed by longer relatively dry periods. More frequent and longer Fort Peck flow releases would result in an incremental increase in riverine infrastructure impacts during that period affected by elevated flow.

Groundwater: More frequent natural peak flows and more prolonged droughts could result in greater variability in groundwater elevations throughout the year under all alternatives in the floodplain and land adjacent to the river, which could affect wetlands and croplands. In addition, groundwater impacts from higher flow releases would also mirror the changes in hydrology. Specifically, more frequent and longer flow releases would result in an incremental increase in groundwater impacts during that period within the reaches affected by elevated flow.

3.2.2.10.3 Conclusions

A risk assessment was performed to evaluate the resilience of the selected alternative to expected changes in climate and hydrology and identify risks that have not been addressed during formulation due to knowledge and data uncertainties. Specific project factors are considered when assessing risk. The FTPTR-EIS is considering short term test flows that are not a permanent change to the water control plan. The test flows will be conducted over a short period of 5-15 years. Relative to the No Action, none of the alternatives being considered will generate a significant difference in total flow being released from Fort Peck annually. Total annual volume being retained and released by the reservoir annually is virtually identical for all cases. Thus, the proposed alternatives are unlikely to cause negative impacts that would be acerbated by climate change relative to the no action alternative.

The results of the vulnerability assessment point to an increase in potential ecosystem restoration and flood risk reduction vulnerabilities for some sub-watersheds in the study area for future years. Projected climate changed hydrology studied, specific to the study area, as well as excerpts from the literature review imply that the study area could be impacted by increased flow peaks in the future. Extremes in climate will magnify periods of wet or dry weather resulting in longer, more severe droughts, and larger, more extensive flooding. These increased sporadic flood and drought periods could prove challenging for reservoir regulation and have impacts to the No Action and all proposed alternatives.

While potential climate change impacts on basin hydrology were identified, the climate change assessment did not illustrate a meaningful difference nor provide information on alternative formulation that could alter FTPTR-EIS vulnerabilities to climate change. No significant difference is noted between the No Action and any of the alternatives. No residual risk for any of the alternatives was identified. The results of the risk assessment summary are shown in Table 3-21.

Table 3-21. Summary of Risk from climate change for No Action and Alternatives

Project Feature	Trigger	Hazard / Harm	Qualitative Residual Risk Rating	Justification for Rating
Fort Peck Test Flow Release	Increased Air Temperature	During the summer, low river levels could have water quality issues if water temperatures increase. Increased air and water temperatures may benefit pallid during the drift phase and growth; increased temperatures may also stress pallid if above optimum	Low	No significant variation is expected from No Action for any alternative due to climate change 1) The test flows will be conducted over a short period of the next 5-15 years 2) Neither the No Action nor any of the alternatives has a significant flow difference and total annual volume is virtually identical 3) A long term climate change assessment did not illustrate a meaningful difference nor provide information on alternative formulation that could alter FTPTR-EIS
	Increased Spring Precipitation and Streamflow	Fort Peck and Garrison operations may be constrained by higher pool levels and inflows; may be able to run spring flows more often due to increased System storage. However, the frequency of a completed flow would likely decrease due to exceeding flow targets. The effect of altered frequency of flow releases on pallid is unknown.	Low	
	Earlier Snowmelt Date and Decreased Snow Accumulation Season Duration	System storage may rise earlier in the year and may be able to run flows more frequently; this may affect Fort Peck and Garrison operations due to higher pool levels earlier in the season, may result in lower navigation service levels for the second half of the season if storage is evacuated during spring runoff. Higher Fort Peck release temperatures may	Low	

		benefit pallid growth while lower system storage may reduce long term flows and reduce pallid habitat.		vulnerabilities to climate change.
	Increased Sedimentation	Decreased System storage may lead to decreased frequency of all releases (assuming release requirements remain the same and sedimentation is not addressed); loss of storage may affect System flood risk reduction operations. Decreased flows may reduce pallid habitat.	Low	
	Decreased Peak Snow Water Equivalent	Forecasting season runoff may become less accurate since runoff from precipitation is more difficult to forecast than snowpack; less accurate forecasts may result in an increased risk of System impacts due to flows (i.e., lower reservoir elevations, higher releases, lower storage levels) due to runoff uncertainty; releases may be seasonally altered with unknown pallid effects.	Low	
	Increased Occurrence and Irregularity of Floods and Droughts	Accuracy of downstream forecasting may decrease, resulting in more frequent flood impacts caused by flows. Has a greater potential to affect System storage with flows if more droughts occur; releases may be seasonally altered with unknown pallid effects.	Low	

3.2.2.11 Physical Monitoring During Flow Test

Physical monitoring of the affected environment will be performed during the flow test for the purposes of evaluating potential impacts to bank erosion, flood extent, water intakes, Fort Peck Dam spillway, and similar concerns. General goals and methods of the monitoring plan are as follows:

- Bank Erosion. Ten to twenty representative locations will be selected for bank erosion monitoring. Repetitive channel and bank surveys will be used to evaluate conditions before, during, and after the flow test.
- Water Intakes. Twenty to thirty representative municipal and irrigation water intakes will be monitored to evaluate sandbar migration, turbidity, and similar geomorphic processes to evaluate potential impact on function. Other areas identified as critical features will be monitored on an as-needed basis.
- Water Surface Elevation Profiles. A water surface profile before, during, and after the flow test will be collected to evaluate hydraulic model accuracy, flood inundation extent, and to identify changes in water surface elevations in the reach.

- Aerial Photography. A before, during, and after test set of aerial photos will be collected for use in identifying bank erosion.
- Ft Peck Dam Spillway.
  - Installation of equipment to monitor flow within the discharge channel sub-drain system to help estimate uplift pressures due to the test flow.
  - Surveys of the new RCC structure walls to determine if they move as a result of the test flow.
  - Surveys of the downstream unlined channel to determine the amount of channel scour and bank erosion due to the test flow.
  - Flow measurement and velocity information will be collected with the spillway exit channel and the Missouri River to assess velocity distribution and magnitude. This information will be used to evaluate risk during sustained releases and drawdown.

Spillway monitoring equipment installation and monitoring is estimated to cost in the range of $200,000 to $400,000. Missouri River channel profiles and aerial photos are estimated to cost in the range of $300,000 to $600,000. Total physical monitoring cost is estimated in the range of $500,000 to $1,000,000. Costs will vary with the number of test flows implemented.

Monitoring data will be used to further inform on flow test implementation regarding impacts downstream within the Missouri River channel to concerns including bank erosion, water intake operations, and river flow levels. Fort Peck spillway monitoring information will be used to assess dam safety and spillway reliability. These are critical components for assessing the capability to conduct future flow tests.

3.3 Pallid Sturgeon

3.3.1 Affected Environment

Pallid sturgeon (*Scaphirhynchus albus*) are large, long-lived benthic (i.e., bottom dwelling) fish that inhabit rivers of the Missouri and Mississippi River basins. They have physical features adapted to life in turbid fast-flowing rivers such as a flattened shovel-shaped snout; a long, slender, and completely armored body; fleshy barbels; and a protrusible mouth (i.e., capable of being extended and withdrawn from its natural position) that supplement their small eyes in detecting and capturing food (Figure 3-23). Pallid sturgeon are similar in appearance to the more common shovelnose sturgeon (*Scaphirhynchus platorynchus*) (Figure 3-23) and the ranges of the two species overlap (USFWS, 2014). However, mature pallid sturgeon attain larger sizes than shovelnose sturgeon and have longer outer barbels and shorter inner barbels (USFWS, 2014).

The primary sources of information for this section are two USACE-funded efforts: the Missouri River Pallid Sturgeon Effects Analysis (Jacobson et al., 2016) and the Comprehensive Sturgeon Research Project (DeLonay et al., 2016). The U.S. Geological Survey (USGS) led both efforts in collaboration with other resource agencies. This section focuses on the aspects of pallid sturgeon life history and biology that are most likely to be affected by the plan alternatives, including actions to achieve recruitment of age-0 pallid sturgeon into the population.

Figure 3-23. Shovelnose sturgeon (left) and pallid sturgeon (right) (Photo courtesy of USGS; inset photo courtesy of Nebraska Game and Parks Commission)

3.3.1.1 Population Status and Distribution

The pallid sturgeon was listed as endangered under the Endangered Species Act (ESA) on September 6, 1990 (55 Federal Regulation 36641–36647). A recent revision of the species recovery plan notes that the species status has improved and is currently stable as a result of artificial propagation and stocking efforts under the Pallid Sturgeon Conservation Augmentation Program (PSCAP) (USFWS, 2014; Steffensen et al., 2013). However, the population remains neither self-sustaining nor viable and if stocking were to cease, pallid sturgeon would face local extirpation in several reaches of the Missouri River (USFWS, 2014).

Jacobson et al. (2016) describe the natural geographic range of the pallid sturgeon to include the Mississippi and Missouri River basins in which turbid fast-flowing waters flow over predominately sandy substrate. This range includes the Yellowstone and Missouri Rivers downstream to the confluence with the Mississippi River and the Mississippi River from Keokuk, Iowa, to the Gulf of Mexico (including the Atchafalaya River distributary). Also included are lower parts of some Missouri River tributaries, including the Milk River in Montana, Niobrara, and Platte Rivers in Nebraska, Big Sioux River in Iowa and South Dakota, Kansas River in Kansas, and Grand and Osage Rivers in Missouri (Figure 3-24).

Since listing in 1990, wild pallid sturgeon have been documented in the following areas (Figure 3-24) (USFWS, 2014):

- In the Missouri River between Fort Benton and the headwaters of Fort Peck Reservoir, Montana;
- Downstream from Fort Peck Dam, Montana to the headwaters of Lake Sakakawea, North Dakota;
- Downstream from Garrison Dam, North Dakota to the headwaters of Lake Oahe, South Dakota;
- From Oahe Dam downstream to within Lake Sharpe, South Dakota;
- Between Fort Randall and Gavins Point Dams, South Dakota and Nebraska;
- Downstream from Gavins Point Dam to St. Louis, Missouri;
- In the lower Milk and Yellowstone Rivers, Montana and North Dakota;
- In the lower Big Sioux River, South Dakota;
- In the lower Platte River, Nebraska;
- In the lower Niobrara River, Nebraska; and,
- In the lower Kansas River, Kansas.

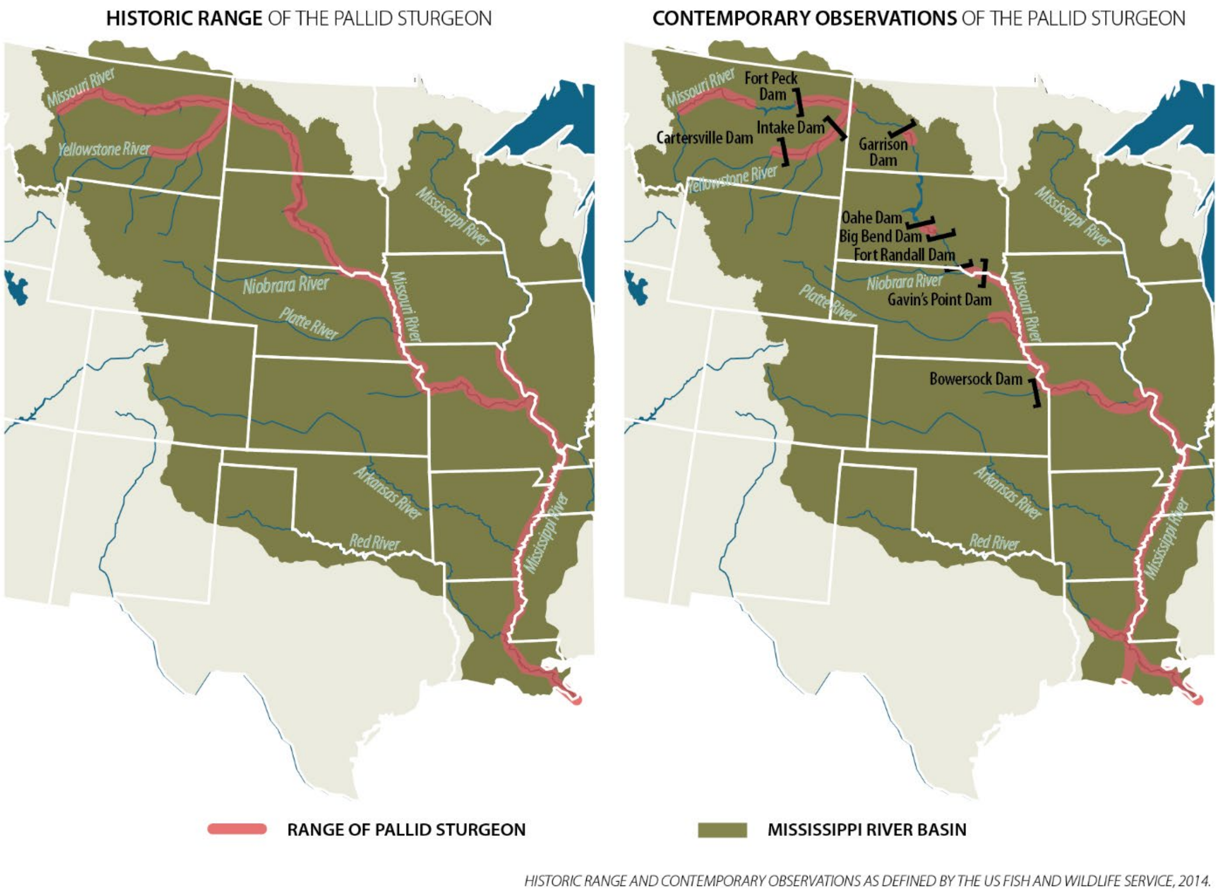


Figure 3-24. Pallid sturgeon natural geographic distribution (A) and current distribution (B)

The following discussion of current pallid sturgeon population estimates comes from Jacobson et al. (2016). Duffy et al. (1996) summarized the estimates of various studies, both published and unpublished, suggesting as few as 6,000 or as many as 12,000 wild pallid sturgeon existed throughout their natural geographic range. A 1995 survey estimated 45 wild adult pallid sturgeon existed in the river upstream from Fort Peck Lake; however, only three wild pallid sturgeon were collected in this location from 2007 to 2013 (USFWS, 2014). Estimates from mark-recapture studies on inter-reservoir populations indicate that the population between Fort Peck and Garrison Dams may range from 125 to 158 wild adults (Jaeger et al., 2009; Braaten et al., 2009).

USFWS (2014) defines four pallid sturgeon recovery management units, two of which fall all or partly within the geographic scope of the MRRMP-EIS: the Great Plains Management Unit and the Central Lowlands Management Unit. The Great Plains Management Unit is defined as the Great Falls of the Missouri River, Montana to Fort Randall Dam, South Dakota, and includes important tributaries like the Yellowstone, Marias and Milk Rivers. The portion of the management unit from Fort Peck Dam to Fort Randall Dam fall within the geographic scope of this EIS. The Central Lowlands Management Unit (Fort Randall Dam, South Dakota to the confluence with the Grand River, Missouri) is partially within the geographic scope of this EIS, because the scope of test flow effects from Fort Peck Dam in Montana were assumed to have no impact downstream of Gavins Point Dam in South Dakota.

USFWS (2014) states that pallid sturgeon will be considered for reclassification from endangered to threatened when the listing/recovery criteria are sufficiently addressed such that a self-sustaining, genetically diverse population of 5,000 adult pallid sturgeon is realized and maintained within each of four management units for two generations (20–30 years). In this context, a self-sustaining population is described as a spawning population that results in sufficient recruitment of naturally produced pallid sturgeon into the adult population at levels necessary to maintain a genetically diverse, wild adult population in the absence of artificial population augmentation (USFWS, 2014).

3.3.1.2 Reproduction and Recruitment

The following discussion of pallid sturgeon reproduction and recruitment is organized by life stages as presented in Jacobson et al. (2016). These stages are similar to those described by Wildhaber et al. (2011) and documented in the pallid sturgeon conceptual ecological models (CEMs) (Jacobson et al., 2015). Table 3-22 summarizes the seven life stages.

Table 3-22. Pallid sturgeon life stages

Life Stage	Description
Embryo	Period from fertilization to hatching (5–8 days)
Free embryo	Period from hatching until the larval fish begins feeding (8–12 days post-hatch)
Exogenously feeding larvae and age-0	Period from full development of fin rays during the winter until June 1 of the following year. (June 1 was selected as a fixed time to demarcate age-0 stages compared to age 1+ fish.)
Juvenile	Period of pallid sturgeon sexual immaturity; a fish can remain in this stage until age-9.
Spawning adult	This stage includes juvenile fish that have become sexually mature and are ready to spawn and adult fish that have already spawned and are ready to spawn again.
Post-spawn adult	An adult fish that has released its gametes.
Recrudescent adult	A post-spawn adult fish that is replenishing gametes. The fish may remain in this state for as many as 4 years.

Source: Jacobson et al. 2016b, See also : Glossary for additional descriptive terms used relative to life stage.

Adult Life Stage

Pallid sturgeon are long-lived, with females reaching sexual maturity later than males (Keenlyne & Jenkins, 1993). However, the age at first reproduction can vary between hatchery-reared and wild fish, depending on local conditions (USFWS, 2014). The estimated age at first reproduction of wild fish is about 15 to 20 years for females and approximately 5 to 7 years for males (Keenlyne & Jenkins, 1993). Minimum age-at-sexual maturity for known-aged hatchery-reared fish was age-9 for females and age-7 for males (Steffensen, 2012).

Pallid sturgeon generally spawn from mid-June through early July in the UMR (DeLonay et al., 2016). Reproductively ready pallid sturgeon indicate consistent patterns of upstream migration before spawning. Migration patterns can differ between males and females; where male patterns are less regular. It is not currently known if males migrate and select spawning locations in advance of the arrival of females in the lower Missouri River; however, aggregations of males have been documented in the lower Yellowstone River, and these areas of aggregation have coincided with sites where spawning by females has been documented (DeLonay et al., 2016). Mapping of migration pathways found minimum migration distances ranging from 20 to 190 miles. In the lower Missouri River, migrating pallid sturgeon in Nebraska and Iowa avoid very shallow areas and use the range of water velocities available to them while avoiding velocities on the low and high ends of the distribution. Migrating pallid sturgeon in Missouri selected shallow places in the channel, and velocities on the low end of the distribution, which indicates selection of migration pathways that optimize energy expenditure (DeLonay et al., 2016).

On the Yellowstone River, the majority of pallid sturgeon spawning occurs in several locations from RM 6 to 20 (DeLonay et al., 2016; Fuller & Braaten, 2012; Bramblett & White, 2001; Bramblett, 1996). Suitable spawning habitat is also presumed to be available for pallid sturgeon in the UMR below Fort Peck Dam in areas of coarse substrate. One spawning location was documented in 2011 downstream of the Milk River and one free embryo was collected in the Missouri River (DeLonay et al., 2014). This was the first time pallid sturgeon spawning was documented below Fort Peck Dam and contrasts with most studies indicating the majority of telemetered pallid sturgeon typically move from the Missouri River into the Yellowstone River to spawn.

Pallid sturgeon do not spawn on a 12-month cycle. DeLonay et al. (2016) tracked one male that had a 2-year spawning periodicty and six males that had a cycle of longer than 1 year, but total cycle length could not be determined. Of 20 female pallid sturgeon tracked, most had spawning periodicity longer than 2 years (DeLonay et al., 2016).

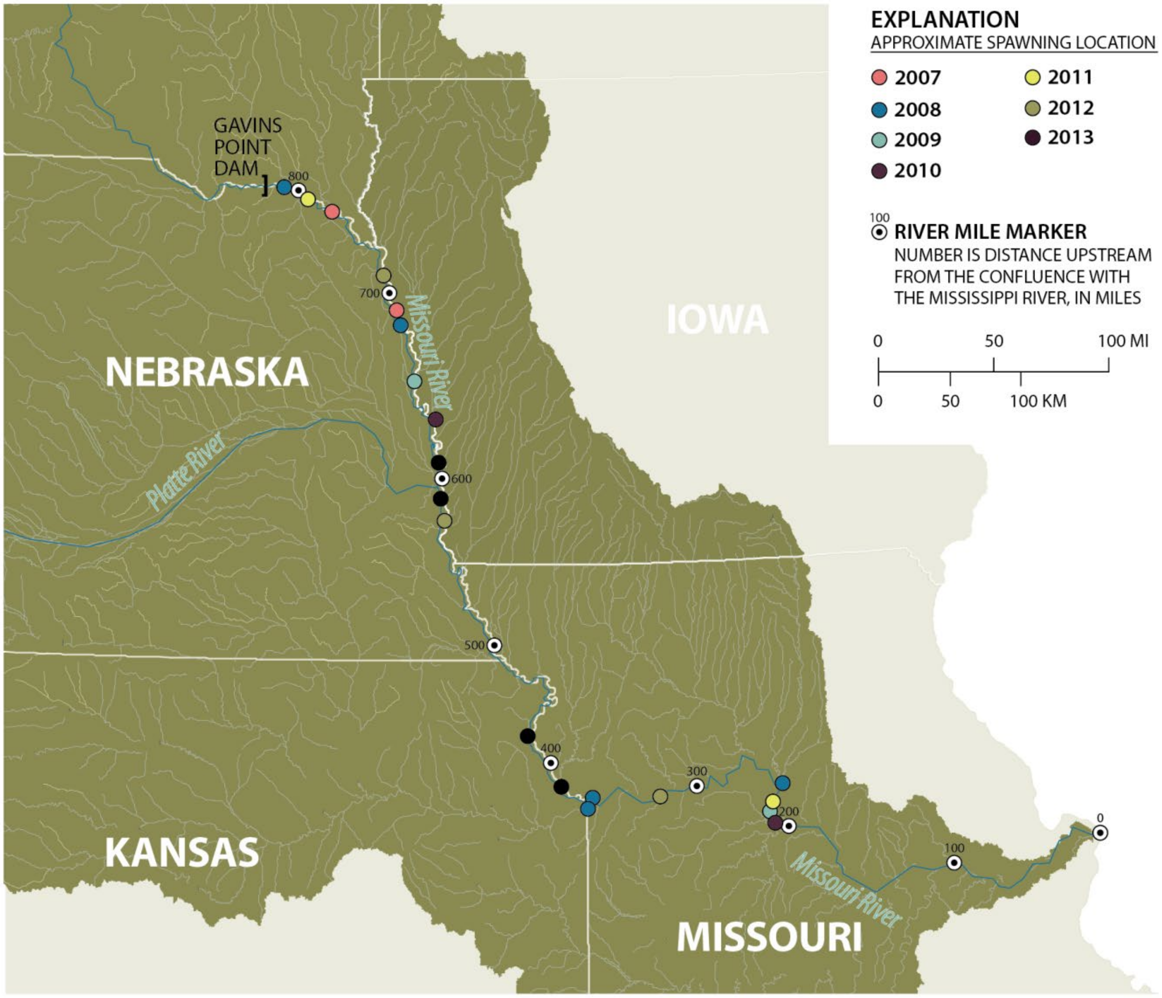


Figure 3-25. Documented pallid sturgeon spawning sites in the lower Missouri River (2007-2014) (Adapted from DeLonay et al., 2016)

Embryo Life Stage

An embryo is a developing fish within the egg membrane; this life stage covers the period from fertilization to hatching (lasting 5–8 days depending on water temperature; DeLonay et al., 2016). Most of what is known about habitat requirements for embryos is extrapolated from laboratory studies. Naturally spawned pallid sturgeon eggs become adhesive 1 to 3 minutes after fertilization (Dettlaff et al., 1993) and presumably fall through the water column to affix to solid substrate such as rock (DeLonay et al., 2016). The relative importance of turbidity for the deposition, fertilization, and hatch of pallid sturgeon embryos is unknown (DeLonay et al., 2016). It is also unknown if predation is a threat to pallid sturgeon embryos (DeLonay et al., 2016). Suitable habitat for embryos is included in the spawning habitat discussion later in this section.

Free Embryo Life Stage

A free embryo is a developing fish that no longer resides within the egg membrane. This life stage lasts 8 to 12 days post-hatch and covers the period from hatch until the larval fish begins feeding (DeLonay et al., 2016). Available information on the pallid sturgeon free embryo life stage primarily comes from laboratory studies. DeLonay et al. (2016) state these studies and complementary field studies (Braaten et al., 2008, 2012) indicate: (1) pallid sturgeon free embryos drift and disperse downstream at a rate slightly less than mean water column velocity; (2) downstream drift and dispersal occur during day and night; (3) duration of the free embryo drift period depends on water temperature and rate of development; and (4) free embryos will drift and disperse several hundred kilometers during development into exogenously (i.e., external) feeding larvae, with total drift distance a function of water temperature, development rate, and velocity conditions in the river channel. As discussed in Chapter 2, hypotheses differ regarding whether free embryos initiate drift immediately after hatch or spend one to several days hiding in interstitial spaces in the substrate. Drifting free embryos use up their yolk sac and develop swimming ability, after which they “settle” into environments conducive to feeding, growth, and survival.

Exogenously Feeding Larvae Life Stage

This life stage is a developing fish without a yolk, feeding exogenously (i.e., it has consumed its yolk sac and must now feed externally). The period of transition from endogenous (growing or produced by growth from deep tissue) to exogenous feeding is considered critical because the larvae must find sufficient food or it will starve. Larval pallid sturgeon have been reported to consume the larvae and pupae of Dipterans (mainly from the family Chironomidae (i.e., midges) and Ephemeroptera nymphs (i.e., mayflies); DeLonay et al., 2016).

Juvenile Life Stage

The juvenile life stage consists of sexually immature fish and lasts until the fish enter their first reproductive cycle. During this period, the juvenile sturgeon shifts their diet from insects to fish (Gerrity et al., 2006; Grohs et al., 2009). Observed conditions where pallid sturgeon have been found as part of the Pallid Sturgeon Population Assessment Program (PSPAP) between 2003 and 2010 provide notable differences between juveniles and adults that suggest differences in habitat use (Welker & Drobish, 2010). During late spring through fall, juveniles found in the Missouri River above Gavins Point Dam tended to be collected in cooler water temperatures than adults, with the reverse pattern observed below Gavins Point Dam.

However, during this same period, juveniles tended to be collected in shallower, slower water than adults throughout the river. Throughout the river, during late fall through early spring, juveniles tended to be collected in warmer water than adults, with depth differences still present but not as dramatic as observed during late spring through fall and with no obvious differences in velocity (DeLonay et al., 2016).

Diet composition plays a large role in the growth of juvenile pallid sturgeon to adult (Grohs et al., 2009), with chironomids (Order: Diptera) and mayflies (Order: Ephemeroptera) serving as important components of the early juvenile diet (Sechler, 2010; Sechler et al., 2013). Pallid sturgeon diets shift from macroinvertebrates to fish as they grow. Of the food eaten by juvenile pallid sturgeon between 350 and 500 mm fork length, 57 percent was fish, whereas fish made up 90 percent of the diets of juvenile pallid sturgeon longer than 500 mm fork length (Gerrity et al., 2006; Grohs et al., 2009). Isotope analyses of pectoral spines support gut analyses and indicate that the diet shift of juvenile pallid sturgeon from invertebrates to fish likely occurs at or before 500 mm fork length–well before pallid sturgeon reach reproductive maturity (French, 2010). Limited prey sources increase mortality and may suppress growth in surviving juveniles (Deng et al., 2003; DeLonay et al., 2009). No clear relationship has been documented between abiotic factors (e.g., water temperature) and pallid sturgeon recruitment, but early diet and growth are hypothesized to affect recruitment into adult spawning populations (DeLonay et al., 2009; Sechler, 2010).

3.3.1.3 Pallid Sturgeon Functional Habitat

Jacobson et al. (2016) defined pallid sturgeon functional habitats based on a synthesis of the best available science. Functional habitat definitions attempt to quantify the broad continuum of habitat conditions experienced by pallid sturgeon into relatively few habitat classes that relate to important biological and population responses. Definitions of spawning and interception habitats are considered especially tentative. The following descriptions are taken from Jacobson et al (2016).

Spawning Habitat

Currently there is no known natural recruitment in either the Yellowstone or Missouri Rivers above Lake Sakakawea despite evidence of successful spawning. Pallid sturgeon drifting free embryos have been collected from these areas in 2011–2013: 2011(n=1, collected near Frazer, Montana in the Missouri River), 2012 (N=1, collected near Fairview Montana, from the

Yellowstone River) and 2013 (n=4, collected near Fairview, Montana from the Yellowstone River); however, there is no evidence of recruitment to age-1 from wild fish.

3.3.1.4 Management Actions to Benefit Pallid Sturgeon

This section describes the actions implemented that are part of the existing condition, which includes implementation of the Science and Adaptive Management Plan and supporting the Fort Peck AM Framework as described in Chapter 1.

Propagation and Augmentation

Wild pallid sturgeon are collected each spring and brought into hatcheries for spawning and the eventual stocking of their progeny in cooperation with USFWS and state agencies and in accordance with USFWS guidance. Federal and state hatcheries involved with propagation of Missouri River pallid sturgeon stocked a combined 24,309 fingerling and yearling-sized pallid sturgeon from the 2013 and 2014 year classes into resource priority management areas (RPMAs) 1–4 during 2014. Monitoring data collected through the PSPAP indicate that stocked pallid sturgeon are surviving, growing, and reaching a size and age capable of spawning. Recent survival estimates for hatchery fish stocked into the Missouri River show relatively high rates of survival (Hadley & Rotella, 2009; Rotella, 2012; Steffensen et al., 2010) that are similar to other sturgeon species (Ireland et al., 2002). Since 2001, more than 290,000 yearling equivalent pallid sturgeon have been stocked into the Missouri River. Survival rates for hatchery pallid sturgeon stocked into the Missouri River (1994–2007) have been estimated as follows: age-0 = 0.051; age-1 = 0.686; and age-2> = 0.922 (Steffensen et al., 2010). Continued monitoring of the stocked population will determine how these fish contribute to the next generation of pallid sturgeon. As previously mentioned, USFWS (2014) credits stocking of pallid sturgeon with stabilizing the population. A Pallid Sturgeon Basin-wide Stocking and Augmentation Plan is being developed by the Pallid Sturgeon Recovery Team and participating federal agencies due to concerns related to fish health/disease, genetics, stocking size, numbers/carrying capacity, and stocking practices.

3.3.2 Environmental Consequences

This section considers the potential impacts of each alternative on the Missouri River pallid sturgeon population with special emphasis on the potential to increase survival of age-0 pallid sturgeon and increase recruitment.

3.3.2.1 Impacts Assessment Methodology

The geographic scope of analysis for pallid sturgeon in the UMR is the area from Fort Peck Dam downstream to the headwaters of Lake Sakakawea. A comprehensive pallid sturgeon population model relating the effects of all potential management actions to population dynamics is not currently available, although a conceptual framework of such a model has been developed (Jacobson et al., 2016). Therefore, to address the objectives of this EIS, benefits to pallid sturgeon for each alternative were assessed using two connected models:

a) an integrated advection/dispersion and temperature model to estimate the fraction of embryos that would develop to the exogenously feeding stage and be retained in the riverine portion of the Upper Missouri (Fischenich, 2019); and
b) population modeling to assess expected long term population growth rates given the predicted retention of embryos, and other assumptions about the population (Colvin et al, 2018).

The Drift and Settling Model (DSM) couples an assessment of larval dispersion and temperature-dependent development to determine the proportion of larvae likely to remain upriver of the Lake Sakakawea headwaters, which are lethal to pallid sturgeon larvae due to anoxic conditions at the bed (Bramblett and Scholl 2015). The primary model output, retention probability, serves as both a useful benefit metric for the EIS and as a critical input to the Population Model, which assesses the effects of alternatives on the long-term population trends for the Upper River pallid sturgeon demographic unit. A technical report detailing the methods and results of the DSM is presented in Appendix

A key difference from earlier A/D modeling (Fischenich et al., 2016; Erwin et al., 2018) is that the DSM couples one-dimensional A/D computations with hourly water temperatures throughout the system calculated with an energy budget using prevailing weather conditions (air temperature, humidity, cloudiness, pressure, solar radiation and wind speed), water temperatures for the reservoir and tributaries, and release operations. A spawning submodel is applied to determine the likelihood of spawning in a given year based on flow and temperature conditions. A settling submodel is used to determine the distribution of pallid sturgeon larvae at the onset of settling and exogenous feeding. Settling is assumed to occur once thermal exposure thresholds are met using one of two free embryo development models (Braaten, 2011; Chojnacki & DeLonay, 2019).

A deterministic, age-structured demographic population model was used to assess the effects to population dynamics of alternative management actions at Fort Peck Dam. Joint spawning and retention probabilities (provided by the DSM) are coupled to pallid sturgeon population dynamics for each year and alternative flow scenario to compute the long-term population growth rate. The long-term population growth rate represents the expected growth rate of a population that consistently experiences the given flow and temperature conditions, and is used as a metric for comparing alternatives. To synthesize the benefits of implementing an alternative flow scenario on population growth with how often it can be implemented, a stochastic modeling approach was used to project the dynamics of two initial populations of pallid sturgeon forward under simulated environmental variability (see Appendix E for complete modeling details).

In addition to providing a metric for comparing Fort Peck flow alternatives, the DSM and Population Models can be used to perform sensitivity analyses that inform actions and conditions to improve population growth rates. See Appendix E for complete details of the modeling approach used to assess benefits for pallid sturgeon in this analysis.

Alternatives were evaluated to determine potential benefits anticipated for pallid sturgeon. The No Action alternative was considered the baseline against which the action alternatives are measured. It assumes that no test flow releases for pallid sturgeon would occur from Fort Peck Dam. Operations at Fort Peck are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. It is assumed that other activities and actions for pallid sturgeon in the Upper Basin would be implemented as described in the Missouri River Recovery Management Plan Environmental Impact Statement (MRRMP-EIS) and 2018 BiOp and the Yellowstone Intake Bypass EIS. These actions include fish bypass construction at Yellowstone Intake, continued propagation and stocking of pallid sturgeon in the Upper Basin, and continued pallid sturgeon science and monitoring activities in the Upper Basin. As noted in Section 3.1.1, Impact Assessment Methodology, No Action does not reflect actual past or future conditions but serves as a reasonable basis or “baseline” for comparing the impacts of the action alternatives on resources.

3.3.2.2 Summary of Environmental Consequences

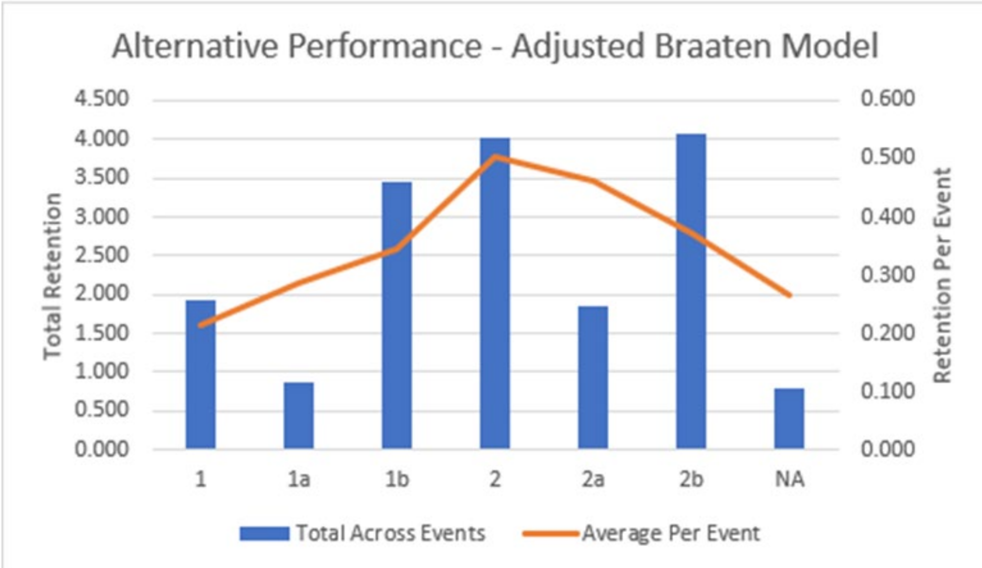
The following modeling results for drift phase retention reflect an average calculated across the suite of models (n=5) used to evaluate drift retention (**Error! Reference source not found.**), see Appendix E for individual model outputs. The Retention Probability Model results suggest that probability of retention of larval pallid sturgeon in the drifting phase to promote growth and development to first exogenous feeding was lowest under the No Action alternative. This suggests that the No Action alternative results in the greatest proportion of larval pallid sturgeon that would experience mortality due to settling out of the drift into the headwaters of

Lake Sakakawea prior to first exogenous feeding. Alternative 1 (including its variants, see Appendix E) retention probabilities show improvement of retention over the No Action alternative, with an average of 2.1% more retention than the No Action alternative (Figure 3-26). Model results for the variations A and B on Alternative 1 suggest altering the start date of test flows could impact retention. Starting the test flow a week earlier than Alternative 1 (i.e., Variation A) resulted in less than half as many years that flows lead to a hatching event (Table 3-24), and model results indicate that retention was reduced to an average of 1.6% above the No Action. Starting the test flow a week later than Alternative 1 (i.e., Variation B) resulted in more years of flows that lead to a hatching event, and 3.7% retention benefit above the No Action. Alternative 2, including its variants A and B as composite (see Appendix E), retention probabilities also show improvement of retention over the No Action alternative, with an average of 16.7% more retention than the No Action alternative. Model results for the variations A and B on Alternative 2 suggest altering the start date of test flows could impact retention. Starting the test flow a week earlier than Alternative 2 (i.e., Variation A) resulted in less than half as many years that flows lead to a hatching event, and model results indicate that retention was reduced to an average of 8.8% above the No Action. Starting the test flow a week later than Alternative 2 (i.e., Variation B) resulted in three more years of flows that lead to a hatching event, and 5.3% retention benefit above the No Action.

The DSM classified each flow year as cool, normal, or warm to set boundary conditions for Fort Peck flow temperatures and assess the role of water temperature on drift model outcomes (see Appendix E). Following the DSM modeling methods for exploring water temperature, Alternative 1 and its variants A and B could introduce higher water temperature than Alternative 2 and its variants A and B during years that test flow releases would exceed 14,000 cfs because some flows could come from warmer reservoir surface water down the concrete spillway. The Fort Peck AM Framework provides a hypothesis (see H_5 in Framework document) that warmer flow releases may increase growth rates and shorten drift distance for larval pallid sturgeon during the drifting phase of the hydrograph. It is uncertain how much warmer water temperature would be realized under Alternative 1 and its variants A and B, but it could be a factor in growth and development of larval pallid sturgeon in years that spillway discharge contributes to the test release flow. For example during April throughout the POR, the average number of April days with spillway contribution among Alternative 1 and its variants A and B was 61.3, while Alternative 2 and its variants A and B was 77.0. However, the volume of potentially warmer water during those days was 7.2 times higher under Alternative 1 and its variants A and B (daily spillway flow = 2,360 CFS) than under Alternative 2 and its variants A and B (daily spillway flow

= 330 CFS). If the greater volume of water was also warmer under Alternative 1 and its variants A and B, hypothesis H_5 suggests it could provide benefit to larval pallid sturgeon growth and development. The DSM (see Appendix E) demonstrates that water temperature is more complex than simply volume of water released through the spillway, and that prevailing meteorological conditions such as solar radiation, cloud cover, wind speed and humidity, and the temperature influence of tributary inflows, play a critical role in Missouri River water temperature. Nevertheless, model results demonstrate that larval pallid sturgeon drift retention shows a dramatic increase from “cool” temperature scenario model runs to “warm” temperature scenario model runs (Appendix E), and reinforces the need to maintain flexibility for decision makers to assess prevailing conditions in determining whether a test flow should be releases to maximize benefits for pallid sturgeon.

The DSM modeling using the latest improvements and parameterizations have demonstrated that prevailing meteorological conditions play a critical role in larval retention upstream of the anoxic zone in Lake Sakakawea. Larval development rates are temperature-dependent, and retention is highly correlated with the air temperatures during drift. Other meteorological factors (e.g., solar radiation, cloud cover, wind speed, humidity) and tributary inflows are also important determinants of water temperature. Because of the strong influence of these fac-tors, the likelihood of success (in terms of retention) increases if there is flexibility in the timing of flow implementation.



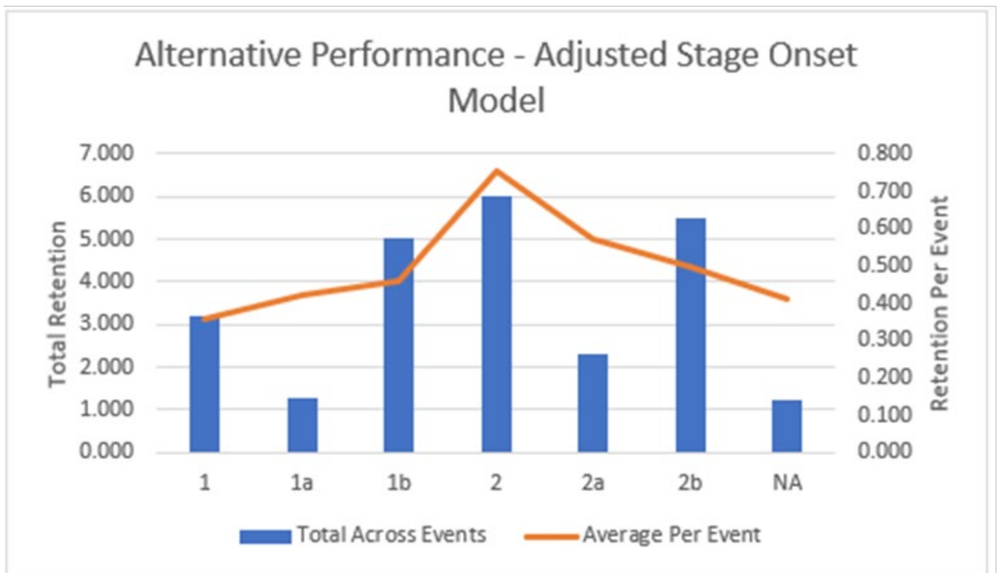


Figure 3-26. Model results - projected retention of drifting larval pallid sturgeon among alternatives and their variants for the adjusted Braaten model (above) and adjusted stage onset model (below). See Appendix E for complete suite of model results.

Table 3-23. Summary of test flow model outputs indicating spawning success and retention of larval pallid sturgeon in the study reach among alternatives and their variants

Alternative	Number of years with test flow	Number of Years Flows lead to Hatch	Retention (% above No Action)
No Action	Full: - Partial: -	3	-
Alternative 1	Full: 11 Partial: 11	9	2.9
Variation 1A	Full: 16 Partial: 6	3	1.6
Variation 1B	Full: 9 Partial: 16	11	3.7
Alternative 2	Full: 10 Partial: 10	8	12.0
Variation 2A	Full: 15 Partial: 5	4	8.8
Variation 2B	Full: 9 Partial: 16	11	5.3

Alternatives 1, variant 1A, and variant 1B represent three variants of the same operational criteria except for of the timing of their implementation. If they were combined into a "composite" alternative that uses prevailing weather conditions to determine which variant to apply in a given year, the overall performance would be improved. Table 5-7 of Appendix E shows the results of compositing Alternatives 1 and 2 in terms of retention rate. Cumulative retention for Alternative 1 (composite) was about four times that for the No Action, while alternative 2 (composite) was about eight times the No Action cumulative retention. The composites of each alternative 1 and 2 outperform the base alternatives (not including variants of 1 and 2) in terms of cumulative retention by 84% and 64%, respectively. Selection of an action alternative includes selection of the operational flexibility of its variants, such that it reflects the composite of the operational variants.

3.3.2.3 No Action Alternative

This section describes benefits to pallid sturgeon from flow releases under the No Action alternative. Under the No Action alternative, operations at Fort Peck are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. As noted above, it is considered the baseline against which the other alternatives are measured.

Attract

The No Action alternative follows the current master manual water control plan which does not include an increase in flow releases from Fort Peck Dam to attract pallid sturgeon upstream for spawning. Therefore, there would be no benefit to pallid sturgeon from a hypothesized attractant flow release to trigger upstream spawning movements and attract reproductively mature pallid sturgeon towards Fort Peck Dam to potential spawning habitats during the attraction period. However, model results over the period of record suggest that river discharge increases that may have been sufficient to trigger upstream spawning movements by reproductively mature pallid sturgeon during the attraction period may have occurred in 1975, 1997 and 2011.

Retain

The No Action alternative follows the current Master Manual water control plan which does not include a steady elevated flow release from Fort Peck Dam to retain pallid sturgeon that were attracted to upstream spawning habitats. Therefore, there would be no benefit to pallid sturgeon from a hypothesized retention flow release to hold reproductively mature pallid sturgeon near Fort Peck Dam at potential spawning habitats during the period leading to the spawning phase of the hydrograph. However, model results over the period of record suggest that river discharge increases that may have been sufficient to trigger upstream spawning movements by reproductively mature pallid sturgeon during the attraction period may have occurred in 1975, 1997 and 2011.

Spawn

The No Action alternative follows the current Master Manual water control plan which does not include a flow release from Fort Peck Dam to aggregate reproductively mature pallid sturgeon that were holding in upstream spawning habitats during the retention phase of the hydrograph. However, some adult pallid sturgeon have been documented exhibiting behaviors consistent with aggregation and spawning during this phase of the hydrograph under the master manual water control plan (Delonay et al., 2016). The degree of successful spawning is unknown, and no natural wild reproduction has been verified in the upper basin. Therefore, there would be no additional benefit to pallid sturgeon from a hypothesized aggregate and spawning flow release under the No Action alternative. Model results suggested that hatching may have occurred during two years in the period of record, 1975 and 2011.

Drift

The No Action alternative follows the current Master Manual water control plan which does not include a flow release from Fort Peck Dam to increase retention probability and promote growth and development of drifting larval pallid sturgeon. However, model results indicate there appears to be some probability of retention. The retention probability listed here for the No Action alternative reflects the baseline to compare relative benefits of the action alternatives. Model results suggest that retention during three flow years when hatching may have occurred could have been as high as 89.5% in the 1997 flow year, and 0% in 2011 flow year (Figure 3-27). Average retention across the suite of models for the three flow years was 38.1%.

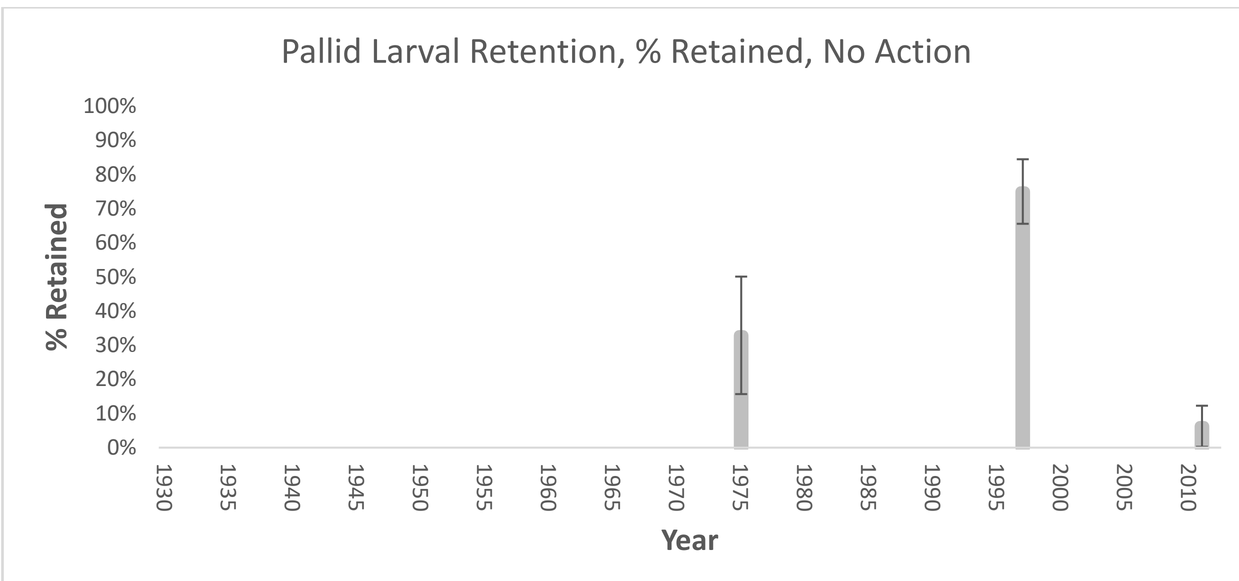


Figure 3-27. Model results predicting percent retention of drifting larval pallid sturgeon during years in the period of record that flow conditions criteria were met to assume spawning and hatch occurred under the No Action alternative. Data is average and standard error of the five retention model outputs

Conclusion

There would be no to negligible benefit to pallid sturgeon from the No Action alternative during the attract, retain, spawn, and drift phase of the hydrograph. Population growth from natural reproduction in the study area would likely not occur. The existing condition of natural reproduction by pallid sturgeon in the study area supports that the model was reasonably reflective of factors effecting pallid sturgeon reproduction and recruitment. The model may be overestimating retention and survival to first exogenous feeding during the 1997 flow year because no wild pallid sturgeon from the 1997 year class are known to exist in the study area.

3.3.2.4 Alternative 1

System operations under Alternative 1 are based on those described under the No Action alternative except that it includes a flow release regime from Fort Peck Dam to benefit pallid sturgeon.

An attraction flow regime would begin on April 16 and the peak flow would be twice as large as the spring release from Fort Peck Dam in a given year. The Spawning Cue Flow Regime under Alternative 1 begins on May 28 and would be 3.5 times the Fort Peck Dam spring flow release in the given release year. A further description of Alternative 1 is detailed in Chapter 2, Section 2.5 Alternatives Carried Forward for Further Evaluation.

Attract-Retain-Spawn

The model was not designed to partition out the benefits to Attraction, Holding, and Spawning phases of the hydrograph separately. Instead the model used a suite of criteria to determine if spawning would have occurred in any given year in the period of record, then calculate the hatch date. Therefore, if a hatch date was presented to the model we can assume that there was sufficiently suitable criteria to have a successful attraction, holding, or spawning flow event that year. Alternative 1 resulted in 22 years with a full or partial test flow and 11 years that flows lead to hatch of pallid sturgeon eggs.

Drift

Average retention of drifting larval pallid sturgeon across the suite of models during years with a test flow was 34%. The range of retention was from 0.1% to 99.9% during years with a test flow (Figure 3-28), suggesting that in at least one year during the POR, nearly all hatched larval pallid sturgeon could have developed and survived to first exogenous feeding prior to drifting and settling out of the drift into the headwaters of Lake Sakakawea and experience mortality.

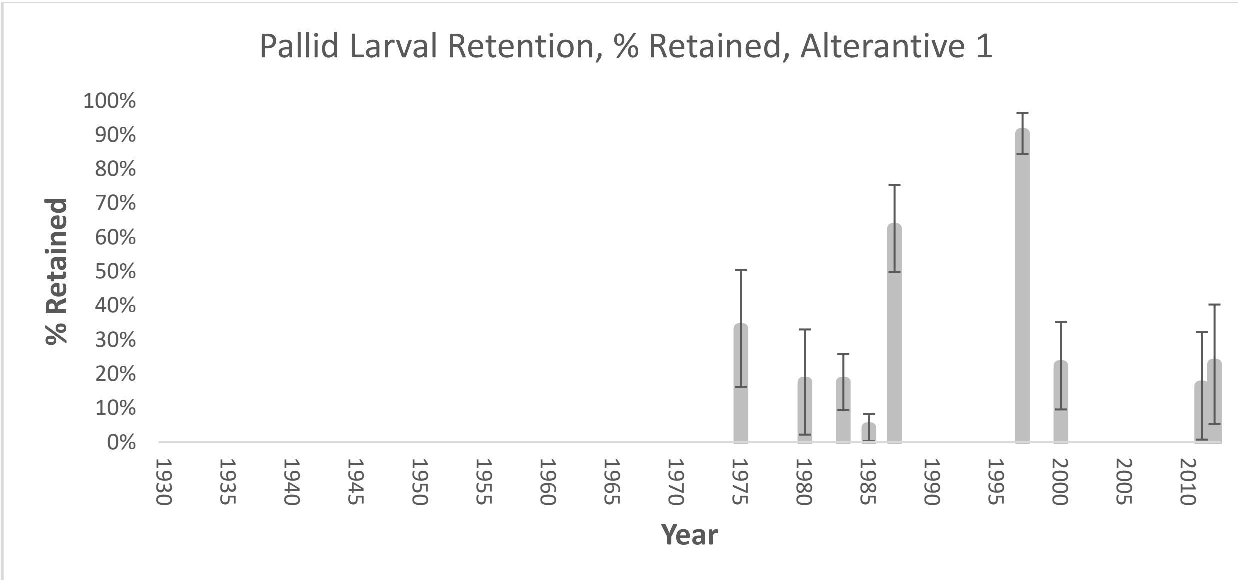


Figure 3-28. Model results predicting percent retention of drifting larval pallid sturgeon during years in the period of record that flow conditions criteria were met to assume spawning and hatch occurred under Alternative 1. Data is average and standard error of the five retention model outputs

3.3.2.4.1 Variation 1A

Variation 1A is a test flow variation of Alternative 1. The parameters for 1A are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue Flow Regime is initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

Attract-Retain-Spawn

The model was not designed to partition out the benefits to Attraction, Holding, and Spawning phases of the hydrograph separately. Instead the model used a suite of criteria to determine if spawning would have occurred in any given year in the period of record, then calculate the hatch date. Therefore, if a hatch date was presented to the model we can assume that there was sufficiently suitable criteria to have a successful attraction, holding, or spawning flow event that year. Alternative 1 variation A resulted in 22 years with a full or partial test flow and 3 years that flows lead to hatch of pallid sturgeon eggs.

Drift

Average retention of drifting larval pallid sturgeon across the suite of models during years with a test flow was 40.6%. The range of retention was from 0% to 100% during years with a test flow (Figure 3-29), suggesting that in at least one year during the POR, all hatched larval pallid sturgeon could have developed and survived to first exogenous feeding prior to drifting and settling out of the drift into the headwaters of Lake Sakakawea and experience mortality.

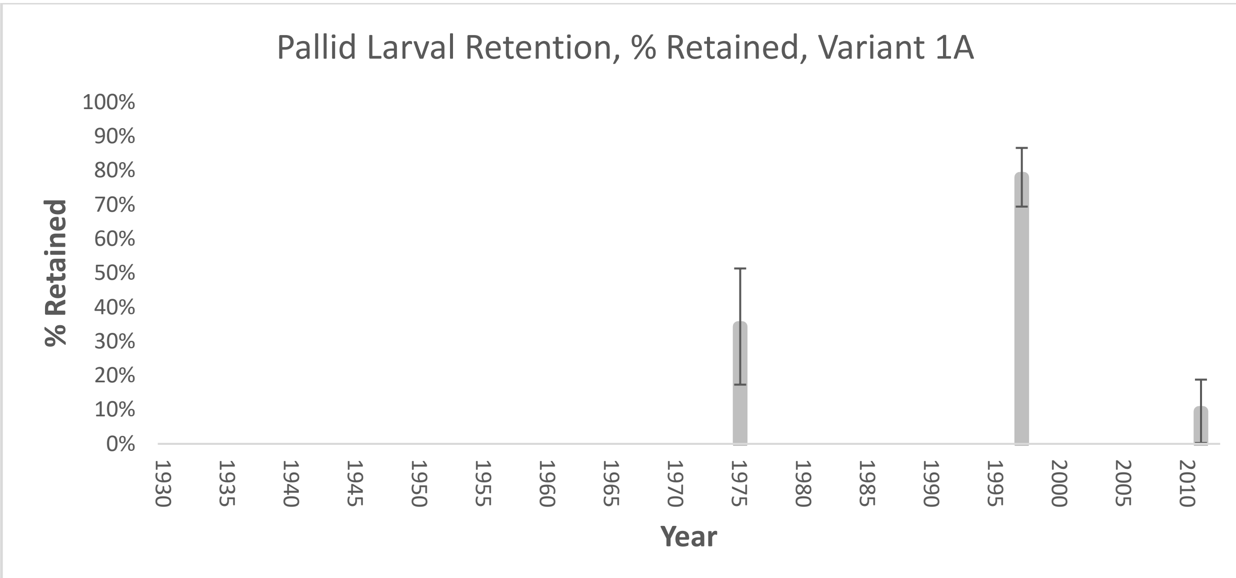


Figure 3-29. Model results predicting percent retention of drifting larval pallid sturgeon during years in the period of record that flow conditions criteria were met to assume spawning and hatch occurred under Alternative 1 variant A. Data is average and standard error of the five retention model outputs..

3.3.2.4.2 Variation 1B

Variation 1B is another test flow variation of Alternative 1. The parameters for 1B are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 23 and the Spawning Cue Flow is initiated on June 4. Similar to the concept described in Variation 1A, the later initiation date is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

Attract-Retain-Spawn

The model was not designed to partition out the benefits to Attraction, Holding, and Spawning phases of the hydrograph separately. Instead the model used a suite of criteria to determine if spawning would have occurred in any given year in the period of record, then calculate the hatch date. Therefore, if a hatch date was presented to the model we can assume that there was sufficiently suitable criteria to have a successful attraction, holding, or spawning flow event that year. Alternative 1 variation B resulted in 25 years with a full or partial test flow and 10 years that flows lead to hatch of pallid sturgeon eggs.

Drift

Average retention of drifting larval pallid sturgeon across the suite of models during years with a test flow was 44.2%. The range of retention was from 0% to 100% during years with a test flow (Figure 3-30), suggesting that in at least one year during the POR, all of the hatched larval pallid sturgeon could have developed and survived to first exogenous feeding prior to drifting and settling out of the drift into the headwaters of Lake Sakakawea and experience mortality.

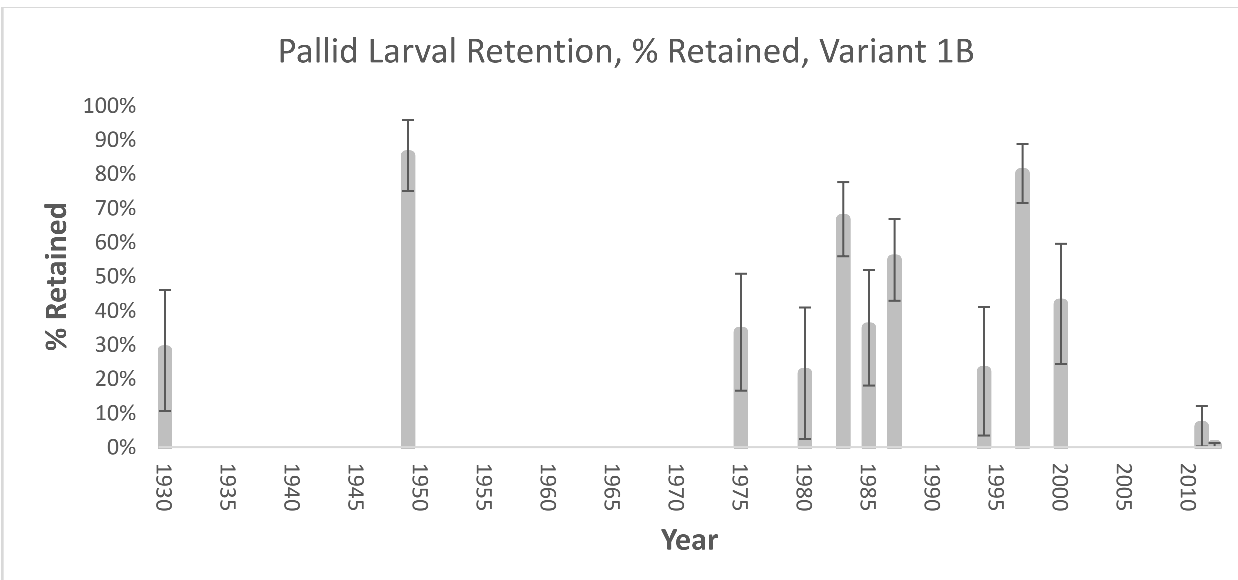


Figure 3-30. Model results predicting percent retention of drifting larval pallid sturgeon during years in the period of record that flow conditions criteria were met to assume spawning and hatch occurred under Alternative 1 variant B. Data is average and standard error of the five retention model outputs.

Conclusion from Alternative 1

Modeling results predict there would be a benefit to pallid sturgeon from Alternative 1 and its variations over the No Action alternative during the attract, retain, spawn, and drift phase of the hydrograph. Population growth from natural reproduction in the study area with Alternative 1 would be more likely to occur than with the No Action alternative according to modeling results.

3.3.2.5 Alternative 2

System operations under Alternative 2 are based on those described under the No Action alternative except that it includes a flow release regime from Fort Peck Dam to benefit pallid sturgeon. The parameters for Alternative 2 are the same as described for Alternative 1 except that the Attraction Flow Regime peak is 14,000 cfs (the maximum powerhouse capacity) rather than twice the average Fort Peck spring flow in the given year. The maximum amount of flow that can be run through the generators is 14,000 cfs. Any additional flow is run through the spillway and does not generate hydroelectricity. Additionally, releases as measured at Wolf Point gage are held at 14,000 cfs until the Spawning Cue release is initiated.

Attract-Retain-Spawn

The model was not designed to partition out the benefits to Attraction, Holding, and Spawning phases of the hydrograph separately. Instead the model used a suite of criteria to determine if spawning would have occurred in any given year in the period of record, then calculate the hatch date. Therefore, if a hatch date was presented to the model we can assume that there was sufficiently suitable criteria to have a successful attraction, holding, or spawning flow event that year. Alternative 2 resulted in 20 years with a full or partial test flow and 10 years that flows lead to hatch of pallid sturgeon eggs.

Drift

Average retention of drifting larval pallid sturgeon across the suite of models during years with a test flow was 62.1%. The range of retention was from 0% to 100% during years with a test flow (Figure 3-31), suggesting that in at least one year during the POR, all hatched larval pallid sturgeon could have developed and survived to first exogenous feeding prior to drifting suggesting that in at least one year during the POR, all hatched larval pallid sturgeon could have developed and survived to first exogenous feeding prior to drifting and settling out of the drift into the headwaters of Lake Sakakawea and experience mortality.

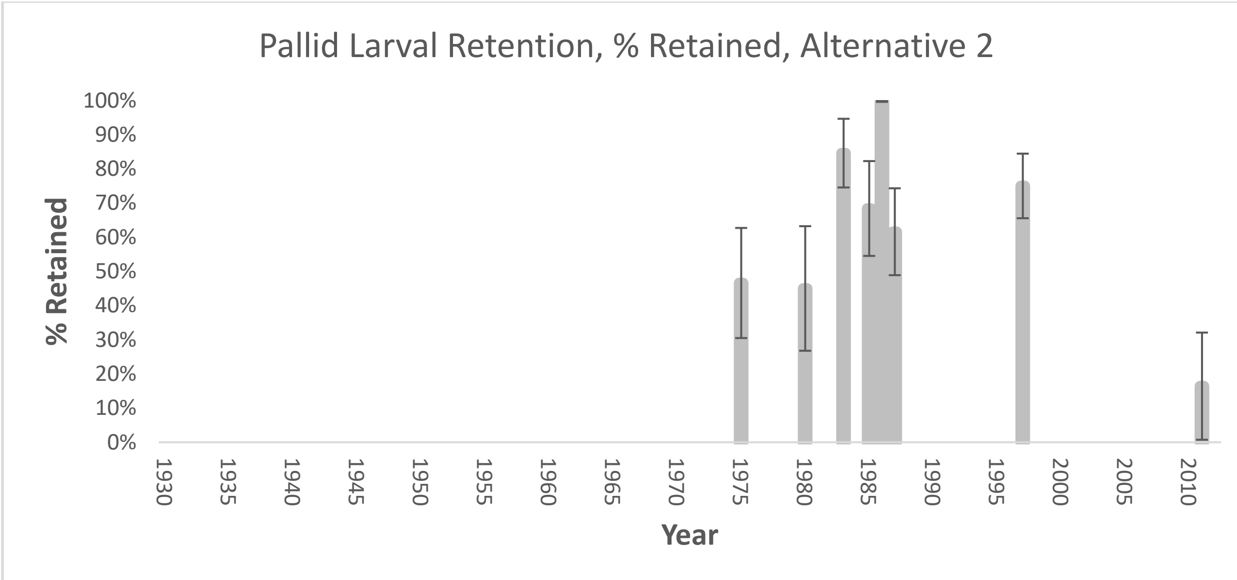


Figure 3-31. Model results predicting percent retention of drifting larval pallid sturgeon during years in the period of record that flow conditions criteria were met to assume spawning and hatch occurred under Alternative 1. Data is average and standard error of the five retention model outputs.

3.3.2.5.1 Variation 2A

Variation 2A is a test flow variation of Alternative 2. The parameters for Alternative 2A are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue flow would be initiated on May 21, rather than May 28. Again, moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

Attract-Retain-Spawn

The model was not designed to partition out the benefits to Attraction, Holding, and Spawning phases of the hydrograph separately. Instead the model used a suite of criteria to determine if spawning would have occurred in any given year in the period of record, then calculate the hatch date. Therefore, if a hatch date was presented to the model we can assume that there was sufficiently suitable criteria to have a successful attraction, holding, or spawning flow event that year. Alternative 2 variation A resulted in 20 years with a full or partial test flow and 4 years that flows lead to hatch of pallid sturgeon eggs.

Drift

Average retention of drifting larval pallid sturgeon across the suite of models during years with a test flow was 54.5%. The range of retention was from 0% to 97% during years with a test flow (Figure 3-32), suggesting that in at least one year during the POR, most hatched larval pallid sturgeon could have developed and survived to first exogenous feeding prior to drifting and settling out of the drift into the headwaters of Lake Sakakawea and experience mortality.

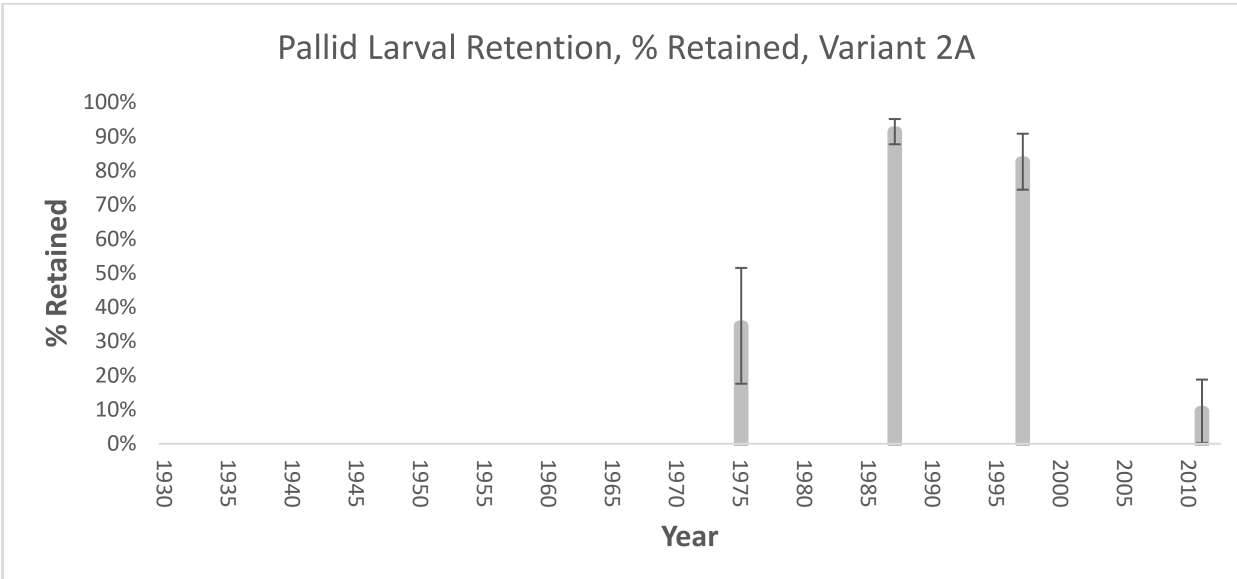


Figure 3-32. Model results predicting percent retention of drifting larval pallid sturgeon during years in the period of record that flow conditions criteria were met to assume spawning and hatch occurred under Alternative 2 variant A. Data is average and standard error of the five retention model outputs.

3.3.2.5.2 Variation 2B

Variation 2B is a test flow is another variation of Alternative 2. The parameters for Alternative 2B are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 23, rather than April 16, and the Spawning Cue flow is initiated on June 4, rather than May 21. Again, the difference in timing is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

Attract-Retain-Spawn

The model was not designed to partition out the benefits to Attraction, Holding, and Spawning phases of the hydrograph separately. Instead the model used a suite of criteria to determine if spawning would have occurred in any given year in the period of record, then calculate the hatch date. Therefore, if a hatch date was presented to the model we can assume that there was sufficiently suitable criteria to have a successful attraction, holding, or spawning flow event that year. Alternative 2 variation B resulted in 25 years with a full or partial test flow and 13 years that flows lead to hatch of pallid sturgeon eggs.

Drift

Average retention of drifting larval pallid sturgeon across the suite of models during years with a test flow was 47.2%. The range of retention was from 0% to 100% during years with a test flow, suggesting that in at least one year during the POR, all of the hatched larval pallid sturgeon could have developed and survived to first exogenous feeding prior to drifting and settling out of the drift into the headwaters of Lake Sakakawea and experience mortality.

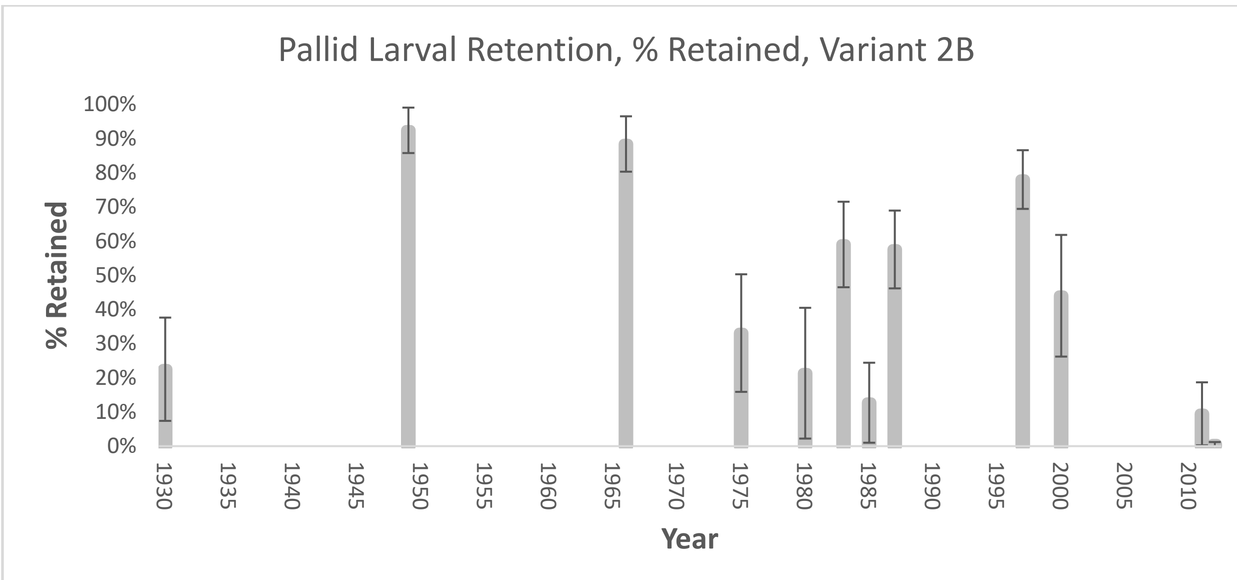


Figure 3-33. Model results predicting percent retention of drifting larval pallid sturgeon during years in the period of record that flow conditions criteria were met to assume spawning and hatch occurred under Alternative 2 variant B. Data is average and standard error of the five retention model outputs.

Conclusion from Alternative 2

Modeling results predict there would be a benefit to pallid sturgeon from Alternative 2 and its variations over the No Action alternative during the attract, retain, spawn, and drift phase of the hydrograph. Population growth from natural reproduction in the study area with Alternative 2 would be more likely to occur than with the No Action alternative based on modeling results.

3.3.2.6 Population Growth Estimates

Preliminary population growth model outputs indicate that long term population growth, given spawning and retention estimates, varied by flow alternative but showed a similar pattern among each flow alternative. Like retention probability, the distribution of long term population growth rates (LTPGRs) is dependent on the timing of flow pulses. While spawning does not occur often for alternatives with earlier pulses (variants 1A and 2A), when spawning does occur, the LTPGRs are relatively high. Mean LTPGR given spawning was highest for Alternative 1b, a management strategy with late flow pulses and the greatest number of years in which spawning occurred. Alternative 2 and variant 2B had the next two highest mean LTPGRs given spawning, as well as high occurrences in spawning. Mean LTPGR given spawning, however, differed by less than 0.01467 across all alternatives (see Appendix E).

The optimal alternative, in terms of population outcomes, is the one with the greatest LTPGR in the given year. Since no natural recruitment occurs without spawning, the greatest observable differences in population model outcomes among alternative flows are expected when some alternative flows allow for spawning in the given year, and others do not. For example, in 1986, only Alternative 2 promoted spawning below Fort Peck Dam, resulting in this alternative flow having an LTPGR much greater than all other alternatives (Appendix E Table 5-10). Alternative 2 was, therefore, the optimal strategy under the environmental conditions observed in 1986. In other years, such as 1985, multiple alternative flows promoted spawning below Fort Peck Dam, and the optimal strategy may have an LTPGR that differs from others only slightly. No one alternative management flow is always the optimal strategy. Instead, the optimal alternative differs across the years.

Considering flow alternatives against population growth outcomes, reported as expected time to quasiextinction (defined as 50 females or less), from modeling that incorporates simulated environmental variability, provides an alternative perspective and insight to the suite of factors influencing pallid sturgeon population growth. Alternative variant 1B had the greatest expected times to extinction, outperforming the No Action Alternative by about 6 and 10 years for female abundances by age dis-tributed as estimated by PSPAP and uniformly, respectively. All action alternatives outperformed the No Action alternative, albeit Alternatives 1a and 2a had similar expected quasiextinction times. For the action alternatives, expected time to quasiextinction increased with the timing of spawning flow releases with earlier flow releases (“A” variants) having the least expected time to quasiextinction and the later flow release (“B” variants) having the greatest expected time to quasiextinction. The variance in time to quasiextinction also was the least for the No Action Alternative and increased with the timing of spawning flow re-leases.

Although the action alternatives all outperform the No Action Alternative, the differences between the expected time to quasiextinction is not large (<6 years). As the sensitivity analyses reveal (Appendix E Section 5.3.2.4), these differences depend on parameter values and could be much larger if age-0 survival given retention, a parameter with high uncertainty, was underestimated. These modeling results point to the existing uncertainties and opportunity for significant learning in the current science knowledgebase, particularly with survival of age-0 pallid sturgeon that survived the drift phase and were retained in the Missouri River upstream of Lake Sakakawea. Existing (Ridenour et al., 2011) and ongoing research coordinated by the SAMP on age-0 sturgeon ecology provides support for improving long term population growth and reducing probability of extinction.

3.3.2.7 Climate Change

Uncertainty associated with the effects of management actions on pallid sturgeon populations begets greater uncertainty regarding how the effects of test flow releases from Fort Peck Dam to benefit pallid sturgeon would be influenced by climate change. Increased precipitation and streamflow, with unknown aggregate impacts related to test flow objectives and constraints, may influence the ability to conduct test flow releases. Increasing air and water temperatures could benefit pallid sturgeon during the drift phase of the hydrograph. Growth and development rate of young pallid sturgeon could increase and reduce drift distance required to achieve first exogenous feeding a survival to juvenile stage. However, increased air and water temperatures above the optimal level could also stress pallid sturgeon during the larval drift and growth stages. Altered spring runoff patterns, with early snowmelt seasons, may elevate Fort Peck release water temperature that could benefit pallid sturgeon. Conversely, earlier runoff may require higher pool evacuation releases that would reduce system storage and result in lower flow releases at critical times for pallid growth. In summary, it is unclear how climate change may impact test flow objectives as the impact of altered test release frequency as well as air and water temperatures on the pallid sturgeon response is also unknown. Implementing any alternative within an adaptive management framework would allow for management actions to be evaluated and adjusted in order to achieve species objectives. As more information becomes available and uncertainty is reduced, adjustments to account for the observed effects of climate change could be implemented. Therefore, it is assumed that the conclusions described for each alternative would not vary substantially under the expected climate change scenario.

3.3.2.8 Cumulative Impacts

Past construction of the six mainstem dams on the UMR created physical barriers to upstream spawning migration of pallid sturgeon and introduces complications for enough free flowing river necessary to complete the larval drift process (Braaten et al., 2008). It is also probable that dams now prevent access to formerly used habitats—either directly or by imposing changes in water quality. The current construction planned for fish passage at the Intake Diversion Dam is anticipated to be effective in improving upstream migration and increasing drift distance. Coupled with slower velocity habitat compared to existing conditions, there would be beneficial impacts to pallid sturgeon. There are no other planned actions in the reasonably foreseeable future that would lead to channel modification, bed degradation or aggradation, or management of flows that would deviate from the existing Missouri River Master Water Control Manual.

Mainstem reservoirs present challenges to downstream-dispersing free embryos and may harbor lethal water-quality conditions (Braaten et al., 2008; Guy et al., 2015). The decrease in sediment load also has been associated with decreases in turbidity that might directly affect native fish fauna (Galat et al., 2005). Galat and Lipkin (2000) documented substantial alteration to the annual hydrograph downstream from the reservoirs, including reduced intra-annual flow variability with generally decreased spring flows and increased summer low flows. Hydrologic changes are especially severe just downstream from the dams and in inter-reservoir reaches where clear, cold water is released. If test flows from Fort Peck Dam were effective at creating conditions required to achieve survival of larval pallid sturgeon to first exogenous feeding, the overall cumulative effect would be an impact beneficial to pallid sturgeon.

Some of the Missouri River reservoirs are stocked artificially with various species of fishes, some non-native, to support sport fisheries (USACE 2017, USFWS 2018). Pallid sturgeon eggs and larval stages could be susceptible to predation and it has been hypothesized that decreased turbidity levels relative to historic conditions in inter-reservoir reaches may result in increased predation on early life stages of pallid sturgeon from sight-feeding predators (e.g., walleye or goldeye) (Jacobson et al., 2016). Experimental data on exogenously feeding larvae and age-0 pallid sturgeon indicate there is little effect from predation (Jacobson et al., 2016).

Predation of embryos and free embryos has not been directly evaluated and there still exists a high degree of uncertainty in the hypothesis and ways to evaluate the hypothesis. USFWS (2016) stated that modeling suggests the numbers and biomass of pallid sturgeon in RPMA 2 (the Missouri River from Fort Peck Dam to the headwaters of Lake Sakakawea, including the Yellowstone River upstream to the mouth of the Tongue River) is significantly higher than historical estimations due to higher than expected survival of stocked fish and increases in stocking from 2005 through 2009. There is potential that this high biomass in addition to sport fishery stocking and natural presence of other native-species may contribute to an increase in inter-specific competition between piscivorous (fish-eating) species. There is no evidence that increased competition is occurring or having adverse effects on the pallid sturgeon population and therefore the contribution to overall cumulative effects to pallid sturgeon is considered small; however, the actual occurrence or severity of impacts is unknown.

Actions that create, develop, and/or manage fish and wildlife habitat, including the USACE Continuing Authority Programs, USFWS National Wildlife Refuge System Lands Management, USFWS Partners for Fish and Wildlife Program, and EPA Section 319 Non-Point Source Grant Program, would have long-term beneficial impacts to pallid sturgeon. Creation of a diversity of aquatic community types that provide improved structure and composition of river habitat could benefit the pallid sturgeon.

Several aquatic nuisance species including zebra mussels have expanded their range into the Missouri River. Zebra mussel colonization has occurred in areas occupied by pallid sturgeon but data on direct effects are limited (USFWS, 2014). Likewise, populations of non-native carp species have expanded exponentially in the Missouri and Mississippi rivers; however, how these populations are affecting pallid sturgeon, if at all, remains an area of uncertainty and their distribution has not yet expanded to the study area below Fort Peck Dam.

The decline of the pallid sturgeon in the Missouri River occurred prior to the introduction of these species. Impacts to pallid sturgeon from invasive species (e.g., competition for resources; displacement of native species; transmission of pathogens and disease) would decrease from implementation of the USFWS Aquatic Invasive Species Program with beneficial impacts expected from monitoring habitats to determine the distribution of invasive species, rapidly responding to new invasions, and controlling established populations. The beneficial impacts are expected to continue into the future.

3.3.2.9 Conclusions

The alternatives with actions for test flow releases are anticipated to have beneficial impacts to pallid sturgeon based on modeling results. The SAMP has been developed to provide flexibility in dealing with remaining uncertainties regarding pallid sturgeon populations. The net result of Alternatives 1 and 2 and their variants A and B would be an incremental benefit in context of adverse past, present, and reasonably foreseeable future effects from cumulative actions and would therefore not contribute to significant adverse cumulative impacts.

3.4 Flood Risk Management

3.4.1 Affected Environment

A main objective of the Mainstem Reservoir System is to regulate the reservoirs to reduce the risk of Missouri River flows from contributing to flood damage in the reaches downstream from dams. Regulation of individual reservoirs is coordinated to reduce the risk of damaging releases from a particular reservoir. The usual reservoir operation is to store flood inflows, which generally extend from March through July, and to release them during the remainder of the year. Most of these releases are made before December. Winter releases are restricted due to the formation of ice bridges and the associated higher river stages. The objective is to have reservoir levels lowered to the bottom of the annual flood control and multiple use zone by the start of the runoff season, approximately March 1 of each year. Operations during the winter require special consideration because ice bridges restrict channel capacity. Upstream from Gavins Point, releases from Garrison Dam are reduced during periods of ice formation until an ice cover is formed, after which releases can be gradually increased. Minimal ice problems exist directly downstream from Big Bend Dam due to its proximity to Lake Francis Case. Operation of the reservoirs for flood risk management must take into account highly variable flows from numerous tributaries. During any flood season, the existence of upstream tributary storage reduces mainstem flood volumes to some extent. Normally, the natural crest flows on the mainstem reservoirs will also be reduced by the existence of tributary reservoir storage, provided significant runoff contributing to the crest flows originates above the tributary projects.

Levees also play a role in flood risk management along the Missouri River. Federal agricultural levee construction in accordance with the 1941 and 1944 Flood Control Acts began in 1947. Most existing federal levees are in the reach located between Omaha and Kansas City. The levees help to manage flood risk to these localities during the most severe flood events of record. Between Sioux City and the mouth of the Missouri River, local interests have built many miles of levees, consisting of about 500 non-federal levee units through this reach of the river. Most of these levees are inadequate to withstand major floods, but generally protect against floods smaller than a 5 percent annual chance of exceedance event (20-year). The geographic boundary for this study extends bluff-to-bluff from Fort Peck Dam in Montana to Gavins Point Dam in South Dakota. The reason for not extending below Gavins Point is that there were no discernable differences in flows past Gavins Point between the No Action and the Action alternatives.

3.4.1.1 Population and Property at Risk

Land, property (both urban and rural), infrastructure, and people in the floodplain can be affected by Missouri River flooding. Approximately 38,000 people reside along the Missouri River floodplain from Fort Peck Dam to Gavins Point Dam. There are over 12,000 residential and 2,500 nonresidential structures in the floodplain. The total estimated value of these structures and their contents is $10.6 billion. Table 3-24 presents the estimated population, number of structures and value (in thousands) by river reach that are within the study area.

Table 3-24. Population and estimated property value of from Fort Peck Dam to Gavins Point Dam by river reach

Reach	Population at Risk	Residential Structures	Residential Value ($000s)	Nonresidential Structures	Nonresidential Value ($000s)	Total Structures	Total Value ($000s)
Fort Peck Dam to Garrison Dam	13,783	4,001	$1,726,729	1,248	$2,168,002	5,249	$3,894,732
Garrison Dam to Oahe Dam	23,588	7,771	$3,535,883	1,283	$3,031,764	9,054	$6,567,647
Fort Randall Dam to Gavins Point Dam	490	418	$103,628	12	$7,556	430	$111,185
Total	**37,861**	**12,190**	**$5,366,240**	**2,543**	**$5,207,322**	**14,733**	**$10,573,564**

Source: National Structure Inventory (NSI2); FY20 Price Level

The population at risk is based on inundation from 2012 geometry with updated calibration to 2018 and the largest event in the 82-year period of record.

Total land area in the floodplain from Fort Peck Dam to Gavins Point Dam is approximately 1.4 million acres with more than 106,000 acres of prime farmland. Agriculture is a dominant land use within the Missouri River floodplain and across the wider Missouri River basin. The upper river from Fort Peck Dam to Gavins Point Dam is a major source of wheat, alfalfa, barley, and hay to the nation.

The Missouri River floodplain comprises a considerable amount of prime farmland. Prime farmland can be defined as "Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management" (NRCS 1983).

Prime farmland from Fort Peck Dam to Gavins Point Dam comprises 7.8 percent of the floodplain acres. Table 3-25 details the prime farmland acreage in each region and the percentage of prime farmland located within the study area.

Table 3-25. Prime farmland from Fort Peck Dam to Gavins Point Dam by state

Region	State	Prime Farmland in the Floodplain	Total Acres in Floodplain	Percent of Prime Farmland
Fort Peck Dam to Gavins Point Dam	MT	83,075	440,284	18.9%
	ND	6,500	502,995	1.3%
	SD	14,767	382,458	3.9%
	NE	1,959	32,367	6.1%
	Total	**106,301**	**1,358,104**	**7.8%**

Source: USDA Natural Resources Conservation Service, 2017

Critical and public infrastructure in the Missouri River floodplain from Fort Peck Dam to Gavins Point Dam is displayed in Table 3-26. Critical infrastructure includes structures, such as public utilities, wastewater treatment plants, and bridges, in the floodplain that are critical to the nation or region, but not part of a traditional structure inventory.

Table 3-26. Critical infrastructure from Fort Peck Dam to Gavins Point Dam

Infrastructure Type	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	Total
Public Utilities				
Energy Producing Plants	1	1	0	2
Propane Locations and Substations	10	15	0	25
Wastewater Treatment Plants	0	1	0	1
Public Facilities				
Emergency Services	7	7	0	14
Law Enforcement	5	3	1	9
Education	9	6	2	17
Public Venues	4	4	1	9
Transportation Infrastructure				
Interstate Miles	0	15	0	15
Highway Miles	37	48	14	99
Local Primary Road Miles	12	24	5	41
Railroad Miles	131	33	0	164
Road and Railroad Bridges	10	31	9	50
Public Use Airports	0	1	0	1
Ports	0	0	0	0

Source: Homeland Security Infrastructure Program Gold Database; U.S. Census Bureau, Geography Division 2015 TIGER/Line Shapefiles

3.4.1.2 Tribal Reservations

The Missouri River floodplain is also home to several Tribal reservations. The population and structures at risk for all of the Tribal reservations in the Missouri River floodplain from Fort Peck Dam to Garrison Dam are listed in Table 3-27.

Table 3-27. Population and property value at risk for Tribal reservations

Tribal Reservation	Population at Risk	Residential Structures	Residential Value ($000s)	Nonresidential Structures	Nonresidential Value ($000s)	Total Structures	Total Value ($000s)
All Tribal Reservations	948	296	$76,409	19	$41,420	315	$117,829

Source: NSI2; all values are at the FY 20 price level.

3.4.2 Environmental Consequences

Two action alternatives, each including three variations, were developed to meet the pallid sturgeon objectives. Alternatives 1 and 2 and their variations have the potential to affect river flows and river stage. The flood risk management impacts analysis focuses on determining if changes in river and reservoir conditions associated with each of the FPDTR-EIS alternatives could result in an impact to risk of flooding. This section summarizes the flood risk management impacts assessment methodology and presents the results of the assessment. A detailed description of the methodology and results is provided in the report “Flood Risk Management Environmental Consequences Analysis Technical Report” (Appendix F).

3.4.2.1 Impact Assessment Methodology

The impacts to flood risk management are evaluated using three of the four accounts (NED, RED, and OSE) from the 1983 Principles and Guidelines (P&G). The accounts framework enables consideration of a range of both monetary and non-monetary values and interests, while ensuring impacts are not double counted. The following section provides a brief overview of the overall methodology for evaluating impacts to flood risk as well as the approach for each account.

Physical characteristics of the Missouri River and its floodplain that are particularly important to flood risk include river flow and associated stages, water storage in system, river channel dimensions, and flow impedance. Changes in these characteristics can result in changes in the patterns of flooding (beneficially or adversely), such as the frequency of flooding, depths of inundation, and extent and duration of flooding. Alterations in the patterns of flooding potentially increase or reduce the risks inherent in flooding to land, property (both urban and rural), infrastructure, and people in the floodplain. The output from the HEC-RAS and HEC-ResSim modeling was used to analyze flood impacts. The analysis focuses on the Missouri River floodplain from Fort Peck Dam in Montana to Gavins Point Dam in South Dakota.

National Economic Development

NED effects are defined as changes in the net value of the national output of goods and services. In the case of flood risk management, the conceptual basis for the NED impacts analysis is an increase or decrease in risk of physical and non-physical damage from flooding. The USACE Hydrologic Engineering Center Flood Impact Analysis model (HEC-FIA) version 3.1 was used to compute property damages and agricultural losses for every year in the modeled POR under each test flow scenario. The model evaluated losses directly related to damages sustained by structures, contents, and vehicles. The model also evaluated losses to crops either related to a loss of a crop in the ground, the inability to plant a crop due to flooding, or to planting a crop later in the season due to flooding at planting time. A detailed description of the NED analysis including data sources and assumptions can be found in the report “Flood Risk Management Environmental Consequences Analysis Technical Report” (Appendix F).

Regional Economic Development

The RED analysis evaluated the regional economic impacts associated with agricultural losses and structural damages, using information from the NED analysis from the POR under each simulated alternative.

Agricultural Damage: The RED analysis used annual agricultural flood losses from the NED analysis to estimate the changes in regional economic conditions under the FPDTR-EIS alternatives. The largest adverse impact to agriculture compared to No Action occurs in the Fort Peck Dam to Garrison Dam reach under the 1983 Alternative 1 simulation. The three most prominent crops in this reach, spring wheat, soybeans, and durum wheat, affect two sectors of farming: oilseeds and grain farming. Applying the full value of the adverse impact, $279,000, to either of these sectors, as modeled, results in less than one direct job affected and less than 2 total jobs affected. Therefore, it was determined that a full quantitative RED analysis was not needed.

Structural Damage: The RED impacts of structural damages could include loss of business activity due to disruptions from transportation detours and delays and/or offices closures, resulting in loss of labor, income, and economic output. The HEC-FIA results from the NED analysis include structure and content damage, although the NED outputs do not include estimates of the potential loss in industry revenues. It is not appropriate to use property damage as a proxy for loss in industry sales because the estimates represent damages (or possible replacement costs) to structures and not disruptions or loss of industry sales, as needed for an economic impact analysis. As a result, the county-level average annual structural damage estimates from the NED evaluation were used to qualitatively describe the counties that would have the largest potential RED impacts under the FPDTR-EIS alternatives.

Other Social Effects

Changes in flood risk have a potential to cause other types of effects on individuals and communities in terms of individual and community safety, health, and well-being. The HEC-FIA model was used to determine impacts to other social effects. Any changes to these areas of concern that would occur under FPDTR-EIS alternatives were examined to the extent possible. HEC-FIA estimates the number and location of people within the inundated area exposed to the flood hazard. This estimate is referred to as the population at risk and it includes people permanently residing in the area, as well as workers, customers of area businesses, and people traveling through the area. Flood risk impacts to critical infrastructure, such as public utilities and bridges, were also determined in the HEC-FIA model. The critical infrastructure inventory was imported from the Homeland Security Infrastructure Program Gold database developed by the National Geospatial-Intelligence Agency.

3.4.2.2 Summary of Environmental Consequences

The environmental consequences relative to flood risk management are summarized in Table 3-28.

Table 3-28. Environmental consequences relative to flood risk management

Alternative	NED Impacts	RED Impacts	OSE Impacts	Summary of Impacts
No Action	Under No Action the expected average annual NED damages total $2,139,123.	Negligible RED impacts.	Negligible OSE impacts.	Baseline

Alternative 1	Average annual increase in flood risk management NED damages of $19,958 relative to No Action. (Range of annual differences: $88,195 decrease to $290,698 increase)	Negligible change in RED impacts.	Negligible OSE impacts.	Alternative 1 would have a small adverse impact on flood risk management compared to No Action.
Variation 1A	Average annual increase in flood risk management NED damages of $3,172 relative to No Action. (Range of annual differences: $167,321 decrease to $138,753 increase)	Negligible change in RED impacts.	Negligible OSE impacts.	Variation 1A would have a negligible adverse impact on flood risk management compared to No Action.
Variation 1B	Average annual increase in flood risk management NED damages of $43,070 relative to No Action. (Range of annual differences: $51,613 decrease to $2,088,346 increase)	Negligible change in RED impacts.	Negligible OSE impacts.	Variation 1B would have a small adverse impact on flood risk management compared to No Action.
Alternative 2	Average annual increase in flood risk management NED damages of $49,312 relative to No Action. (Range of annual differences: $69,762 decrease to $2,714,827 increase)	Negligible change in RED impacts.	Negligible OSE impacts.	Alternative 2 would have a small adverse impact on flood risk management compared to No Action.
Variation 2A	Average annual increase in flood risk management NED damages of $17,476 relative to No Action. (Range of annual differences: $137,518 decrease to $255,643 increase)	Negligible change in RED impacts.	Negligible OSE impacts.	Variation 2A would have a small adverse impact on flood risk management compared to No Action.
Variation 2B	Average annual increase in flood risk management NED damages of $50,668 relative to No Action. (Range of annual differences: $71,443 decrease to $2,696,591 increase)	Negligible change in RED impacts.	Negligible OSE impacts.	Variation 2B would have a small adverse impact on flood risk management compared to No Action.

* FY 2020 price level

In general, the FPDTR-EIS alternatives are expected to have temporary, negligible to small adverse impacts to flood risk management. Overall, the long-term impacts from the alternatives are expected to be small.

3.4.2.3 No Action

Under No Action, operations would be closely based on the 2018 Master Manual criteria. All modeled flood targets are as outlined in the 2018 Master Manual and reservoir storages are based on current reservoir surveys. All four navigation target locations are used when setting navigation releases and the model balances storage in the upper three reservoirs (Fort Peck, Garrison, Oahe) by March 1.

Modeling results under No Action indicate that the Missouri River floodplain would continue to experience flood damages when water surface elevations reach flood stages. The magnitude of these impacts would vary considerably from year to year depending on the natural hydrologic cycles of precipitation and snow pack and not from actions from the No Action alternative.

National Economic Development

The NED analysis for No Action is summarized in Table 3-29 by river reach. Under No Action, the Missouri River floodplain from Fort Peck Dam to Gavins Point Dam exhibited $2.1 million in expected average annual flood damages under the modeled POR. However, the magnitude of these impacts varied considerably from year to year as a result of the natural hydrologic cycles of precipitation and snow pack. In addition, these impacts result from runoff events that occur downstream of the reservoir system, large upstream runoff events that result in evacuation of flood water from the reservoirs, or the combination of the two, and not from the management actions under No Action. These impacts would be much greater without operation of the reservoir system. The reach with the largest impacts is Garrison Dam to Oahe Dam due to the large amount of property in the Bismarck, North Dakota area.

Table 3-29. Summary of damages for No Action

River Reach	Average Annual Property Damages	Average Annual Agricultural Losses	Total Average Annual NED Damages
Total	**$1,616,634**	**$522,489**	**$2,139,123**
Fort Peck Dam to Garrison Dam	$53,945	$388,390	$442,334
Garrison Dam to Oahe Dam	$1,418,334	$25,817	$1,444,151
Fort Randall Dam to Gavins Point Dam	$144,356	$108,282	$252,638

Note: All totals are average annual at the FY 2020 price level.

Regional Economic Development

The RED analysis for flood risk management focuses on the locality of flood damages and the types of property being damaged. The changes to the local economy can be measured in terms of economic output, income, and employment. Under No Action, agricultural damages would result in an annual average reduction of less than 1 job and $50,000 in labor income.

In years when flooding would occur, there would be large adverse impacts to regional economic conditions from agricultural damages and loss in the market value of crop production in most of the regions. These flooding effects are a result of the natural hydrologic cycles of precipitation and snow pack and not from the management actions under No Action.

Other Social Effects

Changes in flood risk have the potential to cause other types of effects on individuals and communities such as impacts to critical infrastructure and populations at risk. While there remains a risk of flooding under No Action, OSE would be negligible. Adverse impacts under No Action can be described as the continued risk to people and critical infrastructure at risk. Table 3-30 shows the modeled population at risk (PAR) totals under No Action by river reach. The largest modeled flood events indicate that more than 9,400 people from Fort Peck Dam to Gavins Point Dam could be affected by flooding. The average annual PAR is 212.

Table 3-30. Population at risk under No Action

River Reach	Largest Flood Event in POR	Average Annual PAR
Total Reaches	**9,412**	**212**
Fort Peck Dam to Garrison Dam	81	2
Garrison Dam to Oahe Dam	9,258	207
Fort Randall Dam to Gavins Point Dam	73	3

In addition to determining impacts to the population, HEC-FIA was used to determine the critical infrastructure that would be impacted during flood events. Table 3-31 lists the type and quantity of critical infrastructure that would be impacted under the largest modeled flood events in the 82-year POR for No Action. While the impacts on average were less, the table provides an indication of the infrastructure impacted under the worst-case scenario.

Table 3-31. Critical infrastructure impacted under No Action

Critical Infrastructure	Total
Agricultural Facilities	4
Chemical Industries	11
Communication Towers	4
Educational Schools	0
Emergency – EMS	4
Emergency – Fire Stations	6
Emergency – National Shelters	2

Critical Infrastructure	Total
Energy – Plants	5
Energy – Propane Locations	7
Energy – Substations	12
Law Enforcement	2
Mail - USPS	10
Manufacturing Plants	10
Public – Campgrounds	2
Public – Libraries	2
Public – Parks	26
Public – Worship	1
Transportation – Airports	20
Transportation – Bridges	528
Transportation – Ports	121
Wastewater Treatment Plants	2

Conclusion

No Action represents the continuation of current system operation and implementation of the MRRP. It primarily serves as a reference condition allowing for a comparison of the action alternatives. Under No Action, the Missouri River floodplain from Fort Peck Dam to Gavins Point Dam incurred average annual flood damages of $2.1 million in the modeled POR. However, the magnitude of these impacts varied considerably from year to year as a result of the natural hydrologic cycles of precipitation and snow pack and not from the management actions that are part of No Action. Similarly, flooding events would result in significant property damage and agricultural losses that could significantly affect regional economic conditions. However, the management actions under No Action would result in negligible RED and OSE impacts. No Action is not anticipated to cause significant impacts to flood risk management because these flooding effects are a result of the natural hydrologic cycles of precipitation and snow pack and flooding effects would be much greater were it not for the current operation of the reservoir system.

3.4.2.4 Alternative 1

System operations under Alternative 1 are based on those described under the No Action alternative except that it includes a test flow release regime from Fort Peck Dam to benefit pallid sturgeon.

An Attraction Flow Regime would begin on April 16 and the peak flow would be twice as large as the spring release from Fort Peck Dam in a given year. The Spawning Cue Flow Regime under Alternative 1 begins on May 28 and would be 3.5 times the Fort Peck Dam spring flow release in the given release year. A further description of Alternative 1 is detailed in Chapter 2, Section 2.5 Alternatives Carried Forward for Further Evaluation.

National Economic Development

The NED analysis for Alternative 1 is summarized in Table 3-32. The modeled flood damages along the Missouri River from Fort Peck Dam to Gavins Point Dam under Alternative 1 were on average $19,958 greater annually relative to No Action. This represents an overall increase in NED impacts in relation to No Action of 0.93 percent. The adverse impact relative to No Action is largely attributable to increases in agricultural losses in the Fort Peck Dam to Garrison Dam reach.

Table 3-32. NED summary for Alternative 1

Alternative 1	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches
Average Annual Property Damages	$55,242	$1,418,233	$147,228	$1,620,703
Average Annual Agricultural Losses	$404,440	$25,760	$108,179	$538,378
Average Annual Total *Flood Damages	$459,681	$1,443,993	$255,407	$2,159,081
Difference in Average Annual Damages from No Action	$17,347	-$158	$2,769	$19,958
Percentage Difference from No Action	3.92%	-0.01%	1.10%	0.93%

Note: FY 2020 price level; negative values indicate a decrease in damages relative to No Action

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that flood risk management would experience more years when damages would increase (31) than when damages would decrease (29) under Alternative 1. There were an additional 22 years that showed no change. However, the overall flood risk management impacts are dominated by five years when damages would increase by approximately $200,000 or more relative to No Action. These adverse impacts are occurring over the period of record when river stages are higher in the upper river under Alternative 1 relative to No Action. The difference in annual damages from No Action ranged from -$88,195 to $290,698.

Additional modeling results are summarized in Table 3-33, which shows the largest increases and decreases in annual flood damages for Alternative 1 relative to No Action in years given a partial or full flow release, as well as all years in the period of record regardless of flow action. The results show that the greatest adverse impacts to flood risk management in the Fort Peck Dam to Garrison Dam and Garrison Dam to Oahe Dam reaches would occur in years when there is partial or full flow release. The increase in damages within the Fort Randall Dam to Gavins Point Dam reach were driven by a non-release year (2011).

Table 3-33. Impacts from modeled flow releases under Alternative 1 compared to No Action

Release	Damage Change	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches [c]
Full Flow Release [a]	Largest Damage Decrease	-$62,045	-$3,468	-$26,095	-$88,195
	Largest Damage Increase	$290,464	$47	$12,789	$290,698
Partial Flow Release [b]	Largest Damage Decrease	-$50,658	-$615	-$7,163	-$47,879
	Largest Damage Increase	$200,869	$248	$10,482	$198,343
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Damage Decrease	-$62,045	-$8,233	-$26,095	-$88,195
	Largest Damage Increase	$290,464	$248	$249,125	$290,698

a Flow action was fully implemented in 11 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to No Action.

b Flow action was partially implemented in 11 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to No Action.

c The reach totals are from a mixture of years, thus the total values are not cumulative totals of the individual reaches.

Regional Economic Development

It is anticipated that Alternative 1 would have negligible RED impacts. Under Alternative 1, agricultural losses would increase slightly relative to No Action. While these loss increases have the potential to result in lower sales and labor income, impacts on jobs and regional economic conditions are expected to be negligible under Alternative 1.

Other Social Effects

On average, flood risk management is expected to experience short-term, relatively small, adverse impacts under Alternative 1 with negligible other social effects.

3.4.2.5 Alternative 1 – Variation 1A

Variation 1A is a test flow variation of Alternative 1. The parameters for 1A are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 9, rather than April

16, and the Spawning Cue Flow Regime is initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

National Economic Development

The NED analysis for Variation 1A is summarized in Table 3-34. The modeled flood damages along the Missouri River from Fort Peck Dam to Gavins Point Dam under Variation 1A were on average $3,172 greater annually relative to No Action. This represents an overall increase in NED impacts in relation to No Action of 0.15 percent which is the smallest among all alternatives. The adverse impacts are largely attributable to increases in agricultural losses in the Fort Peck Dam to Garrison Dam reach as the Garrison Dam to Oahe Dam and Fort Randall Dam to Gavins Point Dam reaches actually experience a reduction in flood damages relative to No Action.

Table 3-34. Summary for Alternative 1 – Variation 1A

Variation 1A	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches
Average Annual Property Damages	$53,334	$1,418,182	$142,650	$1,614,166
Average Annual Agricultural Losses	$394,526	$25,794	$107,809	$528,129
Average Annual Total Flood Damages	$447,860	$1,443,977	$250,458	$2,142,295
Difference in Average Annual Damages from No Action	$5,526	-$174	-$2,180	$3,172
Percentage Difference from No Action	1.25%	-0.01%	-0.86%	0.15%

Note: FY 2020 price level

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts, as well as those that would occur on average, were examined. The annual analysis shows that flood risk management would experience two more years when damages would decrease (31) than when damages would increase (29) under Variation 1A. There were 22 years that exhibited no change. The overall flood risk management impacts were influenced by five years when damages would increase or decrease by approximately $100,000 or more relative to No Action. The difference in damages from No Action for all reaches ranged from -$167,321 to $138,753.

Additional modeling results are summarized in Table 3-35, which shows the largest increases and decreases in annual flood damages for Variation 1A relative to No Action in years given a partial or full flow release, as well as all years in the period of record regardless of flow action. The results show that the greatest adverse impacts to flood risk management in each reach would occur in years when there is a full flow release. The decrease in damages within the Fort Randall Dam to Gavins Point Dam reach were driven by a non-release year (2011).

Table 3-35. Impacts from modeled flow releases under Variation 1A compared to No Action

Release	Damage Change	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches [c]
Full Flow Release [a]	Largest Damage Decrease	-$73,868	-$296	-$16,468	-$90,419
	Largest Damage Increase	$137,324	$487	$30,164	$138,753
Partial Flow Release [b]	Largest Damage Decrease	-$149,672	-$34	-$3,952	-$148,137
	Largest Damage Increase	$10,476	$3	$3,215	$12,963
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Damage Decrease	-$149,672	-$12,593	-$154,364	-$167,321
	Largest Damage Increase	$137,324	$487	$30,164	$138,753

a Flow action was fully implemented in 16 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to Alternative 1.

b Flow action was partially implemented in 6 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to Alternative 1.

c The reach totals are from a mixture of years, thus the total values are not cumulative totals of the individual reaches.

Regional Economic Development

It is anticipated that Variation 1A would have negligible RED impacts. Under Variation 1A, agricultural losses would increase slightly relative to No Action. While these losses have the potential to result in lower sales and labor income, impacts on jobs and regional economic conditions are expected to be negligible under Variation 1A.

Other Social Effects

On average, flood risk management is expected to experience short-term, relatively small, adverse impacts under Variation 1A with negligible other social effects.

3.4.2.6 Alternative 1 – Variation 1B

Variation 1B is another test flow variation of Alternative 1. The parameters for 1B are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 23 and the Spawning Cue Flow is initiated on June 4. Similar to the concept described in Variation 1A, the later initiation date is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

National Economic Development

The NED analysis for Variation 1B is summarized in Table 3-36. The modeled flood damages along the Missouri River from Fort Peck Dam to Gavins Point Dam under Alternative 1B were on average $43,070 greater annually relative to No Action. This represents an overall increase in NED impacts in relation to No Action of 2.01 percent which is the largest among the Alternative 1 variations. The adverse impacts are largely attributable to increases in property damages in the Garrison Dam to Oahe Dam reach.

Table 3-36. NED summary for Alternative 1 – Variation B

Variation 1B	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches
Average Annual Property Damages	$54,787	$1,445,665	$143,996	$1,644,448
Average Annual Agricultural Losses	$402,692	$26,276	$108,777	$537,745
Average Annual Total Flood Damages	$457,479	$1,471,941	$252,773	$2,182,193
Difference in Average Annual Damages from No Action	$15,145	$27,790	$135	$43,070
Percentage Difference from No Action	3.42%	1.92%	0.05%	2.01%

Note: FY 2020 price level

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that flood risk management would experience more years when damages would increase (45) than when damages would decrease (37) under Alternative 1. The overall flood risk management impacts are dominated by one year (2011) when damages would increase by over $2 million relative to No Action. The difference in damages from No Action ranged from -$51,613 to $2,088,346.

Additional modeling results are summarized in Table 3-37, which shows the largest increases and decreases in annual flood damages for Variation 1B relative to No Action in years given a partial or full flow release, as well as all years in the period of record regardless of flow action. The results show that the greatest adverse impacts to flood risk management in the Fort Peck Dam to Garrison Dam reach would occur in a year (1983) when there is partial flow release. The significant increase in damages within the Garrison Dam to Oahe Dam reach were driven by a non-release year (2011).

Table 3-37. Impacts from modeled flow releases under Variation 1B compared to No Action

Release	Damage Change	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches [c]
Full Flow Release [a]	Largest Damage Decrease	NA	-$87	-$12,068	$3,793
	Largest Damage Increase	$165,028	$406	$1,239	$165,426
Partial Flow Release [b]	Largest Damage Decrease	-$51,447	-$453	-$12,212	-$51,613
	Largest Damage Increase	$239,162	$210	$9,900	$239,690
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Damage Decrease	-$51,447	-$4,372	-$47,887	-$51,613
	Largest Damage Increase	$239,162	$2,158,460	$68,475	$2,088,346

a Flow action was fully implemented in 8 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to No Action.

b Flow action was partially implemented in 16 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to No Action

c The reach totals are from a mixture of years, thus the total values are not cumulative totals of the individual reaches.

Regional Economic Development

It is anticipated that Variation 1B would have negligible RED impacts. Under Variation 1B, agricultural losses would increase slightly relative to No Action. While these loss increases have the potential to result in lower sales and labor income, impacts on jobs and regional economic conditions are expected to be negligible under Variation 1B.

Other Social Effects

On average, flood risk management is expected to experience short-term, relatively small, adverse impacts under Variation 1B with negligible other social effects.

3.4.2.7 Conclusion – Alternative 1 including Variants 1A and 1B

Under Alternative 1, including variations 1A and 1B, it is expected that flood risk management would experience relatively small, short-term, adverse impacts relative to No Action. These impacts would be due to slight changes in the timing of inundation and minor increases in river stages relative to No Action. On average these impacts are relatively small in nature but there are some years when the flood impacts would be of greater magnitude. There would be an overall increase in NED impacts in relation to No Action of between 0.15 percent (Variation 1A) and 2.01 percent (Variation 1B). The increase in property damages in the Garrison Dam to Oahe Dam reach is driving the overall total for Variation 1B. The Fort Peck Dam to Oahe Dam reach would experience an increase in damages relative to No Action under all variants due to increased agricultural losses. On average, the change in RED effects would be negligible to small across all locations; although there would be years when damages could occur with adverse impacts to RED effects, they would be offset by years with reductions in damages and beneficial impacts to RED effects compared to No Action. It is anticipated that were would be negligible OSE impacts.

Table 3-38 provides a summary of the NED impacts for Alternative 1 including variations 1A and 1B in years when a partial or full flow release occurs. Over all reaches, annual average damages in partial or full release years would increase between $14,572 and $43,432 (3.85 – 11.77 percent) relative to No Action. Alternative 1 has the largest impact on flood risk management relative to No Action with a maximum damage increase of $290,698. While flood risk management would experience small adverse impacts in some years during a partial or full flow release, these would be relatively small, short-term impacts and it is expected that Alternative 1 and variations 1A and 1B would not have a significant impact to flood risk management.

Table 3-38. Summary of NED analysis for Alternative 1 – full or partial flow years

Costs	Alternative 1	Variant 1A	Variant 1B
Average Annual Damages	$548,514	$520,472	$605,261
Difference in Annual Average Costs from No Action	$43,432	$14,572	$33,125
Percentage Difference from No Action	11.77%	3.85%	8.61%
Largest Damage Increase	$290,698	$138,753	$239,690
Largest Damage Decrease	$88,195	$90,419	$51,613

3.4.2.8 Alternative 2

The parameters for Alternative 2 are the same as described for Alternative 1 except that the Attraction Flow Regime peak is 14,000 cfs (the maximum powerhouse capacity) rather than twice the average Fort Peck spring flow in the given year. The maximum amount of flow that can be run through the generators is 14,000 cfs. Any additional flow is run through the spillway and does not generate hydroelectricity. Additionally, releases as measured at the Wolf Point, MT gage are held at 14,000 cfs until the Spawning Cue release is initiated.

National Economic Development

The NED analysis for Alternative 2 is summarized in Table 3-39. The modeled flood damages along the Missouri River from Fort Peck Dam to Gavins Point Dam under Alternative 2 were on average $49,312 greater annually relative to No Action. This represents an overall increase in NED impacts in relation to No Action of 2.31 percent. The adverse impacts are largely attributable to increases in agricultural losses in the Fort Peck Dam to Garrison Dam reach and property damages in the Garrison Dam to Oahe Dam reach.

Table 3-39. NED summary for Alternative 2

Alternative 2	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches
Average Annual Property Damages	$54,886	$1,444,628	$151,166	$1,650,681
Average Annual Agricultural Losses	$403,342	$25,914	$108,498	$537,754
Average Annual Total Flood Damages	$458,228	$1,470,542	$259,665	$2,188,435
Difference in Average Annual Damages from No Action	$15,894	$26,391	$7,026	$49,312
Percentage Difference from No Action	3.59%	1.83%	2.78%	2.31%

Note: FY 2020 price level

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that flood risk management would experience more years when damages would increase (32) than when damages would decrease (28) under Alternative 2. There were an additional 22 years that showed no change. However, the overall flood risk management impacts are dominated by one year (2011) when damages would increase by approximately $2.7 million relative to No Action. The difference in damages from No Action ranged from -$69,762 to $2,714,827.

Additional modeling results are summarized in Table 3-40, which shows the largest increases and decreases in annual flood damages for Alternative 2 relative to No Action in years given a partial or full flow release, as well as all years in the period of record regardless of flow action. The results show that the greatest adverse impacts to flood risk management in the Fort Peck Dam to Garrison Dam reach would occur in years when there is partial or full flow release. The increase in damages within the Garrison Dam to Oahe Dam and Fort Randall Dam to Gavins Point Dam reaches were driven by a non-release year (2011).

Table 3-40. Impacts from modeled flow releases under Alternative 2 compared to No Action

Release	Damage Change	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches [c]
Full Flow Release [a]	Largest Damage Decrease	-$54,769	-$268	-$14,954	-$69,762
	Largest Damage Increase	$194,462	$37	$5,681	$194,574
Partial Flow Release [b]	Largest Damage Decrease	-$52,914	-$453	-$16,355	-$50,127
	Largest Damage Increase	$203,102	$210	$31,303	$233,719
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Damage Decrease	-$54,769	-$4,372	-$16,355	-$69,762
	Largest Damage Increase	$203,102	$2,158,460	$572,242	$2,714,827

a Flow action was fully implemented in 10 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to No Action.

b Flow action was partially implemented in 10 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to No Action.

c The reach totals are from a mixture of years, thus the total values are not cumulative totals of the individual reaches.

Regional Economic Development

It is anticipated that Alternative 2 would have negligible RED impacts. Under Alternative 2, agricultural losses would increase slightly relative to No Action. While these loss increases have the potential to result in lower sales and labor income, impacts on jobs and regional economic conditions are expected to be negligible under Alternative 2.

Other Social Effects

On average, flood risk management is expected to experience short-term, relatively small, adverse impacts under Alternative 2 with negligible other social effects.

3.4.2.9 Alternative 2 – Variation 2A

Variation 2A is a test flow variation of Alternative 2. The parameters for Alternative 2A are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue flow would be initiated on May 21, rather than May 28. Again, moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

National Economic Development

The NED analysis for Variation 2A is summarized in Table 3-41. The modeled flood damages along the Missouri River from Fort Peck Dam to Gavins Point Dam under Variation 2A were on average $17,476 greater annually relative to No Action. This represents an overall increase in NED impacts in relation to No Action of 0.82 percent. The adverse impacts are largely attributable to increases in agricultural losses in the Fort Peck Dam to Garrison Dam reach.

Table 3-41. NED summary for Alternative 2 – Variation 2A

Variation 2A	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches
Average Annual Property Damages	$53,871	$1,419,593	$147,295	$1,620,759
Average Annual Agricultural Losses	$400,558	$26,182	$109,100	$535,841
Average Annual Total Flood Damages	$454,429	$1,445,775	$256,396	$2,156,599
Difference in Average Annual Damages from No Action	$12,095	$1,624	$3,757	$17,476
Percentage Difference from No Action	2.73%	0.11%	1.49%	0.82%

Note: FY 2020 price level

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that flood risk management would experience more years when damages would increase (33) than when damages would decrease (27) under Variation 2A. There were an additional 22 years that showed no change. The overall flood risk management impacts are driven by one year (2011) in which damages would increase by nearly $250,000 in the Fort Randall Dam to Gavins Point Dam reach and an additional six years that showed damages increasing by $100,000 or more. The difference in damages from No Action ranged from -$137,518 to $255,643.

Additional modeling results are summarized in Table 3-42, which shows the largest increases and decreases in annual flood damages for Variation 2A relative to No Action in years given a partial or full flow release, as well as all years in the period of record regardless of flow action. The results show that the greatest adverse impacts to flood risk management in the Fort Peck Dam to Garrison Dam and Garrison Dam to Oahe Dam reaches would occur in years when there is a full flow release. The increase in damages within the Fort Randall Dam to Gavins Point Dam reach were driven by a non-release year (2011).

Table 3-42. Impacts from modeled flow releases under Variation 2A compared to No Action

Release	Damage Change	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches [c]
Full Flow Release [a]	Largest Damage Decrease	-$59,457	-$781	-$13,369	-$72,878

	Largest Damage Increase	$189,051	$125,655	$31,371	$191,844
Partial Flow Release [b]	Largest Damage Decrease	-$138,294	$0	-$4,947	-$137,518
	Largest Damage Increase	$62,694	$88	$6,381	$65,477
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Damage Decrease	-$138,294	-$781	-$13,369	-$137,518
	Largest Damage Increase	$189,051	$125,655	$249,148	$255,643

a Flow action was fully implemented in 15 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to No Action.

b Flow action was partially implemented in 5 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to No Action.

c The reach totals are from a mixture of years, thus the total values are not cumulative totals of the individual reaches.

Regional Economic Development

It is anticipated that Variation 2A would have negligible RED impacts. Under Variation 2A, agricultural losses would increase slightly relative to No Action. While these loss increases have the potential to result in lower sales and labor income, impacts on jobs and regional economic conditions are expected to be negligible under Variation 2A.

Other Social Effects

On average, flood risk management is expected to experience short-term, relatively small, adverse impacts under Variation 2A with negligible other social effects.

3.4.2.10 Alternative 2 – Variation 2B

Variation 2B is a test flow variation of Alternative 2. The parameters for Alternative 2B are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 23, rather than April 16, and the Spawning Cue flow is initiated on June 4, rather than May 21. Again, the difference in timing is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

National Economic Development

The NED analysis for Variation 2B is summarized in Table 3-43. The modeled flood damages along the Missouri River from Fort Peck Dam to Gavins Point Dam under Variation 2B were on average $50,668 greater annually relative to No Action. This represents an overall increase in NED impacts in relation to No Action of 2.37 percent which is the largest among all alternatives and variations. The adverse impacts are largely attributable to increases in agricultural losses in the Fort Peck Dam to Garrison Dam reach and property damages in the Garrison Dam to Oahe Dam reach.

Table 3-43. NED summary for Alternative 2 – Variation 2B

Variation 2B	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches
Average Annual Property Damages	$54,726	$1,444,277	$151,149	$1,650,152
Average Annual Agricultural Losses	$405,460	$25,902	$108,277	$539,639
Average Annual Total Flood Damages	$460,186	$1,470,178	$259,426	$2,189,791
Difference in Average Annual Damages from No Action	$17,852	$26,027	$6,788	$50,668
Percentage Difference from No Action	4.04%	1.80%	2.69%	2.37%

Note: FY 2020 price level

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that flood risk management would experience more years when damages would increase (45) than when damages would decrease (37) under Variation 2B. However, the overall flood risk management impacts are dominated by one year (2011) when damages would increase by approximately $2.7 million more relative to No Action. These adverse impacts are occurring in the Garrison Dam to Oahe Dam and Fort Randall Dam to Gavins Point Dam reaches. The difference in damages from No Action ranged from -$71,443 to $2,696,591.

Additional modeling results are summarized in Table 3-44, which shows largest increases and decreases in annual flood damages for Variation 2B relative to No Action in years given a partial or full flow release, as well as all years in the period of record regardless of flow action. The results show that the greatest adverse impacts to flood risk management in the Fort Peck Dam to Garrison Dam reach would occur in years when there is partial or full flow release. The increase in damages within the Garrison Dam to Oahe Dam and Fort Randall Dam to Gavins Point Dam were driven by a non-release year (2011).

Table 3-44. Impacts from modeled flow releases under Variation 2B compared to No Action

Release	Damage Change	Fort Peck Dam to Garrison Dam	Garrison Dam to Oahe Dam	Fort Randall Dam to Gavins Point Dam	All Reaches [c]
Full Flow Release [a]	Largest Damage	-$52,808	-$284	-$18,585	-$71,443

	Decrease				
	Largest Damage Increase	$224,428	$1	$150	$224,294
Partial Flow Release [b]	Largest Damage Decrease	-$41,547	-$284	-$4,949	-$41,495
	Largest Damage Increase	$222,371	$1	$10,932	$222,325
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Damage Decrease	-$52,808	-$8,312	-$21,535	-$71,443
	Largest Damage Increase	$224,428	$2,141,683	$572,422	$2,696,591

a Flow action was fully implemented in 8 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to No Action.

b Flow action was partially implemented in 16 years of the period of analysis. Data represents the largest NED damage increase and decrease in the years the action was implemented relative to No Action.

c The reach totals are from a mixture of years, thus the total values are not cumulative totals of the individual reaches.

Regional Economic Development

It is anticipated that Variation 2B would have negligible RED impacts. Under Variation 2B, agricultural losses would increase slightly relative to No Action. While these loss increases have the potential to result in lower sales and labor income, impacts on jobs and regional economic conditions are expected to be negligible under Variation 2B.

Other Social Effects

On average, flood risk management is expected to experience short-term, relatively small, adverse impacts under Variation 2B with negligible other social effects.

3.4.2.11 Conclusion – Alternative 2 including Variants 2A and 2B

Under Alternative 2, including variations 2A and 2B, it is expected that flood risk management would experience relatively small, short-term, adverse impacts relative to No Action. These impacts would be due to slight changes in the timing of inundation and minor increases in river stages relative to No Action. On average these impacts are relatively small in nature but there are some years when the flood impacts would be of greater magnitude. There would be an overall increase in NED impacts in relation to No Action of between 0.82 percent (Variation 2A) and 2.37 percent (Variation 2B). The increase in property damages in the Garrison Dam to Oahe Dam reach is driving the overall total for Variation 2B. All reaches would experience an increase in damages relative to No Action under all variants due to increased agricultural losses in the Fort Peck Dam to Garrison Dam reach and increased property damages in the Garrison Dam to Oahe Dam and Fort Randall Dam to Gavins Point Dam reaches. On average, the change in RED effects would be negligible to small across all locations; although there would be years when damages could occur with adverse impacts to RED effects, they would be offset by years with reductions in damages and beneficial impacts to RED effects compared to No Action. It is anticipated that there would be negligible OSE impacts.

Table 3-45 provides a summary of the NED impacts for Alternative 2 including variations 2A and 2B in years when a partial or full flow release occurs. Over all reaches, annual average damages in partial or full release years would increase between $34,290 and $44,133 (8.86 – 11.44 percent) relative to No Action. Alternative 2 has the largest impact on flood risk management relative to No Action with a maximum damage increase of $233,719. While flood risk management would experience small adverse impacts in some years during a partial or full flow release, these would be relatively small, short-term impacts and it is expected that Alternative 2 and variations 2A and 2B would not have a significant impact to flood risk management.

Table 3-45. Summary of NED analysis for Alternative 2 – full or partial flow years

Costs	Alternative 2	Variant 2A	Variant 2B
Average Annual Damages	$561,379	$554,672	$611,754
Difference in Annual Average Costs from No Action	$44,133	$34,290	$39,978
Percentage Difference from No Action	11.44%	8.86%	10.39%
Largest Damage Increase	$233,719	$191,844	$224,294
Largest Damage Decrease	$69,762	$137,518	$71,443

3.4.2.12 Tribal Impacts

All Tribal reservations located between Fort Peck Dam and Gavins Point Dam were evaluated for flood risk. Similar to the overall reach impacts, Tribal flood risk is likely to incur small, short-term, and adverse impacts under Alternatives 1 and 2 relative to No Action. While the impacts would vary from year to year, on average the impacts to Tribal reservations would be negligible under both Alternatives 1 and 2 and their variants relative to No Action.

3.4.2.13 Climate Change

The following six climate change variables are expected to have an impact on No Action, Alternative 1, and Alternative 2: increased air temperature; increased precipitation and stream flow; decreased peak snow water equivalent; earlier snowmelt date and decreased snow accumulation season duration; increased sedimentation; and increased irregularity of flood and droughts. While all variables will impact the alternatives, increased air temperature was identified as not being a risk to flood risk management. Decreased peak snow water equivalent may reduce the risk to flood risk management by lowering reservoir elevations. However, an earlier snowmelt date and decreased snow accumulation season duration could have either an adverse or beneficial impact on flood risk management depending on the location and season. Both of the climatic change variables for increased sedimentation and flood severity would increase the risk of adverse impacts to flood risk management by potentially exceeding flood targets more frequently or increasing the number of extreme weather events and reducing the overall reliability of the system. Impacts of climate change under Alternatives 1 and 2 and their variants would be similar to those under No Action.

3.4.2.14 Cumulative Impacts

Construction of the System and the associated dams allows operation with controlled flow releases from the upper river into the lower river to achieve multiple management objectives, including flood risk management. Variability in natural hydrologic conditions (precipitation and snowmelt, which include periods of drought and high runoff) and the “rules” governing System operation would continue to dominate the flows in the Missouri River into the future. Natural flow variability and the requirement to operate for all authorized purposes under the Master Manual would continue to be the primary drivers of impact to flood risk management.

The construction and operation of the System and the BSNP significantly altered the Missouri River by creating a system of six dams and channelizing the Missouri River from Sioux City, Iowa to St. Louis, Missouri. These alterations resulted in significant flow changes within the Missouri River and have substantially reduced flood risk over the long term by regulating the flows and river stages on the Missouri River. The flood control purpose of the Missouri River system is given the highest priority during periods of significant runoff when loss of life and property damage could occur. Regulation efforts will be made to minimize these losses.

In general, flood impacts in the Missouri River floodplain vary considerably depending on the year and location and can range from near zero to relatively large impacts. The primary driver affecting flood risk is the hydrologic conditions in the basin including natural cycles of dry and wet periods (including snowpack and precipitation).

Under No Action, existing geomorphological processes and trends would continue, consisting primarily of river degradation and bank erosion, reservoir sediment deposition and aggradation, shoreline erosion in reservoirs, and ice dynamics. Continued degradation in the lower Missouri River would be caused by sediment trapped behind dams as well as by continued sand and aggregate mining downstream of Rulo, Nebraska, which lowers the riverbed and the stage of the river over time. The cumulative impacts of No Action would be a continuation of the substantial beneficial impacts on flood risk management resulting from the past, present, and reasonable foreseeable future actions. No Action measures would provide a negligible contribution to these cumulative impacts to flood risk management. Adverse and beneficial impacts to flood risk management are driven by natural cycles of dry and wet periods (including snowpack and precipitation), and changes in land use management.

Under Alternative 1, including variations 1A and 1B, the Fort Peck test flow releases would modify upper reservoir releases and river flows to some extent, but would overall have a small adverse impact on flood risk management. These impacts would be due to slight changes in the timing of inundation and minor increases in flood stage relative to No Action. On average, these impacts are small in nature but there are a few years when flood risk management would experience larger adverse impacts. The greatest adverse impacts to flood risk management would occur during summer months when flows tend to be at their highest levels in the upper river. When combined with other past, present, and reasonably foreseeable future actions, the cumulative impacts of Alternative 1 would be similar to No Action. Implementation of Alternative 1 and its variants would have a negligible contribution to these cumulative impacts.

Under Alternative 2, including variations 2A and 2B, the Fort Peck test flow releases would modify upper reservoir releases and river flows to some extent, but would overall have a small adverse impact on flood risk management. These impacts would be due to slight changes in the timing of inundation and minor increases in flood stage relative to Alternative 2. On average, these impacts are small in nature but there are a few years when flood risk management would experience larger adverse impacts. The greatest adverse impacts to flood risk management would occur during summer months when flows tend to be at their highest levels in the upper river. When combined with other past, present, and reasonably foreseeable future actions, the cumulative impacts of Alternative 2 and its variants would be similar to No Action. Implementation of Alternative 2 would have a negligible contribution to these cumulative impacts.

3.5 Hydropower

3.5.1 Affected Environment

Mainstem dams hold water in the river reservoir system; passing water through the hydropower plants electricity-generating turbines creates a source of low cost, renewable energy. Hydropower generation is dependent on three primary features of the Missouri River system: river flows (dam releases), water elevations, and reservoir System storage. Changes in available water, including daily and hourly river flows and System storage, can impact both the magnitude of normal seasonal generating patterns and reduce the flexibility to meet hourly peaking demands. The value associated with hydropower is based on the accrued cost of the most likely energy source that would replace reductions in hydropower generation.

3.5.1.1 History of Missouri River Hydropower

In 1933, as part of the New Deal, the construction of Fort Peck Dam began and with it, the interest in hydropower on the mainstem of the Missouri River. Fort Peck began generating hydropower in 1943. During this effort, USACE and the Bureau of Reclamation were finalizing the Pick-Sloan Plan as part of the Flood Control Act of 1944. This plan called for the construction of a number of multi-purpose projects in the Missouri River Basin including five more major hydropower plants on the mainstem of the river.

3.5.1.2 Missouri River Hydropower System Description

The Missouri River hydropower system contains six USACE facilities with a combined nameplate capacity of 2,500 MW. Table 3-46 provides a description of the general characteristics of USACE hydroelectric projects on the mainstem of the Missouri River.

Table 3-46. Hydropower plant characteristics for USACE projects on the Missouri River mainstem

Project	Online Date	Number of Units	Generator Capacity Rated (MW)
Fort Peck	1943	5	185
Garrison	1956	5	583
Oahe	1962	7	786
Big Bend	1964	8	494
Fort Randall	1954	8	320
Gavins Point	1956	3	132
Total	-	36	2,500

3.5.1.3 Regional Energy Development

The Missouri River hydropower system is mostly contained in the North American Electric Reliability Corporation (NERC) Midwest Reliability Organization (MRO) (Figure 3-34). Note: For purposes of this study, the United States section of the MRO region is extended to include Montana. The MRO is one of eight regions in North America tasked with ensuring the reliability and security of the bulk power system. An understanding of the value of the hydropower begins with a look into the current available generating capacity of the region.

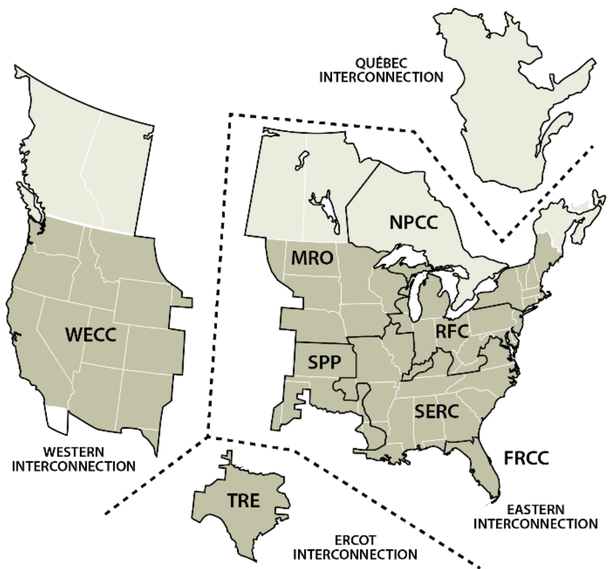
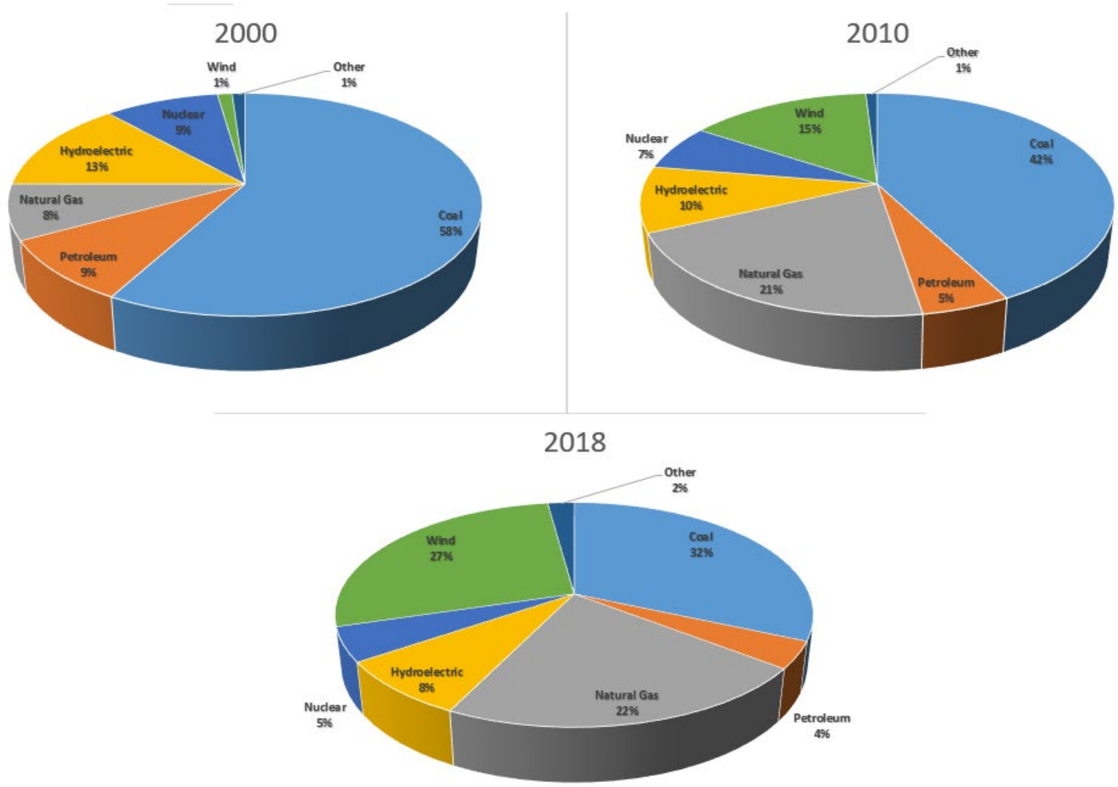


Figure 3-34. North American Reliability Corporations Interconnections

Source: North American Electric Reliability Corporation 2012.
Note: For purposes of this study the United States section of the MRO region is extended to include Montana.

Between 2000 and 2018, there was a dramatic change in the sources of generating capacity in the MRO-US. In 2000, coal represented almost 58 percent of the entire region's capacity with a nameplate capacity of almost 40,000 MW. During this time, natural gas only supplied 3,100 MW of capacity and wind power had 471 MW. By 2018, however, natural gas development was supplying 22 percent of the region's capacity with 14,800 MW of the region's nameplate capacity. The contribution of wind has increased steadily, supplying almost 19,000 MW and 27 percent of the region's nameplate capacity (Figure 3-35). The capacity contributions for coal,

nuclear, petroleum, and hydropower have stayed fairly stable in terms of the actual megawatts



being contributed to the system, but the influx of natural gas and wind has decreased their percent contribution to the system.

3.5.1.4 USACE Hydropower Operations

The amount of power produced from a hydropower facility is directly proportional to three variables; the efficiency of the hydropower plant turbines, the amount of flow going through the turbines, and the head (the height of the water in the reservoir relative to its height after discharge).

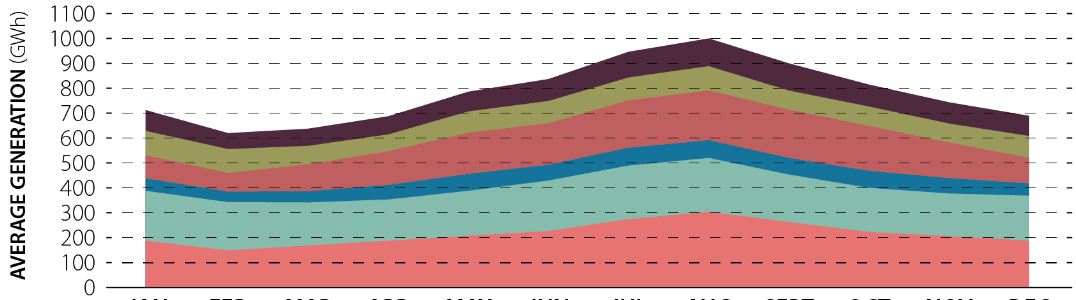
Restrictions on dam releases due to either water availability or other considerations such as minimum flow requirements may reduce both the magnitude and value of the energy produced. Flows outside of the design of the turbines may also reduce the overall efficiency.

Like dam releases, power generated is directly related to the water elevation in the reservoir. Also like dam releases, reservoir elevations outside of the turbine design can lead to a reduction in overall generating efficiency. Since the reservoirs on the mainstem of the

Missouri River are so large, dramatic changes in reservoir elevations are generally a result of system responses to extreme hydrologic events such as an extended drought or a flood.

System storage, represented by the volume of water stored in the six USACE hydropower reservoirs, can affect the magnitude and timing of dam releases at individual plants associated with hydropower generation in an attempt to meet other project purposes, such as reducing flood risk and providing navigation support. Hydropower generation for the federal plants is scheduled to best meet the needs of customers under the constraints of the other projects purposes such as navigation and flood control. Generation patterns can be viewed on time scales of seasonally (monthly), daily, and hourly. These patterns should be viewed both as a system and individually as different plants may have different operating constraints.

In the Missouri River Basin, peak energy loads (demand) increase in the summer months, when temperatures are highest. These loads are intended to be met by generating the maximum amount of energy during the month of August. Figure 3-36 shows the average monthly generation for USACE hydropower plants from 1968 to 2014. Over this period, on average, the least amount of energy was generated during February.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
BIG BEND	75	61	67	70	76	83	97	109	99	86	81	76
FORT PECK	103	96	77	69	87	89	96	97	83	78	78	92
FORT RANDALL	91	77	104	135	161	166	190	200	191	176	139	97
GAVINS POINT	46	42	49	57	64	65	70	73	73	73	63	49
GARRISON	202	191	171	164	190	202	215	216	184	175	176	181
OAHE	192	154	171	192	207	231	278	306	268	226	205	193

Figure 3-35. Average monthly generation in gigawatt hours (GWh) (1968–2014) for USACE hydropower facilities on the Missouri River mainstem

Figure 3-37 illustrates the seasonal differences in hourly generation patterns for USACE hydro-facilities using hourly generation data for a select winter and summer day. The winter heating demand consists of two peaks; early morning and evening with a slight dip in the afternoon. The summer cooling demand consists of a much broader peak time from mid-afternoon until late evening reaching a maximum around 6:00 p.m.

The hydropower operations of the individual power plants within a system can vary significantly. For example, run of river plants are operated (Missouri River plants are not run of river) constantly, using as much installed capacity as possible. Other plants with storage may turn completely off and then increase during peak demand periods, while others even have a minimum flow requirement with a constant generation of a small amount of electricity and with a maximum generation occurring during peak demand periods.

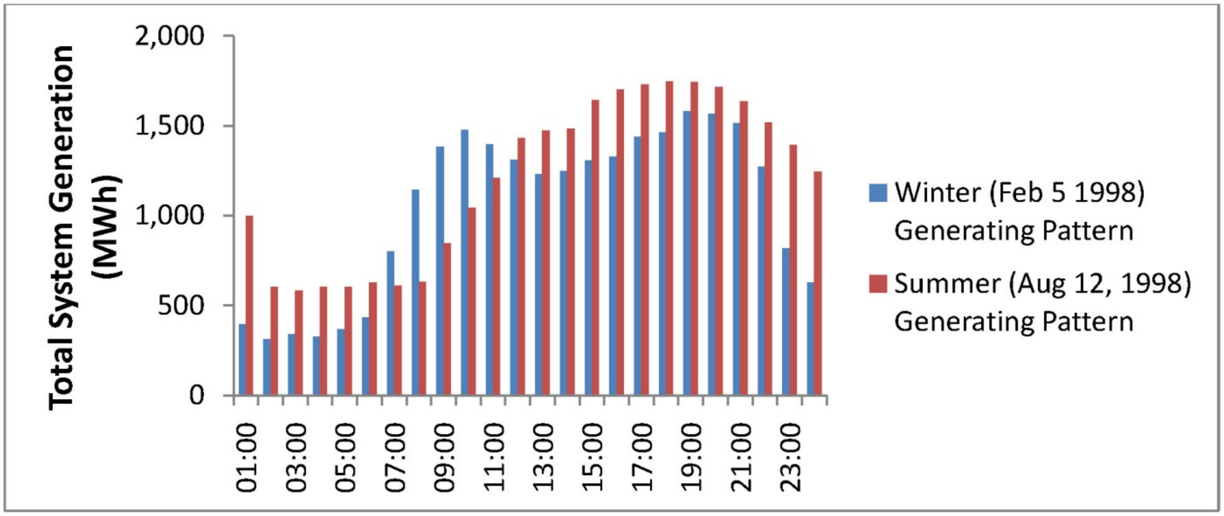


Figure 3-37 Example hourly summer and winter generation schedule for USACE hydropower facilities on the Missouri River mainstem

Source: USACE 2012g

3.5.1.5 Characteristics of the Missouri River Hydropower System

Missouri River hydropower benefits the country in several ways. Water acts as a low cost, renewable energy source, reducing the overall price of electricity. In addition to the lower cost of power, hydropower plant operations are not a major contributor to atmospheric emissions like other fuel sources such as coal and natural gas. Hydropower plants have extremely flexible operating capabilities with the ability to almost immediately match peak load energy demands and emergencies on the power grid, increasing the reliability of the power system. Finally, the revenue generated from the hydropower plants goes toward repayment of the federal investment in the facilities.

Power Marketing

Western Area Power Administration (WAPA) was formed in 1977 as one of four regional power marketing agencies within the United State Department of Energy focused on marketing federal power in the Missouri River basin. Prior to that, the Bureau of Reclamation took responsibility for marketing the federal power in the Missouri River basin.

The Reclamation Project Act of 1939 provided some notable constraints on the preferred customer base for the power marketing agencies along with guidelines for the rate structure. The preference customers include a number of non-profit organizations including municipalities, state and federal agencies, irrigation districts, public utility districts, and rural electric cooperatives. WAPA has extended this base to include Native American Tribes. The preference customer base are the only power users allowed to establish long-term firm power contracts, power that is guaranteed to be available 24 hours a day and receive preference rates (Figure 3-38). The customer service area is generally meant to lie within the watershed due to the desire to maximize local benefits and efficiency in electricity transmission.

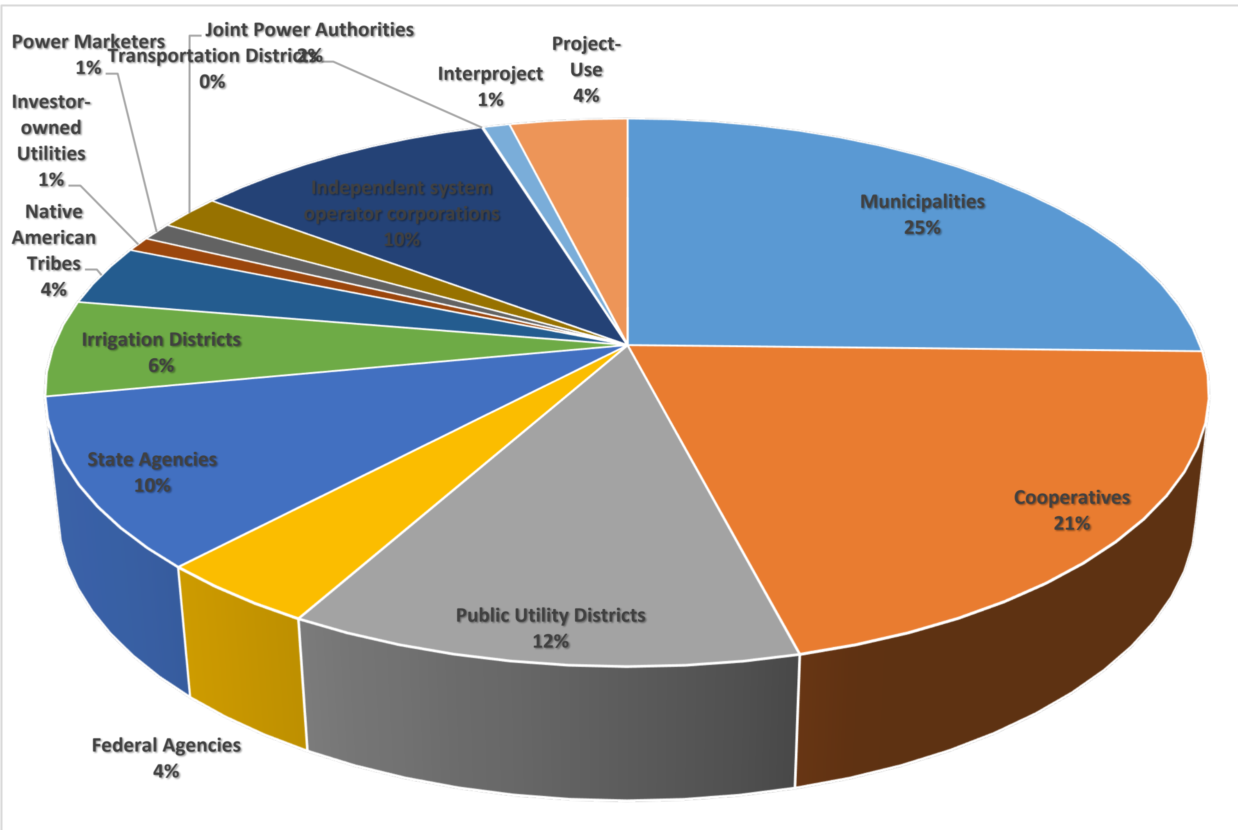


Figure 3-38 Western Area Power Administration 2018 power sales by customer

Tribal Benefits

WAPA allocates low-cost power to Tribal irrigation districts, which is mainly used for pumping water out of the Missouri to Tribal agricultural and ranching productions. In 2001, WAPA also contracted with 25 Tribes in the Upper Great Plains region to provide Tribal allocations of power. Generally, these power allocations provide 50 percent of Tribal power needs (Sundsted, 2011). As part of WAPA's Energy Planning and Management Program, one of the purposes was to extend long-term firm power allocations to those who meet the federally mandated criteria. Since these Tribes are not utilities, WAPA contracts with the rural cooperatives to provide power to Tribes at the cost that WAPA charges the cooperatives. The financial benefit for these Tribes is the difference between what the cooperative would have charged and the rate that WAPA charges the cooperative. The Tribal Council decides who within the reservation will receive the benefit (e.g., school, library, all households, etc.). WAPA works closely with the Tribes to manage and audit these contracts to ensure that these Tribal financial benefits are realized.

3.5.2 Environmental Consequences

Two action alternatives, each including three variations, were developed to meet the pallid sturgeon objectives. Each alternative and its variants are evaluated for their effects on access to hydropower. The alternatives evaluated include management actions with potential to affect river flows, reservoir elevations, and river stage. The hydropower impact analysis focuses on determining if changes in reservoir conditions associated with each of the FPDTR-EIS alternatives could result in an impact to hydropower generation and capacity. This section summarizes the hydropower methodology and presents the results of the assessment. A detailed description of the methods used for the analysis of hydropower including data sources and assumptions can be found in the "Hydropower Environmental Consequences Analysis Technical Report" (Appendix F).

3.5.2.1 Impact Assessment Methodology

The accounts framework (NED, RED, and OSE) enables consideration of a range of both monetary and non-monetary values and interests that are expressed as important to stakeholders and Tribes. The following section provides a brief overview of the methodology for evaluating impacts to hydropower as well as the approach for each account.

Hydropower generation on the Missouri River depends primarily on river flows and dam releases, reservoir elevations, and System storage. Changes in available water can impact both the magnitude of normal seasonal generating patterns and reduce the flexibility to meet hourly peaking demands. This analysis used the HEC-ResSim Missouri River model that simulates reservoir operations over the POR, as well as the Missouri River Hydropower Benefits Calculator model to calculate impacts to generation and capacity for each of the six mainstem dams.

No Action is considered the baseline increase against which the other alternatives are measured. Under No Action, the Missouri River Recovery Program would continue to be implemented as it is currently.

National Economic Development

The NED benefits for hydropower are based on the accrued cost of the most likely alternative energy source that would replace reduced hydropower generation. This benefit is separated into two categories; an energy value (replacement energy) and a capacity value (dependable capacity). The energy value represents the fuel cost or variable cost of an alternative thermal generation resource that replaces the lost hydropower generation. The capacity value represents the capital cost and fixed operation and maintenance cost of the alternative energy resource.

A 2018 estimated U.S. Energy Information Administration energy price (obtained from the 2019 EIA Annual Outlook Report and indexed to 2020 for this report) was used in conjunction with the historic pattern of energy prices to determine specific blocks of hourly, daily, and monthly prices. Capacity unit values were determined using a screening curve analysis that plots annual total plant costs for different types of thermal generating plants (fixed capacity cost plus variable operating costs) versus an annual plant factor. The final value is a mix of the least cost alternative sources for each plant factor range.

Regional Economic Development

The RED benefits for hydropower are based on the results of the NED analysis. WAPA markets its firm power from the hydropower plant to various preferred customers. Sales of electric power must repay all costs associated with power generation. If the rates for repayment that WAPA charges its preferred customers need to be increased to cover an increase in power costs, the low-cost benefits for preferred customers would decrease. WAPA provided a method for obtaining reasonable estimates of the financial impact from each alternative, which would in turn could affect rates. The RED impact includes an assessment of the direct financial impacts to WAPA, the potential of the alternative to affect the rates for preferred customers, and indirect effects on regional economic conditions.

The sales of electric power must repay all costs associated with power generation. WAPA provided their hourly preference customer and pumping load in the Southwest Power Pool (SPP) footprint and their deliveries external to SPP in 2018. The System is mostly contained in MRO, but WAPA is a member of SPP. This was compared to the average generation data from the hydropower benefits model. Then net hourly generation was obtained for every day of that year by subtracting the load or demand from the generation to see when the generation fell short, when they would have to purchase energy to meet the demand, and when there was extra generation that could be sold onto the market. The prices used in these comparisons are different than those used for the NED analysis and were based on actual 2018 prices.

Other Social Effects

The OSE analysis for hydropower relied on the results of the NED analysis to determine the impacts on the OSE account. For hydropower, the OSE impacts would occur when a decrease in hydropower generation leads to an increase in thermal power generation to meet the demand, which increases carbon dioxide, methane, and nitrous oxide emissions.

3.5.2.2 Summary of Environmental Consequences

The environmental consequences relative to hydropower are summarized in Table 3-47. The table summarizes the impacts to the system and to Fort Peck. Please see the Hydropower Technical Report for information on the other Missouri River dams as well as annual impacts over the period of record.

Table 3-47. Environmental consequences relative to hydropower

Alternative	NED Impacts	RED Impacts	OSE Impacts
No Action	Average Annual System Generation - 7,155,949 MWh Average Annual System Value - $409,234,000 Long-term adverse impacts would occur mainly from the variability in hydrology and change in hydrologic conditions over the POR. No specific impacts would occur under this alternative.	No Impact	No Impact
Alternative 1	Change in Average Annual System Value: +$385,000 Change in Average Annual Ft. Peck Value: -$1,271,000 Range of annual differences at Ft. Peck: -$7,179,000 to +74,000 Under this alternative, the Missouri River hydropower system would experience a small average annual benefit on average. However, Ft. Peck hydropower specifically would experience small adverse impacts on average, which can be much larger in full flow and partial flow years.	Average Annual Change in Generation Value for the system (impact to WAPA): -$40,022 Under this alternative, the system will experience a small, adverse impact on an average annual basis which would result in WAPA having to make additional purchases on the market. Additionally, this alternative is shifting the generation availability from the summer to the spring which could have some additional impacts.	Change in Average Annual CO_2 emissions: +3,485,357 lbs Change in Methane emissions: +295 lbs Change in Nitrous Oxide emissions: + 55 lbs Under this alternative, a decrease in hydropower generation could lead to an increase in average annual emissions.

Variation 1A	Change in Average Annual System Value: -$122,000 Change in Average Annual Ft. Peck Value: -$276,000 Range of annual differences at Ft. Peck: -$3,931,000 to +$274,000 Under this alternative, both the Missouri River hydropower system and Ft. Peck specifically would experience small adverse impacts. In fact, the plants other than Ft. Peck are actually experiencing a slight benefit, but it doesn't quite make up for the adverse impact at Ft. Peck. Ft. Peck is experiencing larger adverse impacts in full and partial flow years.	Average Annual Change in Generation Value for the system (impact to WAPA): -$126,756 Under this alternative, the system will experience a small, adverse impact on an average annual basis which would result in WAPA having to make additional purchases on the market. This alternative has the largest impact in this account. Additionally, this alternative is shifting the generation availability from the summer to the spring which could have some additional impacts.	Change in CO2 emissions: +10,239,876 lbs Change in Methane emissions: +865 lbs Change in Nitrous Oxide emissions: + 163 lbs Under this alternative, a decrease in hydropower generation could lead to an increase in average annual emissions. This alternative would have the largest impact on emissions.
Variation 1B	Change in Average Annual System Value: -$211,000 Change in Average Annual Ft. Peck Value: -$364,000 Range of annual differences at Ft. Peck: -$6,750,000 to + $291,000 Under this alternative, both the Missouri River hydropower system and Ft. Peck specifically would experience small adverse impacts. In fact, the plants other than Ft. Peck are actually experiencing a slight benefit, but it doesn't quite make up for the adverse impact at Ft. Peck. Ft. Peck is experiencing slightly larger adverse impacts in full and partial flow years.	Average Annual Change in Generation Value for the system (impact to WAPA): -$30,057 Under this alternative, the system will experience a small, adverse impact on an average annual basis which would result in WAPA having to make additional purchases on the market. Additionally, this alternative is shifting the generation availability from the summer to the spring which could have some additional impacts.	Change in CO2 emissions: +2,461,609 lbs Change in Methane emissions: +208 lbs Change in Nitrous Oxide emissions: + 39 lbs Under this alternative, a decrease in hydropower generation could lead to an increase in average annual emissions.
Alternative 2	Change in Average Annual System Value: -$290,000 Change in Average Annual Ft. Peck Value: -$283,000 Range of annual differences at Ft. Peck: -$4,995,000 Under this alternative, both the Missouri River hydropower system and Ft. Peck specifically would experience small adverse impacts. Ft. Peck is experiencing slightly larger adverse impacts in full and partial flow years.	Average Annual Change in Generation Value for the system (impact to WAPA): -$112,604 Under this alternative, the system will experience a small, adverse impact on an average annual basis which would result in WAPA having to make additional purchases on the market. Additionally, this alternative is shifting the generation availability from the summer to the spring which could have some additional impacts.	Change in CO2 emissions: +9,106,382 lbs Change in Methane emissions: +770 lbs Change in Nitrous Oxide emissions: + 145 lbs Under this alternative, a decrease in hydropower generation could lead to an increase in average annual emissions.

Variation 2A	Change in Average Annual System Value: -$231,000 Change in Average Annual Ft. Peck Value: -$437,000 Range of annual differences at Ft. Peck: -$5,580,000 to +$179,000 Under this alternative, both the Missouri River hydropower system and Ft. Peck specifically would experience small adverse impacts. In fact, the plants other than Ft. Peck are actually experiencing a slight benefit, but it doesn't quite make up for the adverse impact at Ft. Peck. Ft. Peck is experiencing slightly larger adverse impacts in full and partial flow years.	Average Annual Change in Generation Value for the system (impact to WAPA): -$95,453 Under this alternative, the system will experience a small, adverse impact on an average annual basis which would result in WAPA having to make additional purchases on the market. Additionally, this alternative is shifting the generation availability from the summer to the spring which could have some additional impacts.	Change in CO2 emissions: 7,709,011 lbs Change in Methane emissions: +652 lbs Change in Nitrous Oxide emissions: + 123 lbs Under this alternative, a decrease in hydropower generation could lead to an increase in average annual emissions.
Variation 2B	Change in Average Annual System Value: -$136,000 Change in Average Annual Ft. Peck Value: -$371,000 Range of annual differences at Ft. Peck: -$5,603,000 to +$202,000 Under this alternative, both the Missouri River hydropower system and Ft. Peck specifically would experience small adverse impacts. In fact, the plants other than Ft. Peck are actually experiencing a slight benefit, but it doesn't quite make up for the adverse impact at Ft. Peck. Ft. Peck is experiencing slightly larger adverse impacts in full and partial flow years.	Average Annual Change in Generation Value for the system (impact to WAPA): +$11,357 Under this alternative, the system will experience a small, positive impact on an average annual basis. Despite this small benefit, this alternative is still shifting the generation availability from the summer to the spring which could have some additional impacts.	Change in CO2 emissions: -904,012 lbs Change in Methane emissions: -76 lbs Change in Nitrous Oxide emissions: - 14 lbs Under this alternative, an increase in hydropower generation could lead to an increase in average annual emissions.

* Fiscal year 2020 prices

In general, the FPDTR alternatives are expected to have small, short-term adverse effects on the system. Fort Peck may experience some large, short-term impacts depending on the flow year. This contrast occurs because the plants downstream of Fort Peck are experiencing higher flows and head at different times of year that are allowing for increased power production at those plants. Additionally, the large releases from Fort Peck are not able to be fully utilized by the plants at the time they are released. The small positive effect under Alternative 1 is primarily from a change in the dependable capacity benefit which is calculated based on specific months of the year (December/January for winter capacity and July/August for summer capacity). In Alternative 1, there is an increase in flow at Garrison during those months over the no action alternative that is providing the benefit (particularly in 1983 flow year conditions). The dependable capacity impact for the other alternatives is similar to Alternative 1 in 1983, but there are other years under the other alternatives where there is more of a negative result, bringing the overall average down for the other alternatives.

3.5.2.3 No Action

Under the No Action alternative, operations at Fort Peck are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. As noted above, it is considered the baseline against which the other alternatives are measured.

Under No Action, system operations would be the same as current operations, with no change to how the dams are currently operated. This alternative is considered the baseline increase against which the other alternatives are measured. These results are discussed in more detail in the Hydropower Environmental Consequences Analysis Technical Report.

National Economic Development

Under No Action, no changes to the current hydropower operations would occur. The basis of impact description for No Action for hydropower is the value of energy generation and dependable capacity. The NED analysis and baseline level of benefits and impacts of No Action are summarized in Table 3-48. Given that changes are occurring at Fort Peck and Fort Peck hydropower is of particular concern, Fort Peck impacts have been broken out separately from the system in this section.

Average annual generation for the system under this alternative would be estimated at 7,155,949 MWh. The value of the average annual system generation is estimated to be $135,255,000. The annual values during the POR range from a low of $69,391,000 to a high of $219,149,000. The calculated dependable capacity for the summer is estimated at 2,100.1 MW and 1,993.15 MW for winter. The value of the summer dependable capacity is $273,979,000. The value of the winter dependable capacity is $260,054,000. The total average annual value of hydropower (including generation and summer dependable capacity) would be $409,234,000.

Average annual generation at Fort Peck under No Action is estimated to be 859,654 MWh. The value of the average annual Fort Peck generation is estimated to be $15,091,000. The annual values during the period of record range from a low of $5,624,000 to a high of $25,054,000. The calculated dependable capacity at Fort Peck is estimated at 187.26 MW for the summer and 190.59 MW for the winter. The estimated value of the dependable capacity is $24,430,000 in the summer and $24,864,000 for the winter. The total estimated average annual value of hydropower at Fort Peck is estimated to be $39,955,000.

Table 3-48. Summary of NED analysis for No Action

	System	Fort Peck
Average Annual System Generation	7,155,949 MWh	859,654 MWh
Average Annual Generation Value	$135,255	$15,091
Dependable Capacity – Summer	2,100.1 MW	187.26 MW
Average Annual Capacity Value – Summer	$273,979	$24,430
Dependable Capacity – Winter	1,993.15 MW	190.59 MW
Average Annual Capacity Value – Winter	$260,054	$24,864
Total Average Hydropower Value Generation plus Capacity (Summer)	$409,234	$39,955

* Fiscal year 2020 prices ($000)s

Regional Economic Development

RED impacts are based on the results of the NED analysis. WAPA markets its firm power from hydropower to various preferred customers that meet federally mandated criteria. Changes to the operations of the system will impact WAPA's ability to meet the demand for electricity, creating the need to find electricity elsewhere. These values are intended to capture the impact to WAPA of the potential alternatives.

Under No Action, the preferred customer rates would not be anticipated to change with negligible impacts to regional economic conditions.

Other Social Effects

Changes in hydropower operations have the potential to cause other types of effects than simply impacting generation and capacity associated values. An environmental benefit associated with hydropower would be a reduction in greenhouse gases as compared to replacement thermal power generation. If the Missouri River hydropower system generation was replaced by thermal power sources, there would be an increase in annual emissions by 15,889,805,078 lbs of carbon dioxide, 1,343,046 lbs of methane, and 252,911 of nitrous oxide. Hydropower emissions are considered negligible, and therefore this benefit provides the baseline for the Other Social Effects account.

Conclusion

No Action represents the continuation of current system operation. It primarily serves as a reference condition allowing for a comparison of the action alternatives. NED and RED results indicate hydropower would continue to provide NED, RED, and OSE benefits under No Action.

Relatively drier and drought conditions would reduce these benefits, but management actions under No Action would have a negligible adverse contribution to changes in NED, RED, and OSE. Continuation of current system operation and MRRP implementation actions would not be anticipated to have significant impacts to hydropower under No Action.

3.5.2.4 Alternative 1

System operations under Alternative 1 are based on those described under the No Action alternative except that it includes a flow release regime from Fort Peck Dam to benefit pallid sturgeon.

An Attraction Flow Regime would begin on April 16 and the peak flow would be twice as large as the spring release from Fort Peck Dam in a given year. The Spawning Cue Flow Regime under Alternative 1 begins on May 28 and would be 3.5 times the Fort Peck Dam spring flow release in the given release year. A further description of Alternative 1 is detailed in Chapter 2, Section 2.5 Alternatives Carried Forward for Further Evaluation.

NED Analysis

The NED analysis for Alternative 1 is summarized in the Table 3-49. Average annual system generation under this alternative would be 7,154,036 MWh, a decrease of 0.03 percent from No Action. The average annual value of the generation under this alternative would be $135,227,000, a decrease of 0.02 percent. The change in generation and the change in generation value would be proportionally different because the decreases in generation are occurring at times when the value of generation is lower than the average.

The system average annual dependable capacity for the critical summer period is estimated to be valued at $274,392,000, an average annual decrease of 0.15 percent from No Action.

The total value of the impact to hydropower from Alternative 1 for the overall system would be an increase of $385,000 in both generation and capacity value. This includes a generation reduction of $28,000 and a summer dependable capacity increase of $413,000. This is an overall increase of 0.09 percent of the total system value.

Since the system as a whole and Fort Peck are experiencing different impacts, the impacts at Ft. Peck are detailed in the table as well. Full impacts by plant are included in the Hydropower Technical Report.

The average annual value of the generation under this alternative would be $14,943,000, a decrease of $148,000

The average annual dependable capacity at Fort Peck for the critical summer period is estimated to be valued at $24,231,000, an average annual decrease of $200,000 from No Action.

The total value of the impact to hydropower from Alternative 1 for Fort Peck is estimated to be a decrease of $348,000 in both generation and capacity value. This is an overall decrease of 0.88 percent of the value.

Table 3-49. Summary of NED Analysis for Alternative 1 – all years in POR

	Missouri River System	Fort Peck
Average Annual Generation Value	$135,227	$14,943
Average Annual Generation Value Difference from No Action	($28)	($148)
Average Annual Capacity Value - Summer	$274,392	$24,231
Difference in Average Annual Capacity Value - Summer from No Action	$413	($200)
Total average Annual Change in System NED Value from No Action	$386	($348)
Percent Change in Average Annual System NED Value from No Action	0.09%	-0.88%

* Fiscal year 2020 prices ($000)s

Table 3-50 details the estimated impacts occurring for the system and Fort Peck during full or partial flow years. During these years, the generation value is estimated to be $155,826,000 for the system and $18,217,000 for Fort Peck. This is an average reduction from No Action of $164,000 for the system and $378,000 for Fort Peck during those years. These results indicate that some beneficial impacts are occurring at the other plants downstream of Fort Peck which are mitigating the impacts to the whole system. During these types of flow years, the system is experiencing an overall benefit from Alternative 1, an increase of about 0.21 percent from No Action, while Fort Peck is experiencing a 1.97 percent reduction in overall value during these types of years. The impact to the system during these types of years is largest under this alternative, but not to Fort Peck.

Table 3-50. Summary of NED analysis for Alternative 1 – partial or full flow release years only

	Missouri River System	Fort Peck
Average Annual Generation Value	$155,826	$18,217
Average Annual Generation Value Difference from No Action	($164)	($378)

Average Annual Capacity Value - Summer	$287,518	$26,171
Difference in Average Annual Capacity Value - Summer from No Action	$1,076	($512)
Total average Annual Change in System NED Value from No Action	$913	($890)
Percent Change in Average Annual System NED Value from No Action	0.21%	-1.97%

* Fiscal year 2020 prices ($000)s

When evaluating the impacts of each MRRMP-EIS alternative, annual impacts as well as those that would occur on average were examined. For a complete annual list of impacts, see the Hydropower Technical report.

Annual modeling results are summarized in Table 3-51, which shows the difference in the largest adverse and beneficial impacts for Alternative 1 relative to No Action in years, given a partial or full flow release, the year after a release, as well as all years in the period of record regardless of flow action. The results show that both the largest adverse impact would occur in years when there is partial or full flow release. The largest adverse impact to the system occurs in 1995, while the largest adverse impact at Fort Peck occurs in 1983. The largest benefit to the system occurs in 1983, while the largest benefit to Fort Peck occurs in 1975.

Table 3-51. Impacts from modeled flow releases under Alternative 1 compared to No Action ($000s)

Release	Value Change	System	Fort Peck
Partial or full flow release b	Largest Adverse Impact	-$1,944	-$7,179
	Largest Beneficial Impact	$31,521	$74
Year after Partial or Full Flow Release	Largest Adverse Impact	-$2,199	-$2,692
	Largest Beneficial Impact	$122	$38
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Adverse Impact	-$2,199	-$7,179
	Largest Beneficial Impact	$31,521	$74

a Fiscal year 2020 prices.

b Flow action would be partially or fully implemented in 22 years of the period of record. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative costs represent a cost savings from No Action.

Regional Economic Development

RED impacts are based on the results of the NED analysis. WAPA markets its firm power from hydropower to various preferred customers that meet federally mandated criteria. Changes to the operations of the system will impact WAPA's ability to meet the demand for electricity, creating the need to find electricity elsewhere. These values are intended to capture the impact to WAPA of the potential alternatives.

The average annual impact of Alternative 1 is a decrease of $43,022 for the total over the course of the year. However, the changes implemented under Alternative 1 are pushing the system to increase generation availability in the spring and decreasing generation availability in the summer. This means that WAPA would likely need to make additional power purchases in the summer which can be more costly.

Other Social Effects

Changes in hydropower operations have the potential to cause other types of effects than simply impacting generation and capacity associated values. An environmental benefit associated with hydropower would be a reduction in greenhouse gases as compared to replacement thermal power generation. The estimated average annual difference in generation between Alternative 1A and No Action is a reduction in power generation of 1,913 MWh, leading to small increases in air emissions. If the decreased generation was replaced by thermal power sources, there would be an increase in annual emissions by 3,485,357 lbs of carbon dioxide, 295 lbs of methane, and 55 of nitrous oxide.

3.5.2.4.1 Alternative 1 – 1A Variation

Variation 1A is a test flow variation of Alternative 1. The parameters for 1A are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue Flow Regime is initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

National Economic Development

The NED analysis for Alternative 1A is summarized in Table 3-52. Average annual system generation under this alternative would be 7,150,328 MWh, a decrease of 0.08 percent from No Action. The average annual value of the generation under this alternative would be $135,146,000, a decrease of 0.08 percent. This is the largest decrease in generation for the system of any alternative.

The system average annual dependable capacity for the critical summer period is estimated to be valued at $276,966,000, an average annual decrease of 0.005 percent from No Action.

The total value of the impact to hydropower from Alternative 1A for the overall system would be a decrease of $122,000 in both generation and capacity value. This includes a generation reduction of $109,000 and a summer dependable capacity increase of $13,000. This is an overall decrease of 0.03 percent of the total system value.

Since the system as a whole and Fort Peck are experiencing different impacts, the impacts at Fort Peck are also detailed in Table 3-53. The average annual value of the generation under this alternative would be $14,944,000, a decrease of $147,000. The average annual dependable capacity at Fort Peck for the critical summer period is estimated to be valued at $24,303,000, an average annual decrease of $129,000 percent from No Action.

The total value of the impact to hydropower from Alternative 1A for Fort Peck is estimated to be a decrease of $276,000 in both generation and capacity value. This is an overall decrease of 0.97 percent of the value.

Table 3-52. Summary of NED analysis for Alternative 1A – all years in POR ($000s)

	Missouri River System	Ft. Peck
Average Annual Generation Value	$135,146	$14,944
Average Annual Generation Value Difference from No Action	($109)	($147)
Average Annual Capacity Value - Summer	$273,966	$24,303
Difference in Average Annual Capacity Value - Summer from No Action	($13)	($129)
Total average Annual Change in System NED Value from No Action	($122)	($276)
Percent Change in Average Annual System NED Value from No Action	-0.03%	-0.97%

Table 3-53 details the estimated impacts occurring for the system and Fort Peck during full or partial flow years. During these years, the generation value is estimated to be $154,832,000 for the system and $18,040,000 for Fort Peck. This is an average reduction from No Action of $352,000 for the system and $391,000 for Fort Peck during those years. These results indicate that some beneficial impacts are occurring at the other plants downstream of Fort Peck which are mitigating the impacts to the whole system. During these types of flow years, the system is experiencing a small adverse impact from Alternative 1A, a decrease of about 0.08 percent from No Action, while Fort Peck is experiencing a 1.62 percent reduction in overall value during these types of years.

Table 3-53. Summary of NED Analysis for Alternative 1A – partial or full flow release years only ($000s)

	Missouri River System	Fort Peck
Average Annual Generation Value	$154,832	$18,040
Average Annual Generation Value Difference from No Action	($352)	($391)
Average Annual Capacity Value - Summer	$286,144	$26,304
Difference in Average Annual Capacity Value - Summer from No Action	$11	($339)
Total average Annual Change in System NED Value from No Action	($352)	($730)
Percent Change in Average Annual System NED Value from No Action	-0.08%	-1.62%

When evaluating the impacts of each MRRMP-EIS alternative, annual impacts as well as those that would occur on average were examined. For a complete annual list of impacts, see the Hydropower Technical report.

Annual modeling results are summarized in Table 3-54, which shows the difference in the largest adverse and beneficial impacts for Alternative 1A relative to No Action in years, given a partial or full flow release, the year after a release, as well as all years in the period of record regardless of flow action. The results show that both the largest adverse impact would occur in years when there is partial or full flow release. The largest benefit to the system is occurring in a year after a full release, while the largest benefit to Fort Peck is occurring in a full or partial release year. The largest adverse impact to both the system and Fort Peck occurs in 1986. The largest benefit to the system occurs in 1995, while the largest benefit to Fort Peck occurs in 1975.

Table 3-54. Impacts from modeled flow releases under Alternative 1A compared to No Action ($000s)

Release	Value Change	System	Fort Peck
Partial or full flow release	Largest Adverse Impact	-$6,653	-$3,931
	Largest Beneficial Impact	$797	$275
Year after Partial or Full Flow Release	Largest Adverse Impact	-$1,512	-$1,241
	Largest Beneficial Impact	$8,972	$155
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Adverse Impact	-$6,653	-$3,931
	Largest Beneficial Impact	$8,972	$275

Regional Economic Development

The average annual impact of Alternative 1A is a decrease of $126,756 for the total over the course of the year. As with Alternative 1, the changes implemented seem to shift the purchasing that would need to be done to the summer time.

Other Social Effects

Reductions in hydropower generation would need to be replaced with other sources of power generation, likely a reliable fossil fuel source that produces greenhouse gases. The estimated average annual difference in generation between Alternative 1A and No Action is a reduction in power generation of 5,620 MWh, leading to small increases in air emissions. Overall, emissions would increase by 0.08 percent as compared to the baseline assumption of avoided emissions. If these decreases in generation are replaced by thermal power sources as is assumed, there would be an increase in annual emissions by 10,239,876 lbs of carbon dioxide, 865 lbs of methane, and 163 lbs of nitrous oxide.

3.5.2.4.2 Alternative 1 – 1B Variation

Variation 1B is another test flow variation of Alternative 1. The parameters for 1B are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 23 and the Spawning Cue Flow is initiated on June 4. Similar to the concept described in Variation 1A, the later initiation date is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

National Economic Development

The NED analysis for Alternative 1B is summarized in Table 3-55. Average annual system generation under this alternative would be 7,154,597 MWh, a decrease of 0.02 percent from No Action. The average annual value of the generation under this alternative would be $135,221,000, a decrease of 0.02 percent.

The system average annual dependable capacity for the critical summer period is estimated to be valued at $273,802,000, an average annual decrease of 0.1 percent from No Action.

The total value of the impact to hydropower from Alternative 1B for the overall system would be a decrease of $211,000 in both generation and capacity value. This includes a generation reduction of $34,000 and a summer dependable capacity decrease of $177,000. This is an overall decrease of 0.05 percent of the total system value.

Since the system as a whole and Fort Peck are experiencing different impacts, the impacts at Fort Peck are also detailed in Table 3-56. The average annual value of the generation under this alternative would be $14,993,000, a decrease of $99,000. This is the smallest decrease in generation at Ft. Peck for any of the alternatives analyzed. The average annual dependable capacity at Fort Peck for the critical summer period is estimated to be valued at $24,166,000, an average annual decrease of $265,000 percent from No Action.

The total value of the impact to hydropower from Alternative 1B for Fort Peck is estimated to be a decrease of $364,000 in both generation and capacity value. This is an overall decrease of 0.92 percent of the value.

Table 3-55. Summary of NED Analysis for Alternative 1B – all years in POR ($000s)

	Missouri River System	Fort Peck
Average Annual Generation Value	$135,221	$14,993
Average Annual Generation Value Difference from No Action	($34)	($99)
Average Annual Capacity Value - Summer	$273,802	$24,166
Difference in Average Annual Capacity Value - Summer from No Action	($177)	($265)
Total average Annual Change in System NED Value from No Action	($211)	($364)
Percent Change in Average Annual System NED Value from No Action	-0.05%	-0.92%

Table 3-56 details the estimated impacts occurring for the system and Fort Peck during full or partial flow years. During these years, the generation value is estimated to be $155,017,000 for the system and $17,998,000 for Fort Peck. This is an average reduction from No Action of $102,000 for the system and $201,000 for Fort Peck during those years. These results indicate that some beneficial impacts are occurring at the other plants downstream of Fort Peck which are mitigating the impacts to the whole system. During these types of flow years, the system is experiencing a small adverse impact from Alternative 1B, a decrease of about 0.1 percent from No Action, while Fort Peck is experiencing a 1.76 percent reduction in overall value during these types of years.

Table 3-56. Summary of NED analysis for Alternative 1B – partial or full flow release years only ($000s)

	Missouri River System	Fort Peck
Average Annual Generation Value	$155,017	$17,998
Average Annual Generation Value Difference from No Action	($102)	($201)

Average Annual Capacity Value - Summer	$286,154	$26,062
Difference in Average Annual Capacity Value - Summer from No Action	($102)	($588)
Total average Annual Change in System NED Value from No Action	($453)	($790)
Percent Change in Average Annual System NED Value from No Action	-0.10%	-1.76%

Annual modeling results are summarized in Table 3-57, which shows the difference in the largest adverse and beneficial impacts for Alternative 1B relative to No Action in years, given a partial or full flow release, the year after a release, as well as all years in the period of record regardless of flow action. The results show that both the largest adverse impact and largest beneficial impact would occur in years when there is partial or full flow release. The largest adverse impact to the system occurs in 1986, while at Fort Peck, it occurs in 1999. The largest benefit to the system occurs in 1983, while the largest benefit to Fort Peck occurs in 1982.

Table 3-57. Impacts from modeled flow releases under Alternative 1B compared to No Action ($000s)

Release	Value Change	System	Fort Peck
Partial or full flow release	Largest Adverse Impact	-$6,233	-$6,750
	Largest Beneficial Impact	$4,800	$291
Year after Partial or Full Flow Release	Largest Adverse Impact	-$2,284	-$2,408
	Largest Beneficial Impact	$658	$209
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Adverse Impact	-$6,233	-$6,750
	Largest Beneficial Impact	$4,800	$291

Regional Economic Development

The average annual impact of Alternative 1B is a decrease of $30,057 for the total over the course of the year. As with the earlier alternatives, the changes implemented seem to shift the purchasing that would need to be done to the summer time.

Other Social Effects

Reductions in hydropower generation would need replaced with other sources of power generation, likely a reliable fossil fuel source that produces greenhouse gases. The estimated average annual difference in generation between Alternative 1B and No Action is a reduction in power generation of 1,351 MWh, leading to small increases in air emissions. Overall, emissions would increase by 0.02 percent as compared to the baseline assumption of avoided emissions. If these decreases in generation are replaced by thermal power sources as is assumed, there would be an increase in annual emissions by 2,461,609 lbs of carbon dioxide, 208 lbs of methane, and 39 lbs of nitrous oxide.

3.5.2.4.3 Conclusion – Alternative 1 including Variants 1A and 1B

Under Alternative 1, including variations 1A and 1B, it is expected that hydropower would have relatively small, long-term, adverse impacts relative to No Action. These impacts would be due to decreases in generation and capacity value mostly occurring at Fort Peck relative to No Action. During some years, Fort Peck may experience large, adverse, short term impacts.

Tables 3-58 and 3-59 below provide a summary of the NED impacts for Alternative 1 including variations 1A and 1B in years when a partial or full flow release occurs for the system and for Fort Peck.

Annual average system value in partial or full release years would change between $913,000 and -$453,000 (0.21%-0.1) relative to No Action. Variant 1B has the largest impact relative to No Action. Small, long term impacts to the system are expected under Alternative 1.

Table 3-58. System summary of NED analysis for Alternative 1 – full or partial flow years ($000s)

	Alternative 1	Variant 1A	Variant 1B	Range across all variants
Average Annual Generation Value	$155,826	$154,832	$155,017	$154,832 - $155,826
Average Annual Generation Value Difference from No Action	($164)	($352)	($102)	($102) - ($352)
Average Annual Capacity Value - Summer	$287,518	$286,144	$286,154	$286,144 - $287,518
Difference in Average Annual Capacity Value - Summer from No Action	$1,076	$11	($102)	($102) - $1,076
Total average Annual Change in System NED Value from No Action	$913	($352)	($453)	($453) - $913
Percent Change in Average Annual System NED Value from No Action	0.21%	-0.08%	-0.10%	-0.1% - 0.21%

* Fiscal year 2020 prices

Annual average system value in partial or full release years would change between -$730,000 and -$890,000 (-1.76% to -1.97%) relative to No Action for Fort Peck. Alternative 1 has the largest impact relative to No Action at Fort Peck despite having a positive impact on the system overall. Small, long-term impacts to Fort Peck are expected under Alternative 1.

Table 3-59. Fort Peck summary of NED analysis for Alternative 1 – full or partial years ($000s)

	Alternative 1	Variant 1A	Variant 1B	Range across all variants
Average Annual Generation Value	$18,217	$18,040	$17,998	$17,998 - $18,217
Average Annual Generation Value Difference from No Action	($378)	($391)	($201)	($201) – ($378)
Average Annual Capacity Value - Summer	$26,171	$26,304	$26,062	$ 26,062 - $26,304
Difference in Average Annual Capacity Value - Summer from No Action	($512)	($339)	($588)	($339) – ($588)
Total average Annual Change in System NED Value from No Action	($890)	($730)	($790)	($730) – ($890)
Percent Change in Average Annual System NED Value from No Action	-1.97%	-1.62%	-1.76%	-1.76% - -1.97%

3.5.2.5 Alternative 2

The parameters for Alternative 2 are the same as described for Alternative 1 except that the Attraction Flow Regime peak is 14,000 cfs (the maximum powerhouse capacity) rather than twice the average Fort Peck spring flow in the given year. The maximum amount of flow that can be run through the generators is 14,000 cfs. Any additional flow is run through the spillway and does not generate hydroelectricity. Additionally, releases as measured at Wolf Point gage are held at 14,000 cfs until the Spawning Cue release is initiated.

National Economic Development

The NED analysis for Alternative 2 is summarized in Table 3-60. Average annual system generation under this alternative would be 7,150,951 MWh, a decrease of 0.07 percent from No Action. The average annual value of the generation under this alternative would be $135,161,000, a decrease of 0.07 percent.

The system average annual dependable capacity for the critical summer period is estimated to be valued at $273,783,000, an average annual decrease of 0.1 percent from No Action.

The total value of the impact to hydropower from Alternative 2 for the overall system would be a decrease of $290,000 in both generation and capacity value. This includes a generation reduction of $94,000 and a summer dependable capacity decrease of $196,000. This is an overall decrease of 0.07 percent of the total system value. In terms of system impact on an average annual basis, this alternative has the largest adverse impact on system value.

Since the system as a whole and Fort Peck are experiencing different impacts, the impacts at Fort Peck are also detailed Table 3-61. The average annual value of the generation under this alternative would be $14,940,000, a decrease of $151,000. The average annual dependable capacity at Fort Peck for the critical summer period is estimated to be valued at $24,300,000, an average annual decrease of $132,000 percent from No Action.

The total value of the impact to hydropower from Alternative 2 for Fort Peck is estimated to be a decrease of $282,000 in both generation and capacity value. This is an overall decrease of 0.71 percent of the value.

Table 3-60. Summary of NED analysis for Alternative 2 – all years in POR ($000s)

	Missouri River System	Fort Peck
Average Annual Generation Value	$135,161	$14,940
Average Annual Generation Value Difference from No Action	($94)	($151)
Average Annual Capacity Value - Summer	$273,783	$24,300
Difference in Average Annual Capacity Value - Summer from No Action	($196)	($132)
Total average Annual Change in System NED Value from No Action	($290)	($283)
Percent Change in Average Annual System NED Value from No Action	-0.07%	-0.71%

Table 3-61 details the estimated impacts occurring for the system and Fort Peck during full or partial flow years. During these years, the generation value is estimated to be $157,504,000 for the system and $18,442,000 for Fort Peck. This is a reduction from No Action of $210,000 for the system and $410,000 for Fort Peck. These results indicate that some beneficial impacts are occurring at the other plants downstream of Fort Peck which are mitigating the impacts to the whole system. During these types of flow years, the system is experiencing a small adverse impact from Alternative 2, a decrease of about 0.16 percent from No Action, while Fort Peck is experiencing a 1.68 percent reduction in overall value during these types of years.

Table 3-61. Summary of NED analysis for Alternative 2 – partial or full flow release years only ($000s)

	Missouri River System	Fort Peck
Average Annual Generation Value	$157,504	$18,442
Average Annual Generation Value Difference from No Action	($210)	($410)
Average Annual Capacity Value - Summer	$287,205	$26,379
Difference in Average Annual Capacity Value - Summer from No Action	($508)	($358)
Total average Annual Change in System NED Value from No Action	($718)	($768)
Percent Change in Average Annual System NED Value from No Action	-0.16%	-1.68%

Annual modeling results are summarized in Table 3-62 below, which shows the difference in the largest adverse and beneficial impacts for Alternative 2 relative to No Action in years, given a partial or full flow release, the year after a release, as well as all years in the period of record regardless of flow action. The results show that both the largest adverse impact and largest beneficial impact would occur in years when there is partial or full flow release for the system and for Fort Peck. The largest adverse impact to the system occurs in 1987, while at Fort Peck, it occurs in 1986. The largest benefit to both the system and Fort Peck occurs in 1983.

Table 3-62. Impacts from modeled flow releases under Alternative 2 compared to No Action ($000s)

Release	Value Change	System	Fort Peck
Partial or full flow release	Largest Adverse Impact	-$23,330	-$4,995
	Largest Beneficial Impact	$9,477	$2,104
Year after Partial or Full Flow Release	Largest Adverse Impact	-$1,115	-$1,762
	Largest Beneficial Impact	$371	$130
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Adverse Impact	-$23,330	-$4,995
	Largest Beneficial Impact	$9,477	$2,104

Regional Economic Development

The average annual impact of Alternative 2 is a decrease of $112,604 for the total over the course of the year. As with the earlier alternatives, the changes implemented seem to shift the purchasing that would need to be done to the summer time.

Other Social Effects

Reductions in hydropower generation would need to be replaced with other sources of power generation, likely a reliable fossil fuel source that produces greenhouse gases. The estimated average annual difference in generation between Alternative 2 and No Action is a reduction in power generation of 4,998 MWh, leading to small increases in air emissions. Overall, emissions would increase by 0.07 percent as compared to the baseline assumption of avoided emissions. If these decreases in generation are replaced by thermal power sources as is assumed, there would be an increase in annual emissions by 9,106,382 lbs of carbon dioxide, 770 lbs of methane, and 145 lbs of nitrous oxide.

3.5.2.5.1 Alternative 2 – 2A Variation

Variation 2A is a test flow variation of Alternative 2. The parameters for Alternative 2A are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue flow would be initiated on May 21, rather than May 28. Again, moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

National Economic Development

The NED analysis for Alternative 2A is summarized in Table 3-63 below. Average annual system generation under this alternative is estimated to be 7,151717 MWh, a decrease of 0.06 percent from No Action. The average annual value of the generation under this alternative would be $135,181,000, a decrease of 0.05 percent.

The system average annual dependable capacity for the critical summer period is estimated to be valued at $273,822,000, an average annual decrease of 0.1 percent from No Action.

The total value of the impact to hydropower from Alternative 2A for the overall system would be a decrease of $231,000 in both generation and capacity value. This includes a generation reduction of $74,000 and a summer dependable capacity decrease of $158,000. This is an overall decrease of 0.07 percent of the total system value.

Since the system as a whole and Fort Peck are experiencing different impacts, the impacts at Fort Peck are also detailed in Table 3-64. The average annual value of the generation under this alternative would be $14,886,000, a decrease of $206,000. The average annual dependable capacity at Fort Peck for the critical summer period is estimated to be valued at $24,200,000, an average annual decrease of $231,000 from No Action.

The total value of the impact to hydropower from Alternative 2A for Fort Peck is estimated to be a decrease of $437,000 in both generation and capacity value. This is an overall decrease of 1.11 percent of the value. Alternative 2A has the largest impact on Fort Peck of the alternatives analyzed.

Table 3-63. Summary of NED analysis for Alternative 2A – all years in POR ($000s)

	Missouri River System	Fort Peck
Average Annual Generation Value	$135,181	$14,886
Average Annual Generation Value Difference from No Action	($74)	($206)
Average Annual Capacity Value - Summer	$273,822	$24,200
Difference in Average Annual Capacity Value - Summer from No Action	($158)	($231)

Total average Annual Change in System NED Value from No Action	($231)	($437)
Percent Change in Average Annual System NED Value from No Action	-0.06%	-1.11%

Table 3-64 below details the estimated impacts occurring for the system and Fort Peck during full or partial flow years. During these years, the generation value is estimated to be $156,625,000 for the system and $18,110,000 for Fort Peck. This is an average reduction from No Action of $298,000 for the system and $575,000 for Fort Peck during those years. These results indicate that some beneficial impacts are occurring at the other plants downstream of Fort Peck which are mitigating the impacts to the whole system. During these types of flow years, the system is experiencing a small adverse impact from Alternative 2A, a decrease of about 0.17 percent from No Action, while Fort Peck is experiencing a 2.70 percent reduction in overall value during these types of years. This is the largest impact at Fort Peck and the second largest impact for the system overall for these types of impacts.

Table 3-64. Summary of NED analysis for Alternative 2A – partial or full flow release years only ($000s)

	Missouri River System	Fort Peck
Average Annual Generation Value	$156,625	$18,110
Average Annual Generation Value Difference from No Action	($298)	($575)
Average Annual Capacity Value - Summer	$286,974	$26,043
Difference in Average Annual Capacity Value - Summer from No Action	($453)	($652)
Total average Annual Change in System NED Value from No Action	($751)	($1,227)
Percent Change in Average Annual System NED Value from No Action	-0.17%	-2.70%

Annual modeling results are summarized in Table 3-65 below, which shows the difference in the largest adverse and beneficial impacts for Alternative 2A relative to No Action in years, given a partial or full flow release, the year after a release, as well as all years in the period of record regardless of flow action. The results show that both the largest adverse impact and largest beneficial impact would occur in years when there is partial or full flow release for the system. The largest adverse impact to the system occurs in 1987, while at Fort Peck, it occurs in 1986. The largest benefit to the system occurs in 1986 (when the largest adverse impact is occurring at Fort Peck) and at Fort Peck, it occurs in 1995.

Table 3-65. Impacts from modeled flow releases under Alternative 2A compared to No Action ($000s)

Release	Value Change	System	Fort Peck
Partial or full flow release	Largest Adverse Impact	-$23,512	-$5,580
	Largest Beneficial Impact	$7,974	$40
Year after Partial or Full Flow Release	Largest Adverse Impact	-$1,144	-$1,735
	Largest Beneficial Impact	$26	$10
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Adverse Impact	-$23,512	-$5,580
	Largest Beneficial Impact	$7,974	$179

Regional Economic Development

The average annual impact of Alternative 2A is a decrease of $95,453 for the total over the course of the year. As with the earlier alternatives, the changes implemented seem to shift the purchasing that would need to be done to the summer time.

Other Social Effects

Reductions in hydropower generation would need to be replaced with other sources of power generation, likely a reliable fossil fuel source that produces greenhouse gases. The estimated average annual difference in generation between Alternative 2A and No Action is a reduction in power generation of 4,231 MWh, leading to small increases in air emissions. Overall, emissions would increase by 0.06 percent as compared to the baseline assumption of avoided emissions. If these decreases in generation are replaced by thermal power sources as is assumed, there would be an increase in annual emissions by 7,709,011 lbs of carbon dioxide, 652 lbs of methane, and 123 lbs of nitrous oxide.

3.5.2.5.2 Alternative 2 – 2B Variation

Variation 2B is a test flow is another variation of Alternative 2. The parameters for Alternative 2B are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 23, rather than April 16, and the Spawning Cue flow is initiated on June 4, rather than May 21. Again, the difference in timing is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

National Economic Development

The NED analysis for Alternative 2B is summarized in Table 3-66 below. Average annual system generation under this alternative is estimated to be 7,156,445 MWh, an increase of 0.01 percent from No Action. The average annual value of the generation under this alternative would be $135,266,000, an increase of 0.01 percent.

The system average annual dependable capacity for the critical summer period is estimated to be valued at $273,833,000, an average annual decrease of 0.1 percent from No Action.

The total value of the impact to hydropower from Alternative 2B for the overall system would be a decrease of $136,000 in both generation and capacity value. This includes a generation increase of $74,000 and a summer dependable capacity decrease of $147,000. This is an overall decrease of 0.03 percent of the total system value.

Since the system as a whole and Fort Peck are experiencing different impacts, the impacts at Fort Peck are also detailed Table 3-66. The average annual value of the generation under this alternative would be $14,967,000, a decrease of $124,000. The average annual dependable capacity at Fort Peck for the critical summer period is estimated to be valued at $24,185,000, an average annual decrease of $247,000 percent from No Action.

The total value of the impact to hydropower from Alternative 2B for Fort Peck is estimated to be a decrease of $371,000 in both generation and capacity value. This is an overall decrease of 0.82 percent of the value.

Table 3-66. Summary of NED Analysis for Alternative 2B – all years in P of Record ($000s)

	Missouri River System	Fort Peck
Average Annual Generation Value	$135,266	$14,967
Average Annual Generation Value Difference from No Action	$11	($124)
Average Annual Capacity Value - Summer	$273,833	$24,185
Difference in Average Annual Capacity Value - Summer from No Action	($147)	($247)
Total average Annual Change in System NED Value from No Action	($136)	($371)
Percent Change in Average Annual System NED Value from No Action	-0.03%	-0.82%

Table 3-67 below details the estimated impacts occurring for the system and Fort Peck during full or partial flow years. During these years, the generation value is estimated to be $155,101,000 for the system and $17,941,000 for Fort Peck. This is an average reduction from No Action of $345,000 for the system and $802,000 for Fort Peck during those years. These results indicate that some beneficial impacts are occurring at the other plants downstream of

Fort Peck which are mitigating the impacts to the whole system. During these types of flow years, the system is experiencing a small adverse impact from Alternative 2B, a decrease of about 0.08 percent from No Action, while Fort Peck is experiencing a 1.79 percent reduction in overall value during these types of years.

Table 3-67. Summary of NED Analysis for Alternative 2B – partial or full flow release years only ($000s)

	Missouri River System	Fort Peck
Average Annual Generation Value	$155,101	$17,941
Average Annual Generation Value Difference from No Action	($18)	($258)
Average Annual Capacity Value - Summer	$286,178	$26,106
Difference in Average Annual Capacity Value - Summer from No Action	($327)	($544)
Total average Annual Change in System NED Value from No Action	($345)	($802)
Percent Change in Average Annual System NED Value from No Action	-0.08%	-1.79%

Annual modeling results are summarized in Table 3-68 below, which shows the difference in the largest adverse and beneficial impacts for Alternative 2B relative to No Action in years, given a partial or full flow release, the year after a release, as well as all years in the period of record regardless of flow action. The results show that both the largest adverse impact would occur in years when there is partial or full flow release for the system. The largest adverse impact to the system occurs in 1995, while at Fort Peck, it occurs in 1983. The largest benefit to the system occurs in 1986, and at Fort Peck, it occurs in 1969.

Table 3-68. Impacts from modeled flow releases under Alternative 2B compared to No Action ($000s)

Release	Value Change	System	Fort Peck
Partial or full flow release	Largest Adverse Impact	-$2,629	-$5,603
	Largest Beneficial Impact	$6,545	$33
Year after Partial or Full Flow Release	Largest Adverse Impact	-$22,626	-$2,778
	Largest Beneficial Impact	$335	$202
Years with Greatest Range in Impacts Regardless of Flow Actions	Largest Adverse Impact	-$22,626	-$5,603
	Largest Beneficial Impact	$6,545	$202

Regional Economic Development

The average annual impact of Alternative 2B is an increase of $11,357 for the total over the course of the year. As with the earlier alternatives, the changes implemented seem to shift the purchasing that would need to be done to the summer time. However, in this case the overall impact over the course of the year is positive.

Other Social Effects

Reductions in hydropower generation would need to be replaced with other sources of power generation, likely a reliable fossil fuel source that produces greenhouse gases. The estimated average annual difference in generation between Alternative 2A and No Action is an increase in power generation of 496 MWh, leading to small increases in air emissions. Overall, emissions would decrease by 0.01 percent as compared to the baseline assumption of avoided emissions. This could potentially decrease annual emissions by 904,012 lbs of carbon dioxide, 76 lbs of methane, and 14 lbs of nitrous oxide per year.

3.5.2.5.3 Conclusion – Alternative 2 including Variations 2A and 2B

Under Alternative 2, including variations 2A and 2B, it is expected that hydropower would have relatively small, long-term, adverse impacts relative to No Action. These impacts would be due to decreases in generation and capacity value mostly occurring at Fort Peck relative to No Action. During some years, Fort Peck may experience large, adverse, short-term impacts.

Tables 3-69 and 3-70 below provide a summary of the NED impacts for Alternative 2 including variations 2A and 2B in years when a partial or full flow release occurs for the system and for Fort Peck.

Annual average system value in partial or full release years would change between -$345,000 and -$751,000 (-0.17% to -0.08%) relative to No Action. Variant 2A has the largest impact relative to No Action. Small, long term impacts to the system are expected under Alternative 2.

Table 3-69. System summary of NED analysis for Alternative 2 – full or partial flow years ($000s)

	Alternative 2	Variant 2A	Variant 2B	Range across all variants
Average Annual Generation Value	$157,504	$156,625	$155,101	$155,101 - $157,504
Average Annual Generation Value Difference from No Action	($210)	($298)	($18)	($18) –($298)

Average Annual Capacity Value - Summer	$287,205	$286,974	$286,178	$286,178 - $287,205
Difference in Average Annual Capacity Value - Summer from No Action	($508)	($453)	($327)	($327) – ($508)
Total average Annual Change in System NED Value from No Action	($718)	($751)	($345)	($345) – ($751)
Percent Change in Average Annual System NED Value from No Action	-0.16%	-0.17%	-0.08%	-0.08% - -0.17%

Annual average system value in partial or full release years would change between -$768,000 and -$1,227,000 (-1.68% to -2.70%) relative to No Action for Fort Peck. Small, long-term impacts to Fort Peck are expected under Alternative 2, with some larger, short-term impacts occurring in some years.

Table 3-70. Fort Peck summary of NED analysis for Alternative 2 – full or partial flow years ($000s)

	Alternative 2	Variant 2A	Variant 2B	Range across all variants
Average Annual Generation Value	$18,442	$18,110	$17,941	$17,941 - $18,442
Average Annual Generation Value Difference from No Action	($410)	($575)	($258)	($258) – ($575)
Average Annual Capacity Value - Summer	$26,379	$26,043	$26,106	$26,043 - $26,379
Difference in Average Annual Capacity Value - Summer from No Action	($358)	($652)	($544)	($358) – ($652)
Total average Annual Change in System NED Value from No Action	($768)	($1,227)	($802)	($768) – ($1,227)
Percent Change in Average Annual System NED Value from No Action	-1.68%	-2.70%	-1.79%	-1.68% - - 2.70%

3.5.2.6 Tribal Impacts

Tribes benefit from the low-cost power in two ways. WAPA allocates low-cost power to Tribal irrigation districts, which is mainly used for pumping water out of the Missouri to Tribal agricultural and ranching productions. In 2001, WAPA also contracted with 25 Tribes in the Upper Great Plains region to provide Tribal allocations of power. Generally, these power allocations provide 50 percent of Tribal power needs (Sundsted, 2011). As part of WAPA's Energy Planning and Management Program, one of the purposes was to extend long-term firm power allocations to those who meet the federally mandated criteria. Since these Tribes are not utilities, WAPA contracts with the rural cooperatives to provide power to Tribes at the cost that WAPA charges the cooperatives. The financial benefit for these Tribes is the difference between what the cooperative would have charged and the rate that WAPA charges the cooperative. The Tribal Council decides who within the reservation will receive the benefit (e.g., schools, libraries, all households, etc.). WAPA works closely with the Tribes to manage and audit these contracts to ensure that these Tribal financial benefits are realized.

The potential for adverse impacts to the Tribes would follow the same pattern as the NED results. That is, the more adverse the impact on hydropower generation and capacity, the larger potential to negatively affect the rate/credit that the Tribes receive. Since agreements with the Tribes provide them with at-cost power, if the cost of producing the same amount of power goes up, due to changes in river and reservoir operations, this could potentially impact the credit the Tribes receive on their bill. Alternative 2 has the greatest potential to change the cost of producing power and affect the rate/credit the Tribes receive. Alternative 1 has the least potential to impact power production and affect the rate/credit the Tribes receive.

3.5.2.7 Climate Change

Increased precipitation and streamflow has the potential to increase hydropower generation. Decreased peak snow water equivalent could potentially decrease hydropower production and reliability, especially during peak seasons. Decreased snow accumulation and the associated runoff reduction would lead to decreased hydropower generation and reliability. Increased sedimentation could increase O&M at the dams, which would impact hydropower operations, generation, and reliability. Increased sporadic nature of droughts could potentially lead to less reliable and less overall hydropower production during drought years. More extreme drought or flood conditions could reduce reservoir elevations at the upper three reservoirs as System operations become more difficult to forecast. Short term adverse impacts associated with partial test releases may occur. The timing of test flow releases may both increase and decrease hydropower benefits under the alternatives relative to No Action during peak production. Since the No Action and alternatives have negligible difference in annual volume, no significant difference in hydropower is expected.

3.5.2.8 Cumulative Impacts

Consumption of electricity has steadily increased, with sales of electricity increasing by 1.4 percent per year nationwide on average since 1990. Electricity sales in the Missouri River basin states have increased at a slightly higher rate of 2.0 percent on average over the same period. Continued increasing demand for electricity would benefit hydropower, with market pressure to maintain generation and increase capacity.

The Missouri River Mainstem Reservoir System operations and management for other project purposes could reduce the amount of generation during specific periods as water is passed over the spillways. The reduced generation could require the purchase of replacement power to fulfill existing power contracts. In addition, variability in natural hydrologic conditions (precipitation and snowmelt, which include periods of drought and high runoff) and the “rules” governing System operation would continue to dominate the flows in the Missouri River into the future. Natural flow variability and the requirement to operate for all authorized purposes under the Master Manual would continue to be the primary drivers of impacts to hydropower. However, other actions, such as water depletions or withdrawals for agriculture, municipal, and industrial uses have and would continue to have adverse impacts to hydropower, as they would affect the reservoir elevations.

Future aggradation and degradation trends would have similar effects under all of the alternatives. HEC-RAS modeling indicates that the action alternatives would not significantly contribute to aggradation or degradation. As described as part of the year 0 and year 15 analyses (Section 3.2), the elevations in the upper three reservoirs would increase slightly (1 to 2 feet) while changes in elevations in the lower three reservoirs would be negligible in year 15 under all alternatives compared to year 0.

In addition, any resulting changes in aggradation, degradation, and sediment deposition in the reservoirs could increase the need for investment in hydropower infrastructure repairs and/or upgrades to mitigate these impacts.

Hydropower would continue to provide national and regional economic benefits under No Action. The past, present, and foreseeable future actions would result in both beneficial and adverse impacts to hydropower with the natural hydrologic variability most likely to affect hydropower. The management actions under No Action would provide a negligible contribution to these impacts because of the small amount of System storage affected under No Action.

However, the alternatives would likely have adverse impacts on hydropower benefits compared to No Action due to adverse effects on NED and RED benefits. When combined with impacts from other cumulative actions, the cumulative impacts of the alternatives would likely be small to large and adverse depending on the scope of consideration, with the alternatives providing a small to large adverse contribution to the overall cumulative impact because of the potential of the flow releases to reduce System storage and reservoir elevations in subsequent years affecting hydropower generation and capacity.

3.6 Irrigation

3.6.1 Affected Environment

The study area for this analysis includes the 23 counties adjacent to the Missouri River from Fort Peck Dam in Montana to Oahe Dam in South Dakota. Irrigators in these 23 counties in Montana, North Dakota, and South Dakota hold permits to use water from the Missouri River for the purpose of agricultural production. The irrigation intakes permitted on the Missouri River are a mix of semi-permanent (portable) and permanent structures.

According to State Department of Natural Resources and State Water Commission records, 187,068 acres of irrigated cropland are permitted for irrigation using Missouri River water in the study area. In addition, data on the actual acres irrigated was obtained from North Dakota and South Dakota agencies, which require water permit irrigators to report annual water usage. Irrigators in Montana are not required to report actual irrigated acreage and it was conservatively assumed that the entirety of the acres permitted is the irrigation acreage in these counties. Additionally, approximately 19,000 acres of irrigated croplands were apportioned to the total for Valley and Roosevelt counties to account for tribal acreages not included in state estimates. This acreage is based on interviews with a BIA representative and information provided by irrigators during the 2020 summer surveys[2] (Wright, H pers comm. 2019) (see Table 3-71).

[2] The apportionment of these 19,000 acres between Valley and Roosevelt counties is based on a rough percentage of the Fort Peck Tribal Reservations' land that is adjacent to the Missouri River in these two counties. As approximately one-third of the Fort Peck Tribal Reservation is located in Valley County and two-thirds of the reservation is located in Roosevelt County, 6,333 acres of irrigated land were assigned to Valley County and the remaining 12,666 acres of irrigated land were assigned to Roosevelt County.

Irrigation is a common practice in the Upper Basin, where low annual rainfall and a short growing season requires river and reservoir water to improve crop viability. The growing season in the Upper Basin counties is largely constrained by snowfall and low average temperatures. In the upper reaches of the river, the irrigation season lasts approximately from May through September. The planting and harvesting dates were derived from the National Agricultural Statistical Service (NASS) Agricultural Handbook Number 628 (USDA, 2010).

Table 3-71. Precipitation, irrigated crop acreage, and intakes for the 23-county area

County	State	County Precipitation (Inches, 2018)	Acres Permitted to Use Water Withdrawn from Missouri River (2018/2019)[c]	Actual Acres Irrigated Using Missouri River Water (2018/2019)[c]
McCone	Montana	13.4	16,271	n/a [a]
Valley	Montana	12.1	11,049 [b]	n/a [a]
Roosevelt	Montana	13.1	34,515 [b]	n/a [a]
Richland	Montana	15.7	17,927	n/a [a]
Williams	North Dakota	15.9	40,575	14,827
McKenzie	North Dakota	15.9	11,336	734
Mountrail	North Dakota	14.9	1,094	250
Dunn	North Dakota	15.9	0	0
McLean	North Dakota	18.3	6,466	2,623
Mercer	North Dakota	18.2	5,841	2,161
Oliver	North Dakota	18.1	10,992	4,148
Burleigh	North Dakota	18.7	6,448	3,454
Morton	North Dakota	17.3	4,370	1,377
Emmons	North Dakota	18.6	12,294	6,284
Sioux	North Dakota	18.0	679	0
Corson	South Dakota	19.3	1,150	142
Campbell	South Dakota	20.3	2,401	1,636
Walworth	South Dakota	20.9	1,749	434
Dewey	South Dakota	19.4	766	256
Potter	South Dakota	18.9	939	832
Sully	South Dakota	18.0	23,660	16,094
Stanley	South Dakota	17.7	1,448	61
Hughes	South Dakota	18.7	20,662	15,970
Total	–	–	187,068	71,283

Sources: NOAA 2019; USDA 2019; Montana Department of Natural Resources and Conservation 2019; North Dakota State Water Commission 2019; South Dakota Department of Environment and Natural Resources 2019.

a Actual acres irrigated from Missouri River in Montana are not provided by the Montana Department of Natural Resources and Conservation. Therefore, these cells are marked as n/a. The number of acres permitted is assumed to equal number of acres actually irrigated in the environmental consequences section below.

County	State	County Precipitation (Inches, 2018)	Acres Permitted to Use Water Withdrawn from Missouri River (2018/2019)[c]	Actual Acres Irrigated Using Missouri River Water (2018/2019)[c]

b 6,333 acres were added to the total for Valley County and 12,666 acres were added to total for Roosevelt County to account for acres that are technically unpermitted by the state of Montana but allowed through tribal treaties on the Fort Peck Reservation.

c Data from the states of North and South Dakota is provided from the year 2018 while data from the state of Montana is provided as of the date that information is pulled from the DNRC's Water Right Query System. In this case that data was pulled on September 30, 2019 and should be referenced as up-to-date as of the year 2019.

Table 3-72 summarizes the irrigation intakes by state. Montana has the greatest number of intakes of the three states. North Dakota has the greatest number of permitted acres of the three states, with 100,094 acres permitted for irrigation using Missouri River water in 2018. South Dakota and Montana also permit a considerable number of acres for irrigation, with 52,775 acres and 79,763 acres, respectively.

Table 3-72. Irrigation intakes and permitted acres by state

State	Number of Counties	Acres Permitted for Missouri River Irrigation (2018)	Number of Intakes Permitted (2018)
Montana	4	79,763*	272
North Dakota	11	100,094	232
South Dakota	8	52,775	93
Total	23	232,632	601

Source: Montana Department of Natural Resources and Conservation 2019; North Dakota State Water Commission 2019; South Dakota Department of Environment and Natural Resources 2019

* Includes 19,000 acres from Fort Peck Tribe

Table 3-73 summarizes the harvested acres irrigated by crop type across the 23-county study area. The most abundant crop grown amongst all irrigated acreage in the 23 counties is corn, with 48,110 acres harvested in 2018, according to the Farm Service Agency crop acreage data (USDA, 2019). The next most-abundant crop is wheat, with 45,990 acres irrigated (Table 3-74). These are all acres irrigated, not solely irrigated with Missouri River water.

Table 3-73. Harvested acres irrigated in the 23-county area, 2018

Crop	Acres Irrigated	Percentage of Irrigated Acres Harvested in Counties in the State		
		Montana	North Dakota	South Dakota
Barley	10,256	79.4%	20.6%	0.0%
Beans	1,703	50.7%	49.3%	0.0%
Canola	743	72.9%	27.1%	0.0%

Crop	Acres Irrigated	Percentage of Irrigated Acres Harvested in Counties in the State		
		Montana	North Dakota	South Dakota
Corn	48,110	21.8%	51.4%	26.8%
Field Crops, Other	17,104	74.4%	11.6%	13.9%
Grasses	6,187	96.3%	3.2%	0.5%
Hay	39,565	74.0%	19.0%	7.0%
Lentils	528	0.0%	100.0%	0.0%
Oats	4,055	55.5%	44.4%	0.0%
Peas	3,019	8.8%	86.6%	4.5%
Sorghum	800	52.3%	18.2%	29.5%
Soybeans	37,014	7.4%	46.8%	45.8%
Sugarbeets	27,571	60.5%	39.5%	0.0%
Sunflower	2,849	0.0%	20.7%	79.3%
Wheat	45,990	63.4%	34.7%	1.9%
Potatoes	1,562	0.2%	99.8%	0.0%
Vegetables	2,293	0.1%	99.9%	0.0%
Fruit	75	26.4%	0.0%	73.6%
Millet	64	100.0%	0.0%	0.0%
Total (Acres)	**249,487**	**119,699**	**91,310**	**38,478**

Source: USDA 2019

3.6.1.1 Irrigation Resources on Tribal Lands

It is estimated that Tribes in the states of Montana, North Dakota and South Dakota irrigate approximately 175,000 acres of agricultural lands using water from rivers and reservoirs located within the Missouri River Basin (USDA, 2017). This acreage includes the 19,000 acres of irrigated Fort Peck Tribal Reservation land using water from the Missouri River mentioned above. Based on information obtained during the 2020 summer irrigation intake surveys, there are two known irrigation intakes that provide most or all of the water withdrawn from the Missouri River for use in agricultural irrigation on Fort Peck Tribal Reservation lands. The Fort Peck Tribal Reservation’s use of water for agricultural irrigation is considered specifically and separate from other tribal allotments in this analysis given the reservation’s location along the Missouri River between Fort Peck Dam and Lake Sakakawea.

3.6.2 Environmental Consequences

Two action alternatives, each including three variations, were developed to meet the pallid sturgeon objectives. Each alternative and its variants are evaluated for their effects on irrigation intakes. The alternatives evaluated include management actions with potential to affect river flows, reservoir elevations, and river stage. The irrigation impact analysis focuses on determining if changes in river and reservoir conditions associated with each of the FPDTR-EIS alternatives could result in an impact to irrigation intakes and net farm income. This section summarizes the irrigation methodology and presents the results of the assessment. A detailed description of the methods used for the analysis of irrigation impacts including data sources and assumptions can be found in the "Irrigation Environmental Consequences Analysis Technical Report" (Appendix F).

3.6.2.1 Impact Assessment Methodology

3.6.2.1.1 Low Flows

The irrigation environmental consequences were evaluated using three of the four accounts (NED, RED, and OSE) and are summarized according to the impact definitions provided in Section 3.1.2. Impacts to irrigators are modeled based on changing river and reservoir conditions. For the low flow analysis, as river flows and reservoir elevations fall below minimum operating requirements, intakes become unavailable to provide water to farm operations (including private farms, Tribes, and commercial operations). This, in turn, can result in changes to net farm income. Minimum operating flow thresholds for intakes in the Missouri River reach in Montana are 6,000 cfs while flow thresholds for intakes in North Dakota vary between 6,000 and 12,000 cfs in the North Dakota reach of the Missouri River. The analysis used outputs from the HEC-RAS and HEC-ResSim models to simulate river and reservoir conditions at intakes along the river over the POR against which the flow thresholds were compared.

No county in the study area relies exclusively on the Missouri River for irrigation. Counties were included in the impact analysis if more than 1,000 acres in the county were irrigated using water from the Missouri River and if the river conditions evaluation showed that irrigation intakes in each county would experience an intensive short-term impact or a series of consecutive impacts to water access when compared to the No Action Alternative. Counties carried through for evaluation included Richland, Roosevelt, McCone, and Valley in Montana and McLean in North Dakota. Thus, the analysis of irrigation operations in these counties represents the likely impacts that would occur due to low water conditions under the FPDTR-EIS alternatives. The analysis does not evaluate all agriculture production within each of these counties but only the portion that is irrigated with water from the Missouri River.

The No Action Alternative is considered the baseline against which the other alternatives are measured. It assumes that no test flow releases for pallid sturgeon would occur from Fort Peck Dam. Operations at Fort Peck Dam are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. It is assumed that other activities and actions for pallid sturgeon in the Upper Basin would be implemented as described in the FPDTR-EIS to align with the 2018 BiOp. These actions include fish bypass construction at Yellowstone Intake, continued propagation and stocking of pallid sturgeon in the Upper Basin and continued pallid sturgeon science and monitoring activities in the Upper Basin. As noted in Section 3.1.1, Impact Assessment Methodology, No Action does not reflect actual past or future conditions but serves as a reasonable basis or “baseline” for comparing the impacts of the action alternatives on resources.

National Economic Development

The NED analysis estimated changes in net farm income from irrigated agricultural operations in five counties expected to experience measurable impacts because of low flows of the Missouri River from the FPDTR-EIS alternatives. The analysis evaluated the impact of access to water on expected yields for crops grown, as reported by relevant state agriculture crop extension budgets. Estimates of harvested acres for each crop were obtained from the 2017 Census of Agriculture and the North Dakota State Water Commission. Net farm income was calculated by estimating expected yield per acre for crops irrigated with Missouri River water multiplied by the normalized crop prices, considering local factors such as amount of rainfall and local water usage for irrigation, and then subtracting the expected cost of production. Cost of production was obtained from relevant crop extension budgets. The change in yield per acre is assumed to be driven by the change in access to water—as the number of consecutive days an intake would not have access to water increases, the expected yield decreases.[3]

[3] Note that the model includes dryland yields for all crops grown in the area except for sugar beets. Interviews with irrigators and agricultural specialists indicated that sugar beets are very sensitive to soil moisture and yields would decline significantly with a reduction in irrigation. Therefore, a conservative assumption was applied in the model that sugar beet yields would fall to zero with any reduction in irrigation.

Regional Economic Development

The RED analysis used the results from the NED analysis to estimate regional economic effects of FPDTR-EIS alternatives. The RED analysis focused on changes in employment, income, and sales to counties that could be potentially affected by the FPDTR-EIS alternatives. RED impacts were estimated using outputs from the USACE-certified RED model, Regional Economic System (RECONS). RECONS was used to create economic multipliers that describe the economic impact on regional employment, income and sales from a change in spending associated with the directly affected industry—in this case, agricultural crop production. Value of crop production estimated under the NED analysis was multiplied against the outputs from RECONS to estimate the regional economic benefits of irrigated agriculture. The study area for the analysis was the state in which the irrigated agriculture was produced. This includes the direct effects such as on-farm employment while the industries that support farm operations like local co-ops and implement dealers are included in the secondary effects.[4]

Other Social Effects

Changes in irrigation operations have a potential to cause other types of effects on individuals and communities. These impacts are often evaluated under the OSE account. The OSE analysis for irrigation relied in part on the results of the NED and RED analysis to determine the scale of impacts that could occur to community well-being, traditional ways of life, and economic vitality. Impacts of the alternatives on OSE are discussed qualitatively.

3.6.2.1.2 High Flows

The analysis of high flow impacts included two separate evaluations. One that evaluated the impacts to intakes located on the mainstem of the river and a separate analysis of intakes located on side channels. It was determined that the intakes on the mainstem would incur different impacts than those located on side channels and thus required a separate approach. Both approaches evaluated irrigation intakes in the four counties in eastern Montana, which include Richland, Roosevelt, McCone, and Valley Counties, while the mainstem analysis included McKenzie and Williams Counties in western North Dakota. This analysis was undertaken to assess the possible impacts to irrigation operations and maintenance costs for intakes on the mainstem intakes and changes in crop yields for side channel intakes from high river flows. Irrigators noted their operations may be impacted because of increased erosion of

[4] Note that the model used to estimate RED effects is a backward linked model. Therefore, there are other industries that would be impacted by a reduction in crop production in the area that are not picked up by the model (e.g. processing plants). These impacts are discussed qualitatively below.

riverbanks, increase in trash and debris in the river, damage to pump infrastructure, and costs to relocate irrigation pumps, among other impacts.

NED and RED results from both the high flows Missouri River mainstem irrigation intakes analysis and the side channel case study should not be combined with results from the low flow analysis as they use separate sets of input data. Instead, these results of the high flow analysis should be considered a snapshot of the possible NED and RED impacts from a high flow event alone. Finally, the results for the side channel case study are reported solely for side channel intakes and do not represent impacts to net farm income for irrigated agriculture at the county or multi-county level.

The universe of intakes used to estimate impacts in the high flow analysis comes from a 2001 survey of local irrigation districts in the four counties in Montana which indicated 142 intakes along the Missouri River, including main channel and side channel intakes (Goss pers comm 2019). This data set was determined to be the most complete, updated inventory of operational irrigation intakes currently located along the Missouri River in Montana. However, data from the Montana Department of Natural Resources and Conservation's Water Rights Query System indicates there are 365 permitted irrigation water rights claims in the four counties in Montana while a recent analysis prepared by Bartlett & West (2019) which also relies on data from this system, indicates that there are 306 agricultural spraying and irrigation claims along the Missouri River in Montana. These higher estimates of intakes were not used in the analysis because conversations with irrigators and conservation districts speculated that some of these intakes may have been abandoned and not updated in the state's water right database. A recent effort to identify active intakes by the Richland County Conservation District identified 119 intakes that were known to be operating along the river between Fort Peck Dam and Lake Sakakawea. The project team felt that utilizing the estimate of 142 intakes would cover the number of intakes that are known to be operating in Montana and provide a buffer for others that may not have been accounted for at this time. There were an additional 30 intakes identified in the North Dakota stretch of the Missouri River.

For intakes located in Montana, the USACE conducted a survey of intakes in the summer and fall of 2020. Irrigators were surveyed to provide data and information on irrigation intake locations, the location of various shore-side and water- based infrastructure including the intake itself, costs and activities associated with maintaining intakes during high flows and the number of irrigated agricultural acres that the intake services. For the mainstem intake analysis, two metrics, identified as tier 1 and tier 2, defined two high flow levels at each surveyed intake where specific types of operations and maintenance costs would occur. Table 3-74 below defines the two metrics used for this analysis. Using these metrics, an analysis was performed to determine the number of times tier 1 and tier 2 thresholds were crossed during the irrigation season for each alternative.

A separate analysis was completed for irrigation intakes located on side channels. For these intakes, high flow events cause sedimentation to side channels that render intakes inoperable for some of the irrigation season. The loss in irrigation can result in a reduction crop yields as operations move from irrigation to dryland crop production. To determine economic impacts resulting from high flow events to side channel irrigation intakes, a case study was conducted using data from surveyed intakes. The proportion of surveyed intakes that were determined to be side channel intakes (21.6 percent), was applied to the total universe of intakes on the river in Montana (142) to estimate the number of side channel intakes (31). To determine the number of side channel intakes in each county, the number of side channel intakes across the four counties is multiplied by the percent of pump permits in each county relative to the total number of pump permits in the four counties. Impacts to these intakes were assumed to occur in full flow years only because these are years where it is likely that side channel intakes would be inoperable due to sedimentation. Each side channel intake is assumed to irrigate an average of 414 acres based on survey results.

Impacts of these two analyses were scaled up to the estimated 135 mainstem irrigation intakes that are located on the mainstem of the Missouri River between Fort Peck Dam in Montana and Lake Sakakawea. This estimate is obtained by summing the remainder of the 142 irrigation intakes located in Montana after subtracting the 31 side channel irrigation intakes and the product of the percentage of main channel intakes in Montana (78.4 percent) and the number of intakes in North Dakota (30 irrigation intakes).

Table 3-74. Operations and Maintenance Levels

Metric	Performance Measure	Description
Metric 1 – Tier 1 Events	Number of events during an irrigation season by year where the tier 1 threshold was exceeded.	High riverine stage or flow where flows levels would result in normal operations and maintenance costs to irrigation intakes associated with high flows. These include costs associated with cleaning of intake's screen or clearing of debris that a land-based dredge or backhoe could resolve.
Metric 2 – Tier 2 Event	Number of events during an irrigation season by year where the tier 2 threshold was exceeded.	High riverine stage or flow where flows levels would result in larger than normal operations and maintenance costs to irrigation intakes. These costs are associated with impacts to shore-side infrastructure or result in water based-dredging or some combination of these two operations and maintenance costs.

National Economic Development

The analysis of NED impacts associated with high flows was completed in two separate analyses. This includes an evaluation of changes in operations and maintenance costs results from high flows to intakes located on the mainstem channel. The second analysis evaluated NED impacts that occur to intakes located on side channels of the Missouri River. NED impacts to mainstem intakes from high flows are limited to changes in operations and maintenance costs, while NED impacts to side channel intakes include both changes in operations and maintenance costs and changes to irrigator's net income from changes in crop yields. For side channels, this analysis used survey results and county specific crop patterns to determine yearly net farm incomes for all side channel intakes in each county. Local crop enterprise budgets are used to estimate the amount of yield a particular crop will return under irrigated and non-irrigated conditions. The crop yields under both non-irrigated and irrigated conditions were multiplied by the state level normalized price estimates for commodities and used to define the revenue a crop would earn. The sum of revenue for all crops minus the cost of production per crop provides net farm income. In full flow years, the model assumes use of intakes will be lost for the rest of the irrigation season after a high flow event and crop productivity will exclusively result from non-irrigated production.[5] During full flow years, an operations and maintenance cost of $10,000 per intake is added to each estimated side channel intake to calculate NED impacts.

For mainstem intakes, the NED analysis uses the results of an analysis of the number of times a tier 1 or tier 2 event occurs during a flow year, combined with weighted average costs of a tier 1 or tier 2 event that were estimated using information and data obtained during interviews with irrigators and industry experts. The weighted average costs of a tier 1 or tier 2 event is multiplied against the sum of all tier 1 or tier 2 events in an irrigation season by year, by alternative in order to determine the total operations and maintenance costs associated with these events. Results are presented in terms of the flow year type in which they occur and the difference in costs between the No Action Alternative and the Action Alternatives and their variations.

[5] Note that the model includes dryland yields for all crops grown in the area except for sugar beets. Interviews with irrigators and agricultural specialists indicated that sugar beets are very sensitive to soil moisture and yields would decline significantly with a reduction in irrigation. Therefore, a conservative assumption was applied in the model that sugar beet yields would fall to zero with a reduction in irrigation.

Regional Economic Development

The high flows RED evaluation uses an approach like the low flows RED evaluation in that it uses the results of the NED evaluation for side channel intakes, specifically the change in gross sales (i.e., revenue or value of crop production) at side channel intakes, under each of the FPDTR-EIS alternatives relative to No Action to estimate change in regional economic activity measured by changes in employment, income, and sales. Note that this is an assessment of RED impacts only to side channel intakes and not to all intakes on the Missouri River. This analysis used outputs from the USACE-certified RED model, Regional Economic System (RECONS) to estimate these changes. As noted in the NED analysis above, the results from the high flows side channel case study should not be combined with results from the low flow analysis as they use separate sets of input data. Instead, these results should be considered a snapshot of the possible RED impacts from a high flow event alone. Additionally, there is no RED analysis for the Missouri River mainstem irrigation intakes analysis as the operations and maintenance costs analyzed by this analysis only produce NED effects.

3.6.2.2 Summary of Environmental Consequences

Table 3-75 summarizes the impacts to irrigation intakes from each of the FPDTR-EIS alternatives.

Table 3-75. Environmental consequences relative to irrigation

Alternative	NED Impacts	RED Impacts	OSE Impacts
No Action	**High flow analysis – side channel:** Average annual net farm income of $1.8 million for the side channel intakes High flow analysis – mainstem intakes: Average annual impacts of 18 tier 1 and 4 tier 2 events; and $241,981 tier 1 and $137,248 tier 2 O&M costs during the irrigation season over the POR **Low flow analysis:** Average annual net farm income of $9.9 million, with annual values ranging from $2.6 to $12.2 million	**High flow analysis:** Average annual labor income $5.8 million and average annual employment of 121 jobs for side channel intakes **Low flow analysis:** Average annual labor income $36.5 million; average annual employment of 768 jobs	**High and low flow analysis:** The No Action Alternative could have a notable impact to farms during drought conditions and high flow events

Alternative	NED Impacts	RED Impacts	OSE Impacts
Alternative 1	**High flow analysis – side channel:** For side channel intakes, decreases of $7.5 million during flow years compared to No Action, averaging $245,000 in losses per side channel intake **High flow analysis – mainstem intakes:** Average annual impacts of 44 tier 1 and 11 tier 2 events; and $600,000 tier 1 and $350,000 tier 2 O&M costs during the irrigation season of full and partial flow years **Low flow analysis:** Average annual net farm income of $9.6 million, with annual values ranging from $2.6 to $12.2 million Test flows under Alternative 1, would result in moderate adverse impacts to irrigation intakes due to high flows	**High flow analysis:** For side channel intakes, decreases of $3.9 million in labor income and 80 jobs during flow years compared to No Action **Low flow analysis:** Average annual labor income $36.3 million; average annual employment of 764 jobs Test flows under Alternative 1 would have a moderate adverse RED impact especially to side channel irrigation intakes due to high flows	**High flow analysis:** Test flows under Alternative 1 would have moderate adverse short-term and negligible long-term OSE impacts. **Low flow analysis:** Test flows under Alternative 1 would have negligible OSE impacts
Variation 1A	**High flow analysis – side channel:** For side channel intakes, decreases of $7.5 million during flow years compared to No Action, averaging $245,000 in losses per side channel intake **High flow analysis – mainstem intakes:** Average annual impacts of 37 tier 1 and 15 tier 2 events; and $500,000 tier 1 and $250,000 tier 2 O&M costs during the irrigation season of full and partial flow years **Low flow analysis:** Average annual net farm income of $9.5 million, with annual values ranging from -$529,250 to $12.2 million Test flows under Variation 1A would result in moderate adverse impacts to irrigation intakes due to high flows	**High flow analysis:** For side channel intakes, decreases of $3.9 million in labor income and 80 jobs during flow years compared to No Action **Low flow analysis:** Average annual labor income $36.2 million; average annual employment of 763 jobs Test flows under Variation 1A would have a moderate adverse RED impact especially to side channel irrigation intakes due to high flows	**High flow analysis:** Test flows under Variation 1A would have moderate adverse short-term and negligible long-term OSE impacts **Low flow analysis:** Test flows under Variation 1A would have negligible OSE impacts

Alternative	NED Impacts	RED Impacts	OSE Impacts
Variation 1B	**High flow analysis – side channel:** For side channel intakes, decreases of $7.5 million during flow years compared to No Action, averaging $245,000 in losses per side channel intake **High flow analysis – mainstem intakes:** Average annual impacts of 80 tier 1 and 14 tier 2 events; and $550,000 tier 1 and $240,000 tier 2 O&M costs during the irrigation season of full and partial flow years **Low flow analysis:** Average annual net farm income of $9.5 million, with annual values ranging from -$2.4 to $12.2 million Test flows under Variation 1B, would result in moderate adverse impacts to irrigation intakes due to high flows	**High flow analysis:** For side channel intakes, decreases of $3.9 million in labor income and 80 jobs during flow years compared to No Action **Low flow analysis:** Average annual labor income $36.3 million; average annual employment of 763 jobs Test flows under Variation 1B would have a moderate adverse RED impact especially to side channel irrigation intakes due to high flows	**High flow analysis:** Test flows under Variation 1B would have moderate adverse short-term and negligible long-term OSE impacts **Low flow analysis:** Test flows under Variation 1B would have negligible OSE impacts
Alternative 2	**High flow analysis – side channel:** For side channel intakes, decreases of $7.5 million during flow years compared to No Action, averaging $245,000 in losses per side channel intake **High flow analysis – mainstem intakes:** Average annual impacts of 93 tier 1 and 24 tier 2 events; and $630,000 tier 1 and $420,000 tier 2 O&M costs during the irrigation season of full and partial flow years **Low flow analysis:** Average annual net farm income of $9.7 million, with annual values ranging from $1.0 to $12.2 million Test flows under Variation 2, would result in moderate adverse impacts to irrigation intakes due to high flows	**High flow analysis:** For side channel intakes, decreases of $3.9 million in labor income and 80 jobs during flow years compared to No Action **Low flow analysis:** Average annual labor income $36.3 million; average annual employment of 765 jobs Test flows under Alternative 2 have a moderate adverse RED impact especially to side channel irrigation intakes due to high flows	**High flow analysis:** Test flows under Alternative 2 would have moderate adverse short-term and negligible long-term OSE impacts **Low flow analysis:** Test flows under Alternative 2 would have negligible OSE impacts

Alternative	NED Impacts	RED Impacts	OSE Impacts
Variation 2A	**High flow analysis – side channel:** For side channel intakes, decreases of $7.5 million during flow years compared to No Action, averaging $245,000 in losses per side channel intake **High flow analysis – mainstem intakes:** Average annual impacts of 90 tier 1 and 28 tier 2 events; and $600,000 tier 1 and $510,000 tier 2 O&M costs during the irrigation season of full and partial flow years **Low flow analysis:** Average annual net farm income of $9.4 million, with annual values ranging from -$1.3 to $12.2 million Test flows under Variation 2A, would result in moderate adverse impacts to irrigation intakes due to high flows	**High flow analysis:** For side channel intakes, decreases of $3.9 million in labor income and 80 jobs during flow years compared to No Action **Low flow analysis:** Average annual labor income $36.2 million; average annual employment of 762 jobs Test flows under Variation 2A would have a moderate RED impact especially to side channel irrigation intakes due to high flows	**High flow analysis:** Test flows under Variation 2A would have moderate adverse short-term and negligible long-term OSE impacts. **Low flow analysis:** Test flows under Variation 2A would have negligible OSE impacts
Variation 2B	**High flow analysis – side channel:** For side channel intakes, decreases of $7.5 million during flow years compared to No Action, averaging $245,000 in losses per side channel intake **High flow analysis – mainstem intakes:** Average annual impacts of 84 tier 1 and 16 tier 2 events; and $570,000 tier 1 and $280,000 tier 2 O&M costs during the irrigation season of full and partial flow years **Low flow analysis:** Average annual net farm income of $9.2 million, with annual values ranging from -$2.1 to $12.2 million Test flows under Variation 2B, would result in moderate adverse impacts to irrigation intakes due to high flows	**High flow analysis:** For side channel intakes, decreases of $3.9 million in labor income and 80 jobs during flow years compared to No Action **Low flow analysis:** Average annual labor income $36.1 million; average annual employment of 760 jobs Test flows under Variation 2B would have a moderate adverse RED impact especially to side channel irrigation intakes due to high flows	**High flow analysis:** Test flows under Variation 2B would have moderate adverse short-term and negligible long-term OSE impacts **Low flow analysis:** Test flows under Variation 2B would have negligible OSE impacts

* Fiscal year 2020 prices

3.6.2.3 No Action

Under the No Action Alternative, operations at Fort Peck Dam are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. As noted above, it is considered the baseline against which the other alternatives are measured.

3.6.2.3.1 Low Flows

National Economic Development

Table 3-76 summarizes the NED analysis for the No Action Alternative. Overall, average annual net farm income for all five counties evaluated would be approximately $9.9 million. Much of the variation in annual net farm income is a result of the natural cycles of drought and high water conditions.

Table 3-76. NED analysis for No Action Alternative (FY2021 Dollars)

State	County	Total Net Farm Income over the POR	Average Annual Net Farm Income
Montana	McCone	$82,220,000	$1,003,000
	Valley	$100,657,000	$1,228,000
	Roosevelt	$341,934,000	$4,170,000
	Richland	$232,443,000	$2,835,000
North Dakota	McLean	$53,644,000	$654,000
Total		$810,898,000	$9,889,000

Regional Economic Development

The RED analysis for the No Action Alternative estimated the employment, labor income, and sales supported from irrigated crop production in the five counties. The RED analysis estimated the direct and secondary economic effects resulting from gross sales of irrigated crops. Table 3-77 summarizes the economic contribution for all five counties evaluated. Under the No Action Alternative, irrigated agriculture would contribute on average 768 jobs, $36.5 million in labor income and $114.2 million in sales per year. Under the worst year modeled under the No Action Alternative, approximately 679 jobs would be supported, with $32.2 million in labor income and $100.9 million in sales. This reduction in jobs, labor income, and sales occurs during years of drought, especially as simulated in the 1930s. Under the best year modeled under the No Action Alternative, 793 jobs would be supported, with $37.7 million labor income and $118.1 million in sales.

Table 3-77. No Action Alternative RED analysis for value of irrigated crop production (FY2021 Dollars)

RED Metric	Average Annual Contribution	Worst Year Contribution	Best Year Contribution
Employment	768	679	793
Labor Income	$36,460,000	$32,150,000	$37,703,000
Total Sales	$114,259,000	$100,930,000	$118,121,000

Other Social Effects

Agriculture has historically been a critical economic component and way of life in many of the communities within the counties evaluated in this analysis. Compared to all irrigated acreage, the number of acres irrigated by the Missouri River would be relatively large, with 69 percent of irrigated acreage in the five counties relying on water from the Missouri River. Under the No Action Alternative there could be impacts to farms that rely on the Missouri River during drought conditions as a source of water for irrigation, with the potential for adverse impacts to economic vitality, community well-being, and traditional ways of life. These impacts would be due to current river conditions and operations continuing into the future because the No Action Alternative does not include a test flow.

3.6.2.3.2 High Flows

National Economic Development

Side Channel Case Study

Table 3-78 summarizes the NED analysis for the No Action Alternative for the high flows side channel case study. Overall, average annual net farm income associated with side channel intakes in all four counties evaluated would be approximately $1.8 million. Under No Action, intakes on side channels do not experience additional high flow events that lead to loss of irrigation functions. Therefore, net farm income under No Action is a function of irrigated crop production, which remains consistent each year.

Table 3-78. NED Analysis for No Action Alternative (FY2021 Dollars)

State	County	Total Net Farm Income over the POR	Average Annual Net Farm Income
Montana	McCone	$20,287,000	$247,000
	Valley	$16,226,000	$198,000
	Roosevelt	$52,514,000	$640,000
	Richland	$59,157,000	$721,000
Total*		$148,184,000	$1,807,000

*Note: Total values may be slightly different than the sum of their columns due to rounding.

Missouri River Mainstem Irrigation Intakes Analysis

Under the No Action Alternative, there would be 11 out of 135 (8 percent) Missouri River mainstem channel irrigation intakes impacted by tier 1 events and 4 irrigation intakes (3 percent) impacted by tier 2 events on average annually over the POR. Tier 1 impacts occur in all but 5 of 82 years under the POR while tier 2 impacts would occur in 26 of 82 years under the POR. As shown in Table 3-79 below, there are 18 tier 1 events and 8 tier 2 events on average annually over the POR which result in $241,981 in operations and maintenance costs for tier 1 events and $137,248 for tier 2 events annually.

Table 3-79. Summary of NED Analysis for No Action During the Irrigation Season Over the Period of Record (Missouri River Mainstem Intakes) (FY2021 Dollars)

Statistic	Average Annual Impacts	Year of Minimum Impacts	Year of Maximum Impacts
Tier 1 Events	18	0	108
Tier 2 Events	4	0	135
Tier 1 Costs	$241,981	$0	$1,463,037
Tier 2 Costs	$137,248	$0	$4,365,901
Tier 1 Intakes	11	0	81
Tier 2 Intakes	4	0	135

Note that the values presented in Table 3-79 above are annual averages during all years under the POR whereas the average annual impacts presented in the following high flows sections for each alternative or variation are annual averages during full or partial flow years. Therefore, it is not possible to subtract the “Delta from No Action” value from the “Value” column in the following tables in each section below and obtain the result presented in the “Average Annual Impacts” column in Table 3-79 above. This is because each action alternative or its variation runs during a different set of full or partial flow years over the POR, and the results for each of these years are compared against the No Action results in the year in which the flow event is run.

Regional Economic Development

The RED analysis for the No Action Alternative for the side channel intakes case study estimated the employment, labor income, and sales supported from irrigated crop production in the four counties. The RED analysis estimated the direct and secondary economic effects resulting from gross sales of irrigated crops. Table 3-80 summarizes the economic contribution for all four Montana counties evaluated. Under the No Action Alternative, irrigated agriculture associated with the side channel intakes would contribute on average 121 jobs, $5.8 million in labor income and $18.2 million in sales per year (See Table 3-80).

Table 3-80. No Action Alternative RED Analysis for Value of Irrigated Crop Production (FY2021 Dollars)

Economic Contribution	Scenario	Total, All Counties
Employment	Annual Value of Production	121
Labor Income	Annual Value of Production	$5,800,000
Total Sales	Annual Value of Production	$18,200,000

Other Social Effects

As shown in the low flow analysis agriculture has historically been a critical economic component and way of life in many of the communities within the counties evaluated in this analysis. The No Action Alternative could have a notable impact to farms that rely on the Missouri River during high flow conditions as a source of water for irrigation, with the potential for adverse impacts to economic vitality, community well-being, and traditional ways of life resulting from increased operations and maintenance costs or impacts to crop yields due to high flows.

Conclusion

Under current System operations, the Missouri River and the reservoirs will remain a viable source of water for irrigation operations in the Upper Basin. Relative to all irrigated acreage, the number of acres irrigated by the Missouri River would be relatively large, with 69 percent of irrigated acreage in the five counties relying on water from the Missouri River. Considering these conditions, farm operations using water from the Missouri River for irrigation in the five counties evaluated in the low flow analysis are expected on average to support $9.9 million annually in NED benefits (net farm income). On average, this agricultural production would support 768 jobs, $36.5 million in labor income and $114.2 million in sales under the No Action Alternative annually (RED benefits). Net farm income would be lower particularly during drought conditions under the No Action Alternative which could result in NED, RED and OSE impacts during certain years. Approximately eight percent of intakes would be impacted by a tier 1 high flow event and three percent of intakes would be impacted by a tier 2 high flow event during the irrigation season on average annually under the No Action Alternative. Net farm income for side channel intakes would be $617.2 annually, and this would support 121 jobs, $5.8 in labor income, and $18.2 in sales annually.

3.6.2.4 Alternative 1

System operations under Alternative 1 are based on those described under the No Action Alternative except that it includes a flow release regime from Fort Peck Dam to benefit pallid sturgeon.

An Attraction Flow Regime would begin on April 16 and the peak flow would be twice as large as the spring release from Fort Peck Dam in a given year. The Spawning Cue Flow Regime under Alternative 1 would begin on May 28 and would be 3.5 times the Fort Peck Dam spring flow release in the given release year. A further description of Alternative 1 is detailed in Chapter 2, Section 2.5, Alternatives Carried Forward for Further Evaluation.

3.6.2.4.1 Low Flows

National Economic Development

The NED results for the low flow analysis for Alternative 1 are summarized in Table 3-81. On average net farm income would total $9.6 million for all five counties per year under Alternative 1. This represents a slight decrease from the No Action Alternative of $289,000 or -2.9 percent. On average, all counties under this alternative would experience small adverse impacts, except McLean County in North Dakota, which would experience negligible impacts. These impacts in McLean County would be due to the spawning cue release increasing lake elevations at Lake Sakakawea in some full release years, which would increase access to water for irrigation. During the eight years with the lowest crop production values relative to the No Action Alternative, the change in net farm income would be temporary and large across most counties, with Roosevelt County experiencing a decrease of $1.6 million in net farm income in the average of the eight worst difference years from the No Action Alternative. Irrigation in Richland County would experience decreases in net farm income in the eight worst difference years of $1.1 million. In specific counties, individual farms that rely on the Missouri River for irrigation could experience isolated adverse impacts in some years. However, during the best difference years, with increased net farm income compared to No Action Alternative, many of these adverse impacts would be offset, resulting in very small changes in average annual net farm income under Alternative 1 relative to the No Action Alternative.

Table 3-81. County Level Summary of NED analysis for Alternative 1 (FY2021 Dollars)*

State	County	Average Annual Net Farm Income	Change in Average Annual Net Farm Income Relative to No Action Alternative	Percent Change Relative to No Action Alternative	Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	% Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)	% Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)
Montana	McCone	$969,000	-$34,000	-3.4%	$52,000	5.2%	-$362,000	-36.1%
	Valley	$1,198,000	-$30,000	-2.4%	$32,000	2.6%	-$326,000	-26.6%
	Roosevelt	$4,033,000	-$137,000	-3.3%	$305,000	7.3%	-$1,647,000	-39.5%
	Richland	$2,742,000	-$93,000	-3.3%	$208,000	7.3%	-$1,137,000	-40.1%
North Dakota	McLean	$658,000	$4,000	0.6%	$43,000	6.6%	-$4,000	-0.7%
Total		$9,600,000	-$289,000	-2.9%	$591,000	6.0%	-$3,406,000	-34.4%

*data in table represents totals for each county. The data for Roosevelt County, for instance, represents 77 intakes worth of net farm income.

Additional modeling results are summarized in Table 3-82, which shows the difference in annual net farm income during years when there is a release action. Years of full release correspond to the years of highest impact, as shown in Table 3-82. The year of highest adverse impact (-$8.1 million) occurred in conditions similar to 1987, when higher spring releases would require lower fall releases from Fort Peck Reservoir to balance system storage, which causes decreased flows, decreasing access to water for irrigation relative to the No Action Alternative. However, a reduction in flows during the latter part of the irrigation season would have a smaller adverse impact than a reduction in flows during the peak irrigation season, such as July. Therefore, economic impacts due to these reduced flows at the end of the irrigation season may be overstated. Net farm income in Valley, Roosevelt, Richland, and McCone Counties would decrease in particular relative to the No Action Alternative. The one-year decrease in net farm income for the most affected county (Roosevelt County, with a decline of $3.9 million) in 1987 represents 26 percent of net cash farm income of all farming operations in that county ($15.2 million) (USDA, 2017).[6]

Years with partial flow releases also correspond with lower annual net farm income. For example, in conditions similar to 1986 where a partial flow release would occur, the adverse impact relative to the No Action Alternative would be -$944,000. In this year, adverse impacts would be more concentrated downstream of Fort Peck Lake, with reductions in net farm income occurring in Richland County (with a decrease of $264,000 relative to the No Action Alternative), neighboring Roosevelt County (with a decrease of $424,000), and McCone County (with a decrease of $140,000 relative to the No Action Alternative). The decrease in net farm income in Roosevelt County would represent 3 percent of net cash farm income of all farm operations in the county ($15.2 million) (USDA, 2017).

Increases in net farm income relative to the No Action Alternative would also occur in some years, increasing by as much as $3.7 million across all counties (Table 3-82).

[6] Net cash farm income is the gross cash income—all income, such as crop value of production—minus any expenses, which would include raw materials, employees, and even payments on debt. This is a simpler estimation of net farm income as it does not include depreciation and amortization expenses.

Table 3-82. Impacts from modeled flow releases to net farm income in the 12-county area under Alternative 1; change in net farm income relative to the No Action Alternative (FY2021 Dollars)

Full Release[a]		Year After Full Release		Partial Flow Release[b]		Years with Greatest Range in Impacts Regardless of Flow Actions	
Low	High	Low	High	Low	High	Low	High
-$8,062,174	$93,281	-$1,483,739	$0	-$943,581	$3,678,696	-$8,062,174	$3,678,696

a Spawning cue releases and low summer flow events would be fully implemented in 11 years of the POR. Data represents the lowest and highest dollar impacts in the years the action would be implemented. Negative values indicate reductions in net farm income relative to the No Action Alternative.

b Spawning cue release would be partially implemented in 11 years of the POR.

Regional Economic Development

For the five counties evaluated, employment would be reduced by an average of 3 jobs and $159,000 in labor income per year compared to the No Action Alternative (Table 3-83). For the eight years with the greatest reduction in crop production relative to the No Action Alternative, there would be 39 fewer jobs on average across all five counties and labor income would decrease by $1.9 million. In the years with the greatest increase in net farm income relative to the No Action Alternative, there would be an increase in 7 jobs.

Roosevelt County would experience the greatest decrease in jobs and labor income relative to the No Action Alternative during the average of the eight worst difference years of 18 jobs and $924,000, respectively, primarily due to higher spring releases during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation relative to the No Action Alternative. However, as most of these impacts occur in the latter part of the irrigation season they may result in fewer impacts than are shown here. A reduction of 18 jobs represents approximately 3 percent of farm jobs (596 farm jobs) in Roosevelt County in 2018 (U.S. Bureau of Economic Analysis, 2019). On average, there would be negligible to small temporary changes in the RED effects with small increases and decreases in some years with the spawning cue releases and low flow events increasing and decreasing reservoir elevations and river flows and stages.

Table 3-83. Alternative 1 RED analysis for value of irrigated crop production (FY2021 Dollars)

Economic Impact	Scenario	Total
Direct and Secondary Jobs	Average Annual	764
	Change in Average Annual from No Action Alternative	-3.3
	Average of the Eight Best Difference Years Relative to No Action Alternative	7.1
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-39.3
Direct and Secondary Income	Average Annual	$36,301,000
	Change in Average Annual from No Action Alternative	-$159,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$350,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$1,918,000
Direct and Secondary Sales	Average Annual	$113,765,000
	Change in Average Annual from No Action Alternative	-$494,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$1,086,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$5,935,000

Other Social Effects

Changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Alternative 1 would decrease slightly relative to the No Action Alternative as would employment, labor income, and sales. During certain years, these impacts would be small in some counties due to lower reservoir elevations and river stages. During the worst difference years, reductions in net farm income would represent a large percentage of net cash farm income in counties most affected. Alternative 1 would not likely result in long-term OSE impacts to communities or the region because NED and RED impacts would be negligible to small and temporary. However, small short-term adverse impacts to economic vitality and community well-being could occur during a few years if reductions in irrigation are concentrated within the affected counties.

3.6.2.4.2 High Flows

National Economic Development

Side Channel Case Study

The NED results for the side channel case study are consistent across alternatives, where the total annual decrease in net farm income during test flow years compared to the No Action Alternative is $7.5 million across all four counties. Therefore, the average annual NED results described under this alternative will be the same as described under the other variations and alternative 2 and its variations. Note, however, that if system conditions allow and test flows are run as many times as possible some alternatives or their variations may have greater impacts than others. In years that a test flow is run, net farm income breaks down to a decrease of $1.0 million in McCone County, $534,000 in Valley County, $2.8 million in Roosevelt County, and $3.1 million in Richland County. On average, the annual decrease in net farm income per intake is $245,353, but this ranges by county, with the smallest decrease of $131,413 in McCone County and the highest of $355,045 in Richland County. Alternative 1 has 11 potential test flow years where losses in net farm income could occur to side channel intakes because of a high flow. In years without test flows, there is no difference in net farm income compared to No Action (See Table 3-84).

Table 3-84. Summary of NED Analysis for All Action Alternatives (FY2021 Dollars)

State	County	Average Annual Decrease in Net Farm Income During Test Flow Years Compared to No Action	Average Annual Change in Net Farm Income Per Side Channel Intake During Test Flow Years Compared to No Action
Montana	McCone	-$1,040,000	-$131,413
	Valley	-$534,000	-$144,398
	Roosevelt	-$2,820,000	-$274,411
	Richland	-$3,140,000	-$355,045
Total		-$7,530,000	-$245,353

NED results were also tested for their sensitivity to assumptions about the number of intakes that would have crop losses as well as the potential range of operations and maintenance costs that could be incurred by irrigators cleaning up from high flows (see Table 3-85). As described in the high flows methodology section above, the results reported in this analysis assume that 100% of side channel intakes are unable to irrigate following a high flow event which would result in impacts to crop yields. However, there is some uncertainty on which, and how many, of the side channel intakes would experience crop losses based on interviews completed with irrigators and industry experts in early 2021.[7] The annual decrease in net farm income during test flow years compared to the No Action Alternative can be as high as $7.5 million across all four counties but may be lower depending on the number of intakes that see meaningful reductions in access to water for irrigation due to high flow events. Additionally, O&M costs may also fluctuate by intake. As a baseline, O&M costs are assumed to be $10,000 per intake during each year with a test flow; however, they may be as low as $2,000 or as high as $30,000 per intake based on conversations with irrigators and industry experts. For example, irrigators indicated during interviews that contractors and resources needed to repair intakes and clear side channels are in short supply in parts of the study area. As a result, it may be weeks before these repairs can be made. Therefore, due to the uncertainty of high flows impacts to crop yields and operations and maintenance costs, the total annual net decrease in net farm income during test flow years compared to the No Action Alternative can be as high as $8.1 million across all four counties but may be lower. The results of this sensitivity analysis are constant across all alternatives.

Table 3-85. Summary of Sensitivity Results for All Alternatives, Average Annual During Full Flow Year (FY2021 Dollars)

Variable	Assumption	All Alts, Average Annual Net Income, Delta from No Action	Relative Percentage Change from Base Case Assumptions
1. Percent of Intakes with Crops Impacted	100%*	-$7,525,459	0%
	75%	-$5,720,851	-24%
	50%	-$3,916,243	-48%
	25%	-$2,111,635	-72%
	0%	-$307,027	-96%
2. O&M Costs	$30,000	-$8,139,513	8%
	$10,000*	-$7,525,459	0%
	$2,000	-$7,279,838	-3%
	$0	-$7,218,432	-4%

**Note: These values are the base case values for each sensitivity variable and are the values used in throughout the alternatives below.*

[7] Note that the analysis does not consider the potential impacts of the test flows on future crop rotations. Thus, the annual impacts may extend beyond the year that they occur.

Missouri River Mainstem Irrigation Intakes Analysis

For Missouri River mainstem channel intakes under Alternative 1, 19 more intakes have tier 1 impacts on average annually during full and partial flow years while 7 more intakes have tier 2 impacts relative to the No Action Alternative. There would be an increase in the total number of tier 1 events on average annually during full and partial flow years of 18 events and 7 tier 2 events relative to the No Action Alternative. On average, during full and partial flow years tier 1 events cost $242,887 and tier 2 events cost $236,486 more annually than under the No Action Alternative (See Table 3-86).

The number of tier 1 and 2 events would fluctuate between a maximum of 98 tier 1 events and 42 tier 2 events in a partial flow year like 1975 to a minimum of no intakes impacted for either tier impacted in other years. The maximum number of intakes impacted differs slightly from the number of events discussed above. The number of individual intakes impacted fluctuates between a maximum of 81 intakes under tier 1 in a year like 1983 and 42 intakes impacted in a year like 1975 under tier 2 to a minimum of no intakes impacted for either tier in other years. Note that there would be no difference in the number of intakes impacted under Alternative 1 relative to the No Action Alternative during a maximum impact full or partial flow year. Additionally, that there are 10 fewer tier 1 events during a year of maximum impact, like 1983, resulting in reduced tier 1 costs in this year relative the year with the greatest impacts under the No Action Alternative (1975).

Table 3-86. Summary of NED Analysis for Alternative 1 During the Irrigation Season During Full or Partial Flow Years (Missouri River Mainstem Intakes) (FY2021 Dollars)

Statistic	Average Annual Impacts		Year of Minimum Impacts		Year of Maximum Impacts	
	Value	**Delta from No Action**	**Value**	**Delta from No Action**	**Value**	**Delta from No Action**
Tier 1 Events	44	18	0	0	98	(10)
Tier 2 Events	11	7	0	0	42	-
Tier 1 Costs	$600,074	$242,887	$0	$0	$1,325,877	-$137,160
Tier 2 Costs	$354,729	$236,486	$0	$0	$1,358,280	$0
Tier 1 Intakes	34	19	0	0	81	-
Tier 2 Intakes	11	7	0	0	42	-

Note: Annual average impacts presented in this table are taken as annual average during full or partial flow years; whereas annual averages for the No Action Alternative presented in Table 3-79 above are taken as annual averages during all years *under the POR. Therefore, it is not possible to subtract the values in the "Delta from No Action" column from the "Value" column in the table above and obtain the result presented in Table 3-79.*

High flow events would result in increased sedimentation and sediment deposition in both the mainstem of the Missouri River as well as side channels used for irrigation. High flows would also result in increases debris, such as trash and vegetation like cottonwood trees, in the mainstem and side channels that would require removal or cleanup after a flow event. This debris itself could also directly cause damage to pumps or side channels if it becomes lodged in the side channel or damages pump infrastructure. The riverine stretch of the Missouri River in Montana is a relatively rural location with limited resources. Therefore, many intakes are located far from contractor support services that could perform maintenance or repair operations on intakes that would be required because of the impacts described above to intakes from high flows. Furthermore, high flow events that impact many intakes at one time may further constrain local maintenance and repair contractors such that some intakes may remain offline for extended period of time which could result in further impacts to crops including a reduction or total loss of crop yields. Impacts to crop yields and additional costs incurred to farmers occurring as a result of these extended irrigation intake down-times described above are not captured in the modeling analysis and should be considered additional potential costs associated with high flow events.

Regional Economic Development

For the four counties evaluated for the side channel intakes case study, employment would be reduced by an average of 80 jobs and $3.9 million in labor income during test flow years compared to the No Action Alternative. These results are consistent across alternatives, with impacts amongst the alternatives and their variations only changing in the number of potential full test flow years. Alternative 1 has 11 potential test flow releases. In years without test flow releases, there would be no difference in employment, labor income, and sales compared to No Action across alternatives. Richland County would experience the greatest decrease in jobs and labor income relative to the No Action Alternative during test flow years, with decreases in employment and labor income of 32 jobs and $1.7 million, respectively, Valley County would be least impacted during test flow years, with decreases in employment and labor income of 7 jobs and $0.3 million, respectively. This is because the mix of crops grown in Valley County result in fewer economic damages when switching to dryland production than in Richland County (See Table 3-87).

Table 3-87. Summary of RED Analysis for Alternative 1 (FY2021 Dollars)

State	County	Annual Decrease in Employment Relative to No Action During Test Flow Years	Annual Decrease in Labor Income Relative to No Action During Test Flow Years (millions)	Annual Decrease in Sales Relative to No Action During Test Flow Years (millions)
Montana	McCone	-11	-$0.4	-$1.6
	Valley	-7	-$0.3	-$0.8
	Roosevelt	-30	-$1.5	-$4.6
	Richland	-32	-$1.7	-$5.2
Total		-80	-$3.9	-$12.3

It is important to note that the RED results do not include downstream industries that are dependent on crops produced in the study area. Industries such as processing facilities, storage facilities and transportation entities would also be adversely impacted by a reduction in crop production. Because these industries are not included in the model, the RED impacts are likely underestimated.

Other Social Effects

As shown in the low flow analysis, agriculture changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Alternative 1 would decrease relative to the No Action Alternative during full flow years as would employment, labor income, and sales. This reduction in net farm income would impact farms relying on side channel intakes for irrigation and represents a large percentage of net cash farm income in counties most affected. Additionally, operations and maintenance costs for all irrigators would increase because of high flows, particularly during full and partial flow release years. There is also a potential for adverse impacts to occur to downstream industries that are dependent on crop production from the study area. These impacts would occur primarily during full or partial flow years with the potential for OSE impacts to be moderately adverse to economic vitality and community well-being with negligible long-term OSE impacts.

3.6.2.5 Alternative 1 – 1A Variation

Variation 1A is a test flow variation of Alternative 1. The parameters for Variation 1A are the same as described for Alternative 1 except that the Attraction Flow would be initiated on April 9, rather than April 16, and the Spawning Cue Flow Regime would be initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

3.6.2.5.1 Low Flows

National Economic Development

The NED results for Variation 1A are summarized in Table 3-88. On average net farm income would total $9.5 million for all five counties per year under Variation 1A. This represents a slight decrease from the No Action Alternative of $391,000 or -4.0 percent. On average, all counties under this alternative would experience small adverse impacts, except McLean County in North Dakota, which would experience negligible impacts. These impacts in McLean County would be due to the spawning cue release increasing lake elevations at Lake Sakakawea in some full release years, which would increase access to water for irrigation. During the eight years with the lowest crop production values relative to the No Action Alternative, the change in net farm income would be temporary and large across most counties, with Richland County experiencing a decrease of $1,410,000 in net farm income in the average of the eight worst difference years from the No Action Alternative. Irrigation in Roosevelt County would experience decreases in net farm income in the eight worst difference years of $2,104,000. In specific counties, individual farms that rely on the Missouri River for irrigation could experience isolated adverse impacts in some years. However, during the best difference years, with increased net farm income compared to No Action Alternative, many of these adverse impacts would be offset, resulting in small changes in average annual net farm income under Variation 1A relative to the No Action Alternative.

Table 3-88. County Level Summary of NED analysis for Variation 1A (FY2021 Dollars)

State	County	Average Annual Net Farm Income	Change in Average Annual Net Farm Income Relative to No Action Alternative	Percent Change Relative to No Action Alternative	Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	% Increase during eight greatest crop production value years compared No Action Alternative (average annual)	Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)	% Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)
Montana	McCone	$951,000	-$52,000	-5.2%	$25,000	2.5%	-$549,000	-54.7%
	Valley	$1,188,000	-$39,000	-3.2%	$33,000	2.6%	-$436,000	-35.5%
	Roosevelt	$3,983,000	-$187,000	-4.5%	$215,000	5.2%	-$2,104,000	-50.4%
	Richland	$2,712,000	-$122,000	-4.3%	$169,000	5.9%	-$1,410,000	-49.7%
North Dakota	McLean	$664,000	$9,000	1.4%	$66,000	10.1%	-$9,000	-1.4%
Total		$9,498,000	-$391,000	-4.0%	$459,000	4.6%	-$4,467,000	-45.2%

*data in table represents totals for each county. The data for Roosevelt County, for instance, represents 77 intakes worth of net farm income.

Additional modeling results are summarized in Table 3-89, which shows the difference in annual net farm income during years when there is a release action. Years of full release correspond to the years of highest impact, as shown in Table 3-89. The year of highest adverse impact (-$8.1 million) occurred in conditions similar to 1987, when higher spring releases would require lower fall releases from Fort Peck Reservoir to balance system storage, which causes decreased flows, decreasing access to water for irrigation relative to the No Action Alternative. However, a reduction in flows during this latter part of the irrigation season would have a less adverse impact than a reduction in flows during the peak irrigation season, such as July. Therefore, economic impacts due to these reduced flows at the end of the irrigation season may be overstated. Net farm income in Valley, Roosevelt, Richland, and McCone Counties would decrease in particular relative to the No Action Alternative. The one-year decrease in net farm income for the most affected county (Roosevelt County, with a decline of $3.9 million) in 1987 represents 26 percent of net cash farm income of all farming operations in that county ($15.2 million) (USDA 2017).[8]

Years with partial flow releases also correspond with lower annual net farm income. For example, in conditions similar 1973 where a partial flow release would occur, the adverse impact relative to the No Action Alternative would be -$3,954,646. In this year, adverse impacts would be more concentrated downstream of Fort Peck Lake, with reductions in net farm income especially occurring in Roosevelt County (with a decrease of $2.0 million relative to the No Action Alternative), Richland County (with a decrease of $1.3 million), and McCone County (with a decrease of $441,000 relative to the No Action Alternative). The decrease in net farm income in Roosevelt County would represent 13 percent of net cash farm income of all farm operations in the county ($15.2 million) (USDA, 2017).

Increases in net farm income relative to the No Action Alternative would also occur in some years, increasing by as much at $2.6 million across all counties (Table 3-89).

[8] Net cash farm income is the gross cash income—all income, such as crop value of production—minus any expenses, which would include raw materials, employees, and even payments on debt. This is a simpler estimation of net farm income as it does not include depreciation and amortization expenses.

Table 3-89. Impacts from modeled flow releases to net farm income in the 5 counties under Variation 1A; change in net farm income relative to the No Action Alternative (FY2021 Dollars)

Full Release[a]		Year After Full Release		Partial Flow Release [b]		Years with Greatest Range in Impacts Regardless of Flow Actions	
Low	High	Low	High	Low	High	Low	High
-$8,055,785	$89,873	-$945,618	$2,553,535	-$3,954,646	$674,877	-$8,055,785	$2,553,535

a Spawning cue releases would be fully implemented in 16 years of the POR. Data represents the lowest and highest dollar impacts in the years the action would be implemented. Negative values indicate reductions in net farm income relative to the No Action Alternative.

b Spawning cue release would be partially implemented in 6 years of the POR.

Regional Economic Development

For the five counties evaluated, employment would be reduced by an average of 4 jobs and $216,000 in labor income per year compared to the No Action Alternative (Table 3-90). For the eight years with the greatest reduction in crop production relative to the No Action Alternative, there would be 51 fewer jobs on average across all five counties and labor income would decrease by $2.5 million. However, in the years with the greatest increase in net farm income relative to the No Action Alternative, there would be an increase in 6 jobs.

Roosevelt County would experience the greatest decrease in jobs and labor income relative to the No Action Alternative during the average of the eight worst difference years of 24 jobs and $1.2 million, respectively, primarily due to higher spring releases during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation relative to the No Action Alternative. However, as most of these impacts occur in the latter part of the irrigation season they may result in fewer impacts than are shown here. A reduction of 24 jobs represents approximately 4 percent of farm jobs (596 farm jobs) in Roosevelt County in 2018 (U.S. Bureau of Economic Analysis, 2019). On average, there would be negligible to small temporary changes in the RED effects with small increases and decreases in some years with the spawning cue releases and low flow events increasing and decreasing reservoir elevations and river flows and stages.

Table 3-90. Variation 1A RED analysis for value of irrigated crop production (FY2021 Dollars)

Economic Impact	Scenario	Total
Direct and Secondary jobs	Average Annual	763
	Change in Average Annual from No Action Alternative	-4.4
	Average of the Eight Best Difference Years Relative to No Action Alternative	5.7
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-51.1
Direct and Secondary income	Average Annual	$36,244,000
	Change in Average Annual from No Action Alternative	-$216,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$276,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$2,475,000
Direct and Secondary sales	Average Annual	$113,589,000
	Change in Average Annual from No action Alternative	-$670,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$855,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$7,690,000

Other Social Effects

Changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Variation 1A would decrease slightly relative to the No Action Alternative as would employment, labor income, and sales. During certain years, these impacts would be large in some counties due to lower reservoir elevations and river stages. During the worst difference years, reductions in net farm income would represent a large percentage of net farm income in counties most affected. Variation 1A would not likely result in long-term OSE impacts to communities or the region because NED and RED impacts would be negligible to small and temporary. However, small short-term adverse impacts to economic vitality and community well-being could occur during a few years if reductions in irrigation are concentrated within the affected counties.

3.6.2.5.2 High Flows

National Economic Development

Side Channel Case Study

The NED results for the side channel case study are consistent across alternatives, where the total annual decrease in net farm income during test flow years compared to the No Action Alternative could be as high as $7.5 million across all four counties (See Table 3-84 above). The decrease in net farm income breaks down to a decrease of $1.0 million in McCone County, $530,000 in Valley County, $2.8 million in Roosevelt County, and $3.1 million in Richland County. On average, the decrease in net income per intake is $245,353, but this ranges by county, with the smallest decrease of $131,413 in McCone County and the highest of $355,045 in Richland County. Variation 1A has 16 potential test flow years where losses in net farm income to side channel intakes could result from high flows. In years without test flows, there is no difference in net farm income compared to No Action. According to the sensitivity analysis (see Table 3-85 above), which is consistent across alternatives, total annual decrease in net farm income during test flow years compared to the No Action Alternative can be as high as $7.5 million across all four counties but may be lower depending on the number of intakes with losses in crop productivity due to a test flow. Decreases in net farm income will also vary depending on the O&M costs incurred at each intake. Net farm income during test flow years compared to the No Action Alternative may be as high as $8.1 million across all four counties but may be lower, depending on the actual costs incurred.

Missouri River Mainstem Irrigation Intakes Analysis

For Missouri River mainstem channel intakes under Variation 1A, 16 more intakes have tier 1 impacts on average annually during full and partial flow years and 4 more intakes have tier 2 impacts relative to the No Action Alternative. There would be an increase in the total number of tier 1 events on average annually during full and partial flow years of 13 events and 4 tier 2 events relative to the No Action Alternative. On average, during full and partial flow years tier 1 events cost $169,606 and tier 2 events cost $131,446 more annually than under the No Action Alternative (See Table 3-91).

The number of tier 1 and 2 events would fluctuate between a maximum of 101 tier 1 events and 42 tier 2 events in a partial flow year like 1975 to a minimum of no intakes impacted for either tier events in other years. The maximum number of intakes impacted differs slightly from the number of events discussed above. The number of individual intakes impacted fluctuates between a maximum of 81 intakes under tier 1 and 42 intakes impacted under tier 2 in a year like 1975 to a minimum of no intakes impacted for either tier impacted in other years. Note that there would be no difference in the number of intakes impacted under Variation 1A relative to the No Action Alternative during a maximum impact full or partial flow year. Additionally, there are 7 fewer tier 1 events during a year of maximum impact, like 1975, resulting in reduced tier 1 costs in this year relative to the year with the greatest impacts under the No Action Alternative (1975).

Table 3-91. Summary of NED Analysis for Variation 1A During the Irrigation Season During Full or Partial Flow Years (Missouri River Mainstem Intakes) (FY2021 Dollars)

Statistic	Average Annual Impacts		Year of Minimum Impacts		Year of Maximum Impacts	
	Value	Delta from No Action	Value	Delta from No Action	Value	Delta from No Action
Tier 1 Events	37	13	0	0	101	(7)
Tier 2 Events	8	4	0	0	42	-
Tier 1 Costs	$495,545	$169,606	$0	$0	$1,371,597	-$91,440
Tier 2 Costs	$250,374	$131,446	$0	$0	$1,358,280	$0
Tier 1 Intakes	32	16	0	0	81	-
Tier 2 Intakes	8	4	0	0	42	-

Note: Annual average impacts presented in this table are taken as annual average during full or partial flow years; whereas annual averages for the No Action Alternative presented in Table 3-79 above are taken as annual averages during all years under the POR. Therefore, it is not possible to subtract the values in the "Delta from No Action" column from the "Value" column in the table above and obtain the result presented in Table 3-79.

Regional Economic Development

For the four counties evaluated for the side channel intakes case study, employment would be reduced by an average of 80 jobs and $3.9 million in labor income during test flow years compared to the No Action Alternative. These results are consistent across alternatives, and alternatives only vary in the number of potential test flow years (See Table 3-91 above). Variation 1A has 16 potential test flow releases. In years without test flow releases, there would be no difference in employment, labor income, and sales compared to No Action across alternatives.

Richland County would experience the greatest decrease in jobs and labor income relative to the No Action Alternative during test flow years, with decreases in employment and labor income of 32 jobs and $1.7 million, respectively. Valley County would be least impacted during test flow years, with decreases in employment and labor income of 7 jobs and $0.3 million, respectively. This is because the mix of crops grown in Valley County result in fewer economic damages when switching to dryland production.

It is important to note that the RED results do not include downstream industries that are dependent on crops produced in the study area. Industries such as processing facilities, storage facilities and transportation entities would also be adversely impacted by a reduction in crop production. Because these industries are not included in the model, the RED impacts are likely underestimated.

Other Social Effects

As shown in the low flow analysis, agriculture changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Variation 1A would decrease relative to the No Action Alternative during full flow years as would employment, labor income, and sales. This reduction in net farm income would impact farms relying on side channel intakes for irrigation and represents a large percentage of net farm income in counties most affected. Additionally, operations and maintenance costs for all irrigators would increase because of high flows, particularly during full and partial flow release years. There is also a potential for adverse impacts to occur to downstream industries that are dependent on crop production from the study area. These impacts would occur primarily during full or partial flow years with the potential for OSE impacts to be moderately adverse to economic vitality and community well-being with negligible long-term OSE impacts.

3.6.2.6 Alternative 1 – 1B Variation

Variation 1B is another test flow variation of Alternative 1. The parameters for Variation 1B are the same as described for Alternative 1 except that the Attraction Flow would be initiated on April 23 and the Spawning Cue Flow would be initiated on June 4. Similar to the concept described in Variation 1A, the later initiation date is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

3.6.2.6.1 Low Flows

National Economic Development

The NED results for Variation 1B are summarized in Table 3-92. On average net farm income would total $9.5 million for all five counties per year under Variation 1B. This represents a slight decrease from the No Action Alternative of $363,000 or -3.7 percent. On average, all counties under this alternative would experience small adverse impacts, except McLean County in North Dakota, which would experience negligible impacts. These impacts in McLean County would be due to the spawning cue release increasing lake elevations at Lake Sakakawea in some full release years, which would increase access to water for irrigation. During the eight years with the lowest crop production values relative to the No Action Alternative, the change in net farm income would be temporary and large across most counties, with Roosevelt County experiencing a decrease of $1.8 million in net farm income in the average of the eight worst difference years from the No Action Alternative. Irrigation in Richland County would experience decreases in net farm income in the eight worst difference years of $1.3 million. In specific counties, individual farms that rely on the Missouri River for irrigation could experience isolated adverse impacts in some years. However, during the best difference years, with increased net farm income compared to No Action Alternative, many of these adverse impacts would be offset, resulting in very small changes in average annual net farm income under Variation 1B relative to the No Action Alternative.

Table 3-92. County Level Summary of NED analysis for Variation 1B (FY2021 Dollars)*

State	County	Average Annual Net Farm Income	Change in Average Annual Net Farm Income Relative to No Action Alternative	Percent Change Relative to No Action Alternative	Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	% Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)	% Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)
Montana	McCone	$960,000	-$43,000	-4.3%	$44,000	4.4%	-$435,000	-43.4%
	Valley	$1,187,000	-$40,000	-3.3%	$13,000	1.1%	-$401,000	-32.7%
	Roosevelt	$4,005,000	-$165,000	-3.9%	$293,000	7.0%	-$1,774,000	-42.5%
	Richland	$2,718,000	-$117,000	-4.1%	$193,000	6.8%	-$1,294,000	-45.6%
North Dakota	McLean	$655,000	$1,000	0.2%	$36,000	5.5%	-$24,000	-3.7%
Total		$9,526,000	-$363,000	-3.7%	$521,000	5.3%	-$3,812,000	-38.6%

*data in table represents totals for each county. The data for Roosevelt County, for instance, represents 77 intakes worth of net farm income.

Additional modeling results are summarized in Table 3-92, which shows the difference in annual net farm income during years when there is a release action. Years of full release correspond to year of high impact, as shown in Table 3-92. The year of highest adverse impact for a full release year (-$8.1 million) occurred in conditions similar to 1987, when higher spring releases would require lower fall releases from Fort Peck Reservoir to balance system storage, which causes decreased flows, decreasing access to water for irrigation relative to the No Action Alternative. However, a reduction in flows during this latter part of the irrigation season would have a less adverse impact than a reduction in flows during the peak irrigation season, such as July. Therefore, the economic impacts due to these reduced flows at the end of the irrigation season may be overstated. Net farm income in Valley, Roosevelt, Richland, and McCone Counties would decrease in particular relative to the No Action Alternative. The one-year decrease in net farm income for the most affected county (Roosevelt County, with a decline of $3.9 million) in 1987 represents 26 percent of net cash farm income of all farming operations in that county ($15.2 million) (USDA, 2017).[9]

Years with partial flow releases also correspond with lower annual net farm income. For example, the highest adverse impact year regardless of flow action relative to the No Action Alternative would occur in 1983, a partial release year when reservoir releases would be lower than under No Action Alternative. In this year, adverse impacts would be more concentrated downstream of Fort Peck Lake, with reductions in net farm income occurring in Roosevelt County (with a decrease of $3.6 million relative to the No Action Alternative), Roosevelt County (with a decrease of $3.2 million), and Valley County (with a decrease of $935,000 relative to the No Action Alternative). The decrease in net farm income in Roosevelt County would represent 24 percent of net farm income of all farm operations in the county ($15.2 million) (USDA 2017).

Increases in net farm income relative to the No Action Alternative would also occur in some years, increasing by as much at $2.1 million across all counties (Table 3-93).

[9] Net cash farm income is the gross cash income—all income, such as crop value of production—minus any expenses, which would include raw materials, employees, and even payments on debt. This is a simpler estimation of net farm income as it does not include depreciation and amortization expenses.

Table 3-93. Impacts from modeled flow releases to net farm income in the 5 counties under Variation 1B; change in net farm income relative to the No Action Alternative (FY2021 Dollars)

Full Release[a]		Year After Full Release		Partial Flow Release [b]		Years with Greatest Range in Impacts Regardless of Flow Actions	
Low	High	Low	High	Low	High	Low	High
-$8,056,211	$87,743	-$1,157,214	$0	-$8,473,387	$2,102,627	-$8,473,387	$2,102,627

a Spawning cue releases and low summer flow events would be fully implemented in 9 years of the POR. Data represents the lowest and highest dollar impacts in the years the action would be implemented. Negative values indicate reductions in net farm income relative to the No Action Alternative.

b Spawning cue release would be partially implemented in 16 years of the POR.

Regional Economic Development

For the five counties evaluated, employment would be reduced by an average of 4 jobs and $200,000 in labor income per year compared to the No Action Alternative (Table 3-94). For the eight years with the greatest reduction in crop production relative to the No Action Alternative, there would be 45 fewer jobs on average across all five counties and labor income would decrease by $2.2 million. In the years with the greatest increase in net farm income relative to the No Action Alternative, there would be an increase in 6 jobs.

Roosevelt County would experience the greatest decrease in jobs and labor income relative to the No Action Alternative during the average of the eight worst difference years of 20 jobs and $995,000, respectively, primarily due to higher spring releases during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation relative to the No Action Alternative. However, as most of these impacts occur in the latter part of the irrigation season they may result in fewer impacts than are shown here. A reduction of 20 jobs represents approximately 3 percent of farm jobs (596 farm jobs) in Roosevelt County in 2018 (U.S. Bureau of Economic Analysis, 2019). On average, there would be negligible to small temporary changes in the RED effects with small increases and decreases in some years with the spawning cue releases and low flow events increasing and decreasing reservoir elevations and river flows and stages.

Table 3-94. Variation 1B RED analysis for value of irrigated crop production (FY2021 Dollars)

Economic Impact	Scenario	Total
Direct and Secondary jobs	Average Annual	764
	Change in Average Annual from No Action Alternative	-4.1
	Average of the Eight Best Difference Years Relative to No Action Alternative	6.4
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-44.6
Direct and Secondary income	Average Annual	$36,260,000
	Change in Average Annual from No Action Alternative	-$200,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$318,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$2,161,000
Direct and Secondary sales	Average Annual	$113,639,000
	Change in Average Annual from No Action Alternative	-$620,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$984,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$6,702,000

Other Social Effects

Changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Variation 1B would decrease slightly relative to the No Action Alternative as would employment, labor income, and sales. During certain years, these impacts would be small in some counties due to lower reservoir elevations and river stages. During the worst difference years, reductions in net farm income would represent a large percentage of net cash farm income in counties most affected. Variation 1B would not likely result in long-term OSE impacts to communities or the region because NED and RED impacts would be negligible to small and temporary. However, short-term small adverse impacts to economic vitality and community well-being could occur during a few years if reductions in irrigation are concentrated within the affected counties.

3.6.2.6.2 High Flows

National Economic Development

Side Channel Case Study

The NED results for the side channel case study are consistent across alternatives, where the total annual decrease in net farm income during test flow years compared to the No Action Alternative is $7.5 million across all four counties (See Table 3-84 above). The decrease in net farm income breaks down to a decrease of $1.0 million in McCone County, $530,000 in Valley County, $2.8 million in Roosevelt County, and $3.1 million in Richland County. On average, the decrease in net income per intake is $245,353, but this ranges by county, with the smallest decrease of $131,413 in McCone County and the highest of $355,045 in Richland County.

Variation 1B has eight potential test flow years where losses in net farm income to side channel intakes could result from high flows. In years without test flows, there is no difference in net farm income compared to No Action. According to the sensitivity analysis (see 3-85 above), which is consistent across alternatives, total annual decrease in net farm income during test flow years compared to the No Action Alternative can be as high as $7.5 million across all four counties but may be lower depending on the number of intakes with losses in crop productivity due to a test flow. Decreases in net farm income will also vary depending on the O&M costs incurred at each intake. Net farm income during test flow years compared to the No Action Alternative may be as high as $8.1 million across all four counties but may be lower, depending on the actual costs incurred.

Missouri River Mainstem Irrigation Intakes Analysis

For Missouri River mainstem channel intakes under Variation 1B, 15 more intakes have tier 1 impacts on average annually during full and partial flow years and 4 more intakes have tier 2 impacts relative to the No Action Alternative. There would be an increase in the total number of tier 1 events on average annually during full and partial flow years of 17 events and 4 tier 2 events relative to the No Action Alternative. On average, during full and partial flow years tier 1 events cost $229,835 and tier 2 events cost $133,730 more annually than under the No Action Alternative (See Table 3-95).

The number of tier 1 and 2 events would fluctuate between a maximum of 111 tier 1 events and 42 tier 2 events in a partial flow year like 1975 to a minimum of no intakes impacted for either tier in other years. The maximum number of intakes impacted differs slightly from the number of events discussed above. The number of individual intakes impacted fluctuates between a maximum of 81 intakes under tier 1 and 42 intakes impacted under tier 2 in a year like 1983 to a minimum of no intakes impacted for either tier in other years. Note that there would be no difference in the number of intakes impacted under Variation 1B relative to the No Action Alternative during a maximum impact full or partial flow year. Additionally, there are three more tier 1 events during a year of maximum impact, like 1975, resulting in a slightly increased tier 1 costs in this year relative the year with the greatest impacts under the No Action Alternative (1975).

Table 3-95. Summary of NED Analysis for Variation 1B During the Irrigation Season During Full or Partial Flow Years (Missouri River Mainstem Intakes) (FY2021 Dollars)

Statistic	Average Annual Impacts		Year of Minimum Impacts		Year of Maximum Impacts	
	Value	Delta from No Action	Value	Delta from No Action	Value	Delta from No Action
Tier 1 Events	41	17	0	0	111	3
Tier 2 Events	7	4	0	0	42	-
Tier 1 Costs	$554,817	$229,835	$0	$0	$1,508,756	$45,720
Tier 2 Costs	$238,617	$133,730	$0	$0	$1,358,280	$0
Tier 1 Intakes	29	15	0	0	81	-
Tier 2 Intakes	7	4	0	0	42	-

Note: Annual average impacts presented in this table are taken as annual average during full or partial flow years; whereas annual averages for the No Action Alternative presented in Table 3-79 above are taken as annual averages during all years under the POR. Therefore, it is not possible to subtract the values in the "Delta from No Action" column from the "Value" column in the table above and obtain the result presented in Table 3-79.

Regional Economic Development

For the four counties evaluated under the side channel intakes case study, employment would be reduced by an average of 80 jobs and $3.9 million in labor income during test flow years compared to the No Action Alternative. These results are consistent across alternatives, and alternatives only vary in the number of potential test flow years. Variation 1B has eight potential test flow releases. In years without test flow releases, there would be no difference in employment, labor income, and sales compared to No Action across alternatives. Richland County would experience the greatest decrease in jobs and labor income relative to the No Action Alternative during test flow years, with decreases in employment and labor income of 32 jobs and $1.7 million, respectively. Valley County would be least impacted during test flow years, with decreases in employment and labor income of 7 jobs and $0.3 million, respectively. This is because the mix of crops grown in Valley County result in fewer economic damages when switching to dryland production.

It is important to note that the RED results do not include downstream industries that are dependent on crops produced in the study area. Industries such as processing facilities, storage facilities and transportation entities would also be adversely impacted by a reduction in crop production. Because these industries are not included in the model, the RED impacts are likely underestimated.

Other Social Effects

As shown in the low flow analysis, agriculture changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Variation 1B would decrease relative to the No Action Alternative during full flow years as would employment, labor income, and sales. This reduction in net farm income would impact farms relying on side channel intakes for irrigation and represents a large percentage of net farm income in counties most affected. Additionally, operations and maintenance costs for all irrigators would increase because of high flows, particularly during full and partial flow release years. There is also a potential for adverse impacts to occur to downstream industries that are dependent on crop production from the study area. These impacts would occur primarily during full or partial flow years with the potential for OSE impacts to be moderately adverse to economic vitality and community well-being with negligible long-term OSE impacts.

Conclusion – Alternative 1 including Variations 1A and 1B

Under Alternative 1, including Variations 1A and 1B, it is expected that farms using Missouri River water for irrigation would have relatively small, short-term, adverse impacts relative to the No Action Alternative due to lower reservoir elevations and river flows in certain years. High flows could result in moderate adverse impacts to irrigation intakes in Montana, with side channel intakes being at greater risk of sedimentation and other high flow related issues.

The low flow analysis under Alternative 1, showed on average, farms using Missouri River water for irrigation would experience a slight decrease in net farm income of $289,000 to $391,000 (2.9% to 4.0%) under Alternative 1 including Variations 1A and 1B relative to the No Action Alternative. Overall, the change in NED would be small, with some large changes in worst change years relative to the No Action Alternative. There would be small changes in RED and OSE impacts relative to the No Action Alternative because impacts on irrigation operations would be temporary and small under Alternative 1 including Variations 1A and 1B.

The high flow analysis showed that approximately 21 to 25 percent of intakes would be impacted by a tier 1 high flow event and 5 to 8 percent of intakes would be impacted by a tier 2 high flow event during the irrigation season on average annually during full or partial flow years. Impacts to side channel intakes from high flows would result in a decrease of -$245,353 in net farm income per side channel intake during high flow years. This annual impact is the same for Alternative 1 and all the variations. The difference across alternative and variation for side channel intakes is due to the number of years with test flows. Variation 1A has the most test flow years that could result in these net farm income decreases, followed by Alternative 1, and then by Variation 1B. Regionally, years with test flows would lead to employment losses of 80 jobs and labor income losses of $4.0 million due to impacts on side channels.

3.6.2.7 Alternative 2

The parameters for Alternative 2 are the same as described for Alternative 1 except that the Attraction Flow Regime peak would be 14,000 cfs (the maximum powerhouse capacity) rather than twice the average Fort Peck spring flow in the given year. The maximum amount of flow that can be run through the generators is 14,000 cfs. Any additional flow would be run through the spillway and does not generate hydroelectricity. Additionally, releases as measured at Wolf Point gage would be held at 14,000 cfs until the Spawning Cue release is initiated.

3.6.2.7.1 Low Flows

National Economic Development

The NED results for Alternative 2 are summarized in Table 3-96. On average net farm income would total $9.7 million for all five counties per year under Alternative 2. This represents a slight decrease from the No Action Alternative of $237,000 or -2.4 percent. On average, all counties under this alternative would experience small adverse impacts, except McLean County in North Dakota, which would experience negligible impacts. These impacts in McLean County would be due to the spawning cue release increasing lake elevations at Lake Sakakawea in some full release years, which would increase access to water for irrigation. During the eight years with the lowest crop production values relative to the No Action Alternative, the change in net farm income would be temporary and large across most counties, with Roosevelt County experiencing a decrease of $1.7 million in net farm income in the average of the eight worst difference years from the No Action Alternative. Irrigation in Richland County would experience decreases in net farm income in the eight worst difference years of $1.2 million. In specific counties, individual farms that rely on the Missouri River for irrigation could experience isolated adverse impacts in some years. However, during the best difference years, with increased net farm income compared to No Action Alternative, many of these adverse impacts would be offset, resulting in small changes in average annual net farm income under Alternative 2 relative to the No Action Alternative.

Table 3-96. County level Summary of NED analysis for Alternative 2 (FY2021 Dollars)*

State	County	Average Annual Net Farm Income	Change in Average Annual Net Farm Income Relative to No Action Alternative	Percent Change Relative to No Action Alternative	Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	% Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)	% Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)
Montana	McCone	$971,000	-$31,000	-3.1%	$118,000	11.8%	-$440,000	-43.9%
	Valley	$1,202,000	-$26,000	-2.1%	$89,000	7.3%	-$351,000	-28.6%
	Roosevelt	$4,060,000	-$110,000	-2.6%	$636,000	15.3%	-$1,739,000	-41.7%
	Richland	$2,761,000	-$74,000	-2.6%	$425,000	15.0%	-$1,163,000	-41.0%
North Dakota	McLean	$658,000	$4,000	0.6%	$48,000	7.3%	-$12,000	-1.9%
Total		$9,652,000	-$237,000	-2.4%	$1,292,000	13.1%	-$3,682,000	-37.2%

*data in table represents totals for each county. The data for Roosevelt County, for instance, represents 77 intakes worth of net farm income.

Additional modeling results are summarized in Table 3-97, which shows the difference in annual net farm income during years when there is a release action. Years of full release correspond to the years of highest impact, as shown in Table 3-97. The year of highest adverse impact (-$8.1 million) occurred in conditions similar to 1987, when higher spring releases would require lower fall releases from Fort Peck Reservoir to balance system storage, which causes decreased flows, decreasing access to water for irrigation relative to the No Action Alternative. However, a reduction in flows during this latter part of the irrigation season would have a less adverse impact than a reduction in flows during the peak irrigation season, such as July. Therefore, the economic impacts due to these reduced flows at the end of the irrigation season may be overstated. Net farm income in Valley, Roosevelt, Richland, and McCone Counties would decrease in particular relative to the No Action Alternative. The one-year decrease in net farm income for the most affected county (Roosevelt County, with a decline of $3.9 million) in 1987 represents 26 percent of net farm income of all farming operations in that county ($15.2 million) (USDA, 2017).[10]

Years with partial flow releases also correspond with lower annual net farm income. For example, the second-highest adverse impact year relative to the No Action Alternative would occur in 1986, a partial release year when reservoir releases would be lower than under the No Action Alternative. In this year, adverse impacts would be more concentrated downstream of Fort Peck Lake, with reductions in net farm income greatest in Roosevelt County (with a decrease of $2.2 million relative to the No Action Alternative), Richland County (with a decrease of $1.1 million), Valley County (with a decrease of $1.2 million), and McCone County (with a decrease of $1.2 million relative to the No Action Alternative). The decrease in net farm income in Roosevelt County would represent 15 percent of net cash farm income of all farm operations in the county ($15.2 million) (USDA, 2017).

Increases in net farm income relative to the No Action Alternative would also occur in some years, increasing by as much at $6.0 million across all counties (Table 3-97).

[10] Net cash farm income is the gross cash income—all income, such as crop value of production—minus any expenses, which would include raw materials, employees, and even payments on debt. This is a simpler estimation of net farm income as it does not include depreciation and amortization expenses.

Table 3-97. Impacts from modeled flow releases to net farm income in the 5 counties under Alternative 2; change in net farm income relative to the No Action Alternative (FY2021 Dollars)

Full Release[a]		Year After Full Release		Partial Flow Release [b]		Years with Greatest Range in Impacts Regardless of Flow Actions	
Low	High	Low	High	Low	High	Low	High
-$8,072,016	$5,961,756	-$1,930,797	$0	-$5,715,207	$3,823,714	-$8,072,016	$5,961,756

a Spawning cue releases and low summer flow events would be fully implemented in 10 years of the POR. Data represents the lowest and highest dollar impacts in the years the action would be implemented. Negative values indicate reductions in net farm income relative to the No Action Alternative.

b Spawning cue release would be partially implemented in 10 years of the POR.

Regional Economic Development

For the five counties evaluated, employment would be reduced by an average of 3 jobs and $130,000 in labor income per year compared to the No Action Alternative (Table 3-98). For the eight years with the greatest reduction in crop production relative to the No Action Alternative, there would be 42 fewer jobs on average across all five counties and labor income would decrease by $2.0 million. However, in the years with the greatest increase in net farm income relative to the No Action Alternative, there would be an increase in 15 jobs.

Roosevelt County would experience the greatest decrease in jobs and labor income relative to the No Action Alternative during the average of the eight worst difference years of 19 jobs and $975,000, respectively, primarily due to higher spring releases during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation relative to the No Action Alternative. However, as most of these impacts occur in the latter part of the irrigation season they may result in fewer impacts than are shown here. A reduction of 19 jobs represents approximately 3 percent of farm jobs (596 farm jobs) in Roosevelt County in 2018 (U.S. Bureau of Economic Analysis, 2019). On average, there would be negligible to small temporary changes in the RED effects with small increases and decreases in some years with the spawning cue releases and low flow events increasing and decreasing reservoir elevations and river flows and stages.

Table 3-98. Alternative 2 RED analysis for value of irrigated crop production (FY2021 Dollars)

Economic Impact	Scenario	Total
Direct and Secondary jobs	Average Annual	765
	Change in Average Annual from No Action Alternative	-2.7
	Average of the Eight Best Difference Years Relative to No Action Alternative	14.8
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-42.0
Direct and Secondary income	Average Annual	$36,330,000
	Change in Average Annual from No Action Alternative	-$130,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$724,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$2,037,000
Direct and Secondary sales	Average Annual	$113,854,000
	Change in Average Annual from No Action Alternative	-$405,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$2,240,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$6,324,000

Other Social Effects

Changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Alternative 2 would decrease slightly relative to the No Action Alternative as would employment, labor income, and sales. During certain years, these impacts would be small in some counties due to lower reservoir elevations and river stages. During the worst difference years, reductions in net farm income would represent a large percentage of net cash farm income in counties most affected. Alternative 2 would not likely result in long-term OSE impacts to communities or the region because NED and RED impacts would be negligible to small and temporary. However, short-term small adverse impacts to economic vitality and community well-being could occur during a few years if reductions in irrigation are concentrated within the affected counties.

3.6.2.7.2 High Flows

National Economic Development

Side Channel Case Study

The NED results for the side channel case study are consistent across alternatives, where the total annual decrease in net farm income during test flow years compared to the No Action Alternative is $7.5 million across all four counties (See Table 3-84 above). The decrease in net farm income breaks down to a decrease of $1.0 million in McCone County, $530,000 in Valley County, $2.8 million in Roosevelt County, and $3.1 million in Richland County. On average, the decrease in net income per intake is $245,353, but this ranges by county, with the smallest decrease of $131,413 in McCone County and the highest of $355,045 in Richland County. Alternative 2 has 10 potential test flow years where losses in net farm income to side channel intakes could result from high flows. In years without test flows, there is no difference in net farm income compared to No Action. According to the sensitivity analysis (see Table 3-85 above), which is consistent across alternatives, total annual decrease in net farm income during test flow years compared to the No Action Alternative can be as high as $7.5 million across all four counties but may be lower depending on the number of intakes with losses in crop productivity due to a test flow. Decreases in net farm income will also vary depending on the O&M costs incurred at each intake. Net farm income during test flow years compared to the No Action Alternative may be as high as $8.1 million across all four counties but may be lower, depending on the actual costs incurred.

Missouri River Mainstem Irrigation Intakes Analysis

For Missouri River mainstem channel intakes under Alternative 2, 18 more intakes have tier 1 impacts on average annually during full and partial flow years while 9 more intakes have tier 2 impacts relative to the No Action Alternative. There would be an increase in the total number of tier 1 events on average annually during full and partial flow years of 19 events and 9 tier 2 events relative to the No Action Alternative. On average, during full and partial flow years tier 1 events cost $259,079 and tier 2 events cost $297,528 more annually than under the No Action Alternative (See Table 3-99).

The number of tier 1 and 2 events would fluctuate between a maximum of 101 tier 1 events and 42 tier 2 events in a partial flow year like 1975 to a minimum of no intakes impacted for either tier in other years. The maximum number of intakes impacted differs slightly from the number of events discussed above. The number of individual intakes impacted fluctuates between a maximum of 81 intakes under tier 1 and 42 intakes impacted under tier 2 in a year like 1975 to a minimum of no intakes impacted under either tier in other years. Note that there would be no difference in the number of intakes impacted under Alternative 2 relative to the No Action Alternative during a maximum impact full or partial flow year. Additionally, there are 7 fewer tier 1 events during a year of maximum impact, like 1975, resulting in reduced tier 1 costs in this year relative the year with the greatest impacts under the No Action Alternative (1975).

Table 3-99. Summary of NED Analysis for Alternative 2 During the Irrigation Season During Full or Partial Flow Years (Missouri River Mainstem Intakes) (FY2021 Dollars)

Statistic	Average Annual Impacts		Year of Minimum Impacts		Year of Maximum Impacts	
	Value	Delta from No Action	Value	Delta from No Action	Value	Delta from No Action
Tier 1 Events	47	19	0	0	101	(7)
Tier 2 Events	13	9	0	0	42	-
Tier 1 Costs	$633,983	$259,079	$0	$0	$1,371,597	-$91,440
Tier 2 Costs	$423,654	$297,528	$0	$0	$1,358,280	$0
Tier 1 Intakes	35	18	0	0	81	-
Tier 2 Intakes	13	9	0	0	42	-

Note: Annual average impacts presented in this table are taken as annual average during full or partial flow years; whereas annual averages for the No Action Alternative presented in Table 3-79 above are taken as annual averages during all years under the POR. Therefore, it is not possible to subtract the values in the "Delta from No Action" column from the "Value" column in the table above and obtain the result presented in Table 3-79.

Regional Economic Development

For the four counties evaluated under the side channel intakes case study, employment would be reduced by an average of 80 jobs and $3.9 million in labor income during test flow years compared to the No Action Alternative. These results are consistent across alternatives, and alternatives only vary in the number of potential test flow years. Alternative 2 has 10 potential test flow releases. In years without test flow releases, there would be no difference in employment, labor income, and sales compared to No Action across alternatives.

Richland County would experience the greatest decrease in jobs and labor income relative to the No Action Alternative during test flow years, with decreases in employment and labor income of 32 jobs and $1.7 million, respectively, due to losses in crop productivity in those years. Valley County would be least impacted during test flow years, with decreases in employment and labor income of 7 jobs and $0.3 million, respectively. This is because the mix of crops grown in Valley County result in fewer economic damages when switching to dryland production.

It is important to note that the RED results do not include downstream industries that are dependent on crops produced in the study area. Industries such as processing facilities, storage facilities and transportation entities would also be adversely impacted by a reduction in crop production. Because these industries are not included in the model, the RED impacts are likely underestimated.

Other Social Effects

As shown in the low flow analysis, agriculture changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Alternative 2 would decrease relative to the No Action Alternative during full flow years as would employment, labor income, and sales. This reduction in net farm income would impact farms relying on side channel intakes for irrigation and represents a large percentage of net cash farm income in counties most affected. Additionally, operations and maintenance costs for all irrigators would increase because of high flows, particularly during full and partial flow release years. There is also a potential for adverse impacts to occur to downstream industries that are dependent on crop production from the study area. These impacts would occur primarily during full or partial flow years with the potential for OSE impacts to be moderately adverse to economic vitality and community well-being with negligible long-term OSE impacts. Alternative 2 – 2A Variation

Variation 2A is a test flow variation of Alternative 2. The parameters for Variation 2A are the same as described for Alternative 2 except that the Attraction Flow would be initiated on April 9, rather than April 16, and the Spawning Cue flow would be initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

3.6.2.7.3 Low Flows

National Economic Development

The NED results for Variation 2A are summarized in Table 3-100. On average net farm income would total $9.4 million for all five counties per year under Variation 2A. This represents a decrease from the No Action Alternative of $512,000 or -5.2 percent. On average, all counties under this alternative would experience small adverse impacts, except McLean County in North Dakota, which would experience negligible impacts. These impacts in McLean County would be due to the spawning cue release increasing lake elevations at Lake Sakakawea in some full release years, which would increase access to water for irrigation. During the eight years with the lowest crop production values relative to the No Action Alternative, the change in net farm income would be temporary and large across most counties, with Roosevelt County experiencing a decrease of $2.4 million in net farm income in the average of the eight worst difference years from the No Action Alternative. Irrigation in Richland County would experience decreases in net farm income in the eight worst difference years of $1.7 million. In specific counties, individual farms that rely on the Missouri River for irrigation could experience isolated adverse impacts in some years. However, during the best difference years, with increased net farm income compared to No Action Alternative, many of these adverse impacts would be offset, resulting in very small changes in average annual net farm income under Variation 2A relative to the No Action Alternative.

Table 3-100. County Level Summary of NED Analysis for Variation 2A (FY2021 Dollars)

State	County	Average Annual Net Farm Income	Change in Average Annual Net Farm Income Relative to No Action Alternative	Percent Change Relative to No Action Alternative	Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	% Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)	% Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)
Montana	McCone	$946,000	-$57,000	-5.6%	$44,000	4.4%	-$619,000	-61.7%
	Valley	$1,179,000	-$49,000	-4.0%	$28,000	2.3%	-$528,000	-43.0%
	Roosevelt	$3,929,000	-$241,000	-5.8%	$106,000	2.5%	-$2,429,000	-58.3%
	Richland	$2,666,000	-$169,000	-5.9%	$62,000	2.2%	-$1,690,000	-59.6%
North Dakota	McLean	$656,000	$2,000	0.3%	$44,000	6.7%	-$24,000	-3.6%
Total		$9,377,000	-$512,000	-5.2%	$256,000	2.6%	-$5,243,000	-53.0%

*data in table represents totals for each county. The data for Roosevelt County, for instance, represents 77 intakes worth of net farm income.

Additional modeling results are summarized in Table 3-101, which shows the difference in annual net farm income during years when there is a release action. Years of full release correspond to the years of highest impact, as shown in Table 3-101. The year of highest adverse impact (-$8.1 million) occurred in conditions similar to 1987, when higher spring releases would require lower fall releases from Fort Peck Reservoir to balance system storage, which causes decreased flows, decreasing access to water for irrigation relative to the No Action Alternative. However, a reduction in flows during this latter part of the irrigation season would have a less adverse impact than a reduction in flows during the peak irrigation season, such as July. Therefore, the economic impacts due to these reduced flows at the end of the irrigation season may be overstated. Net farm income in Valley, Roosevelt, Richland, and McCone Counties would decrease in particular relative to the No Action Alternative. The one-year decrease in net farm income for the most affected county (Roosevelt County, with a decline of $3.9 million) in 1987 represents 26 percent of net cash farm income of all farming operations in that county ($15.2 million) (USDA, 2017).[11]

Years with partial flow releases also correspond with lower annual net farm income. For example, the second-highest adverse impact year relative to the No Action Alternative would occur in 1973, a partial release year when reservoir releases would be lower than under the No Action Alternative. In this year, adverse impacts would be more concentrated downstream of Fort Peck Lake, with reductions in net farm income occurring in Roosevelt County (with a decrease of $3.7 million relative to the No Action Alternative, Richland County (with a decrease of $2.5 million), and McCone County (with a decrease of $833,000 relative to the No Action Alternative). The decrease in net farm income in Roosevelt County would represent 24 percent of net cash farm income of all farm operations in the county ($15.2 million) (USDA, 2017).

Increases in net farm income relative to the No Action Alternative would also occur in some years, increasing by as much at $1.2 million across all counties (Table 3-101).

[11] Net cash farm income is the gross cash income—all income, such as crop value of production—minus any expenses, which would include raw materials, employees, and even payments on debt. This is a simpler estimation of net farm income as it does not include depreciation and amortization expenses.

Table 3-101. Impacts from modeled flow releases to net farm income in the 5 counties under Variation 2A; change in net farm income relative to the No Action Alternative (FY2021 Dollars)

Full Release[a]		Year After Full Release		Partial Flow Release [b]		Years with Greatest Range in Impacts Regardless of Flow Actions	
Low	High	Low	High	Low	High	Low	High
-$8,072,868	$103,929	-$1,930,797	$447,284	-$7,560,686	$0	-$8,072,868	$1,163,741

a Spawning cue releases and low summer flow events would be fully implemented in 15 years of the POR. Data represents the lowest and highest dollar impacts in the years the action would be implemented. Negative values indicate reductions in net farm income relative to the No Action Alternative.

b Spawning cue release would be partially implemented in 5 years of the POR.

Regional Economic Development

For the five counties evaluated, employment would be reduced by an average of 6 jobs and $283,000 in labor income per year compared to the No Action Alternative (Table 3-102). For the eight years with the greatest reduction in crop production relative to the No Action Alternative, there would be 60 fewer jobs on average across all five counties and labor income would decrease by $2.9 million. In the years with the greatest increase in net farm income relative to the No Action Alternative, there would be an increase in 3 jobs.

Roosevelt County would experience the greatest decrease in jobs and labor income relative to the No Action Alternative during the average of the eight worst difference years of 27 jobs and $1.4 million, respectively. This impact would be largely caused by the higher spring releases during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation relative to the No Action Alternative. However, as most of these impacts occur in the latter part of the irrigation season they may result in fewer impacts than are shown here. A reduction of 27 jobs represents approximately 5 percent of farm jobs (596 farm jobs) in Roosevelt County in 2018 (U.S. Bureau of Economic Analysis, 2019). On average, there would be negligible to small temporary changes in the RED effects with small increases and decreases in some years with the spawning cue releases and low summer flow events increasing and decreasing reservoir elevations and river flows and stages.

Table 3-102. Variation 2A RED analysis for value of irrigated crop production (FY2021 Dollars)

Economic Impact	Scenario	Total
Direct and Secondary jobs	Average Annual	762
	Change in Average Annual from No Action Alternative	-5.8
	Average of the Eight Best Difference Years Relative to No Action Alternative	3.3
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-60.0
Direct and Secondary income	Average Annual	$36,177,000
	Change in Average Annual from No Action Alternative	-$283,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$149,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$2,906,000
Direct and Secondary sales	Average Annual	$113,384,000
	Change in Average Annual from No Action Alternative	-$875,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$476,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$9,025,000

Other Social Effects

Changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Variation 2A would decrease slightly relative to the No Action Alternative as would employment, labor income, and sales. During certain years, these impacts would be small in some counties due to lower reservoir elevations and river stages. During the worst difference years, reductions in net farm income would represent a large percentage of net cash farm income in counties most affected. Variation 2A would not likely result in long-term OSE impacts to communities or the region because NED and RED impacts would be negligible to small and temporary. However, small short-term adverse impacts to economic vitality and community well-being could occur during a few years if reductions in irrigation are concentrated within the affected counties.

3.6.2.7.4 High Flows

National Economic Development

Side Channel Case Study

The NED results for the side channel case study are consistent across alternatives, where the total annual decrease in net farm income during test flow years compared to the No Action Alternative is $7.5 million across all four counties (See Table 3-84 above). The decrease in net farm income breaks down to a decrease of $1.0 million in McCone County, $530,000 in Valley County, $2.8 million in Roosevelt County, and $3.1 million in Richland County. On average, the decrease in net income per intake is $245,353, but this ranges by county, with the smallest decrease of $131,413 in McCone County and the highest of $355,045 in Richland County. Variation 2A has 15 potential test flow years where losses in net farm income to side channel intakes could result from high flows. In years without test flows, there is no difference in net farm income compared to No Action. According to the sensitivity analysis (see Table 3-85 above), which is consistent across alternatives, total annual decrease in net farm income during test flow years compared to the No Action Alternative can be as high as $7.5 million across all four counties but may be lower depending on the number of intakes with losses in crop productivity due to a test flow. Decreases in net farm income will also vary depending on the O&M costs incurred at each intake. Net farm income during test flow years compared to the No Action Alternative may be as high as $8.1 million across all four counties but may be lower, depending on the actual costs incurred.

Missouri River Mainstem Irrigation Intakes Analysis

For Missouri River mainstem channel intakes under Variation 2A, 21 more intakes have tier 1 impacts on average annually during full and partial flow years while 12 more intakes have tier 2 impacts relative to the No Action Alternative. There would be an increase in the total number of tier 1 events on average annually during full and partial flow years of 19 events and 12 tier 2 events relative to the No Action Alternative. On average, during full and partial flow years tier 1 events cost $252,248 and tier 2 events cost $378,044 more annually than under the No Action Alternative (See Table 3-103).

The number of tier 1 and 2 events would fluctuate between a maximum of 105 tier 1 events and 42 tier 2 events in a partial flow year like 1975 to a minimum of no intakes impacted for either tier in other years. The maximum number of intakes impacted differs slightly from the number of events discussed above. The number of individual intakes impacted fluctuates between a maximum of 84 intakes under tier 1 and 42 intakes impacted under tier 2 in a year like 1975 to a minimum of no intakes impacted for either tier in other years. Note that there are only three more intakes impacted under Variation 2A relative to the No Action Alternative during a maximum impact full or partial flow year, a four percent increase in the number of impacted intakes. Additionally, there are three fewer tier 1 events during a year of maximum impact, like 1975, resulting in reduced tier 1 costs in this year relative to the year with the greatest impacts under the No Action Alternative (1975).

Table 3-103. Summary of NED Analysis for Variation 2A During the Irrigation Season During Full or Partial Flow years (Missouri River Mainstem Intakes) (FY2021 Dollars)

Statistic	Average Annual Impacts		Year of Minimum Impacts		Year of Maximum Impacts	
	Value	Delta from No Action	Value	Delta from No Action	Value	Delta from No Action
Tier 1 Events	44	19	0	0	105	(3)
Tier 2 Events	16	12	0	0	42	-
Tier 1 Costs	$594,359	$252,248	$0	$0	$1,417,317	-$45,720
Tier 2 Costs	$505,173	$378,044	$0	$0	$1,358,280	$0
Tier 1 Intakes	37	21	0	0	84	3
Tier 2 Intakes	16	12	0	0	42	-

Note: Annual average impacts presented in this table are taken as annual average during full or partial flow years; whereas annual averages for the No Action Alternative presented in Table 3-79 above are taken as annual averages during all years under the POR. Therefore, it is not possible to subtract the values in the "Delta from No Action" column from the "Value" column in the table above and obtain the result presented in Table 3-79.

Regional Economic Development

For the four counties evaluated under the side channel intakes case study, employment would be reduced by an average of 80 jobs and $3.9 million in labor income during test flow years compared to the No Action Alternative. These results are consistent across alternatives, and alternatives only vary in the number of potential test flow years (See Table 3-86 above). Variation 2A has 15 potential test flow releases. In years without test flow releases, there would be no difference in employment, labor income, and sales compared to No Action across alternatives.

It is important to note that the RED results do not include downstream industries that are dependent on crops produced in the study area. Industries such as processing facilities, storage facilities and transportation entities would also be adversely impacted by a reduction in crop production. Because these industries are not included in the model, the RED impacts are likely underestimated.

Other Social Effects

As shown in the low flow analysis, agriculture changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Variation 2A would decrease relative to the No Action Alternative during full flow years as would employment, labor income, and sales. This reduction in net farm income would impact farms relying on side channel intakes for irrigation and represents a large percentage of net cash farm income in counties most affected. Additionally, operations and maintenance costs for all irrigators would increase because of high flows, particularly during full and partial flow release years. There is also a potential for adverse impacts to occur to downstream industries that are dependent on crop production from the study area. These impacts would occur primarily during full or partial flow years with the potential for OSE impacts to be moderately adverse to economic vitality and community well-being with negligible long-term OSE impacts. Alternative 2 – 2B Variation

Variation 2B is a test flow is another variation of Alternative 2. The parameters for Variation 2B are the same as described for Alternative 2 except that the Attraction Flow would be initiated on April 23, rather than April 16, and the Spawning Cue flow would be initiated on June 4, rather than May 21. The difference in timing is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

3.6.2.7.5 Low Flows

National Economic Development

The NED results for Variation 2B are summarized in Table 3-104. On average net farm income would total $9.2 million for all five counties per year under Alternative 1. This represents a decrease from the No Action Alternative of $658,000 or -6.7 percent. On average, all counties under this alternative would experience small adverse impacts, except McLean County in North Dakota, which would experience negligible impacts. These impacts in McLean County would be due to the spawning cue release increasing lake elevations at Lake Sakakawea in some full release years, which would increase access to water for irrigation. During the eight years with the lowest crop production values relative to the No Action Alternative, the change in net farm income would be temporary and large across most counties, with Roosevelt County experiencing a decrease of $1.6 million in net farm income in the average of the eight worst difference years from the No Action Alternative. Irrigation in Richland County would experience decreases in net farm income in the eight worst difference years of $1.1 million. In specific counties, individual farms that rely on the Missouri River for irrigation could experience isolated adverse impacts in some years. However, during the best difference years, with increased net farm income compared to No Action Alternative, many of these adverse impacts would be offset, resulting in small changes in average annual net farm income under Variation 2B relative to the No Action Alternative.

Table 3-104. County Level Summary of NED analysis for Variation 2B (FY2021 Dollars)

State	County	Average Annual Net Farm Income	Change in Average Annual Net Farm Income Relative to No Action Alternative	Percent Change Relative to No Action Alternative	Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	% Increase during eight greatest crop production value years compared to No Action Alternative (average annual)	Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)	% Decrease during eight lowest crop production value years compared to No Action Alternative (average annual)
Montana	McCone	$936,000	-$67,000	-6.7%	$6,000	0.6%	-$570,000	-56.8%
	Valley	$1,174,000	-$54,000	-4.4%	$1,000	0.0%	-$482,000	-39.2%
	Roosevelt	$3,854,000	-$316,000	-7.6%	$6,000	0.2%	-$2,646,000	-63.4%
	Richland	$2,610,000	-$225,000	-7.9%	$7,000	0.2%	-$1,943,000	-68.5%
North Dakota	McLean	$658,000	$3,000	0.5%	$43,000	6.5%	-$12,000	-1.9%
Total		$9,231,000	-$658,000	-6.7%	$35,000	0.4%	-$5,535,000	-56.0%

*data in table represents totals for each county. The data for Roosevelt County, for instance, represents 77 intakes worth of net farm income.

Additional modeling results are summarized in Table 3-105, which shows the difference in annual net farm income during years when there is a release action. Years of full release correspond to the years of highest impact, as shown in Table 3-105. The year of highest adverse impact (-$8.2 million) occurred in conditions similar to 1983, when flows decreased earlier in the year than they would have under the No Action Alternative to facilitate system rebalancing. Net farm income in Valley, Roosevelt, Richland, and McCone Counties would decrease in particular relative to the No Action Alternative. The one-year decrease in net farm income for the most affected county (Roosevelt County, with a decline of $3.5 million) in 1983 represents 23 percent of net cash farm income of all farming operations in that county ($15.2 million) (USDA, 2017).[12]

Years with partial flow releases also correspond with lower annual net farm income. For example, the third-highest adverse impact year relative to the No Action Alternative would occur in 1949, a partial release year when reservoir releases would be lower than under the No Action Alternative. In this year, adverse impacts would be more concentrated downstream of Fort Peck Lake, with reductions in net farm income occurring in Roosevelt County (with a decrease of $3.6 million relative to the No Action Alternative), Richland County (with a decrease of $2.4 million), and McCone County (with a decrease of $869,000 relative to the No Action Alternative). The decrease in net farm income in Roosevelt County would represent 24 percent of net cash farm income of all farm operations in the county ($15.2 million) (USDA, 2017).

Increases in net farm income relative to the No Action Alternative would also occur in some years, increasing by as much at $100,000 across all counties (Table 3-105).

Table 3-105. Impacts from modeled flow releases to net farm income in the 5 counties under Variation 2B; change in net farm income relative to the No Action Alternative (FY2021 Dollars)

Full Release[a]		Year After Full Release		Partial Flow Release [b]		Years with Greatest Range in Impacts Regardless of Flow Actions	
Low	High	Low	High	Low	High	Low	High
-$8,202,580	$100,096	-$1,930,797	$60,276	-$7,558,660	$29,816	-$8,202,580	$100,096

a Spawning cue releases and low summer flow events would be fully implemented in 9 years of the POR. Data represents the lowest and highest dollar impacts in the years the action would be implemented. Negative values indicate reductions in net farm income relative to the No Action Alternative.

b Spawning cue release would be partially implemented in 16 years of the POR.

[12] Net cash farm income is the gross cash income—all income, such as crop value of production—minus any expenses, which would include raw materials, employees, and even payments on debt. This is a simpler estimation of net farm income as it does not include depreciation and amortization expenses.

Regional Economic Development

For the five counties evaluated, employment would be reduced by an average of 7 jobs and $364,000 in labor income per year compared to the No Action Alternative (Table 3-106). For the eight years with the greatest reduction in crop production relative to the No Action Alternative, there would be 64 fewer jobs on average across all five counties and labor income would decrease by $3.1 million. In the years with the greatest increase in net farm income relative to Alternative 1, there would be an increase in 1 job.

Roosevelt County would experience the greatest decrease in jobs and labor income relative to the No Action Alternative during the average of the eight worst difference years of 30 jobs and $1.5 million, respectively. This impact is primarily due to higher spring releases during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation relative to the No Action Alternative. However, as most of these impacts occur in the latter part of the irrigation season they may result in fewer impacts than are shown here. A reduction of 30 jobs represents approximately 5 percent of farm jobs (596 farm jobs) in Roosevelt County in 2018 (U.S. Bureau of Economic Analysis, 2019). On average, there would be negligible to small temporary changes in the RED effects with small increases and decreases in some years with the spawning cue releases and low summer flow events increasing and decreasing reservoir elevations and river flows and stages.

Table 3-106. Variation 2B RED analysis for value of irrigated crop production (FY2021 Dollars)

Economic Impact	Scenario	Total
Direct and Secondary jobs	Average Annual	760
	Change in Average Annual from No Action Alternative	-7.4
	Average of the Eight Best Difference Years Relative to No Action Alternative	0.7
	Average of the Eight Worst Difference Years Relative to No Acton Alternative	-63.7
Direct and Secondary income	Average Annual	$36,096,000
	Change in Average Annual from No Action Alternative	-$364,000
	Average of the Eight Best Difference Years Relative to No Acton Alternative	$30,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$3,120,000

Economic Impact	Scenario	Total
Direct and Secondary sales	Average Annual	$113,134,000
	Change in Average Annual from No Action Alternative	-$1,125,000
	Average of the Eight Best Difference Years Relative to No Action Alternative	$99,000
	Average of the Eight Worst Difference Years Relative to No Action Alternative	-$9,650,000

Other Social Effects

Changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Variation 2B would decrease slightly relative to the No Action Alternative as would employment, labor income, and sales. During certain years, these impacts would be small in some counties due to lower reservoir elevations and river stages. During the worst difference years, reductions in net farm income would represent a large percentage of net cash farm income in counties most affected. Variation 2B would not likely result in long-term OSE impacts to communities or the region because NED and RED impacts would be negligible to small and temporary. However, small short-term adverse impacts to economic vitality and community well-being could occur during a few years if reductions in irrigation are concentrated within the affected counties.

3.6.2.7.6 High Flows

National Economic Development

Side Channel Intakes Case Study

The NED results for the side channel case study are consistent across alternatives, where the total annual decrease in net farm income during test flow years compared to the No Action Alternative is $7.5 million across all four counties (See Table 3-84 above). The decrease in net farm income breaks down to a decrease of $1.0 million in McCone County, $530,000 in Valley County, $2.8 million in Roosevelt County, and $3.1 million in Richland County. On average, the decrease in net income per intake is $245,353, but this ranges by county, with the smallest decrease of $131,413 in McCone County and the highest of $355,045 in Richland County. Variation 2B has eight potential test flow years where losses in net farm income to side channel intakes could result from high flows. In years without test flows, there is no difference in net farm income compared to No Action. According to the sensitivity analysis (see Table 3-85 above), which is consistent across alternatives, total annual decrease in net farm income during test flow years compared to the No Action Alternative can be as high as $7.5 million across all four counties but may be lower depending on the number of intakes with losses in crop productivity due to a test flow. Decreases in net farm income will also vary depending on the O&M costs incurred at each intake. Net farm income during test flow years compared to the No Action Alternative may be as high as $8.1 million across all four counties but may be lower, depending on the actual costs incurred.

Missouri River Mainstem Irrigation Intakes Analysis

For Missouri River mainstem channel intakes under Variation 2B, 15 more intakes have tier 1 impacts on average annually during full and partial flow years while 5 more intakes have tier 2 impacts relative to the No Action Alternative. There would be an increase in the total number of tier 1 events on average annually during full and partial flow years of 18 events and 5 tier 2 events relative to the No Action Alternative. On average, during full and partial flow years tier 1 events cost $248,370 and tier 2 events cost $173,063 more annually than under the No Action Alternative (See Table 3-107).

The number of tier 1 and 2 events would fluctuate between a maximum of 111 tier 1 events and 42 tier 2 events in a partial flow year like 1975 to a minimum of no intakes impacted for either tier in other years. The maximum number of intakes impacted differs slightly from the number of events discussed above. The number of individual intakes impacted fluctuates between a maximum of 81 intakes under tier 1 and 42 intakes impacted under tier 2 in a year like 1975 to a minimum of no intakes impacted for either tier in other years. Note that there would be no difference in the number of intakes impacted under Variation 2B relative to the No Action Alternative during a maximum impact full or partial flow year. Additionally, there are three more tier 1 events during a year of maximum impact, like 1975, resulting in slightly increased tier 1 costs in this year relative to the year with the greatest impacts under the No Action Alternative (1975).

Table 3-107. Summary of NED Analysis for Variation 2B During the Irrigation Season During Full or Partial Flow Years (Missouri River Mainstem Intakes) (FY2021 Dollars)

Statistic	Average Annual Impacts		Year of Minimum Impacts		Year of Maximum Impacts	
	Value	Delta from No Action	Value	Delta from No Action	Value	Delta from No Action
Tier 1 Events	42	18	0	0	111	3
Tier 2 Events	9	5	0	0	42	-
Tier 1 Costs	$573,352	$248,370	$0	$0	$1,508,756	$45,720
Tier 2 Costs	$277,949	$173,063	$0	$0	$1,358,280	$0
Tier 1 Intakes	30	15	0	0	81	-
Tier 2 Intakes	9	5	0	0	42	-

Note: Annual average impacts presented in this table are taken as annual average during full or partial flow years; whereas annual averages for the No Action Alternative presented in Table 3-79 above are taken as annual averages during all years under the POR. Therefore, it is not possible to subtract the values in the "Delta from No Action" column from the "Value" column in the table above and obtain the result presented in Table 3-79.

Regional Economic Development

For the four counties evaluated for the side channel intakes case study, employment would be reduced by an average of 80 jobs and $3.9 million in labor income during test flow years compared to the No Action Alternative. These results are consistent across alternatives, and alternatives only vary in the number of potential test flow years. Variation 2B has eight potential test flow releases. In years without test flow releases, there would be no difference in employment, labor income, and sales compared to No Action across alternatives.

It is important to note that the RED results do not include downstream industries that are dependent on crops produced in the study area. Industries such as processing facilities, storage facilities and transportation entities would also be adversely impacted by a reduction in crop production. Because these industries are not included in the model, the RED impacts are likely underestimated.

Other Social Effects

As shown in the low flow analysis, agriculture changes in irrigation operations have the potential to cause other types of effects, such as changes in community well-being, traditional ways of life, and economic vitality. On average, annual net farm income under Variation 2B would decrease relative to the No Action Alternative during full flow years as would employment, labor income, and sales. This reduction in net farm income would impact farms relying on side channel intakes for irrigation and represents a large percentage of net cash farm income in counties most affected. Additionally, operations and maintenance costs for all irrigators would increase because of high flows, particularly during full and partial flow release years. There is also a potential for adverse impacts to occur to downstream industries that are dependent on crop production from the study area. These impacts would occur primarily during full or partial flow years with the potential for OSE impacts to be moderately adverse to economic vitality and community well-being with negligible long-term OSE impacts.

Conclusion – Alternative 2 including Variations 2A and 2B

Under Alternative 2, including Variations 2A and 2B, it is expected that farms using Missouri River water for irrigation would have relatively small, short-term, adverse impacts relative to the No Action due to lower reservoir elevations and river flows in certain years. High flows could result in moderate adverse impacts to irrigation intakes in Montana, with side channel intakes being at greater risk of sedimentation and other high flow related issues.

On average, farms using Missouri River water for irrigation would experience a slight decrease in net farm income ranging from $237,000 – 658,000 (2.4% - 6.7%) under Alternative 2 including Variations 2A and 2B relative to the No Action Alternative due to low flow conditions. Overall, the change in NED would be small, with some large changes in worst change years relative to the No Action Alternative. There would be small changes in RED and OSE impacts relative to the No Action Alternative because impacts on irrigation operations would be temporary and small under Alternative 2 including Variations 2A and 2B.

The high flow analysis indicated that approximately 22 to 27 percent of intakes would be impacted by a tier 1 high flow event and 7 to 12 percent of intakes would be impacted by a tier 2 high flow event during the irrigation season on average annually for full or partial flow years. Impacts to side channel intakes from high flows would result in a decrease of $245,353 in net farm income per side channel intake each year that a high flow occurs. This annual impact to side channels is the same across Alternative 2 and all its variations. The number of years with test flows that could cause this impact vary by alternative and variation. Variation 2A has the most test flow years that could result in these net farm income decreases, followed by Alternative 2, and then by Variation 2B. Regionally, years with test flows would lead to employment losses of 80 jobs and labor income losses of $4.0 million due to impacts on side channel intakes.

3.6.2.8 Tribal Intakes

Tribal lands that may be impacted by the test flows are located below Fort Peck Dam in Roosevelt and Valley counties, Montana. Tribal land held by sovereign nations in these two counties represent 73.9 percent and 22.2 percent of all county land, respectively (USGS, 2012). As described in the affected environment section, there are an estimated 19,000 acres of tribal agricultural lands that are irrigated with water withdrawn from the Missouri River on the Fort Peck Tribal Reservation (Wright, H pers. comm. 2019). Most, if not all, of this irrigated acreage is served by two irrigation intakes. According to information obtained during the 2020 summer irrigation intake surveys the larger of the two tribal irrigation intake pumps water for about 70 percent of these lands while the smaller intake provides water to the remaining 30 percent. Both of these intakes are located on the mainstem of the Missouri River and were therefore not included in the high flows side channel case study analysis. Furthermore, during high flows, both intakes have no tier 2 impacts during any full or partial flow year while the larger intake also has no tier 1 impacts during any full or partial flow year. However, the smaller of the two intakes does have some tier 1 impacts during some, but not all, of the full or partial flow years depending on the alternative or variation relative to the No Action Alternative. In full or partial flow years in which this pump is impacted, approximately two-thirds of all mainstem irrigation pumps are also impacted. Additionally, in these impact years there is never more than one tier 1 event per irrigation season at this pump. To put this in context, about half the irrigation pumps have only one tier 1 event during the irrigation season of a full or partial flow year. The remaining half of irrigation pumps that are impacted in these years experience between two and seven tier 1 events per irrigation season. Thus, while the smaller of the irrigation intakes that service tribal lands would be expected to have some impacts associated with the high flows, these impacts are not expected to be as frequent as the impacts experienced at other intakes.

3.6.2.9 Climate Change

A discussion on the influence of climate change on the alternatives is included in Section 3.2, River Infrastructure and Hydrologic Processes. In the future, climate change would have an increasing influence on irrigators. Earlier spring snowmelt and lower summer flows could reduce irrigators’ access to water. More irregular rainfall could also result in irrigators needing to rely more on the Missouri River and other water sources for irrigation. Longer duration of lower river flows or increased higher river flows may adversely impact access to water for irrigation or result in increased operations and maintenance costs. More extreme rain events could adversely impact irrigation intakes through sediment deposition and increased river flows. Impacts of climate change under Alternatives 1 and 2 and their variants would be similar to those under No Action.

3.6.2.10 Cumulative Impacts

The System, along with controlled flow releases from the upper river into the lower river, fulfills multiple management objectives, including providing water for irrigators along the Missouri River. Natural variability in hydrologic conditions (precipitation and snowmelt, which include periods of drought and high runoff) and the “rules” governing System operation would continue to dominate the flows in the Missouri River into the future. Natural flow variability and the requirement to operate the System for all authorized purposes under the Master Manual would continue to be the primary drivers of impact to irrigation access of the Missouri River. However, other actions and programs, such as water depletions or withdrawals for water supply, municipal, and industrial uses have and would continue to have adverse impacts to irrigation access, as they would notably affect the water surface elevations and flows of the river and reservoirs. Groundwater withdrawal practices would continue to offer an alternative to withdrawals from the Missouri River, and any changes to those practices could result in an adverse impact to access to Missouri River water for irrigation, as this would affect the water surface elevations and flows of the river and reservoirs.

Furthermore, many of the mechanical intakes may be nearing the end of their useful life and will require further investments to continue operation, resulting in increased operations and maintenance costs for irrigators in the future. Other changes in the reliability of the Missouri River as a water source may further encourage irrigators to turn to other sources of water, such as groundwater adjacent to the Missouri River, or turn to other farming methods. Depending on the frequency and duration of these impacts, irrigation operators may realize an increase in costs associated with moving intakes more frequently, dredging, pumping, and/or cleaning screens when intakes become clogged with sediment.

Cumulative actions that impact agricultural operations include federal technical and financial assistance programs such as Environmental Quality Incentives Program, which support the replacement or upgrade of existing irrigation intakes, or expand the number of acres irrigated as more water becomes available (Nixon, 2013; Waas, 2015).

State and federal regulations governing water quality have the potential to create adverse impacts and impose additional costs to farm operations including irrigated agriculture. Non-point source agricultural runoff was not included in the 2015 EPA Clean Water Act rulemaking, but as national attention is increasingly focused on the Gulf of Mexico’s dead zone and toxic blooms in the country’s lakes, it is likely that states would increase restrictions on non-point source agricultural runoff in the future which potentially could lead to fewer irrigated acres using Missouri River water in the future (EPA, 2015).

Current System operations under the No Action Alternative would continue to support water for irrigation. Precipitation and snowpack would vary over the period of record, with drought conditions reducing access to irrigation water and large rain events resulting in high flows, with adverse impacts to irrigation operations. When combined with other past, present, and reasonably foreseeable future actions, the cumulative impacts to irrigation access associated with the No Action Alternative would continue to be small, adverse, and long-term primarily due to natural variability in hydrologic conditions and the need for future investments in irrigation infrastructure.

Under Alternative 1, including Variations 1A and 1B, the Fort Peck Dam test flow releases would modify reservoir releases and river flows to some extent, but would overall have a small, short-term, adverse impact on irrigators relative to the No Action Alternative due to lower reservoir elevations and river flows in certain years. High flows are expected to result in moderate adverse impacts to irrigation intakes in Montana, including intakes located on the mainstem and on side channels. When combined with other past, present, and reasonably foreseeable future actions, cumulative impacts under Alternative 1 would be small and adverse, similar to the No Action Alternative, and the implementation of Alternative 1 would provide a small contribution to cumulative impacts in most years and counties. In a few locations there could be a temporary, moderate, and adverse contribution to these cumulative impacts due to higher river flows in some years.

Under Alternative 2, including Variations 2A and 2B, the Fort Peck Dam test flow releases would modify upper reservoir releases and river flows to some extent, but would overall have a small, short term, adverse impacts to irrigators relative to the No Action Alternative due to lower reservoir elevations and river flows in certain years. High flows could result in small to large adverse impacts to some irrigation intakes in Montana, with side channel intakes being at greater risk of sedimentation and other high flow related issues.

When combined with other past, present, and reasonably foreseeable future actions, cumulative impacts under Alternative 2 would be small and adverse, similar to the No Action Alternative, and the implementation of Alternative 2 would provide a small contribution to cumulative impacts in most years and counties. In a few locations there could be a temporary, moderate, and adverse contribution to these cumulative impacts due to higher river flows in some years.

3.7 Water Supply

3.7.1 Affected Environment

Water is withdrawn from the Missouri River and its Mainstem lakes for multiple purposes including municipal, industrial, and commercial water supply as well as domestic and public uses. Municipal water supply includes Tribal and public supply of water to reservations, residents of cities and towns, and customers of rural water districts and associations. The study area includes smaller municipal water supply intakes and rural water districts that are located on the lakes and the river reaches from Fort Peck Lake to Lake Oahe. Some of the small intakes operate part-time, especially during the winter months. Treated water is provided for drinking water and other household uses, as well as for businesses and industries. Water is withdrawn from the river and reservoirs and sent to water treatment facilities. Following treatment, the supply is sent to the various water systems for distribution to users. Most municipalities located on the river or reservoirs have limited or no alternative sources of water other than the Missouri River. Some have existing wells that serve only as backup systems whereas others can store a limited volume of water for use.

There are commercial and industrial water users that withdraw directly from the river or reservoirs (rather than buy water from a public water system) for manufacturing and other processing and commercial uses. Commercial and industrial users do not include thermal power plants. The Missouri River and reservoirs also supply water to domestic and public users. Most domestic intakes are portable, providing water to one household and are sometimes used for drinking water. However, more often the water is used for other domestic uses such as small lawn or garden irrigation, stock watering, or washing cars; many domestic uses are seasonal. Public water supply intakes also typically provide water for recreation areas such as parks and golf courses. Municipal, commercial, and industrial intakes are the focus of this water supply analysis as these intakes tend to be larger and at a fixed location, and are more likely to be impacted by the FPDTR-EIS alternatives. Table 3-108 presents the distribution of water supply intakes by location along the Missouri River within the FPDTR study area.

Table 3-108. Number of water supply intakes by river/lake location

Lake/River Reach	Intakes Municipal	Commercial/Industrial	Domestic	Public
Fort Peck Lake	1	0	101	2
Fort Peck Dam to Lake Sakakawea	4	0	162	1
Lake Sakakawea	15	27	228	11
Garrison Dam to Lake Oahe	7	7	28	3
Lake Oahe	8	0	21	8
Total	35	34	540	25

Source: USACE, 2018

There are an estimated 35 municipal intakes and 34 commercial/industrial water supply intakes on the reservoir and river reaches of the Missouri River Mainstem between Fort Peck Lake and Lake Oahe. Approximately 280,916 people are served by Missouri River municipal water supply intakes and associated facilities. Several Tribes are served by water supply intakes along the UMR including the Assiniboine and Sioux of Fort Peck, Three Affiliated Tribes, Standing Rock Sioux, and Cheyenne River Sioux. The Mni Wiconi Pipeline project supplies water to several reservations that are not located on the Missouri River including the Oglala Sioux Tribe and Rosebud Sioux Tribe. The estimated 34 commercial/industrial water supply intakes operating along the Missouri River between Fort Peck Lake and Lake Oahe are all in North Dakota.

Water supply for municipal and industrial/commercial uses along the Missouri River can be affected by conditions such as river flows and stages, reservoir water surface elevations, river water chemistry including sediment, and channel locations. Changes to these physical components, in turn, lead to changes in water supply access, operation and maintenance, and water treatment requirements.

Access to water is vital to the operations of water supply intakes. The ability of the water supply intakes to access water is typically affected by the river flow or river/reservoir elevation, the amount of sediment in the water and around the intake and, less frequently, by the presence of ice. Each water supply intake typically has a minimum elevation necessary for normal operation as well as a critical shutdown elevation. River or reservoir conditions above the minimum flow/elevation allow for the unimpeded pumping of water or free-flow of water through the intake.

However, when the conditions are below the minimum flow/elevation, the ability for free-flow or pumping becomes more difficult requiring additional measures as discussed in Section 3.7.1.2, Intake Operations, Maintenance, and Modifications. An intake cannot access water when the elevation falls below the intake screen. Suspended sediment can clog intake screens and impede the withdrawal of water through the intake. Depending on the position of the screen, ice can build up or be pulled through the intake. If sediment and ice issues do occur, it is usually during periods of low flow/elevation or during conditions specific to a site (e.g., a wind set-up lowering local water levels). Permanent water supply intakes have been built at specific elevations and locations to access river and lake water. If access to river water is decreased or interrupted, permanent intakes would require more effort (i.e., labor, cost, infrastructure modification, etc.) to ensure continued water withdrawal compared to portable intakes. Many of the municipal and industrial intakes are permanent because of their large size, and so disruptions to serve could affect the biggest water users and a large number of people.

3.7.1.1 Water Quality and Water Treatment

Water quality is important to municipal and commercial/industrial water supplies because it can affect the level of treatment required to provide potable water for various needs. Various treatment requirements, processes, and associated costs are necessary to protect public health by limiting the levels of contaminants, pollutants, and other undesirable characteristics in drinking water. The Safe Drinking Water Act of 1974 established the basic framework for protecting drinking water used by public water systems in the United States.[13] EPA sets the national standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards. The amount and type of treatment applied to drinking water can vary greatly depending on the quality of the source. Water suppliers use one or a combination of treatment processes to remove contaminants from drinking water including flocculation and sedimentation, filtration, ion exchange, absorption, and disinfection (EPA, 2004). Monitoring ensures that treated water complies with federal and state or Tribal standards. Changes in the level of contaminants, pollutants, and river sediment concentration and in the size of suspended sediment particles can affect the level of treatment, operations, and maintenance activities required for water supply needs.

High and low flow events also have implications for water treatment. Interviews indicated that some water supply facilities, such as the one at Dry Prairie, address sediment and associated water quality concerns during high flow events through treatment at the water treatment plant. Any sediment concerns at the intake itself are addressed with technologies such as compression driven air systems. Low flow events do not raise as many cost concerns

[13] The EPA describes public water systems as follows: "A public water system provides water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serves an average of at least 25 people for at least 60 days a year. A public water system may be publicly or privately owned" (EPA, 2017).

as high flow events because of the location of the intake, which was designed to account for continuous erosion of sediment.

The chemical and physical properties of the Missouri River affect human uses of the river including water supply. The primary sources of pollution, both point and non-point sources, along the Missouri River are from urban, agricultural, and industrial land uses. The construction of dams and impoundments trap suspended sediment and particulates, modify the flow regime of the river, and influence water quality within the reservoirs and the downstream reaches. Additionally, the river flows, stages and channel geometry can influence water quality within the river. A more detailed discussion of water quality of the Missouri River is discussed in Section 3.8, Water Quality.

3.7.1.2 Intake Operations, Maintenance, and Modifications

Physical and chemical river conditions described above influence operational and maintenance activities and associated operational, maintenance, and capital costs. Low flows or low pool elevations can affect the efficiency of intake pumping operations and can require operational shutdown if water levels are too low. Inadequate access to water requires intake operators to alter operations and/or modify their intake structures. Intakes can be extended or pumping operations modified. Interviews and published information[14] also indicated that water supply operations can adapt to small, infrequent changes in river flows and reservoir elevations under the FPDTR-EIS alternatives by using different-sized portable submersible pumps. Other modifications can include installation of new pumps or a new intake or screen, modification of the intake screen position, enhanced connections to other water providers for emergency supplies, temporary modifications of intakes, or drilling of a well for an alternative water source. Ice deflectors can be installed to prevent water access issues from ice jams. Changes or extreme fluctuations to river stages would require pumps to be reset. Frequent disruptions in water supply due to access issues may require intake modification and/or investment in substitute water sources.

Transport of sediment during high flows and sedimentation during low flows can affect operations and maintenance in various ways. Increased suspended sediment or bed load material during low flows can clog screens and settle around the intakes reducing their pumping efficiency and cause instability to the intake structure. This situation would require increased maintenance efforts such as cleaning and re-stabilization to allow for reliable access to water

[14] A presentation provided by WaterOne dated August 15, 2007, indicates a temporary solution used to address low river flows was to rent pumps. This temporary approach was used prior to a $2 million investment in a low water level pumping facility could be completed (WaterOne 2007).

and efficient pumping. Sedimentation and other events associated with low flow like algal blooms could lead to increased water treatment costs. Extreme situations require the replacement of equipment or the shutdown of an intake or associated water treatment facility. Excessive erosion can occur during high flow events and adversely affect the support and stability of the intake. Some municipal and industrial water supply facilities have raw and finished water storage that can help with short-term disruptions like those described above.

Operating and shut-down elevations of water supply intakes are designed to accommodate changing water surface elevations of the river and reservoirs. If the water surface elevation falls below the operating elevation, the intake begins to require more than “normal” measures in order to operate, in the form of increased pumping or operations, maintenance, and water treatment. The shutdown elevation is the point at which the intake is no longer operable or can no longer function without damaging the infrastructure.

3.7.2 Environmental Consequences

Two action alternatives, each including three variations, were developed to meet the pallid sturgeon objectives. Each alternative and its variants were evaluated for their effects on access to water supply. The alternatives evaluated include management actions with potential to affect river flows, reservoir elevations, and river stage. The water supply impact analysis focuses on determining if changes in river and reservoir conditions associated with each of the FPDTR-EIS alternatives could result in an impact to water supply access and costs. This section summarizes the water supply methodology and presents the results of the assessment. A detailed description of the methods used for the analysis of water supply access including data sources and assumptions can be found in the “Water Supply Environmental Consequences Analysis Technical Report” available in Appendix H.

3.7.2.1 Impact Assessment Methodology

The impacts to water supply access and costs are evaluated using three of the four accounts (NED, RED, and OSE). The analysis focuses on the costs to water supply operations to adapt to changing river and reservoir conditions. The costs estimated for each action alternative are compared to the costs incurred under the No Action Alternative.

As river flows and reservoir elevations fall below minimum operating requirements, intakes are unable to access water for municipalities, Tribes, commercial operations, and others. This in turn can drive changes in costs to operate water supply intakes. The analysis used outputs from the HEC-RAS and HEC-ResSim Missouri River models to simulate river and reservoir operations over the POR. The impact analysis first determined the operating and shut-down thresholds for each water intake. Model simulations were used to determine how many days river or reservoir levels would be below the threshold at each intake annually under each alternative. The analysis focuses on 26 municipal and commercial intakes used for water supply along the river from Fort Peck Lake to Oahe Lake that were determined to be operable during FPDTR-EIS study period and could potentially be impacted by the FPDTR-EIS alternatives. These fixed intakes are likely to realize any impacts that may occur from the FPDTR-EIS alternatives and are representative of the impacts that may occur to other intakes. While there are other intakes located along the Missouri River from Fort Peck Lake to Lake Oahe, including domestic and public water supply intakes, the analysis focused on those with sufficient information to evaluate potential impacts.

The No Action Alternative is considered the baseline against which the other alternatives are measured. It assumes that no test flow releases for pallid sturgeon would occur from Fort Peck Dam. Operations at Fort Peck Dam are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. It is assumed that other activities and actions for pallid sturgeon in the Upper Basin would be implemented as described in the MRRMP-EIS, 2018 BiOp, and Yellowstone Intake Bypass EIS. These actions include fish bypass construction at Yellowstone Intake, continued propagation and stocking of pallid sturgeon in the Upper Basin, and continued pallid sturgeon science and monitoring activities in the Upper Basin. As noted in Section 3.1.1, Impact Assessment Methodology, No Action does not reflect actual past or future conditions but serves as a reasonable basis (or baseline) for comparing the impacts of the action alternatives on resources.

National Economic Development

The NED analysis calculated the change in costs from changes in access to water from the Missouri River. An Excel®-based model was developed that estimated the costs to access water under each alternative. The NED analysis for water supply access focuses on the change in variable and fixed costs to municipal and commercial water facilities.

Regional Economic Development

The RED analysis for water supply was based on the results of the NED analysis. The NED analysis showed small changes in costs to access water from the Missouri River under each of the FPDTR-EIS alternatives relative to No Action. Although there are measurable differences in costs between alternatives, these differences are not large enough to result in measurable impacts to water rates and regional economic conditions. Therefore, any RED effects are discussed qualitatively.

Other Social Effects

Changes in water supply access have a potential to cause other types of effects on individuals and communities, which are analyzed under the OSE account. The OSE analysis for water supply relied on the results of the NED and RED analysis to determine the scale of impacts that could occur to individual and community well-being, access to safe water sources, and economic vitality. Although there are measurable differences in costs between alternatives, these differences are not large enough to result in measurable OSE impacts. Impacts of the alternatives on OSE are discussed qualitatively.

3.7.2.2 Summary of Environmental Consequences

The environmental consequences relative to water supply are summarized in Table 3-109.

Table 3-109. Environmental consequences relative to water supply

Alternative	NED Impacts	RED Impacts	OSE Impacts
No Action	Average Annual Costs: $89,812. Range of Annual Costs: $31,778 to $239,832. Long-term adverse impacts would occur mainly from the variability in hydrology and change in hydrologic conditions over the POR.	Intake improvements may result in increases in water utility rates to customers.	Negligible OSE impacts.
Alternative 1	Change in Average Annual Costs: -$5,267 or -0.1%. Range of Annual Costs: $31,687 to $239,832. Small short-term, beneficial impacts would occur primarily in the years of a partial or full release or in the years following a release.	Negligible change in RED impacts.	Negligible OSE impacts.
Variation 1A	Change in Average Annual Costs: -$2,512 or -0.03%. Range of Annual Costs: $31,943 to $239,832. Small short-term, beneficial impacts would occur primarily in the years of a partial or full release or in the years following a release.	Negligible change in RED impacts.	Negligible OSE impacts.
Variation 1B	Change in Average Annual Costs: -$1,455 or -0.02%. Range of Annual Costs: $35,515 to $240,051.Small short-term, beneficial impacts would occur primarily in the years of a partial or full release or in the years following a release.	Negligible change in RED impacts.	Negligible OSE impacts.
Alternative 2	Change in Average Annual Costs: -$151 or -0.002%. Range of Annual Costs: $32,121 to $239,832. Small short-term, beneficial impacts would occur primarily in the years of a partial or full release or in the years following a release.	Negligible change in RED impacts.	Negligible OSE impacts.

Alternative	NED Impacts	RED Impacts	OSE Impacts
Variation 2A	Change in Average Annual Costs: -$8,139 or -0.1%. Range of Annual Costs: $33,045 to $239,832. Small short-term, beneficial impacts would occur primarily in the years of a partial or full release or in the years following a release.	Negligible change in RED impacts.	Negligible OSE impacts.
Variation 2B	Change in Average Annual Costs: -$11,049 or -0.2%. Range of Annual Costs: $32,564 to $240,074. Small short-term, beneficial impacts would occur primarily in the years of a partial or full release or in the years following a release.	Negligible change in RED impacts.	Negligible OSE impacts.

* FY 2021 Dollars

Impacts of the FPDTR-EIS alternatives on water quality are discussed in Section 3.10. In general, the FPDTR-EIS alternatives are expected to have temporary, negligible adverse impacts from increased nutrients, pollutants, water temperatures, and lower dissolved oxygen concentrations and small temporary adverse impacts from increased sediment and turbidity.

Overall, the long-term impacts from the alternatives are expected to be negligible.

3.7.2.3 No Action

Under the No Action Alternative, operations at Fort Peck Dam are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. As noted above, it is considered the baseline against which the other alternatives are measured.

Consistent water supply for communities requires intakes to be submerged in the water at all times and at the same time to not be buried by sediment deposits. Water supply intakes are thus affected from the variability in hydrology and change in hydrologic conditions over the POR as well as aggradation and degradation processes (see Section 3.2, River Infrastructure and Hydrologic Processes). The POR is characterized by substantial variability in hydrologic conditions which includes periods of drought (i.e., 1930s) and high runoff. This variation results in substantial variability in impacts to water supply intakes in the basin which can be adverse or beneficial depending on the conditions at the site of the intake.

Modeling results for No Action indicate that water supply intakes, if they were to remain at existing elevations, would experience long-term, adverse impacts under continuation of current System operations. These impacts would be due to instances when water surface elevations fall below critical operating thresholds (operating and shut-down). The modeling results show that 15 of the 26 intakes would experience, on average, 57.1 days per year when water surface elevations would fall below operating thresholds. In addition, 12 of the 26 intakes would experience, on average, 8.6 days when water surface elevations are below shut-down elevations under No Action. Impacts appear to occur most often during extended drought periods like those of the 1930s when reservoir storage levels would fall to a point where releases are reduced to levels that do not support navigation.

System operations under No Action would be consistent with current operations. However, as described in Section 3.1, Introduction, the impacts modeled do not account for the ability of water management to adapt to changing conditions on the System to serve authorized purposes, such as water supply. Thus, it is possible that some of the adverse impacts predicted under the No Action alternative would be avoided with a change in operations initiated by USACE.

Given the frequency and duration of these periods where water surface elevations fall below critical operational thresholds, it is likely that water supply operators would need to make intake improvements, modifications, or relocation to adapt to changing conditions along the river even without changes to reservoir operations, including FPDTR.

National Economic Development

Under No Action, several of the water supply intakes would experience long-term, adverse impacts. The project team did not attempt to evaluate the cost of intake modifications that may occur due to changes in hydrologic conditions modeled under No Action because these modifications would likely address any short-term impacts that are likely to occur under the FPDTR-EIS alternatives. Instead, the NED analysis focused on actions that water supply operators can take to adapt to small changes in river flows and reservoir elevations that are expected to occur under the FPDTR-EIS alternatives compared to No Action. Interviews with a representative sample of water supply managers indicated that one such approach would be to use different-sized submersible pumps; a method that has been applied by intake operators during periods of low water surface elevations. In order to compare the FPDTR-EIS alternatives to No Action, this same approach of using submersible pumps to adapt to periods of low water surface elevations was used in the NED analysis for No Action. The NED analysis evaluated the costs of using submersible pumps under No Action to adapt to periods when water surface elevations would be below critical water supply intake thresholds.

The NED analysis for No Action is summarized in Table 3-110. Among all water supply intake operators the average of predicted annual costs to adapt to changing conditions of the river is over $89,812; the range of predicted annual costs would be $31,778 to over $239,832. Higher costs in some years would be caused by extended drought conditions and the spring flow under No Action would have negligible contributions to these effects.

Table 3-110. Summary of NED analysis for No Action – all years in POR

Costs	All Reach and Intakes
Total Variable Costs (POR)	$5,825,893
Total Fixed Costs (POR)	$1,538,725
Total Costs (POR)	$7,364,619
Annual Average Total Costs	$89,812
Annual Average Total Costs per Intake	$3,454
Maximum Annual Costs	$239,832
Minimum Annual Costs	$31,778

* FY 2021 Dollars

Regional Economic Development

The RED analysis for water supply intakes focuses on the potential for local customers to realize an increase in rates due to changes in operations, which could have implications for regional economic conditions. Under No Action, some water supply operators would consider making capital investments for intake modifications to adapt to changing river conditions. The NED analysis showed that, on average, water supply operators would incur approximately $3,454 per year to adapt to changing conditions along the river and reservoirs using submersible pumps.

For many of the water supply operators, these average annual cost increases would be a small percentage of annual operating budgets. However, the expense to deal with conditions under No Action are likely already affecting costs and potentially rates.

Other Social Effects

Changes in access to water supply have the potential to cause other types of effects on individuals and communities such as community well-being, access to safe water sources, and economic vitality. While water supply intakes are expected to experience long-term, adverse impacts under No Action, OSE impacts would be negligible.

The modeled results do not show instances with individual intakes where access is completely eliminated. These impacts are likely to result in increased costs and possible subsequent rate increases; however, OSE including community well-being, economic vitality and public health and safety are not expected under No Action.

Conclusion

Consistent water supply for communities requires intakes be submerged in the water at all times while not getting buried by sediment deposits. Water supply intakes are thus affected from the variability in the hydrologic conditions over the POR. Modeling results for No Action indicate that water supply intakes, if they were to remain at existing elevations, would experience long-term, adverse impacts under continuation of current operations. These impacts would be due to instances when water surface elevations fall below critical operating thresholds (operating and shut-down). It was estimated that the total annual cost to adapt to changing conditions of the river for 26 water supply intake operators along the UMR would average $89,812. Total annual costs for all intakes would range from a low of just under $31,778 to over $239,832. Under No Action, some water supply facilities would likely consider making capital investments associated with intake modifications to adapt to changing conditions. These cost increases have the potential to lead to an increase in rates although the magnitude of the rate increases is unknown; however, OSE including community well-being, economic vitality, and public health and safety are expected to be negligible under No Action.

3.7.2.4 Alternative 1

System operations under Alternative 1 are based on those described under the No Action Alternative except that Alternative 1 includes a flow release regime from Fort Peck Dam to benefit pallid sturgeon.

An Attraction Flow Regime would begin on April 16 and the peak flow would be twice as large as the spring release from Fort Peck Dam in a given year. The Spawning Cue Flow Regime under Alternative 1 would begin on May 28 and would be 3.5 times the Fort Peck Dam spring flow release in the given release year. A further description of Alternative 1 is detailed in Chapter 2, Alternatives.

National Economic Development

The NED analysis for Alternative 1 is summarized in Tables 3-110 and 3-111. Table 3-111 includes a summary of all the years in the period of analysis, whereas Table 3-111 includes only those years in which there is a partial or full flow test release from Fort Peck Dam. As noted in Table 3-111, water supply operations along the Missouri River to Lake Oahe would incur, on average, $89,748 per year to adapt to changing conditions of the river. Total annual costs would range from $31,687 to $239,832. This represents an overall small decrease in costs to water supply intakes of 0.1 percent relative to the No Action Alternative.

Table 3-111. Summary of NED analysis for Alternative 1 – all years in POR

Costs [a]	All Reaches and Intakes
Total Variable Costs (POR) [b]	$5,821,824
Total Fixed Costs (POR) [c]	$1,537,527
Total Costs (POR)	$7,359,351
Difference in Total Costs from No Action	-$5,267
Percentage Difference from No Action	-0.1%
Annual Average Total Costs	$89,748
Difference in Annual Average Costs from No Action	-$64
Difference in Annual Costs per Intake	-$2
Maximum Annual Costs	$239,832
Minimum Annual Costs	$31,687

a. FY 2021 Dollars.

b. Variable costs in this context are those costs that change with amount of water that must be pumped at each intake.

c. Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

As noted in Table 3-112, in years with a partial or full flow release from Fort Peck Dam, water supply operations along the Missouri River to Lake Oahe would incur, on average, $67,468 per year to adapt to changing conditions of the river. Total annual costs would range from $41,267 to $98,789. This represents an overall small decrease in costs to water supply intakes of 0.33 percent relative to the No Action Alternative.

Table 3-112. Summary of NED analysis for Alternative 1 – Partial or Full Flow Release Years Only

Costs [a]	All Reaches and Intakes
Total Variable Costs (POR) [b]	$1,748,719
Total Fixed Costs (POR) [c]	$410,264
Total Costs (POR)	$2,158,983
Difference in Total Costs from No Action	-$7,129
Percentage Difference from No Action	-0.33%
Annual Average Total Costs	$67,468
Difference in Annual Average Costs from No Action	-$223
Difference in Annual Costs per Intake	-$8.58
Maximum Annual Costs	$98,789
Minimum Annual Costs	$41,267

Costs [a]	All Reaches and Intakes

a FY2021 Dollars.

b Variable costs in this context are those costs that change with amount of water that must be pumped at eachintake.

c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that under Alternative 1 access to water supply would result in more years with increased costs than with decreased costs. However, the overall costs are dominated by four years when costs would decrease by more than $1,000 relative to No Action. These impacts are occurring in years with partial or full releases, or years following a release. The difference in costs from No Action for intakes in the river, including Tribal intakes, would range from -$3,388 to $2,178.

Additional modeling results are summarized in Table 3-113, which shows difference in the lowest and highest annual costs to water supply intakes for Alternative 1 relative to No Action in years given a partial or full flow release, as well as the years following flow years in the period of record. The results show that there are minimal impacts to intakes regardless of flow compared to the No Action Alternative. Years with small beneficial impacts compared to the No Action Alternative most often occur in years with partial or full releases, and occasionally in years following a release. The changes to the flow under Alternative 1 would increase water levels at many of the intakes that would otherwise have been disrupted without those releases.

Table 3-113. Impacts from modeled flow releases under Alternative 1 compared to No Action

Release	Annual Cost Change	All Intakes[a]
Partial or full flow release[b]	Lowest Cost Change	-$3,388
	Highest Cost Change	$2,178
Year after Partial of Full Flow Release	Lowest Cost Change	-$2,813
	Highest Cost Change	$181
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Cost Change	-$3,388
	Highest Cost Change	$2,178

a FY2021 Dollars.

b Flow action would be partially or fully implemented in 22 years of the period of record. A partial release year is defined as a year when a partial spawning cue occurs in March and/or May or a full release happens in March or May. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented relative to the No Action Alternative. Negative costs represent a cost savings from No Action.

Regional Economic Development

It is anticipated that Alternative 1 would have negligible RED impacts. Under Alternative 1, a number of water supply facilities would likely realize a small decrease in costs associated with test flow releases, but these differences are small enough that impacts on rates and regional economic conditions are expected to be negligible under Alternative 1.

Other Social Effects

On average, water supply intakes are expected to experience negligible impacts under Alternative 1 with negligible other social effects.

3.7.2.5 Alternative 1 – 1A Variation

Variation 1A is a test flow variation of Alternative 1. The parameters for 1A are the same as described for Alternative 1 except that the Attraction Flow would be initiated on April 9, rather than April 16, and the Spawning Cue Flow Regime would be initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

National Economic Development

The NED analysis for Variation 1A is summarized in Table 3-114 and 3-115. Table 3-114 includes a summary of all the years in the period of analysis, whereas Table 3-115 includes only those years in which there is a partial or full flow release from Fort Peck Dam. As noted in Table 3-114, water supply operations along the Missouri River to Lake Oahe would incur, on average, $89,782 per year to adapt to changing conditions of the river. Total annual costs would range from $31,943 to $239,832. This represents an overall small decrease in costs to water supply intakes of 0.03 percent relative to the No Action Alternative.

Table 3-114. Summary of NED analysis for Variation 1A – all years in POR

Costs [a]	All Reaches and Intakes
Total Variable Costs (POR) [b]	$5,823,906
Total Fixed Costs (POR) [c]	$1,538,200
Total Costs (POR)	$7,362,106
Difference in Total Costs from No Action	-$2,512
Percentage Difference from No Action	-0.03%
Annual Average Total Costs	$89,782
Difference in Annual Average Costs from No Action	-$31
Difference in Annual Costs per Intake	-$1

Costs [a]	All Reaches and Intakes
Maximum Annual Costs	$239,832
Minimum Annual Costs	$31,943

a FY2021 Dollars.
b Variable costs in this context are those costs that change with amount of water that must be pumped at each intake.
c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

As noted in Table 3-115, in years with a partial or full flow release from Fort Peck Dam, water supply operations along the Missouri River to Lake Oahe would incur, on average, $68,456 per year to adapt to changing conditions of the river. Total annual costs would range from $41,979 to $98,773. This represents an overall small decrease in costs to water supply intakes of 0.13 percent relative to the No Action Alternative.

Table 3-115. Summary of NED analysis for Variation 1A – partial or full flow release years only

Costs [a]	All Reaches and Intakes
Total Variable Costs (POR) [b]	$1,718,649
Total Fixed Costs (POR) [c]	$403,476
Total Costs (POR)	$2,122,125
Difference in Total Costs from No Action	-$2,720
Percentage Difference from No Action	-0.13%
Annual Average Total Costs	$68,456
Difference in Annual Average Costs from No Action	-$88
Difference in Annual Costs per Intake	-$3.38
Maximum Annual Costs	$98,773
Minimum Annual Costs	$41,979

a FY2021 Dollars.
b Variable costs in this context are those costs that change with amount of water that must be pumped at each intake.
c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that access to water supply would experience more years when costs would increase than when costs would decrease under Variation 1A. However, the overall costs are dominated by one year when costs would decrease by more than $4,000 relative to No Action. These impacts are occurring in years with partial or full releases, or years following a release. The difference in costs from No Action for intakes in the river, including Tribal intakes, would range from -$5,249 to $4,803.

Additional modeling results are summarized in Table 3-116, which shows difference in the lowest and highest annual costs to water supply for Variation 1A relative to No Action in years given a partial or full flow release, as well as the years following flow years in the period of record. The results show that there are minimal impacts to intakes regardless of flow compared to the No Action Alternative. Years with small beneficial impacts compared to the No Action Alternative most often occur in years with partial or full releases, and occasionally in years following a release. The changes to the flow under Variation 1A increase water levels at many of the intakes that would otherwise have been disrupted without those releases.

Table 3-116. Impacts from modeled flow releases under Variation 1A compared to No Action

Release	Cost Change	All Intakes[a]
Partial or full flow release[b]	Lowest Cost Change	-$5,249
	Highest Cost Change	$2,631
Year after Partial or Full Flow Release	Lowest Cost Change	-$2,813
	Highest Cost Change	$4,803[c]
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Cost Change	-$5,249
	Highest Cost Change	$4,803

a FY2021 Dollars.

b Flow action would be partially or fully implemented in 22 years of the period of record. A partial release year is defined as a year when a partial spawning cue occurs in March and/or May or a full release happens in March or May. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented relative to the No Action Alternative. Negative costs represent a cost savings from No Action.

c Highest cost change for a year after partial or full flow release occurs in year 1995

Regional Economic Development

It is anticipated that Variation 1A would have negligible RED impacts. Under Variation 1A, a number of water supply facilities would likely realize a small decrease in costs associated with test flow releases but these differences are small enough that they are expected to have a negligible impact on rates and regional economic conditions under Variation 1A.

Other Social Effects

On average, water supply intakes are expected to experience negligible impacts under Variation 1A with negligible other social effects.

3.7.2.6 Alternative 1 – 1B Variation

Variation 1B is another test flow variation of Alternative 1. The parameters for 1B are the same as described for Alternative 1 except that the Attraction Flow would be initiated on April 23 and the Spawning Cue Flow Regime would be initiated on June 4. Similar to the concept described in Variation 1B, the later initiation date is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

National Economic Development

The NED analysis for Variation 1B is summarized in Table 3-117 and 3-118. Table 3-117 includes a summary of all the years in the period of analysis, whereas Table 3-118 includes only those years in which there is a partial or full flow release from Fort Peck Dam. As noted in Table 3-117, water supply operations along the Missouri River to Lake Oahe would incur, on average, $89,795 per year to adapt to changing conditions of the river. Total annual costs would range from $35,515 to $240,051. This represents an overall small decrease in costs to water supply intakes of 0.02 percent relative to the No Action Alternative.

Table 3-117. Summary of NED analysis for Variation 1B – all years in POR

Costs [a]	All Reaches and Intakes
Total Variable Costs (POR) [b]	$5,824,707
Total Fixed Costs (POR) [c]	$1,538,457
Total Costs (POR)	$7,363,163
Difference in Total Costs from No Action	-$1,455
Percentage Difference from No Action	-0.02%
Annual Average Total Costs	$89,795
Difference in Annual Average Costs from No Action	-$18
Difference in Annual Costs per Intake	-$1
Maximum Annual Costs	$240,051
Minimum Annual Costs	$35,515

a FY2021 Dollars.

b Variable costs in this context are those costs that change with amount of water that must be pumped at each intake.

c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

As noted in Table 3-118, in years with a partial or full flow release from Fort Peck Dam, water supply operations along the Missouri River to Lake Oahe would incur, on average, $70,259 per year to adapt to changing conditions of the river. Total annual costs would range from $40,734 to $99,109. This represents an overall small decrease in costs to water supply intakes of 0.17 percent relative to the No Action Alternative.

Table 3-118. Summary of NED analysis for Variation 1B – partial or full flow release years only

Costs [a]	All Reaches and Intakes
Total Variable Costs (POR) [b]	$2,104,676
Total Fixed Costs (POR) [c]	$494,888
Total Costs (POR)	$2,599,565
Difference in Total Costs from No Action	-$4,533
Percentage Difference from No Action	-0.17%
Annual Average Total Costs	$70,259
Difference in Annual Average Costs from No Action	-$123
Difference in Annual Costs per Intake	-$4.73
Maximum Annual Costs	$99,109
Minimum Annual Costs	$40,734

a FY2021 Dollars.
b Variable costs in this context are those costs that change with amount of water that must be pumped at each intake.
c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that access to water supply would experience more years when costs would increase than when costs would decrease under Variation 1B. However, the overall costs are dominated by three years when costs would decrease by more than $2,000 relative to No Action. These impacts are occurring in years with partial or full releases, or years following a release. The difference in costs from No Action for intakes in the river, including Tribal intakes, would range from -$4,455 to $3,737.

Additional modeling results are summarized in Table 3-119, which shows difference in the lowest and highest annual costs to water supply for Variation 1B relative to No Action in years given a partial or full flow release, as well as the years following flow years in the period of record. The results show that there are minimal impacts to intakes regardless of flow compared to the No Action Alternative. Years with small beneficial impacts compared to the No Action Alternative most often occur in years with partial or full releases, and occasionally in years following a release. The changes to the flow under Variation 1B increase water levels at many of the intakes that would otherwise have been disrupted without those releases.

Table 3-119. Impacts from modeled flow releases under Variation 1B compared to No Action

Release	Cost Change	All Intakes[a]
Partial or full flow release[b]	Lowest Cost Change	-$4,455
	Highest Cost Change	$2,631
Year after Partial of Full Flow Release	Lowest Cost Change	-$2,813
	Highest Cost Change	$1,245
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Cost Change	-$4,455
	Highest Cost Change	$3,737

a FY2021 Dollars.

b Flow action would be partially or fully implemented in 25 years of the period of record. A partial release year is defined as a year when a partial spawning cue occurs in March and/or May or a full release happens in March or May. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented relative to the No Action Alternative. Negative costs represent a cost savings from No Action.

Regional Economic Development

It is anticipated that Variation 1B would have negligible RED impacts. Under Variation 1B, a number of water supply facilities would likely realize a small decrease in costs associated with test flow releases but these differences are small enough that they are expected to have a negligible impacts on rates and economic conditions under Variation 1B.

Other Social Effects

On average, water supply intakes are expected to experience negligible impacts under Variation 1B with negligible other social effects.

3.7.2.7 Conclusion – Alternative 1 including Variants 1A and 1B

Under Alternative 1, including Variations 1A and 1B, it is expected that water supply intakes would have no adverse impacts relative to No Action.

Table 3-120 provides a summary of the NED impacts for Alternative 1 including Variations 1A and 1B in years when a partial or full flow release occurs. Over all intake locations, annual average costs in partial or full release years would decrease between $88 and $223 (0.13 –0.33 percent) relative to No Action. Alternative 1 has the largest impact on water supply access relative to No Action with a maximum annual cost of $98,789. While water supply intakes would experience both small adverse and beneficial impacts in some years during a partial or full flow release, these would be small, short-term impacts and it is expected that Alternative 1 would have beneficial but small impacts to water supply access. It is also anticipated that Alternative 1 would have negligible RED and OSE impacts.

Table 3-120. Summary of NED analysis for Alternative 1 – full or partial years

Costs	Alternative 1	Variant 1A	Variant 1B	Range across alternative and variants (Absolute)
Annual Average Total Costs	$67,468	$68,456	$70,259	$2,791
Difference in Annual Average Costs from No Action	-$223	-$88	-$123	$135
Percentage Difference from No Action	-0.33%	-0.13%	-0.17%	0.26%
Difference in Annual Costs per Intake	-$8.58	-$3.38	-$4.73	$5.2
Maximum Annual Costs	$98,789	$98,773	$99,109	$336
Minimum Annual Costs	$41,267	$41,979	$40,734	$1,245

* FY2021 Dollars

3.7.2.8 Alternative 2

The parameters for Alternative 2 are the same as described for Alternative 1 except that the Attraction Flow Regime peak would be 14,000 cfs (the maximum powerhouse capacity) rather than twice the average Fort Peck Dam spring flow in the given year. The maximum amount of flow that can be run through the generators is 14,000 cfs. Any additional flow would be run through the spillway and would not generate hydroelectricity. Additionally, releases as measured at Wolf Point gage would be held at 14,000 cfs until the Spawning Cue flow is initiated. A further description of Alternative 2 is detailed in Chapter 2, Alternatives.

National Economic Development

The NED analysis for Alternative 2 is summarized in Tables 3-121 and 3-122. Table 3-121 includes a summary of all the years in the period of analysis, whereas Table 3-122 includes only those years in which there is a partial or full flow release from Fort Peck Dam. As noted in Table 3-121, water supply operations along the Missouri River to Lake Oahe would incur, on average, $89,811 per year to adapt to changing conditions of the river. Total annual costs would range from $32,121 to $239,832. This represents an overall small decrease in costs to water supply intakes of 0.002 percent relative to the No Action Alternative.

Table 3-121. Summary of NED analysis for Alternative 2 – all years in POR

Costs [a]	All Reaches and Intakes
Total Variable Costs (POR) [b]	$5,826,125
Total Fixed Costs (POR) [c]	$1,538,343
Total Costs (POR)	$7,364,468
Difference in Total Costs from No Action	-$151
Percentage Difference from No Action	-0.002%
Annual Average Total Costs	$89,811
Difference in Annual Average Costs from No Action	-$2
Difference in Annual Costs per Intake	-$0.1
Maximum Annual Costs	$239,832
Minimum Annual Costs	$32,121

a FY2021 Dollars.
b Variable costs in this context are those costs that change with amount of water that must be pumped at eachintake.
c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

As noted in Table 3-122, in years with a partial or full flow release from Fort Peck Dam, water supply operations along the Missouri River to Lake Oahe would incur, on average, $67,839 per year to adapt to changing conditions of the river. Total annual costs would range from $41,267 to $98,764. This represents an overall small decrease in costs to water supply intakes of 0.25 percent relative to the No Action Alternative.

Table 3-122. Summary of NED analysis for Alternative 2 – partial or full flow release years only

Costs [a]	All Reaches and Intakes
Total Variable Costs (POR) [b]	$1,648,525
Total Fixed Costs (POR) [c]	$386,646
Total Costs (POR)	$2,035,171
Difference in Total Costs from No Action	-$5,203
Percentage Difference from No Action	-0.25%
Annual Average Total Costs	$67,839
Difference in Annual Average Costs from No Action	-$173
Difference in Annual Costs per Intake	-$6.65
Maximum Annual Costs	$98,764
Minimum Annual Costs	$41,267

a FY2021 Dollars.
b Variable costs in this context are those costs that change with amount of water that must be pumped at eachintake.
c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that access to water supply would experience more years when costs would increase than when costs would decrease under Alternative 2. However, the overall costs are dominated by two years when costs would decrease by more than $4,000 relative to No Action. These impacts are occurring in years with partial or full releases, or years following a release. The difference in costs from No Action for intakes in the river, including Tribal intakes, would range from -$4,990 to $5,462.

Additional modeling results are summarized in Table 3-123, which shows difference in the lowest and highest annual costs to water supply for Alternative 2 relative to No Action in years given a partial or full flow release, as well as the years following flow years in the period of record. The results show that there are minimal impacts to intakes regardless of flow compared to the No Action Alternative. Years with small beneficial impacts compared to the No Action Alternative most often occur in years with partial or full releases, and occasionally in years following a release. The changes to the flow under Alternative 2 increase water levels at many of the intakes that would otherwise have been disrupted without those releases.

Table 3-123. Impacts from modeled flow releases under Alternative 2 compared to No Action

Release	Cost Change	All Intakes[a]
Partial or full flow release[b]	Lowest Cost Change	-$4,443
	Highest Cost Change	$5,462
Year after Partial of Full Flow Release	Lowest Cost Change	-$4,990
	Highest Cost Change	$0
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Cost Change	-$4,990
	Highest Cost Change	$5,462

a FY2021 Dollars.

b Flow action would be partially or fully implemented in 20 years of the period of record. A partial release year is defined as a year when a partial spawning cue occurs in March and/or May or a full release happens in March or May. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented relative to the No Action Alternative. Negative costs represent a cost savings from No Action.

Regional Economic Development

It is anticipated that Alternative 2 would have negligible RED impacts. Under Alternative 2, a number of water supply facilities would likely realize a small decrease in costs associated with test flow releases but these differences are small enough that they are expected to have a negligible impacts on rates and economic conditions under Alternative 2.

Other Social Effects

On average, water supply intakes are expected to experience negligible impacts under Alternative 2 with negligible other social effects.

3.7.2.9 Alternative 2 – 2A Variation

Variation 2A is a test flow variation of Alternative 2. The parameters for Variation 2A are the same as described for Alternative 2 except that the Attraction Flow would be initiated on April 9, rather than April 16, and the Spawning Cue Flow would be initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

National Economic Development

The NED analysis for Variation 2A is summarized in Tables 3-124 and 3-125. Table 3-124 includes a summary of all the years in the period of analysis, whereas Table 3-125 includes only those years in which there is a partial or full flow release from Fort Peck Dam. As noted in Table 3-124, water supply operations along the Missouri River to Lake Oahe would incur, on average, $89,713 per year to adapt to changing conditions of the river. Total annual costs would range from $33,045 to $239,832. This represents an overall small decrease in costs to water supply intakes of -0.1 percent relative to the No Action Alternative.

Table 3-124. Summary of NED analysis for Variation 2A – all years in POR

Costs [a]	**All Reaches and Intakes**
Total Variable Costs (POR) [b]	$5,819,698
Total Fixed Costs (POR) [c]	$1,536,782
Total Costs (POR)	$7,356,480
Difference in Total Costs from No Action	-$8,139
Percentage Difference from No Action	-0.1%
Annual Average Total Costs	$89,713
Difference in Annual Average Costs from No Action	-$99
Difference in Annual Costs per Intake	-$4
Maximum Annual Costs	$239,832
Minimum Annual Costs	$33,045

a FY2021 Dollars.

b Variable costs in this context are those costs that change with amount of water that must be pumped at each intake.

c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

As noted in Table 3-125, in years with a partial or full flow release from Fort Peck Dam, water supply operations along the Missouri River to Lake Oahe would incur, on average,

$68,388 per year to adapt to changing conditions of the river. Total annual costs would range from $41,979 to $98,764. This represents an overall small decrease in costs to water supply intakes of 0.79 percent relative to the No Action Alternative.

Table 3-125. Summary of NED analysis for Variation 2A – partial or full flow release years only

Costs [a]	All Reaches and Intakes
Total Variable Costs (POR) [b]	$1,606,389
Total Fixed Costs (POR) [c]	$376,856
Total Costs (POR)	$1,983,245
Difference in Total Costs from No Action	-$15,861
Percentage Difference from No Action	-0.79%
Annual Average Total Costs	$68,388
Difference in Annual Average Costs from No Action	-$547
Difference in Annual Costs per Intake	-$21.04
Maximum Annual Costs	$98,764
Minimum Annual Costs	$41,979

a FY2021 Dollars.

b Variable costs in this context are those costs that change with amount of water that must be pumped at each intake.

c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that access to water supply would experience more years when costs would increase than when costs would decrease under Variation 2A. However, the overall costs are dominated by three years when costs would decrease by more than $4,000 relative to No Action. These impacts are occurring in years with partial or full releases, or years following a release. The difference in costs from No Action for intakes in the river, including Tribal intakes, would range from -$5,262 to $4,389.

Additional modeling results are summarized in Table 3-126, which shows difference in the lowest and highest annual costs to water supply for Variation 2A relative to No Action in years given a partial or full flow release, as well as the years following flow years in the period of record. The results show that there are minimal impacts to intakes regardless of flow compared to the No Action Alternative. Years with small beneficial impacts compared to the No Action Alternative most often occur in years with partial or full releases, and occasionally in years following a release. The changes to the flow under Variation 2A increase water levels at many of the intakes that would otherwise have been disrupted without those releases.

Table 3-126. Impacts from modeled flow releases under Variation 2A compared to No Action

Release	Cost Change	All Intakes[a]
Partial or full flow release[b]	Lowest Cost Change	-$5,249
	Highest Cost Change	$2,087
Year after Partial of Full Flow Release	Lowest Cost Change	-$5,262
	Highest Cost Change	$91
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Cost Change	-$5,262
	Highest Cost Change	$4,389[c]

a FY2021 Dollars.

b Flow action would be partially or fully implemented in 20 years of the period of record. A partial release year is defined as a year when a partial spawning cue occurs in March and/or May or a full release happens in March or May. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented relative to the No Action Alternative. Negative costs represent a cost savings from No Action.

c Highest cost change regardless of flow actions occurs in year 2005, which is a non-release year that is not a year after a release.

Regional Economic Development

It is anticipated that Variation 2A would have negligible RED impacts. Under Variation 2A, a number of water supply facilities would likely realize a small decrease in costs associated with test flow releases but these differences are small enough that they are expected to have a negligible impacts on rates and economic conditions under Variation 2A.

Other Social Effects

On average, water supply intakes are expected to experience negligible impacts under Variation 2A with negligible other social effects.

3.7.2.10 Alternative 2 – 2B Variation

Variation 2B is a test flow is another variation of Alternative 2. The parameters for Variation 2B are the same as described for Alternative 2 except that the Attraction Flow would be initiated on April 23, rather than April 16, and the Spawning Cue flow would be initiated on June 4, rather than May 21. The difference in timing is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

National Economic Development

The NED analysis for Variation 2B is summarized in Tables 3-127 and 3-128. Table 3-127 includes a summary of all the years in the period of analysis, whereas Table 3-128 includes only those years in which there is a partial or full flow release from Fort Peck Dam. As noted in Table 3-127, water supply operations along the Missouri River to Lake Oahe would incur, on average, $89,678 per year to adapt to changing conditions of the river. Total annual costs would range from $32,564 to $240,074. This represents an overall small decrease in costs to water supply intakes of 0.2 percent relative to the No Action Alternative.

Table 3-127. Summary of NED analysis for Variation 2B – all years in POR

Costs [a]	All Reaches
Total Variable Costs (POR) [b]	$5,817,547
Total Fixed Costs (POR) [c]	$1,536,023
Total Costs (POR)	$7,353,570
Difference in Total Costs from No Action	-$11,049
Percentage Difference from No Action	-0.2%
Annual Average Total Costs	$89,678
Difference in Annual Average Costs from No Action	-$135
Difference in Annual Costs per Intake	-$5
Maximum Annual Costs	$240,074
Minimum Annual Costs	$32,564

a FY2021 Dollars.
b Variable costs in this context are those costs that change with amount of water that must be pumped at each intake.
c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

As noted in Table 3-128, in years with a partial or full flow release from Fort Peck Dam, water supply operations along the Missouri River to Lake Oahe would incur, on average, $69,947 per year to adapt to changing conditions of the river. Total annual costs would range from $41,267 to $98,857. This represents an overall small decrease in costs to water supply intakes of 0.62 percent relative to the No Action Alternative.

Table 3-128. Summary of NED analysis for Variation 2B – partial or full flow release years only

Costs [a]	All Reaches and Intakes
Total Variable Costs (POR) [b]	$2,095,657
Total Fixed Costs (POR) [c]	$492,375
Total Costs (POR)	$2,588,032
Difference in Total Costs from No Action	-$16,065
Percentage Difference from No Action	-0.62%
Annual Average Total Costs	$69,947
Difference in Annual Average Costs from No Action	-$434
Difference in Annual Costs per Intake	-$16.69
Maximum Annual Costs	$98,857
Minimum Annual Costs	$41,267

a FY2021 Dollars.
b Variable costs in this context are those costs that change with amount of water that must be pumped at each intake.
c Fixed costs are those that do not change with pumping requirements and are based on the size and number of pumps being used on an annual basis at each intake.

When evaluating the impacts of each FPDTR-EIS alternative, annual impacts as well as those that would occur on average were examined. The annual analysis shows that access to water supply would experience more years when costs would increase than when costs would decrease under Variation 2B. However, the overall costs are dominated by three years when costs would decrease by more than $4,000 relative to No Action. These impacts are occurring in years with partial or full releases, or years following a release. The difference in costs from No Action for intakes in the river, including Tribal intakes, would range from -$5,601 to $4,389.

Additional modeling results are summarized in Table 3-129, which shows difference in the lowest and highest annual costs to water supply for Variation 2B relative to No Action in years given a partial or full flow release, as well as the years following flow years in the period of record. The results show that there are minimal impacts to intakes regardless of flow compared to the No Action Alternative. Years with small beneficial impacts compared to the No Action Alternative most often occur in years with partial or full releases, and occasionally in years following a release. The changes to the flow under Variation 2B increase water levels at many of the intakes that would otherwise have been disrupted without those releases.

Table 3-129. Impacts from modeled flow releases under Variation 2B compared to No Action

Release	Cost Change	All Intakes[a]
Partial or full flow release[b]	Lowest Cost Change	-$5,601
	Highest Cost Change	$2,178
Year after Partial of Full Flow Release	Lowest Cost Change	-$4,990
	Highest Cost Change	$1,779
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Cost Change	-$5,601
	Highest Cost Change	$4,389

a FY2021 Dollars.
b Flow action would be partially or fully implemented in 25 years of the period of record. A partial release year is defined as a year when a partial spawning cue occurs in March and/or May or a full release happens in March or May. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented relative to the No Action Alternative. Negative costs represent a cost savings from No Action.

Regional Economic Development

It is anticipated that Variation 2B would have negligible RED impacts. Under Variation 2B, a number of water supply facilities would likely realize a small increase in costs associated with test flow releases but these differences are small enough that they are expected to have a negligible impacts on rates and economic conditions under Variation 2B.

Other Social Effects

On average, water supply intakes are expected to experience negligible impacts under Variation 2B with negligible other social effects.

3.7.2.11 Conclusion – Alternative 2 including Variations 2A and 2B

Under Alternative 2, including Variations 2A and 2B, it is expected that water supply intakes would have no adverse impacts relative to No Action.

Table 3-130 provides a summary of the NED impacts for Alternative 2 including Variations 2A and 2B in years when a partial or full flow release occurs. Over all intake locations, annual average costs in partial or full release years would decrease between $173 and $547 (0.25 – 0.79 percent) relative to No Action. Variant 2A has the largest impact on water supply access relative to No Action with a maximum annual cost of $98,764. While water supply intakes would experience both small adverse and beneficial impacts in some years during a partial or full flow release, these would be small, short-term impacts and it is expected that Alternative 1 would have beneficial but small impacts to water supply access. It is also anticipated that Alternative 2 would have negligible RED and OSE impacts.

Table 3-130. Summary of NED analysis for Alternative 2 – full or partial years

Costs	Alternative 2	Variant 2A	Variant 2B	Range across alternative and variants (Absolute)
Annual Average Total Costs	$67,839	$68,388	$69,947	$2,108
Difference in Annual Average Costs from No Action	-$173	-$547	-$434	$374
Percentage Difference from No Action	-0.25%	-0.79%	-0.62%	0.54%
Difference in Annual Costs per Intake	-$6.65	-$21.04	-$16.69	$14.39
Maximum Annual Costs	$98,764	$98,764	$98,857	$93
Minimum Annual Costs	$41,267	$41,979	$41,267	$712

* Fiscal year 2021 prices.

3.7.2.12 Tribal Intakes

The intakes serving Tribal communities are located along the reservoirs and riverine stretches along the Missouri River. Similar to other intakes in the upper river, Tribal intakes are likely to experience negligible impacts under Alternatives 1 and 2 relative to No Action.

The range of annual average costs to access water in the river under Alternative 1 (including Variations 1A and 1B) as compared to the No Action Alternative is expected to be between -$88 and -$223, which equates to a decrease of approximately $3.38 and $8.58 per intake. The range of annual average costs to access water in the river under Alternative 2 (including Variations 2A and 2B) as compared to the No Action Alternative is expected to be between -$173 and -$547 which equates to a decrease of approximately $6.65 and $21.04 per intake.

3.7.2.13 Climate Change

A discussion on the influence of climate change on the alternatives is included in Section 3.2 River Infrastructure under Climate Change. Drought periods along with decreased peak snow water equivalent would result in difficulties forecasting runoff and System storage. Higher spring runoff would result in higher spring System storage, leading to early spring releases in order to meet System criteria. However, relatively lower late summer and fall river flows may have adverse impacts to water supply access with increased periods when water surface elevations fall below critical thresholds. Given a possibility for longer, drier periods, water supply access could be affected with an increase in the number of days that water surface elevations would fall below critical thresholds for intakes. Impacts of climate change under Alternatives 1 and 2 would be similar to those described under No Action.

3.7.2.14 Cumulative Impacts

Construction of the System and the associated dams allows operation with controlled flow releases from the Fort Peck Dam to achieve multiple management objectives, including providing water supply access for various uses.

Variability in natural hydrologic conditions (precipitation and snowmelt, which include periods of drought and high runoff) and the “rules” governing System operation would continue to dominate the flows in the Missouri River into the future. Natural flow variability and the requirement to operate for all authorized purposes under the Master Manual would continue to be the primary drivers of impact to water supply access of the Missouri River. However, other actions and programs, such as water depletions or withdrawals for agriculture, municipal, industrial uses, or oil and natural gas production have and would continue to have adverse impacts to water supply access, as they would notably affect the water surface elevations and flows of the river and reservoirs. Groundwater withdrawal practices would continue to offer an alternative to withdrawals from the Missouri River, and any changes to those practices could result in an adverse impact to water supply access, as they would affect the water surface elevations and flows of the river and reservoirs.

Future aggradation and degradation trends would have similar effects under all of the alternatives. HEC-RAS modeling indicates that the action alternatives would not significantly contribute to aggradation or degradation (Section 3.2, River Infrastructure and Hydrologic Processes).

Past, present, and future actions that would affect bed degradation or aggradation of the Missouri River can impact the stability of the intakes and result in frequent and prolonged instances when water surface elevations fall below critical operating thresholds. Cumulative actions that affect aggradation such as floodplain development including agricultural operations affecting runoff can impact sediment and/or silting in intakes.

Under No Action, existing geomorphological processes and trends would continue, consisting primarily of river degradation and bank erosion, reservoir sediment deposition and aggradation, shoreline erosion in reservoirs, and ice dynamics.

Impacts of No Action would be adverse and long-term if water supply intakes remain at their existing elevations, but these impacts would not be the result of any of the actions described for No Action in the FPDTR-EIS. When combined with other past, present, and reasonably foreseeable future actions, the cumulative impacts to water supply access associated with No Action would continue to be adverse and long-term primarily due to natural variability in hydrologic conditions and actions that contribute to bed degradation and aggradation.

Under Alternative 1, including Variations 1A and 1B, the Fort Peck Dam test flow releases would modify reservoir releases and river flows to some extent, but would overall have a small beneficial impact on water supply access. These impacts would be due to higher water surface elevations in the spring months relative to the No Action Alternative. On average, these impacts would be small in nature but there are a few years when water supply access would experience adverse impacts. When combined with other past, present, and reasonably foreseeable future actions, the cumulative impacts of Alternative 1 would be similar to No Action. Implementation of Alternative 1 would have a negligible contribution to these cumulative impacts.

Under Alternative 2, including Variations 2A and 2B, the Fort Peck Dam test flow releases would modify upper reservoir releases and river flows to some extent, but would overall have a small beneficial impact on water supply access. These impacts would be due to higher water surface elevations in the spring months relative to the No Action Alternative. As in Alternative 1 and Variations 1A and 1B, these impacts are small in nature on average but there are a few years when water supply access would experience adverse impacts. When combined with other past, present, and reasonably foreseeable future actions, the cumulative impacts of Alternative 2 would be similar to No Action. Implementation of Alternative 2 would have a negligible contribution to these cumulative impacts.

3.8 Water Quality

3.8.1 Affected Environment

The chemical and physical properties of Missouri River water influence the presence, growth, and survival of aquatic species and affect human uses of the river including water supply, irrigation, power generation, and recreation. Water quality and sources of pollution can vary greatly along the length of the Missouri River. Humans have modified the Missouri River ecosystem and the resulting changes in land uses, landscape cover types, and their associated nutrient and pollutant sources within the basin influence water quality. The primary sources of pollution, both point and nonpoint sources, along the Missouri River are from urban, agricultural, and industrial land uses. The construction of the dams and impoundments trap suspended sediment and particulates, modify the flow regime of the river, and influence water quality within the reservoirs and the downstream free-flowing reaches. Additionally, the natural river flows, stages, and channel geometry can influence water quality within the river.

The physicochemical water quality parameters identified for assessment include: water temperature, dissolved oxygen, nutrients (nitrogen and phosphorus), sediment and turbidity, and other pollutants including metals/metalloids. These parameters are common water quality assessment metrics and are important for the health of ecological communities and the human uses of the river.

This section provides a description of the existing water quality of Fort Peck Lake and the Missouri River downstream of Fort Peck Dam to the headwaters of Lake Sakakawea. Water quality effects related to test-flow releases would tend to attenuate below larger tributaries such as the Milk, Poplar and Yellowstone Rivers in the Fort Peck Dam to Lake Sakakawea reach.

3.8.1.1 Reservoir Water Quality

General water quality concerns in the Missouri River mainstem reservoirs include eutrophication and sedimentation, depletion of dissolved oxygen in the hypolimnion, shoreline erosion, and bioaccumulation of contaminants in aquatic organisms. The deeper mainstem reservoirs (including Fort Peck Lake) have issues with seasonally depleted hypolimnetic dissolved oxygen (i.e., hypoxic) and hypolimnetic discharges (cold water from the bottom layer of the reservoir that can have low dissolved oxygen concentrations) especially when lake pool levels are low.

Turbidity levels are typically higher at the upper end of the reservoirs due to the inflow of suspended material from the mainstem Missouri River. However, turbidity quickly decreases as the river enters the reservoirs. The water columns of the reservoirs are relatively free of sediment and turbidity because sediment and particulate nutrients drop out of suspension and settle to the bottom of the reservoir behind the dam. Water temperatures can vary with depth as thermal stratification takes place with warmer water on the top and colder water on the bottom. In general, lake water temperatures are higher when the lake pool elevation is low and/or when the ambient air temperature is higher. Deeper reservoirs will experience thermal stratification of their impoundments in the summer. As air temperatures heat up in warmer months, an epilimnion (upper layer), metalimnion (middle layer or thermocline), and hypolimnion (bottom layer) can form and the waters at the upstream end of the reservoir warm up faster than those close to the dam (USACE, 2006a). The cold hypolimnion can be as much as 10°C colder than the epilimnion (USACE, 2006a). Winter stratification causes denser water (4°C) to settle to the bottom with colder less dense water (< 1°C) to rise above the slightly warmer water below (USACE, 2006a). The water temperatures in most reservoirs vary both longitudinally (i.e., from the dam upstream to where the mainstem Missouri River enters the reservoir) and vertically (i.e., from the lake surface to the bottom), as well as seasonally. Surface waters in the upstream area of the reservoirs typically warm up sooner than areas close to the dams. Stratification takes place near the dams whereas the shallower upstream areas of the reservoirs usually do not stratify. Dissolved oxygen concentrations are affected by water temperature with warmer water holding less oxygen than colder water. Deeper areas of reservoirs areas show more pronounced vertical variations in temperature and dissolved oxygen compared to shallower areas (USACE, 2006a). Where stratification occurs, dissolved oxygen concentrations decrease along the bottom of the reservoir and are degraded in the hypolimnion.

The State of Montana has assigned Fort Peck Lake a B-3 classification in the State's water quality standards. As such, the reservoir is to be maintained suitable for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply. Fort Peck Lake is not assigned a coldwater fishery use by the State in its water quality standards; however, the reservoir supports a stocked salmon fishery and a naturally reproducing lake trout and lake cisco fishery – all are considered coldwater species. Pursuant to Section 303(d) of the Federal CWA, Montana has placed Fort Peck Lake on the State's 2018 list of impaired waters citing impairment to the uses of aquatic life and drinking water. The impairment of the uses is attributed to the pollutants of lead and mercury. The identified sources of these pollutants are atmospheric deposition, historic bottom deposits (not sediment), and impacts from abandoned mine lands (inactive). The State of Montana has also issued a fish consumption advisory for Fort Peck Lake due to mercury concerns.

Water quality conditions that were monitored in Fort Peck Lake from May through September during the 5-year period 2014 through 2018 found no significant water quality concerns. On a few occasions measured dissolved oxygen concentrations were below the water quality standards criterion of 5 mg/L for the protection of Class B-3 warmwater aquatic life. The measured low dissolved oxygen concentrations occurred in the hypolimnion near the reservoir bottom during the latter part of the summer thermal stratification period.

3.8.1.2 Missouri River below Fort Peck Dam

The discharge from Fort Peck Lake is from the hypolimnion layer (i.e., bottom layer) of the stratified reservoir. In the spring and summer, withdrawing water from this layer results in cooler water temperatures downstream of the dams than would naturally occur. The temperature below dams can be cold for long periods. Differences in the water temperature of inflow and outflow reservoir water can range from 4°C to 10°C (Galat et al., 2005; USACE, 2010). During winter reservoir stratification, Fort Peck Lake discharges hypolimnetic water into tailwater areas that is warmer by 1°C to 3°C than would naturally occur (USACE 2006a; USACE 2010). Hourly temperature, dissolved oxygen, and dam discharge recorded at the Fort Peck powerplant during from 2014-2018 showed seasonal warming and cooling through the year. Dissolved oxygen levels remained relatively high and stable during the winter, steadily declined through the spring and summer, and steadily increased during the fall. The lowest dissolved oxygen levels occurred during the late summer/early fall period. The higher winter, declining spring/summer, and increasing fall dissolved oxygen concentrations are attributed to decreasing dissolved oxygen solubility with warmer water temperatures. The decreasing dissolved oxygen in the July to September period is attributed to ongoing degradation of dissolved oxygen in the hypolimnion of Fort Peck Lake as the summer progresses. Water is withdrawn from the reservoir into the dam's power tunnels from below the thermocline at an elevation 65 feet above the reservoir bottom. Power Plant 1 and Power Plant 2 have a combined capacity of 14,000 cfs. Discharges higher than these rates are drawn from warmer surface water and passes through the Fort Peck spillway which is located east of the Dam (Figure 1-4). The spillway discharges approximately 9 miles downstream of Fort Peck Dam, approximately 1 mile upstream of the Milk River confluence.

The water quality in the Fort Peck Dam to Lake Sakakawea Reach is generally in compliance with water quality standards. Land use in the upper basin is primarily agriculture (livestock and cropland) and undeveloped open spaces with few urban areas or industrial uses (USGS 2001). Development and urbanization, which usually contribute the most nitrogen and phosphorus to the river, are not significant parts of the landscape in this part of the basin. Small municipal wastewater treatment systems associated with the existing riverside communities likely have modest water quality impacts. The presence of the dams influences sediment and turbidity, water temperature, and phosphorus concentrations. The mainstem Missouri River reservoirs act as a sink for sediment and nutrients (USACE, 2006a). The river reaches located between the reservoirs typically have very low sediment, turbidity, and particulate nutrients due to the capture of particulates behind the dams (Galat et al., 2001).

Hypolimnetic releases from Fort Peck Dam cause the river, from the tailwaters to the Milk River confluence, to be characterized by cold, clear waters that support a popular cold water trout fishery. At Frazer, Montana, approximately 30 miles downstream from the dam, model simulations show that the average temperature in the period June to August was 13.2°C with a high of 17.3°C (USACE 2006a). Approximately 100 miles downstream from Garrison Dam the temperature is still low (15.6°C) (USFWS, 2000). In general, water temperatures below Fork Peck Dam are higher when the lake pool elevation is low, dam discharges are lower, and when the ambient air temperature is higher (USACE, 2006a). Water released from the Fort Peck Dam spillway is warmer than the tailwater released directly into the Missouri River (USACE, 2006a). Simulations showed that spillway temperatures reach 17°C in late June and stay above 17°C until the end of September (USACE, 2006a). Table 3-131 shows mean water temperature for May to September during the period from 2012 to 2014.

Table 3-131. Mean monthly water temperature (°C) in the inter-reservoir reaches (2012–2014)

-	**Water Temperature (°C)**							
Location	**January**	**April**	**May**	**June**	**July**	**August**	**Sept**	**October**
Fort Peck Dam to Lake Sakakawea								
Powerplant Discharge	3.6	4.6	7.0	9.3	11.5	13.6	12.4	13.3
Williston, North Dakota	–	8.1	16.0	21.4	23.4	19.4	16.0	8.1

Source: USACE 2016b

Recent measurements showed that water released from Fort Peck Lake is low in dissolved oxygen but that the levels do not fall below the minimum water quality standards (USACE, 2018e). Table 3-132 shows mean dissolved oxygen concentrations for May to September during the period 2012 to 2014.

Table 3-132. Mean monthly dissolved oxygen concentrations (mg/L) in the inter-reservoir reaches (2012–2014)

Location	**Dissolved Oxygen (mg/L)**							
	January	**April**	**May**	**June**	**July**	**August**	**Sept**	**October**
Fort Peck Dam to Lake Sakakawea								
Powerplant Discharge	12.6	12.2	11.5	9.9	8.2	6.8	6.2	8.3
Williston, North Dakota	–	10.9	8.9	8.4	8.0	8.7	9.4	10.8

Source: USACE, 2016b

Sediment, turbidity, and phosphorus concentrations downstream from Fort Peck Dam are much lower than upstream concentrations because most sediment and particulate phosphorus and nitrogen is trapped behind the dam and settles out in the reservoir (Ward & Stanford, 1983; Schmulbach et al., 1992). However, compared to the reaches downstream from Oahe, Big Bend, and Fort Randall Dams, the reaches downstream from Fort Peck and Garrison Dams are less affected by sediment and phosphorus entrapment. Turbidity and phosphorus concentrations increase with greater distances downstream from the Fort Peck tailwaters as tributaries supply sediment, particulates, and nutrients (Galat et al., 2001). The Milk River inputs turbidity to the Missouri River but the mainstem does not fully recover its naturally turbid condition until the confluence of the Yellowstone River. Table 3-133 shows the median and range of turbidity and nutrient concentrations for the Fort Peck Dam powerplant discharge and Williston, North Dakota during the period 2010 to 2014. The table shows that approximately 200 miles downstream at Williston, the concentrations have increased (USACE, 2018e). Higher nutrient flux rates at Williston were attributed to higher nonpoint source runoff at certain times (USACE, 2018e).

Historically, the lower Missouri River in Montana was a turbid, warmwater environment with seasonally fluctuating flows. Native Missouri River fish are adapted to highly turbid and low visibility environments by physiologically evolving to enhance their ability to capture prey and avoid capture as juveniles and larvae in this low visibility environment. Fort Peck Dam and Reservoir is trapping sediment that historically moved down the Missouri River.

Table 3-133. Turbidity and nutrients in the inter-reservoir reaches (2010–2014)

Reservoir Location	Turbidity (in Nephelometric Turbidity Units [NTU])		Nitrate-Nitrite Nitrogen (mg/L)		Total Nitrogen (mg/L)		Total Phosphorus (mg/L)	
	Range	Median	Range	Median	Range	Median	Range	Median
Fort Peck Dam to Lake Sakakawea								
Powerplant Discharge	n.d.–30	–	n.d.–17	n.d.	–	–	n.d.–17	n.d.
Williston, North Dakota	3–1,447	114	n.d.–0.39	0.06	0.3–2.5	0.6	0.06–1.39	0.16

Source: USACE, 2016a
n.d. – Not detected

A pesticide scan of water released from the Fort Peck Dam, sampled from 2010 to 2014, did not detect any of 29 pesticides (USACE, 2018e). Monitoring of water quality near Williston, North Dakota, indicated high levels of total aluminum, total iron, and total manganese; however, it was noted that the higher concentrations are due to the local geology and are not considered water quality problems (USACE, 2018e). Arsenic, cadmium, chromium, copper, and nickel were also found but in lower concentrations (USACE, 2018e). Monitoring of water released from the Fort Peck Dam powerplant showed no water quality exceedances except for cadmium in one sample (USACE, 2018e).

In Montana's water quality standards, the Missouri River downstream of Fort Peck Dam has been designated a B-2 classification from the dam to the confluence of the Milk River, and a B-3 classification from the Milk River confluence to the Montana/North Dakota state line. Both B-2 and B-3 waters are to be maintained suitable for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; waterfowl and furbearers; and agricultural and industrial water supply. In addition, B-2 waters are to maintain growth and marginal propagation of salmonid fishes and associated aquatic life, and B-3 waters are to maintain growth and propagation of non-salmonid fishes and associated aquatic life. The river is used as a water supply by several towns along the reach. Pursuant to Section 303(d) of the Federal Clean Water Act, Montana has placed the Missouri River downstream of Fort Peck Dam on the State's 2018 list of impaired waters citing impairment to aquatic life. The coldwater aquatic life use from Fort Peck Dam to the Milk River is believed impaired due to alterations in stream-side or littoral vegetative cover, flow regime alterations, and water temperature. The source of the impairments is identified as impacts from hydrostructure flow regulation/modification. The warmwater aquatic life use from the Milk River to the Popular River is believed impaired due to alterations in stream-side or littoral vegetative cover, flow regime alterations, and water temperature. The sources of the impairments are identified as impacts from hydrostructure flow regulation/modification and loss of riparian habitat. The warmwater aquatic life use from the Popular River to the North Dakota border is believed impaired due to flow regime alterations and water temperature. The sources of the impairments are identified as dam or impoundment and impacts from hydrostructure flow regulation/modification. No fish consumption advisories have been issued for the Missouri River downstream of Fort Peck Dam by the State of Montana.

3.8.1.3 Water Quality on Tribal Lands

The Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation have developed water quality standards, approved by the U.S. Environmental Protection Agency, that are applicable to their tribal lands. This includes an area on the north side of the Missouri River downstream of Fort Peck Dam from the Milk River to Big Muddy Creek. The tribal water quality standards applicable to this reach of the Missouri River are comparable to the State of Montana's water quality standards.

3.8.2 Environmental Consequences

The water quality environmental consequences analysis assesses the anticipated changes to Missouri River water quality conditions in riverine and reservoir reaches for each alternative.

3.8.2.1 Impacts Assessment Methodology

Identified water quality parameters of interest to this assessment include water temperature, dissolved oxygen, sediment and turbidity, nitrogen and phosphorus, and other pollutants including metals/metalloids. These parameters are common water quality assessment metrics and are important for the health of ecological communities and the human uses of the river. The impacts assessment was qualitative and based on available data, published literature, and unpublished agency studies and reports on the water quality of the Missouri River. The impacts analysis also assesses effects based on State water quality standards developed pursuant to the CWA. The No Action Alternative is considered the baseline against which the other alternatives are measured. Under The No Action Alternative, the Missouri River Recovery Program would continue to be implemented as it is currently and no test releases from Fort Peck Dam would occur.

3.8.2.2 Summary of Environmental Consequences

Table 3-134 summarizes the impacts of each alternative to water quality.

Table 3-134. Environmental consequences for water quality

Alternative	Impacts to Water Quality
No Action Alternative	Operation of the System would continue without test-flow releases from Fort Peck Dam. Periods of higher a nd lower than average flows would occur based on runoff conditions. Overall, under the No Action Alternative it is anticipated that impacts to water quality parameters would result in the same or similar water quality conditions as described in the Affected Environment section because operation of the System would be the same or similar. State and tribal water quality standards would continue to be met as they are currently.
Alternative 1 and variations	Small temporary increases in water temperature and decreases in dissolved oxygen would occur in April and then again in mid-May to July below the Fort Peck Dam Spillway which discharges approximately 9 miles downstream of the Dam. This would occur in conjunction with attraction and spawning flows that discharge warmer surface water through the spillway rather than deeper colder water that discharges through the powerhouse. Negligible to small temporary increases in sediment and turbidity could occur during test flow years below Fort Peck Dam from increased erosion due to higher flows. These impacts would attenuate moving downstream as sediment is added from major tributaries such as the Milk River and Yellowstone River. No to negligible effects from introduction of pollutants from increased flows and floodplain connectivity. State and tribal water quality standards would continue to be met based on negligible to small changes in water quality parameters.
Alternative 2 and variations	Small temporary increases in water temperature and decreases in dissolved oxygen would occur in in mid-May to July below the Fort Peck Dam Spillway which discharges approximately 9 miles downstream of the Dam. This would occur in conjunction with spawning flows that discharge warmer surface water through the spillway rather than deeper colder water that discharges through the powerhouse. Negligible to small temporary increases in sediment and turbidity could occur during test flow years below Fort Peck Dam from increased erosion due to higher flows. These impacts would attenuate moving downstream as sediment is added from major tributaries such as the Milk River and Yellowstone River. No to negligible effects from introduction of pollutants from increased flows and floodplain connectivity. State and tribal water quality standards would continue to be met based on negligible to small changes in water quality parameters.

3.8.2.3 No Action Alternative (Current System Operation and Current MRRP Implementation)

Water quality conditions under the No Action Alternative are anticipated to be the same or similar to those described for the Affected Environment. Water temperatures would continue to show seasonal warming and cooling through each calendar year. Dissolved oxygen levels would remain relatively high and stable during the winter, steadily decline through the spring and summer, and steadily increase during the fall. The lowest dissolved oxygen levels would occur during the late summer/early fall period. The higher winter, declining spring/summer, and increasing fall dissolved oxygen concentrations are attributed to decreasing dissolved oxygen solubility with warmer water temperatures. The decreasing dissolved oxygen in the July to September period is attributed to ongoing degradation of dissolved oxygen in the hypolimnion of Fort Peck Lake as the summer progressed.

Sediment, turbidity, and phosphorus concentrations downstream from Fort Peck Dam would continue to be much lower than upstream concentrations because most sediment and particulate phosphorus and nitrogen is trapped behind the dam and settle out in the reservoir. Turbidity and phosphorus concentrations would continue to increase with greater distances downstream from the Fort Peck tailwaters as tributaries supply sediment, particulates, and nutrients (Galat et al., 2001).

Other water quality issues would continue to include impairment of Fort Peck Lake from lead and mercury. The identified sources of these pollutants are atmospheric deposition, historic bottom deposits (not sediment), and impacts from abandoned mine lands (inactive).

The coldwater aquatic life use from Fort Peck Dam to the Milk River would continue to be impaired due to alterations in stream-side or littoral vegetative cover, flow regime alterations, and water temperature. The warmwater aquatic life use from the Milk River to the Popular River would continue to be impaired due to alterations in stream-side or littoral vegetative cover, flow regime alterations, and water temperature.

Conclusion

Operation of the System would continue without test-flow releases from Fort Peck Dam. Periods of higher and lower than average flows would occur based on runoff conditions. Overall, under the No Action Alternative it is anticipated that impacts to water quality parameters will result in the same or similar water quality conditions as described in the Affected Environment section because operation of the System would be the same or similar.

3.8.2.4 Alternative 1 and Variations

Under Alternative 1, there would be increases in water temperature and decreases in dissolved oxygen below the Fort Peck Dam spillway in April and again in mid-May to July in years where the attraction and spawning flows are greater than the maximum powerhouse capacity. Warmer water and lower dissolved oxygen would only effect approximately the lower one mile of the 10 mile cold water fishery that runs from Fort Peck Dam to the Milk River confluence. There could be a temporary negligible to small increase in the upper layer of Fort Peck Lake water temperatures due to lower reservoir levels. It is not anticipated that these changes would be long-term or large because the reservoir levels would gradually drop 3-5 feet starting in April and returning to normal by the end of December.

There would be negligible to small temporary increase in sediment, turbidity, and nutrients (nitrogen and phosphorus) during test flow years from increased erosion due to higher flows. The impacts attributable to the test flow release would be negligible to small because these effects would attenuate moving downstream as sediment is added from major tributaries such as the Milk, Poplar, and Yellowstone Rivers and the effect would be localized rather than occurring over a wider area of the river reach. Additionally, nitrogen and phosphorus levels in areas that would likely be affected by flows are much lower than levels upstream of Fort Peck Dam.

There could be a negligible impact from introduction of pollutants from increased flows and floodplain connectivity. Due to negligible to small impacts to water quality parameters it is anticipated that state and tribal water quality standards would continue to be met under Alternative1.

Conclusion

The main water quality effect under Alternative 1 would be a small temporary increase in temperature and decrease in dissolved oxygen in test-flow years below the Fort Peck Dam spillway. This would only occur below the spillway which discharges to the Missouri River approximately 1 mile above the Milk River confluence. Only the last mile of 10 miles of cold water fishery would be affected by increased temperatures and decreased dissolved oxygen. Impacts could also include a temporary small to negligible increase in turbidity and sediment in localized areas due to higher flows. Given water quality impacts would be negligible to small and occur only during test-flow years, and would not contribute to exceeding state or Tribal water quality standards, Alternative 1 would not have significant impacts on water quality.

3.8.2.5 Alternative 2 and Variations

Under Alternative 2, there would be increases in water temperature and decreases in dissolved oxygen below the Fort Peck Dam spillway in mid-May to July in years where the attraction and spawning flows are greater than the maximum powerhouse capacity. Warmer water and lower dissolved oxygen would only effect approximately the lower one mile of the 10 mile cold water fishery that runs from Fort Peck Dam to the Milk River confluence. There could be a temporary negligible to small increase in the upper layer of Fort Peck Lake water temperatures due to lower reservoir levels. It is not anticipated that these changes would be long-term or large because the reservoir levels would gradually drop 3-5 feet starting in April and returning to normal by the end of December.

There would be negligible to small temporary increase in sediment, turbidity, and nutrients (nitrogen and phosphorus) during test flow years from increased erosion due to higher flows. The impacts attributable to the test flow release would be negligible to small because these effects would attenuate moving downstream as sediment is added from major tributaries such as the Milk, Poplar, and Yellowstone Rivers and the effect would be localized rather than occurring over a wider area of the river reach. Additionally, nitrogen and phosphorus levels in areas that would likely be effected by flows are much lower than levels upstream of Fort Peck Dam.

There could be a negligible impact from introduction of pollutants from increased flows and floodplain connectivity. Due to negligible to small impacts to water quality parameters it is anticipated that state and tribal water quality standards would continue to be met under Alternative 2.

Conclusion

The main water quality effect under Alternative 2 would be a temporary increase in temperature and decrease in dissolved oxygen in test-flow years below the Fort Peck Dam spillway. This would only occur below the spillway which discharges to the Missouri River approximately 1 mile above the Milk River confluence. Alternative 2 would only spill water through the spillway in the mid-May to July timeframe compared to Alternative 1 which spills water through the spillway also in April. Only the last mile of 10 miles of cold water fishery would be affected by increased temperatures and decreased dissolved oxygen. Impacts could also include a temporary small to negligible increase in turbidity and sediment in localized areas due to higher flows. Given water quality impacts would be negligible to small and occur only during test-flow years, and would not contribute to exceeding state or Tribal water quality standards, Alternative 2 would not have significant impacts on water quality.

3.8.2.6 Tribal Water Quality

Due to the anticipated negligible to small water quality effects under Alternatives 1 and 2 (and their variants) there would be no impacts specific to Tribal water quality standards as identified in Section 3.8.1.3.

3.8.2.7 Climate Change

The climate change scenario states that there will likely be increased air temperature, precipitation, and streamflow in the future. Higher air temperatures would likely influence water temperature especially in areas of low river flow or low reservoir elevations resulting in warmer water temperatures that could influence the amount of time that the mainstem reservoirs are thermally stratified. Periods of intense rain could increase runoff, mobilize land-based particulates, and increase sediment and pollutant loading in the Missouri River. The general impacts of climate change under all alternatives would consist of adverse impacts from altered water temperature regimes and, by association, dissolved oxygen conditions, as well as potential increases in sediment loading and nutrient and other pollutant loading. It is not anticipated that the effects of climate change would appreciably change between the No Action and alternatives.

3.8.2.8 Cumulative Impacts

Past, present, and reasonably foreseeable future actions, projects, and programs have both temporary and long-term impacts on water quality. Temporary impacts result from construction activities, including oil and natural gas production, and other development actions. Temporary impacts include adverse impacts from increased levels of sediment, turbidity, nutrients, and other pollutants as well as impacts from alterations to water temperature and dissolved oxygen conditions.

The mainstem reservoirs have altered all aspects of water quality over a large portion of the river. Specifically, the dams and reservoirs have resulted in seasonally depleted dissolved oxygen in reservoirs; discharges of cold water in the tailwaters of some dams and the potential for higher concentrations of nitrogen, phosphorus, and other pollutants in reservoirs during low elevation periods.

Surface water withdrawals for agriculture, municipal, and industrial uses, as well as groundwater withdrawals, such as those from oil and natural gas production, could lower water flows or elevations in the river and reservoirs and impact water quality. In these conditions, water heats up more rapidly; dissolved oxygen concentrations decrease; and nitrogen, phosphorus, and other pollutants become concentrated, resulting in small to large adverse impacts to water quality. Additionally, return flows would adversely impact water quality with increased nitrogen and phosphorus concentrations, higher localized water temperatures, and potentially higher levels of other harmful pollutants.

Urban, residential, transportation/utility, commercial, and industrial development and oil and gas production on the floodplain result in temporary impacts associated with construction including adverse impacts from increased levels of sediment, turbidity, nutrients, and other pollutants as well as impacts from alterations to water temperature and dissolved oxygen conditions. Small long-term adverse impacts to water quality result from stormwater runoff and discharges characterized by increased water temperatures, sediment and turbidity, nutrients, and other pollutant loads. Agricultural actions including floodplain animal pasturing and crop production result in large long-term adverse impacts from increased loading of nutrients and other pollutants. Spills associated with oil and gas production result in small long-term adverse impacts to water quality from increased levels of oil or gas and related production materials and chemicals.

The past, present, or reasonably foreseeable future actions of programs associated with water quality improvement such as nutrient reduction, and ecosystem restoration, and the actions of other federal agencies that focus on land and river conservation and management and restoration of natural habitats would result in long-term beneficial impacts for water quality including reduction of sediment, nutrient, and other pollutant loading.

Cumulative impacts would be the same for each of the alternatives. Overall, cumulative actions from past, present, and reasonably future actions would be long-term, adverse or beneficial to water quality. Cumulative actions significantly affect water quality on the Missouri River by altering all aspects of water quality over a large portion of the river. The management actions under the alternatives are anticipated to have temporary negligible to small impacts from alteration of water quality parameters. When combined with other past, present, and reasonably foreseeable future actions, the Alternatives would result in both adverse and beneficial impacts largely based on changes to levels of sediment, turbidity, nutrients, and other pollutants and from alterations to water temperature and dissolved oxygen conditions. The implementation of Alternative 1 or 2 would provide a negligible to small contribution to the cumulative impacts to water quality, based on the temporary and localized scale of the impacts.

3.9 Recreation

3.9.1 Affected Environment

The upper basin of the Missouri River corridor supports a wide range of water, land, and wildlife-related activities. Recreational opportunities, settings, and access to public facilities vary along the river. For this analysis, the river was divided into two main geographic locations: the upper three reservoirs (Fort Peck, Sakakawea, and Oahe); and the river reaches between these three reservoirs. Recreation in the locations below Lake Oahe are not anticipated to be affected by the FPDTR-EIS alternatives (see Section 3.2. River Infrastructure and Hydrologic Processes).

The natural amenities and features of the Missouri River corridor are a popular destination for outdoor enthusiasts, attracting millions of visitors to the corridor each year. Recreational opportunities supported by the Missouri River corridor include a variety of land- and water-based activities. Water-based recreation includes shoreline fishing, boat fishing, power boating, waterskiing, tube towing, jet skiing, tubing, canoeing, kayaking, and swimming. Sport fishing (i.e., fishing for sport or recreation) is a prevalent activity along the UMR and upper three reservoirs, including cold water and cool water reservoir fishing for salmon and walleye; rainbow trout fishing along the river reaches of Montana; and warm water fishing for bass and catfish. Wetlands, sandbars, and shoreline along the river corridor serve as waterfowl habitat and support opportunities for waterfowl hunting and bird watching. Natural landscapes and viewscapes surrounding the reservoirs and inter-reservoir river reaches of the UMR also attract a large number of sightseers.

As visitors travel to and from recreation areas along the Missouri River, they spend money in local communities on food, gas, lodging, and other trip-related expenses. Visitors who live outside the river corridor stimulate economic activity and inject new money into local economies within the corridor, supporting jobs and income of residents.

3.9.1.1 Upper Three Reservoirs

In 2018, the three upper basin mainstem reservoirs were estimated to support more than 5.6 million recreation visits (Table 3-135). The visitation data is provided by month and by day and overnight visits; as such, the data does not reflect recreational visitor days since overnight visitors would be at the reservoir for more than one day. Recreational opportunities at these reservoirs range from primitive to more developed, providing the general public with access to facilities that enhance recreational experiences. Note that this visitation data include visits to developed recreation areas in the river reaches on which the USACE collects visitation data.

Table 3-135. Annual visitation on the upper three reservoirs, 2014-2018 (includes visitation below the dam)

Reservoir	2014	2015	2016	2017	2018	Percent Change 2014-18
Fort Peck Lake	566,123	435,208	614,564	607,780	681,313	20.35%
Lake Sakakawea	1,669,848	1,811,595	2,001,321	2,341,030	2,868,567	71.79%
Lake Oahe	2,016,240	2,443,225	2,497,749	2,357,080	2,071,462	2.74%
Total	4,252,211	4,690,028	5,113,634	5,305,890	5,621,342	32.20%

Source: USACE Visitation Estimation and Reporting System (VERS) 2019a.

Note: Visitation includes recreation areas that are on the reservoirs as well as some recreation areas that are located below the dam or above the reservoir; this is all of the visitation data collected through the USACE VERS.

Table 3-136 summarizes the annual recreation visitor days for the recreation areas that are located on the reservoirs; all visitation data for recreation areas located in the river reaches above or below the reservoirs have been removed and included in the appropriate river reach visitation data. The visitation data was also adjusted to reflect recreational visitor days by adding an additional day for overnight visitors. Lake Sakakawea supported the highest annual visitation of the reservoirs with 3.4 million recreational visitor days in 2018. Most recreational use of the lakes occurs during the spring, summer, and fall months.

Table 3-136. Annual recreation visitor days on the reservoirs, 2018

Reservoir	Winter Recreation Visitor Days	Spring, Summer, and Fall Recreation Visitor Days	Total Recreation Visitor Days
Fort Peck Lake	69,885	618,832	688,717
Lake Sakakawea	338,142	3,046,258	3,384,400
Lake Oahe	323,203	1,212,192	1,535,395
Total	731,230	4,877,282	5,608,512

Source: USACE Visitation Estimation and Reporting System (VERS) 2019a.

Note: Reservoir visitation in this table for 2018 removes visitation at the recreation areas above and below the reservoirs; this visitation has been added to visitation in the inter-reservoir reaches.

USACE and state, county, and local government agencies manage the recreation facilities at the reservoirs. The quality and quantity of amenities varies across recreation sites and may include: interpretive centers, boat ramps, camp sites, swimming beaches, picnic areas, playgrounds, bathrooms and showers, handicap accessible facilities, electrical hookups and dump stations, grills, fish cleaning stations, and small bait or grocery stores. Public recreation facilities at each of the lakes are summarized in Table 3-137.

Table 3-137. Recreation facilities at the upper three reservoirs

Reservoir	Recreation Areas	Normal Water Boat Ramps (Low-water Boat Ramps)[a]	Marina Slips	Camping Sites	Swim Areas
Fort Peck Lake	34	20 (8)	74	507	3
Lake Sakakawea	35	67 (42)	341	1,944	3
Lake Oahe	50	50 (5)	165	748	2

Sources: USACE Value to the Nation Fast Facts 2016.
[a] Sources: McMurray 2019; Busche 2015; Fincel 2015.

Reservoir visitors participate in a variety of land and water-based activities. Water-based activities that attract a large number of visitors to the reservoirs each year include boating, swimming, and waterskiing. Although most boating is associated with hook-and-line fishing, many visitors partake in pleasure boating and sailing during the warm summer months. Wind surfing, waterskiing, tubing, and jet skiing are also popular water-based activities, as is swimming and sunbathing along the shoreline or in designated swimming areas during the summer months.

Fish and wildlife-associated recreation are some of the most popular uses of the reservoirs. The reservoirs support both cool and cold-water fisheries and provide critical nesting and feeding habitat for upland birds and waterfowl. Several of the lake fisheries are recognized nationally and support competitive fishing events. Chinook salmon, walleye, catfish, bass, northern pike, sauger, crappie, trout, and yellow perch are the primary gamefish. Since wildlife is abundant in areas surrounding the lakes, opportunities exist for wildlife photographers and enthusiasts, birders, and upland game and waterfowl hunters. In addition, the diverse natural landscapes surrounding the upper three reservoirs attract a large number of sightseers each year.

Camping and picnicking are very popular activities at many of the recreation areas during the warmer months. More developed camping and picnicking facilities are available at many of the public and semi-private recreation sites. These areas are popular destinations for visitors making weekend trips or traveling with families. On summer weekends, especially holiday weekends, these campgrounds are often near capacity.

Recreational opportunities at Fort Peck Lake, Lake Sakakawea, and Lake Oahe attract thousands of visitors to local communities surrounding the lakes. Visitors coming from outside of the region stay in local gateway communities and spend their money on food, gas, lodging, and supplies. These expenditures stimulate economic activity and support jobs and income in these communities and counties. The residency of the visitors can affect the economic impact of spending in local economies; Table 3-138 summarizes recent data on the residency of visitors to the upper three lakes.

Table 3-138. Residency of visitors to the upper three reservoirs

Reservoir	Visitors from Counties Surrounding or Adjacent to Project Area	Non-local Visitors*
Fort Peck Lake	8%	92%
Lake Sakakawea	22%	78%
Lake Oahe	30%	70%

Source: Longhenry pers. comm. 2016; Fryda pers. comm. 2016; USGS 2011; South Dakota Game Fish and Parks 2016.
*Non-local visitors include visitors from counties with population centers greater than 50 miles from the reservoir project area.

3.9.1.2 Inter-Reservoir River Reaches

The Missouri River System includes free-flowing river segments between the dam and reservoir projects. Unlike the reservoir projects, USACE does not manage most of the lands adjacent to the riverine reaches. Instead, the inter-reservoir river reaches pass through a variety of Tribal, state, municipal, and private lands. River access along these reaches is limited and usually restricted to designated access points at recreation sites. Partner agencies and local businesses manage most of the river accesses and recreational facilities within these reaches. Recreation specialists with USACE conducted an extensive effort to reach out to partner agencies, local organizations, and private businesses to collect data on recreational facilities and visitation to non-USACE-administered sites along the inter-reservoir river reaches conducted in 2009 and 2010. Information collected on facilities are summarized in Table 3-139.

Recreation opportunities and facilities within the riverine reaches differ from those at the reservoirs. A number of recreation sites within the riverine reaches are “low density use” sites, with relatively low visitation and few facilities. However, some “intensive use” recreation sites also exist within the inter-reservoir river reaches, such as those in proximity to Bismarck. These areas tend to offer more amenities and support much higher visitation levels. Both low density and intensive use areas within the riverine reaches include interpretative centers, swimming beaches, boat ramps, and marinas.

Visitation data for the river reaches comes from two sources: USACE VERS data; and data collection in 2010 and 2011 that reflects 2009 visitation at areas that were not reflected in the VERS data. Annual visitation for the non-VERS data for 2009 was used as it represents a comprehensive accounting of visitation to these sites. To update this baseline visitation figure for 2018 for consistency with the VERS data, the 2009 visitation was increased by the percentage change in the population between 2009 and 2018 for the counties along the river reach segments. The population grew by 50% and 21% for the counties adjacent to the Fort Peck to Lake Sakakawea and Garrison Dam to Lake Oahe river reaches, respectively (U.S. Census Bureau, 2019).

The USACE VERS data was adjusted to reflect recreational visitor days by adding a day to all overnight visitors. In addition, USACE visitation by project from the VERS database includes visitation to some recreation areas that are located below the dams and/or along the river reaches; the VERS recreational visitor day estimates for 2018 were added to the updated 2009 visitation estimates for the recreation areas not accounted for in the VERS data to provide a complete picture of river use in the inter-reservoir river reaches. The two inter-reservoir river reaches are estimated to support over 860,000 recreational visitor days in 2018. Recreation visitor days for each of the inter-reservoir river reaches are summarized in Table 3-140.

Table 3-139. Recreation facilities at upper inter-reservoir river reaches

River Reaches	Recreation Sites	Boat Ramps	Marinas or Resorts	Camp Sites	Swim Areas
Fort Peck Dam to Lake Sakakawea	19	14	0	121	4
Garrison Dam to Lake Oahe	22	20	2	489	2

Source: USACE 2012.

Table 3-140. Recreation visitor days in the upper inter-reservoir river reaches, 2018

River Reaches	Winter Recreation Days	Spring, Summer, and Fall Recreation Days	Total Recreation Days
Fort Peck Dam to Lake Sakakawea	26,525	261,795	288,320
Garrison Dam to Lake Oahe	78,023	499,927	577,950
Total Recreation Visitor Days	104,549	761,722	866,270

Sources: USACE VERS 2019a; USACE 2012.

The inter-reservoir river reaches are very popular with hunters and anglers. River access points within the inter-reservoir reaches are used for launching boats for fishing, waterfowl hunting, pleasure boating, and other water-based recreational activities. These riverine reaches act as a staging area for migrating geese and ducks in the spring and fall, where they rest and forage before continuing their migration. Waterfowl hunters access these islands and shoreline by boats and from shore (USACE, 2011). Northern pike, salmon, bullhead, sauger, bass, walleye, paddlefish, catfish, panfish, and trout are popular species harvested by both shore and boat anglers.

Recreational use of the river increases considerably near the Bismarck-Mandan area in the Garrison Dam to Lake Oahe reach, which has marinas, public boat access sites, and popular intensive use areas like the Kimball Bottoms Recreation Area (also known as the Desert). The overall concentration of marinas, private docks, and boat access in and around Bismarck is the greatest concentration of boating activity in any of the inter-reservoir river reaches.

3.9.1.3 Recreation Resources on Tribal Lands

There are 13 Native American Tribes, plus the Turtle Mountain Band of Chippewa Indians, who continue to live in rural areas along the Mainstem of the Missouri River. While each of these Tribes has a unique history and heritage, Native American cultures can share land-based worldviews rooted in the active recognition of kinship with the natural world. Thus, culture and lifestyles on Tribal reservations do not always create a clear distinction between work, leisure, family, and spirituality. Some Tribal members participate in a number of outdoor activities along the UMR, including hunting, fishing, trapping, berry and mushroom picking, camping, hiking, swimming, and collecting medicinal plants. Although these activities at times may include a subsistence component, many Tribal members also view them as recreational experiences that provide personal enjoyment.

In addition to supporting recreational opportunities for Tribal members, many Tribes have begun to manage reservation lands for recreational use and enjoyment by Tribal and non-Tribal members. Several Tribes along the Missouri River have developed public recreation areas to attract outdoor enthusiasts and visitors interested in learning about the heritage and culture of native Tribes. Many of these reservations are in rural areas with outstanding opportunities for fishing and hunting. Although it is illegal for non-Tribal members to harvest plants or animals from reservation lands without Tribal consent, many Tribes have begun selling special hunting and fishing permits to non-Tribal members. Non-Tribal visitor spending and revenues from non-Tribal hunting and fishing permits help fund Tribal operations and support economic opportunities for those living on Tribal reservations.

A number of Tribes regularly hold pow-wows and recreation-related events along Lake Sakakawea and Lake Oahe. Some of these Tribal events are held on lands administered by USACE and leased in perpetuity by the Three Affiliated Tribes and South Dakota Game, Fish and Parks. Pow-wows and other Tribal events held along the river promote community empowerment and social cohesion, contribute to the spiritual and social well-being of Tribal members, and attract non-Tribal members interested in learning about Native American cultures and traditions. Many Tribal and non-Tribal visitors who attend these events (on or off USACE lands) often visit other recreational sites and use facilities at nearby USACE recreation areas (USACE, 2011).

3.9.2 Environmental Consequences

Two action alternatives, each including three variations, were developed to meet the pallid sturgeon objectives. Each alternative and its variants are evaluated for their effects on recreation. The alternatives evaluated include management actions with potential to affect river flows, reservoir elevations, and river stage. The recreation impact analysis focuses on determining if changes in river and reservoir conditions associated with each of the FPDTR-EIS alternatives could result in an impact to visitation. This section summarizes the recreation methodology and presents the results of the assessment. A detailed description of the methods used for the recreation evaluation including data sources and assumptions can be found in the "Recreation Environmental Consequences Analysis Technical Report."

3.9.2.1 Impact Assessment Methodology

Environmental consequences associated with recreation were evaluated using three of the four Principles and Guidelines accounts (NED, RED, and OSE). These accounts provide a framework for evaluating and displaying effects of management actions to ensure monetary and non-monetary values and interests expressed as important to stakeholders and Tribes are considered, while ensuring impacts are not double-counted. The following section provides a brief overview of the methodology that was used to evaluate impacts reflected in each account.

River flows and reservoir elevations can fluctuate, causing changes in access to recreational resources and fishing opportunities. Changes in environmental conditions and the quantity and quality of recreational experiences along the UMR affect recreation benefits to users and costs associated with maintaining recreation access. The analysis of impacts on recreation used outputs from the HEC-RAS and HEC-ResSim Missouri River models to simulate river and reservoir operations over an 81-year POR under each of the FPDTR – EIS alternatives.[15] These modeled simulations were then used to estimate boat ramp operability and reservoir elevations under the alternatives.

[15] An 81-year period of record was used for the recreation evaluation because of how the seasons were defined in the modeling and because there was a one-year lagged variable in the upper three reservoirs visitation regression modeling.

No Action is considered the baseline against which the other alternatives are measured. Under No Action, the Missouri River system would continue to be implemented as it is currently under the Master Manual. As noted in Section 3.1.1, Impact Assessment Methodology, No Action does not reflect actual past or future conditions but serve as a reasonable basis or "baseline" for comparing the impacts of the action alternatives on resources.

National Economic Development

Contributions to the NED account reflect net benefits that accrue in the planning area and the rest of the Nation from recreation opportunities along the Missouri River. These consumer surplus benefits are measured using a hybrid approach that considers both the Unit Day Value (UDV) and travel cost method (TCM) approach (U.S. Water Resources Council, 1983; USACE ER 1105-2-100 Appendix E; USACE, 2020) and reflect the maximum amount individuals are willing to pay to engage in recreation activities on the Missouri River, rather than forego them (Walsh, 1986). The TCM is a revealed preference method of economic valuation that deduces willingness to pay through observing human behavior (i.e., the number and trips and costs per trip to a recreation area). The UDV method of estimating willingness to pay relies on expert and informed opinion to assign relative values to recreation days based on the quality of recreational opportunities supported by individual recreation areas. The approach to estimate the consumer surplus recreation values uses the UDV, which is based on USACE guidance and site-specific ratings and activities, but also recognizes that the UDV may reflect a relatively lower estimate of the consumer surplus value for a recreation visitor-day. Therefore, the UDV (in 2020$) was estimated and then proportionally increased based on the difference between the UDV and TCM as estimated in the Recreation Economics Volume 6C of the Master Water Control Manual Missouri River Review and Update (USACE, 1994). The UDV ratings were obtained from the USACE Rec-BEST database and applied to the visitation to estimate recreation NED benefits.

In the two inter-reservoir reaches, boat ramp operability, as estimated from modeled river and reservoir elevations, was used to assess recreational access and visitation at these locations.[16] A statistical process was used to estimate the best variables in predicting visitation at the upper three reservoirs. As a result, mid-August lake elevations, the price of gas, and a fishing success dummy variable[17] were determined to be the greatest influential factors to predict visitation and were used to estimate visitation at each of the upper three reservoirs.

[16] A supplemental boat ramp analysis was conducted for the boat ramps on Fort Peck Lake. Please see Appendix A in the Recreation Technical Report (located in Appendix F of the FEIS).

[17] Biological and other factors can also influence boating and fishing visitation to the lakes, including biomass of smelt, abundance of sport fish such as walleye, angler effort, catch rates, and others. However, because these variables cannot be estimated for the 82-year period of analysis, the recreation visitation regression models focused on

Regional Economic Development

The RED analysis estimates the direct, indirect, and induced effects to local regions as measured through jobs, labor income, and sales. The recreation RED analysis assesses how changes in visitation under the FPDTR – EIS alternatives, as estimated in the NED analysis, would affect non-local visitor spending and associated impacts on regional economic conditions. The inter-reservoir river reaches were excluded from the RED analysis because these river reaches primarily wind through private lands where public access is limited, and previous reports indicate that visitation is primarily by residents who live nearby (USACE, 2006; USACE, 2011). As a result, the RED analysis assesses economic impacts of non-local visitor spending in regional and state economies surrounding the upper three mainstem reservoirs. These economic impacts were estimated using the USACE-certified RED model, RECONS.

Other Social Effects

OSE associated with recreation include contributions to individual and community well-being and quality of life; these considerations are evaluated qualitatively based on the results from the recreation NED and RED analyses.

3.9.2.2 Summary of Environmental Consequences

The environmental consequences relative to recreation are summarized in Table 3-141. In general, the FPDTR alternatives are expected to have temporary, small to large adverse impacts to recreation at Fort Peck Lake from the releases reducing pool elevations affecting recreation access and fishing opportunities compared to No Action. At all other locations, there would be negligible or beneficial changes in recreation compared to No Action. Overall, the long-term impacts from the alternatives are expected to be negligible.

Implementation of the test flows could flush sediment out of Fort Peck Dam and into the river reach below Fort Peck Dam. Boat ramps may be impacted by increased sediment accumulation around the ramp, perhaps requiring cleaning and dredging to maintain access. The operability of the boat ramps in this inter-reservoir river reach are not anticipated to be adversely affected by the test flows. However, the sediment could close boat ramps to visitation, depending on the

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independent variables associated with lake elevations for the analysis, including the fishing success dummy variable. The fishing success dummy variable is a variable that was developed with Missouri River reservoir fisheries biologists to estimate, in a given year, if lake level criteria were met to provide adequate fishing success (a 1 if lake level criteria are met, a 0 if criteria were not met). A rising pool in the spring is important for habitat for spawning and nutrient productivity, both of which improve sport fishing at the reservoirs. In addition, fishing success also occurs when the fishery is in a healthy state and the pool drops, often at the onset of a drought, which serves to concentrate the fish. Additional details on the fishing success criteria are provided in Appendix F, Recreation Technical Report.

severity of the sediment accumulation. Adverse impacts would occur under all he action alternatives, although they would be temporary in nature.

Table 3-141. Environmental consequences relative to recreation

Alternative	NED Impacts	RED Impacts	OSE Impacts
No Action	Average Annual Recreation NED Benefits: $191 million Range of Annual NED Benefits: $110 million to $236 million. Large and long-term benefits; variations in the natural hydrological cycles during drought years cause lower visitation levels and recreation NED benefits over the POR. Short- to long-term adverse impacts would occur from the variability in hydrology and change in hydrologic conditions over the POR.	3,679 jobs and $161.3 million in labor income on average over the POR at the upper three reservoirs Annual jobs would range from 1,902 to 4,609 and annual labor income from $86 million to $201 million over the POR associated with hydrologic conditions affecting recreation access and opportunities.	No Action would continue to provide large OSE benefits associated with considerable recreational opportunities, supporting connections with place and identity, educational opportunities, and other quality of life amenities.
Alternative 1	Change in Average Annual NED Benefits across all locations: +$50,000 or +0.03%. Change in Average Annual NED Benefits at Fort Peck Lake: −$179,000 or −1.2%. Change in Average Annual NED Benefits at Lake Sakakawea: +$224,000 or +0.2%. Negligible or small and adverse changes in visitation and NED at Fort Peck Lake in most years. Lower pool elevations would cause diminished fishing in three years over the POR, with the potential for large, temporary impacts during these conditions. Negligible or beneficial change in NED at all other locations.	Negligible changes to RED in the river reaches due to local visitation. Average annual change in recreation RED benefits: 2 fewer jobs and $2,000 less in labor income at upper three reservoirs. At Fort Peck, average annual change in RED benefits: 5 fewer jobs and $160,000 less in labor income. Negligible RED impacts in the regional context but impacts could be large and adverse on tourism businesses in some years in communities surrounding Fort Peck Lake. Negligible change in RED benefits at all other locations.	Temporary, negligible to small adverse OSE impacts at Fort Peck Lake from diminished fishing conditions; negligible changes from No Action at all other locations.
Variation 1A	Change in Average Annual NED Benefits across all locations: −$20,000 or −0.01%. Change in Average Annual NED Benefits at Fort Peck Lake: −$82,000 or −0.6%. Change in Average Annual NED Benefits at Lake Sakakawea: +$70,000 or +0.1%. Negligible or small and adverse changes in visitation and NED at Fort Peck Lake in most years. Lower pool elevations would cause diminished fishing in three years over the POR, with the potential for large, temporary impacts during	Negligible changes to RED in the river reaches due to local visitation. Average annual change in recreation RED benefits: 2 fewer jobs and $47,000 less in labor income at upper three reservoirs. At Fort Peck, average annual change in RED benefits: 2 fewer jobs and $73,000 less in labor income. Negligible RED impacts in the regional context but impacts could be large and adverse on tourism businesses in some years in communities surrounding Fort	Temporary, negligible to small adverse OSE impacts at Fort Peck Lake from diminished fishing conditions; negligible changes from No Action at all other locations.

	these conditions. Negligible or beneficial change in NED at all other locations.	Peck Lake. Negligible change in RED benefits at all other locations.	
Variation 1B	Change in Average Annual NED Benefits: +$10,000 or 0.01% across all locations. Change in Average Annual NED Benefits at Fort Peck Lake: −$171,000 or −1.2%. Change in Average Annual NED Benefits at Lake Sakakawea: +$200,000 or +0.1%. Negligible or small and adverse changes in visitation and NED at Fort Peck Lake in most years. Lower pool elevations would cause diminished fishing in three years over the POR, with the potential for large, temporary impacts during these conditions. Negligible or beneficial change in NED at all other locations.	Negligible changes to RED in the river reaches due to local visitation. Average annual change in recreation RED benefits: 2 fewer jobs and $36,000 less in labor income at upper three reservoirs. At Fort Peck, average annual change in RED benefits: 5 fewer jobs and $153,000 less in labor income. Negligible RED impacts in the regional context but impacts could be large and adverse on tourism businesses in some years in communities surrounding Fort Peck Lake. Negligible change in RED benefits at all other locations.	Temporary, negligible to small adverse OSE impacts at Fort Peck Lake from diminished fishing conditions; negligible changes from No Action at all other locations.
Alternative 2	Change in Average Annual NED Benefits across all locations: +$137,000 or +0.1%. Change in Average Annual NED Benefits at Fort Peck Lake: −$133,000 or −0.9%. Change in Average Annual NED Benefits at Lake Sakakawea: +$267,000 or +0.2%. Negligible or small and adverse changes in visitation and NED at Fort Peck Lake in most years. Lower pool elevations would cause diminished fishing in two years over the POR, with the potential for large, temporary impacts during these conditions. Negligible or beneficial change in NED at all other locations.	Negligible changes to RED in the river reaches due to local visitation. Average annual change in recreation RED benefits: no change in jobs and $43,000 more labor income at upper three reservoirs. At Fort Peck, average annual change in RED benefits: 2 fewer jobs and $82,000 less in labor income. Negligible RED impacts in the regional context but impacts could be large and adverse on tourism businesses in some years in communities surrounding Fort Peck Lake. Negligible change in RED benefits at all other locations.	Temporary, negligible to small adverse OSE impacts at Fort Peck Lake from diminished fishing conditions; negligible changes from No Action at all other locations.
Variation 2A	Change in Average Annual NED Benefits across all locations: +$175,000 or +0.1%. Change in Average Annual NED Benefits at Fort Peck Lake: −$133,000 or −0.9%. Change in Average Annual NED Benefits at Lake Sakakawea: +$311,000 or +0.2%. Negligible or small and adverse changes in visitation and NED at	Negligible changes to RED in the river reaches due to local visitation. Average annual change in recreation RED benefits: 1 more job and $99,000 more in labor income at upper three reservoirs. At Fort Peck, average annual change in RED benefits: 4 fewer jobs and $119,000 less in labor income.	Temporary, negligible to small adverse OSE impacts at Fort Peck Lake from diminished fishing conditions; negligible changes from No Action at all other locations.

	Fort Peck Lake in most years. Lower pool elevations would cause diminished fishing in two years over the POR, with the potential for large, temporary impacts during these conditions. Negligible or beneficial change in NED at all other locations.	Negligible RED impacts in the regional context but impacts could be large and adverse on tourism businesses in some years in communities surrounding Fort Peck Lake. Negligible change in RED benefits at all other locations.	
Variation 2B	Change in Average Annual NED Benefits across all locations: +$102,000 or +0.1%. Change in Average Annual NED Benefits at Fort Peck Lake: −$282,000 or −2.0%. Change in Average Annual NED Benefits at Lake Sakakawea: +$371,000 or +0.3%. Negligible or small and adverse changes in visitation and NED at Fort Peck Lake in most years. Lower pool elevations would cause diminished fishing in three years over the POR, with the potential for large, temporary impacts during these conditions. Negligible or beneficial change in NED at all other locations.	Negligible changes to RED in the river reaches due to local visitation. Average annual change in recreation RED benefits: 2 fewer jobs and $39,000 more in labor income at upper three reservoirs. At Fort Peck, average annual change in RED benefits: 7 fewer jobs and $252,000 less in labor income. Negligible RED impacts in the regional context but impacts could be large and adverse on tourism businesses in some years in communities surrounding Fort Peck Lake. Negligible change in RED benefits at all other locations.	Temporary, negligible to small adverse OSE impacts at Fort Peck Lake from diminished fishing conditions; negligible changes from No Action at all other locations. .

* Fiscal year 2020 prices

3.9.2.3 No Action

Under No Action, operations at Fort Peck are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. As noted above, it is considered the baseline against which the other alternatives are measured.

Consistent recreational access to the Missouri River and its reservoirs requires water surface elevations to be within the operating elevations of boat ramps and other infrastructure. Recreation infrastructure is thus affected from the variability in hydrology and change in hydrologic conditions over the POR as well as aggradation and degradation processes (see Section 3.2 River Infrastructure and Hydrologic Processes). The POR is characterized by substantial variability in hydrologic conditions which includes periods of drought (i.e., 1930s, mid-1950s to early 1960s, mid-2000s) and high runoff. This variation results in variability in impacts to recreation in the basin that can be adverse or beneficial depending on the conditions at the recreation area.

System operations under No Action would be consistent with current operations. However, as described in Section 3.1, Introduction, the impacts modeled do not account for the ability of water management to adapt to changing conditions on the System to serve authorized purposes, such as recreation. It also does not account for what activities may be implemented in the future relative to bed degradation which may be influencing model results. This is because the 2012 river geometry used in HEC-RAS modeling reflects a level of bed degradation that was not present in prior years included in the POR analysis. These impacts are discussed in more detail in Section 3.2, River Infrastructure and Hydrologic Processes.

National Economic Development

Under No Action, average annual recreation NED benefits in the upper three reservoirs and the two inter-reservoir river reaches are estimated to be $191 million, which is associated with approximately 5.4 million average annual recreation visitor days (Table 3-125). Variation in the hydrologic cycle would cause recreation NED benefits to vary over the period of record, from a low of $110 million to a high of $236 million. Notable periods of drought or relatively drier conditions include the 1930s to early 1940s; mid-1950s, late 1980s to early 1990s, and mid-2000s. The largest annual decreases in the recreation NED benefits under No Action would occur on the upper three reservoirs when access to the lakes and fishing opportunities are directly affected by lower lake elevations during the natural cycles of drought and relatively drier periods. In fact, the visitation modeling shows that during the drought of the 1930s, in Fort Peck Lake, no visitation would occur.

On annual average, Fort Peck Lake, Lake Sakakawea, and Lake Oahe would support $14 million, $140 million, and $32 million recreation NED benefits, respectively. The two river reaches would support approximately $5 million in average annual recreation NED benefits, with the majority of the benefit from recreation in the Garrison Dam to Lake Oahe reach. Overall, recreation NED benefits supported by the UMR under No Action would be large and long term, providing local residents and non-local visitors with considerable recreational opportunities. Table 3-142 summarizes the recreation NED benefits under Alternative 1.

Table 3-142. Summary of NED analysis for No Action, 1932–2012 (thousands of 2020 dollars)

Recreation NED Benefits	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	All Locations
Annual Average Recreation Visitor Days	526,704	3,360,637	1,323,821	66,784	116,029	5,393,975
Annual Average NED Benefits	$14,403	$139,737	$31,792	$1,204	$3,903	$191,039
Maximum Annual NED Benefits	$20,427	$171,888	$39,761	$1,407	$4,240	$235,898

Minimum Annual NED Benefits	$0	$87,102	$14,661	$980	$2,813	$109,801

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

Regional Economic Development

Reservoir conditions can adversely affect visitation, which in turn can affect the amount of visitor spending in local economies. Non-local visitor spending injects new money into local economies, stimulating sales (i.e., economic output), jobs, and income in local businesses. Table 3-143 summarizes the economic contributions of non-local visitor spending under No Action. On average, spending by these non-local visitors at the upper three reservoirs supports 3,679 jobs and $161 million in labor income under No Action. In the highest visitation year, the upper three reservoirs were shown to support approximately 535, 2,791, and 1,283 jobs at Fort Peck Lake, Lake Sakakawea, and Lake Oahe, respectively. In the worst drought conditions, Fort Peck Lake would not have any visitors (as simulated in the drought of the 1930s), while recreation opportunities at Lake Sakakawea and Lake Oahe would support 1,429 and 473 jobs, respectively.

Table 3-143. Economic benefits of non-local visitor spending for the reservoirs under No Action (thousands of 2020 Dollars)

Economic Impact Parameter	Year	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Direct, Indirect, and Induced Jobs	Lowest visitation year	0	1,429	473	1,902
	Highest visitation year	535	2,791	1,283	4,609
	Average	378	2,275	1,026	3,679
Direct, Indirect, and Induced Labor Income	Lowest visitation year	$0	$66,801	$19,438	$86,239
	Highest visitation year	$18,051	$130,498	$52,700	$201,249
	Average	$12,733	$106,383	$42,141	$161,257
Direct, Indirect, and Induced Sales	Lowest visitation year	$0	$172,768	$54,757	$227,524
	Highest visitation year	$54,005	$337,523	$148,453	$539,981
	Average	$38,094	$275,138	$118,710	$431,942

a The lowest visitation year and highest visitation years are not necessarily the same year at each reservoir. Note that the totals may not exactly reflect the sum of the individual reservoirs due to rounding in the calculations.

The economic contributions of non-local visitor spending to communities surrounding these lakes would be large and beneficial in the context of their relatively small rural economies. For example, recreation-based employment (i.e., in the food and beverage, accommodations, arts, entertainment, and recreation, and retail trade businesses) account for approximately 12,333 jobs in the communities surrounding the upper three reservoirs, as summarized in Table 3-144 (US Census Bureau, 2017). Approximately 30 percent of the recreation jobs in these communities are supported by non-local visitors to the upper three reservoirs in the average visitation year (3,679 jobs divided by 12,333 jobs). However, if the bulk of the spending would occur in the smaller rural communities, the impacts would be relatively larger. Removing Bismarck from the employment figures would increase the proportion of jobs accounted for by non-local visitor spending in the upper three reservoirs to 76 percent of recreation-based employment (3,679 divided by 4,858) and 13 percent of all employment in the communities surrounding the lakes (3,679 divided by 28,419).

When lake elevations are lower because of drought conditions, limited boat access and reduced fishing opportunities would considerably reduce economic activity in these local economies as non-local visitation falls. Declines in non-local visitation and recreation-related spending during drought or drier periods would have large, adverse impacts on regional economic conditions in the local economies surrounding the lakes. A reduction of up to 1,777 jobs (3,679 during average visitation less 1,902 jobs during the low visitation) would represent approximately 14 percent of recreation jobs in adjacent communities and 2.6 percent of all jobs in these communities. However, if the bulk of the reduction in visitation was experienced in the smaller rural communities, the impacts would be relatively larger. Removing Bismarck from the employment figures, the reduction in jobs during drought conditions could represent 37 percent of the recreation employment in these communities and over 6 percent of all employment in adjacent communities.

Table 3-144. Employment in adjacent communities to the upper three reservoirs

Reservoirs	Recreation Employment (without Bismarck)	Total Employment (without Bismarck)	Recreation Employment as a Percent of Total Employment (without Bismarck)
Fort Peck Lake	687 (687)	3,051 (3,051)	22.5% (22.5%)
Lake Sakakawea	9,653 (2,178)	54,862 (15,760)	17.6% (13.8%)
Lake Oahe	1,993 (1,993)	9,608 (2,096)	20.7% (20.7%)

Upper Three Reservoirs	12,333 (4,858)	67,521 (28,419)	18.3% (17.1%)

Source: U.S. Census Bureau, American Community Survey, 2013- 2017 Five-Year Estimates.

Notes: The adjacent communities included in the recreation employment for the upper three reservoirs include Fort Peck Lake: Glasgow, Fort Peck, and Wolf Point; Lake Sakakawea: Bismarck, New Town, Pick City, Riverdale, Garrison, and Williston; and Lake Oahe: Pierre, Mobridge, Cannon Ball, and Fort Yates.

Fort Peck Lake, Lake Sakakawea, and Lake Oahe are world-famous for their walleye, northern pike, and other boating and fishing opportunities. In general, the upper three reservoirs provide a remote and unique recreational experience. There are limited recreational opportunities located within the local region (defined at 50-miles from the lakes) that provide similar substitute recreational opportunities (refer to Section 2.6 of the "Recreation Environmental Consequences Analysis Technical Report" for additional details on substitute recreation sites). During adverse recreation conditions on the Missouri River reservoirs, visitors would likely choose to visit alternative reservoirs or recreation areas in other locations; therefore, the visitor spending and associated regional jobs and income would be reduced in the communities surrounding the Missouri River reservoirs. Limited alternative sites within the region would not be able provide recreational opportunities to offset the RED impacts in adjacent communities.

Other Social Effects

OSE associated with recreation include factors such as individual and community well-being and quality of life. The Missouri River, including the reservoirs and inter-reservoir reaches, provide considerable recreational opportunities with large long-term social benefits to individual and community well-being, quality of life, and the recreation features and associated opportunities also provide a connection with place. Drought and relatively drier conditions can especially affect recreational access at the reservoirs as well as fishing conditions and opportunities, reducing visitation, visitor spending, and tourism-related jobs at the reservoirs. While these conditions persist, they result in short-term adverse impacts to quality of life and community well-being to residents and visitors that have close ties to the upper three reservoirs.

Conclusion

Under No Action, the Missouri River and its reservoirs would continue to provide a variety of recreational opportunities that would support large NED, RED, and OSE benefits on average, over the long term. Variations in recreation NED and RED would occur from natural variations in the hydrologic cycle. Generally, higher river flows and stages and reservoir elevations (but not flooding) would support greater access and improved fishing opportunities. The upper three reservoirs would have the largest decreases in visitation occurring when access to the lakes and fishing opportunities are adversely affected by lower lake elevations during drought or relatively drier periods.

During the worst visitation year attributable to drought conditions, 1,777 fewer jobs would be supported across these three reservoirs from reduced non-local visitor spending compared to average annual jobs of 3,679. These decreases in recreation RED benefits would be small in the regional context of all county economies surrounding the lakes but would be relatively large in small rural communities adjacent to the reservoirs whose economies may rely on reservoir tourism and outdoor recreation, accounting from between 14 and 37 percent of recreation-based jobs in adjacent communities. Drought and relatively drier conditions can also affect the social benefits associated with recreational opportunities at the reservoirs. While these conditions persist, they would result in short-term adverse impacts to quality of life and community well-being to residents and visitors that have close ties to the reservoirs. Depending on the magnitude of the effects and the number of people and businesses impacted, these NED, RED, and OSE impacts could be small to large and adverse.

3.9.2.4 Alternative 1

System operations under Alternative 1 are based on those described under the No Action alternative except that it includes a flow release regime from Fort Peck Dam to benefit pallid sturgeon. An Attraction Flow Regime would begin on April 16 and the peak flow would be twice as large as the spring release from Fort Peck Dam in a given year. The Spawning Cue Flow Regime under Alternative 1 begins on May 28 and would be 3.5 times the Fort Peck Dam spring flow release in the given release year. A further description of Alternative 1 is detailed in Chapter 2, Section 2.5 Alternatives Carried Forward for Further Evaluation.

National Economic Development

Under Alternative 1, the UMR would support on average $191 million in recreation NED benefits per year, an increase of $50,000 (+0.03 percent) compared to No Action (Table 3-145). The largest variation in recreational benefits would occur at Fort Peck Lake and Lake Sakakawea, where management actions under Alternative 1 would cause annual average NED benefits to decrease by 1.2 percent at Fort Peck Lake and increase by 0.2 percent at Lake Sakakawea. The flow releases would decrease Fort Peck Lake pool elevations affecting recreational access and fishing conditions, while visitation at Lake Sakakawea would increase from relatively higher pool elevations on average; there would be very little changes in visitation and recreation NED benefits at Lake Oahe and the inter-reservoir river reaches.

On average, Fort Peck Lake would experience a decrease in annual visitation of over 6,500 recreation visitor days, with a decrease in average annual recreation NED benefits of $179,000 (-1.2%). On the other hand, on average, Lake Sakakawea would experience an increase in annual visitation of over 5,400 recreation visitor days, with an increase in average annual recreation NED benefits of $224,000 (+0.2%).

Table 3-145. Summary of NED analysis for Alternative 1,1932–2012 (Thousands of 2020 Dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Annual Average Recreation Visitor Days	520,155	3,366,031	1,323,773	66,828	116,181	5,392,967
Change in Average Annual Recreation Visitor Days from No Action	-6,549	5,393	-47	44	151	-1,008
Annual Average NED Benefits	$14,224	$139,961	$31,791	$1,205	$3,908	$191,088
Change in Average Annual NED Benefits from No Action	-$179	$224	-$1	$1	$5	$50
Percent Change in Average Annual NED Benefits from No Action	-1.24%	0.16%	0.00%	0.07%	0.13%	0.03%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

When considering only the years when a partial or full release would be simulated to occur, on average, there would be decreased NED benefits at Fort Peck Lake and slightly higher benefits at Lake Sakakawea compared to the average effects over the period of record (Table 3-146). At Fort Peck Lake, years with a partial or full flow release would result in an average decrease in $450,000 or 2.6 percent compared to No Action in these years. In other locations, there are negligible changes in the flow release years.

Table 3-146. Summary of NED analysis for Alternative 1, 1932–2012 – partial or full flow release years only (thousands of 2020 dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Annual Average Recreation Visitor Days	613,027	3,759,952	1,518,257	69,864	120,549	6,081,649
Change in Average Annual Recreation Visitor Days from No Action	-16,473	13,390	-88	41	299	-2,831

Annual Average NED Benefits	$16,764	$156,340	$36,461	$1,259	$4,055	$214,880
Change in Average Annual NED Benefits from No Action	-$450	$557	-$2	$1	$10	$115
Percent Change in Average Annual NED Benefits from No Action	-2.62%	0.36%	-0.01%	0.06%	0.25%	0.05%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

Additional results of flow actions are summarized in Table 3-147. These results show the difference in annual recreation NED benefits by location during years when there would be a release action. Results from the simulations at Fort Peck Lake show that relatively larger adverse effects could occur in the years when a partial or full release or in the year after a release is simulated when the fishing success criteria is not met under Alternative 1 (simulated to occur in three years over the period of record). There is one year with a considerable increase in recreation NED benefits at Fort Peck Lake in the year following a release (when fishing success metric is met under Alternative 1 and not under No Action).

At Lake Sakakawea, the largest changes compared to No Action, both beneficial and adverse, would occur during the full or partial release years. There are only two years where there would be impacts with greater than $500,000 reduction in recreation NED benefits at Lake Sakakawea, one in a full release year, and one in a year after a full release, as the reservoir system rebalances. In general, beneficial impacts at Lake Sakakawea would occur during release years and the year after releases would occur, as pool elevations are higher than under No Action. At the remaining locations, annual changes are relatively small and the years with adverse effects are offset with years with beneficial effects.

Table 3-147. Changes in NED benefits from flow releases under Alternative 1 compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	All Locations
Partial or full flow release[a]	Lowest Benefit Change	-$5,812	-$681	-$420	-$37	-$50	-$5,602
	Highest Benefit Change	$135	$3,807	$280	$54	$332	$3,795
Year after Partial of Full Flow Release	Lowest Benefit Change	-$5,497	-$610	-$33	-$22	-$61	-$2,836
	Highest Benefit Change	$5,285	$2,657	$87	$1	$2	$6,612

Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$5,812	-$681	-$420	-$37	-$61	-$5,602
	Highest Benefit Change	$5,285	$3,807	$280	$54	$332	$6,612

a Flow action would be partially or fully implemented in 22 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation NED benefits compared to No Action, while positive values indicate an increase in recreation NED benefits compared to No Action.

Regional Economic Development

Under Alternative 1, non-local visitor spending associated with the upper three reservoirs would support sales in local businesses, 3,677 jobs, and $161 million in labor income on an annual basis. When compared to No Action, on average across all locations there would be 2 fewer jobs, and $2,000 less in labor income across all locations. When compared to No Action, for the years when there would be a full or partial test release, there would be minimal changes in regional economic conditions when considering impacts across all locations. Tables 3-148 and 3-149 summarize the RED effects under Alternative 1.

Lake Sakakawea would experience beneficial impacts in most years under Alternative 1 compared to No Action, an increase in 4 jobs for the average year, compared to No Action. The average of the 8 highest visitation years would result in an increase in 32 jobs and $1.5 million in labor income, while the average of the 8 lowest visitation years would result in a decrease in 4 jobs and $200,000 in labor income.

The Fort Peck releases under Alternative 1 would cause visitation to Fort Peck Lake to decrease in some of the years when a release would occur or the year following a release, when reservoir elevations are lower than under No Action. Reduced non-local visitation would result in a reduction in recreation RED benefits at Fort Peck Lake while these conditions persist. On average, there would be a reduction in 5 jobs compared to No Action at Fort Peck Lake. During the eight lowest visitation years relative to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 62 jobs and $2 million in labor income under Alternative 1.

Table 3-148. Economic benefits of non-local visitor spending for the reservoirs under Alternative 1 relative to No Action (thousands of 2020 dollars)

Economic Impact Parameter	Year	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Direct, Indirect, and Induced Jobs	Average annual over 81 years	373	2,278	1,026	3,677
	Change in annual average over 81 years relative to No Action	-5	3	-1	-2

	Annual average during 8 highest visitation years relative to No Action	19	32	4	NA
	Annual average during 8 lowest visitation years relative to No Action	-62	-4	-3	NA
Direct, Indirect, and Induced Labor Income	Annual average over 81 years	$12,573	$106,546	$42,136	$161,255
	Change in annual average over 81 years relative to No Action	-$160	$163	-$5	-$2
	Annual average during 8 highest visitation years relative to No Action	$635	$1,491	$160	NA
	Annual average during 8 lowest visitation years relative to No Action	-$2,091	-$200	-$140	NA
Direct, Indirect, and Induced Sales	Annual Average over 81 years	$37,615	$275,561	$118,695	$431,871
	Change in average annual average over 81 years relative to No Action	-$479	$423	-$15	-$71
	Annual average during 8 highest visitation years relative to No Action	$1,901	$3,857	$451	NA
	Annual average during 8 lowest visitation years relative to No Action	-$6,256	-$517	-$394	NA

Note: The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir. Note that the totals may not exactly reflect the sum of the individual reservoirs due to rounding in the calculations.

Table 3-149. Summary of RED analysis for Alternative 1, 1932–2012 – partial or full flow release years only

Recreation RED Benefits	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Annual Average Jobs	438	2,539	1,176	4,153
Change in Average Annual Jobs from No Action	-12	+9	0	-3
Annual Average Labor Income (thousands, 2020$)	$14,768	$118,713	$48,320	$181,801
Change in Average Annual Jobs from No Action (thousands, 2020$)	-$403	+$413	-$6	+$4

Note: Flow action would be partially or fully implemented in 22 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

In an average year under No Action, recreation-based employment associated with Fort Peck Lake accounts for approximately 55 percent (378/687) of the tourism jobs (retail sales; arts, entertainment, and recreation; food and beverage; and accommodations in the gateway communities of Fort Peck Lake. Sixty-two jobs represent 9 percent of recreation employment and 2 percent of all employment in the communities adjacent to Fort Peck Lake. In years when the conditions adversely affect the fishery at Fort Peck Lake (typically when a release is implemented at the beginning of a relatively drier period), recreation visitor days and jobs and income would be reduced by up to 41 percent when compared to average annual visitation under No Action. In the year with the largest decrease in visitation compared to No Action, annual RED benefits supported by Fort Peck Lake would be reduced by 154 jobs and $5.1 million in labor income under Alternative 1 (Table 3-150 and 3-151).

Although these effects as modeled would be temporary and fall within the range of visitation at Fort Peck Lake, they could have large and adverse impacts for tourism industries and businesses and small communities that support these recreational activities. The fishing success metric (modeled as a dummy variable) has a large impact on visitation estimates in the regression analysis, with large changes from No Action (beneficial and adverse) with changes in the fishing success metric (0-1 variable); in reality, it is likely the changes wouldn't as dramatic and possibly would take longer to be experienced and the ability of the fishery to recover to normal conditions may also be longer than represented in the modeled results. The USACE would work with the natural resource specialists at the Lake and state fishery biologists to help minimize the adverse impacts to the fishery and visitation.

Table 3-150. Changes in RED benefits (Jobs) from flow releases under Alternative 1 compared to No Action

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-154	-11	-14
	Highest Benefit Change	+19	+61	+9
Year after Partial of Full Flow Release	Lowest Benefit Change	-145	-10	-1
	Highest Benefit Change	+141	+43	+3
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-154	-11	-14
	Highest Benefit Change	+141	+61	+9

a Flow action would be partially or fully implemented in 22 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Table 3-151. Changes in RED benefits (Labor Income) from flow releases under Alternative 1 compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe

Partial or full flow release[a]	Lowest Benefit Change	-$5,128	-$536	-$561
	Highest Benefit Change	-$121	$2,865	$371
Year after Partial of Full Flow Release	Lowest Benefit Change	-$4,911	-$482	-$50
	Highest Benefit Change	$4,729	$2,005	+$114
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$5,128	-$536	-$561
	Highest Benefit Change	+$4,729	$2,865	$371

a Flow action would be partially or fully implemented in 22 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Other Social Effects

OSE associated with recreation include factors such as individual and community well-being, quality of life, and sense of place. Alternative 1 would include decreased lake elevations during some of the years and years after the flow releases. These conditions could result in some adverse effects to OSE, however the impacts as modeled are temporary and the ranges in conditions and recreation NED and RED benefits under Alternative 1 are within the range of effects under No Action. There would be a few years with notable differences in fishing success at Fort Peck Lake, but the temporary effects are likely to have negligible to small social impacts in the long-term. There would be negligible changes in OSE compared to No Action at the other reservoirs and in the inter-reservoir river reaches.

3.9.2.5 Alternative 1 – 1A Variation

Variation 1A is a test flow variation of Alternative 1. The parameters for 1A are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue Flow Regime is initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

National Economic Development

Under Variation 1A, the UMR would support on average $191 million in recreation NED benefits per year, a decrease of $20,000 (0.01 percent) compared to No Action (Table 3-152). The impacts would be similar to Alternative 1, with adverse impacts to Fort Peck Lake and beneficial impacts at Lake Sakakawea compared to No Action. However, compared to Alternative 1 on average, there would be fewer adverse impacts to Fort Peck Lake (0.6 percent average annual decrease from No Action) and fewer beneficial impacts to Lake Sakakawea (0.05 percent average annual increase from No Action) under Variation 1A. Compared to Alternative 1, there is one more year when the fishing success metric would be met at Fort Peck Lake under Variation 1A, which reduces the average adverse effects of Variation 1A when compared to Alternative 1. At Fort Peck Lake, there would be a reduction in visitors days of 3,000 and $82,000 in recreation NED benefits (-0.6%).

On the other hand, on average, Lake Sakakawea would experience an increase in annual visitation of about 1,700 recreation visitor days, with an increase in average annual recreation NED benefits of $70,000. There are very little changes in visitation and recreation NED benefits at Lake Oahe and the inter-reservoir river reaches.

Table 3-152. Summary of NED analysis for Variation 1A, 1932-2012 (thousands of 2020 dallars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Average Annual Recreation Visitor Days	523,721	3,362,312	1,323,315	66,938	116,081	5,392,367
Change in Average Annual Recreation Days from No Action	-2,983	1,674	-506	154	52	-1,608
Annual Average NED Benefits	$14,322	$139,806	$31,780	$1,207	$3,905	$191,019
Change in Average Annual NED Benefits from No Action	-$82	$70	-$12	$3	$2	-$20
Percent Change in Average Annual NED Benefits from No Action	-0.57%	0.05%	-0.04%	0.23%	0.04%	-0.01%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

When considering only the years when a partial or full release would be simulated to occur, on average, there would be decreased NED benefits at Fort Peck Lake and slightly higher benefits at Lake Sakakawea and Fort Peck Dam to Lake compared to the average effects over the period of record (Table 3-153). At Fort Peck Lake, years with a partial or full flow release would result in an average decrease in $211,000 or 1.2 percent compared to No Action in these years. In other locations, there are negligible changes in the flow release years.

Table 3-153. Summary of NED analysis for Variation 1A, 1932-2012 - partial or full flow release years only (thousands of 2020 dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Annual Average Recreation Visitor Days	618,641	3,742,094	1,515,034	70,066	120,295	6,066,130
Change in Average Annual Recreation Visitor Days from No Action	-7,714	4,005	-538	370	67	-3,811
Annual Average NED Benefits	$16,917,587	$155,597,794	$36,383,655	$1,263,121	$4,046,332	$214,208,490
Change in Average Annual NED Benefits from No Action	-$210,962	$166,512	-$12,930	$6,677	$2,242	-$48,460
Percent Change in Average Annual NED Benefits from No Action	-1.23%	0.11%	-0.04%	0.53%	0.06%	-0.02%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

Additional results of flow actions are summarized in Table 3-154. These results show the difference in annual recreation NED benefits by location during years when there would be an Attraction Flow release action. Results from the simulations at Fort Peck Lake show that relatively larger adverse effects would occur in some years when a partial or full release would occur or in the year following a release when the fishing success criteria is not met under Variation 1A (simulated to occur in three years over the period of record). In addition, there are two years with a considerable increase in recreation NED benefits at Fort Peck Lake in the year following a release (when fishing success metric is met under Variation 1A and not under No Action).

At Lake Sakakawea, the largest decreases in recreation NED benefits would occur during the full or partial release years, while the largest increases would occur in the year following a release year. There are three years when there would be impacts with greater than $500,000 reduction in recreation NED benefits at Lake Sakakawea compared to No Action, two in full release years, and one in a year after a full release as the reservoir system rebalances. Many of the years over the period of record would result in beneficial effects; however, one notable year, as simulated in 1977, would result in reductions in recreation NED benefits of $3.3 million from lower reservoir elevations in Lake Sakakawea in 1976. At the remaining locations, annual changes are relatively small and the years with adverse effects are offset with years with beneficial effects.

Table 3-154. Changes in NED benefits from flow releases under Variation 1A compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	All Locations
Partial or full flow release[a]	Lowest Benefit Change	-$5,800	-$3,320	-$240	-$34	-$13	$121
	Highest Benefit Change	$149	$1,390	$109	$112	$67	-$5,571
Year after Partial of Full Flow Release	Lowest Benefit Change	-$5,468	-$867	-$107	-$13	-$93	-$287
	Highest Benefit Change	$5,294	$2,603	$95	$1	$43	$5,828
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$5,800	-$3,320	$413	-$34	$93	-$5,571
	Highest Benefit Change	$5,294	$2,603	$142	$112	$67	$5,828

Fiscal year 2020 prices.

[a] Flow action would be partially or fully implemented in 22 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represent the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation NED benefits compared to No Action, while positive values indicate an increase in recreation NED benefits compared to No Action.

Regional Economic Development

Under Variation 1A, non-local visitor spending associated with the upper three reservoirs would support sales in local businesses, 3,677 jobs, and $161 million in labor income on an annual basis. When compared to No Action, on average across all locations under Variations 1A, there would be 2 fewer jobs, and $47,000 less in labor income across all locations. When compared to No Action, for the years when there would be a full or partial test release, there would be 4 fewer annual jobs, and $93,000 less in average annual labor income across all locations. Tables 3-155 and 3-156 summarizes the RED effects under Variation 1A.

Lake Sakakawea would experience both beneficial and adverse impacts compared to No Action; on average, there would be an increase in 1 job compared to No Action. The average of the 8 highest visitation years would result in an increase in 20 jobs and $916,000 in labor income, while the average of the 8 lowest visitation years would result in a decrease in 15 jobs and $683,000 in labor income. Lake Oahe would experience little change from No Action.

Table 3-155. Economic benefits of non-local visitor spending for the reservoirs under Variation 1A – relative to No Action (thousands of 2020 dollars)

Economic Impact Parameter	Year	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Direct, Indirect, and Induced Jobs	Average annual over 81 years	375	2,276	1,026	3,677
	Change in annual average over 81 years relative to No Action	-2	1	0	-2
	Annual average during 8 highest visitation years relative to No Action	40	20	2	NA
	Annual average during 8 lowest visitation years relative to No Action	-59	-15	-5	NA
Direct, Indirect, and Induced Labor Income	Annual average over 81 years	$12,660	$106,429	$42,121	$161,210
	Change in annual average over 81 years relative to No Action	-$73	$46	-$20	-$47
	Annual average during 8 highest visitation years relative to No Action	$1,336	$916	$91	NA
	Annual average during 8 lowest visitation years relative to No Action	-$1,999	-$683	-$223	NA
Direct, Indirect, and Induced Sales	Annual Average over 81 years	$37,876	$275,256	$118,654	$431,786
	Change in average annual average over 81 years relative to No Action	-$218	$118	-$56	-$156
	Annual average during 8 highest visitation years relative to No Action	$3,997	$2,370	$256	NA
	Annual average during 8 lowest visitation years relative to No Action	-$5,979	-$1,767	-$627	NA

Note: The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir. Note that the totals may not exactly reflect the sum of the individual reservoirs due to rounding in the calculations.

Table 3-156. Summary of RED analysis for Variation 1A, 1932–2012 – partial or full flow release years only

Recreation RED Benefits	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Annual Average Jobs	442	2,527	1,174	4,143
Change in Average Annual Jobs from No Action	-6	+2	0	-4
Annual Average Labor Income (thousands, 2020$)	$14,905	$118,149	$48,217	$181,271
Change in Average Annual Labor Income from No Action (thousands, 2020$)	-$189	$116	-$20	-$93

Note: Flow action would be partially or fully implemented in 22 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

Similar to Alternative 1, the Fort Peck releases under Variation 1A would cause visitation to Fort Peck Lake to decrease in some of the years when a release would occur or the year following a release, when reservoir elevations are lower than under No Action. Reduced non-local visitation would result in a reduction in recreation RED benefits at Fort Peck Lake while these conditions persist. On average, there would be a reduction in 2 jobs compared to No Action at Fort Peck Lake. During the eight lowest visitation years relative to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 59 jobs and $2 million in labor income under Variation 1A. In years when the conditions adversely affect the fishery at Fort Peck Lake, as simulated in three years over the period of record, there would be a decrease of 154 jobs (largest change year) and $5.2 million in labor income under Variation 1A compared to No Action (Tables 3-157 and 3-158).

A decrease of 59 jobs represents 9 percent of recreation employment and 2 percent of all employment in the communities adjacent to Fort Peck Lake. Similar to Alternative 1, in years when the conditions adversely affect the fishery at Fort Peck Lake (typically when a release is implemented at the beginning of a relatively drier period), recreation visitor days and jobs and income would be reduced by up to 41 percent compared to average annual conditions. Although these effects as modeled would be temporary and fall within the range of visitation at Fort Peck Lake, they could have large and adverse impacts for tourism industries and businesses and small communities that support these recreational activities. The USACE would work with the natural resource specialists at the Lake and state fishery biologists in implementing the releases to minimize the adverse impacts to the fishery and visitation.

Table 3-157. Changes in RED benefits (Jobs) from flow releases under Variation 1A compared to No Action

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-154	-55	-8
	Highest Benefit Change	+19	+23	+4
Year after Partial of Full Flow Release	Lowest Benefit Change	-145	-15	-4
	Highest Benefit Change	+141	+42	+3

Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-154	-55	-13
	Highest Benefit Change	+141	+42	+5

a Flow action would be partially or fully implemented in 22 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Table 3-158. Changes in RED benefits (Labor Income) from flow releases under Variation 1A compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-$5,188	-$2,575	-$320
	Highest Benefit Change	+$633	$1,053	+$144
Year after Partial of Full Flow Release	Lowest Benefit Change	-$4,890	-$679	-$151
	Highest Benefit Change	$4,746	+$1,963	+124
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$5,188	-$2,575	-$548
	Highest Benefit Change	$4,746	+$1,963	+$188

a Flow action would be partially or fully implemented in 22 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation NED benefits compared to No Action, while positive values indicate an increase in recreation NED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Other Social Effects

Variation 1A would be very similar to Alternative 1, with decreased lake elevations during some of the years and years after the flow releases at Fort Peck Lake. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse social impacts in the long-term. There would be negligible changes in OSE compared to No Action at the other reservoirs and in the inter-reservoir river reaches.

3.9.2.6 Alternative 1 – 1B Variation

Variation 1B is another test flow variation of Alternative 1. The parameters for 1B are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 23 and the Spawning Cue Flow is initiated on June 4. Similar to the concept described in Variation 1A, the later initiation date is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

National Economic Development

Under Variation 1B, the UMR would support on average $191 million in recreation NED benefits per year, with an increase of $10,000 compared to No Action (Table 3-153). The largest variations in recreational benefits would occur at Fort Peck Lake and Lake Sakakawea, where management actions under Variation 1B would cause annual average NED benefits to decrease by 1.2 percent at Fort Peck Lake and increase by 0.1 percent at Lake Sakakawea. The flow releases would decrease Fort Peck Lake pool elevations affecting recreational access and fishing conditions, while visitation at Lake Sakakawea would increase from relatively higher pool elevations on average; there would be very little changes in visitation and recreation NED benefits at Lake Oahe and the inter-reservoir river reaches.

On average, Fort Peck Lake would experience a decrease in annual visitation of over 6,200 recreation visitor days, with a decrease in average annual recreation NED benefits of $171,000 (-1.2%). On the other hand, on average, Lake Sakakawea would experience an increase in annual visitation of over 4,800 recreation visitor days, with an increase in average annual recreation NED benefits of $200,000 (+0.1%).

Table 3-159. Summary of NED analysis for Variation 1B, 1932–2012 (thousands of 2020 dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Average Annual Recreation Visitor Days	520,455	3,365,451	1,323,044	66,854	115,974	5,391,778
Change in Average Annual Recreation Days from No Action	-6,249	4,814	-777	70	-56	-2,198
Annual Average NED Benefits	$14,233	$139,937	$31,773	$1,205	$3,901	$191,049
Change in Average Annual NED Benefits from No Action	-$171	$200	-$19	$1	-$2	$10
Percent Change in Average Annual NED Benefits from No Action	-1.19%	0.14%	-0.06%	0.11%	-0.05%	0.01%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

When considering only the years when a partial or full release would be simulated to occur, on average, there would be decreased NED benefits at Fort Peck Lake and slightly higher benefits at Lake Sakakawea compared to the average effects over the period of record (Table 3-154). At Fort Peck Lake, in years with a partial or full flow release would result in an average decrease in $385,000 or 2.2 percent compared to No Action in these years. In other locations, there are negligible changes in the flow release years.

Table 3-160. Summary of NED analysis for Alternative 1 – Variation 1B, 1932–2012 – partial or full flow release years only (thousands of 2020 dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Annual Average Recreation Visitor Days	617,681	3,744,145	1,508,411	70,079	120,595	6,060,911
Change in Average Annual Recreation Visitor Days from No Action	-14,085	10,498	-1,502	11	-57	-5,136
Annual Average NED Benefits	$16,891	$155,683	$36,224	$1,263	$4,056	$214,119
Change in Average Annual NED Benefits from No Action	-$385	$436	-$36	$0	-$2	$14
Percent Change in Average Annual NED Benefits from No Action	-2.23%	0.28%	-0.10%	0.02%	-0.05%	0.01%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

Additional results of flow actions are summarized in Table 3-155. These results show the difference in annual recreation NED benefits by location during years when there would be an Attraction Flow release action. Results from the simulations at Fort Peck Lake show that relatively larger adverse effects would occur in some years when a partial or full release would occur or in the year following a release when the fishing success criteria is not met under Variation 1B (simulated to occur in three years over the period of record). In addition, there is one year with a considerable increase in recreation NED benefits at Fort Peck Lake in the year following a release (when fishing success metric is met under Variation 1B and not under No Action).

At Lake Sakakawea, the largest decreases in recreation NED benefits would occur during the full or partial release years, while the largest increases would occur in the year following a release year. There are three years when there would be impacts with greater than $500,000 reduction in recreation NED benefits at Lake Sakakawea compared to No Action, both in full release years. Many of the years over the period of record would result in beneficial effects, mostly occurring in full or partial release years and in years following a release. One notable year, as simulated in 1986, that results in an increase in recreation NED benefits of $3.4 million from higher reservoir elevations in Lake Sakakawea in 1985. At the remaining locations, annual changes are relatively small and the years with adverse effects are offset by years with beneficial effects.

Table 3-161. Changes in NED benefits from flow releases under Variation 1B compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	All Locations
Partial or full flow release[a]	Lowest Benefit Change	-$5,800	-$867	-$405	-$52	-$43	-$5,557
	Highest Benefit Change	$86	$3,441	$181	$91	$100	$3,199
Year after Partial of Full Flow Release	Lowest Benefit Change	-$5,447	-$39	-$417	-$13	-$93	-$3,126
	Highest Benefit Change	$5,287	$2,326	$169	$0	$2	$6,839
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$5,447	-$867	-$417	-$52	-$130	-$5,557
	Highest Benefit Change	$5,287	$3,441	$260	$91	$99	$6,839

Fiscal year 2020 prices.

[a] Flow action would be partially or fully implemented in 24 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represent the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation NED benefits compared to No Action, while positive values indicate an increase in recreation NED benefits compared to No Action.

Regional Economic Development

Under Variation 1B, non-local visitor spending associated with the upper three reservoirs would support sales in local businesses, 3,676 jobs, and $161 million in labor income on an annual basis. When compared to No Action, on average across all locations under Variations 1B, there would be 2 fewer jobs, and $36,000 less in labor income across all locations. When compared to No Action, for the years when there would be a full or partial test release, there would be 4 fewer annual jobs, and $64,000 less in average annual labor income across all locations. Tables 3-162 and 3-163 summarize the RED effects under Variation 1B.

Lake Sakakawea would experience mostly beneficial impacts in most years compared to No Action; on average, there would be an increase in 3 jobs compared to No Action. The average of the 8 highest visitation years would result in an increase in 29 jobs and $1.4 million in labor income, while the average of the 8 lowest visitation years would result in a decrease in 7 jobs and $304,000 in labor income.

Table 3-162. Economic benefits of non-local visitor spending for the reservoirs under Alternative 1B relative to No Action (thousands of 2020 dollars)

Economic Impact Parameter	Year	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Direct, Indirect, and Induced Jobs	Average annual over 81 years	373	2,278	1,025	3,676
	Change in annual average over 81 years relative to No Action	-5	3	-1	-2
	Annual average during 8 highest visitation years relative to No Action	19	29	4	NA
	Annual average during 8 lowest visitation years relative to No Action	-62	-7	-8	NA
Direct, Indirect, and Induced Labor Income	Annual average over 81 years	$12,580	$106,529	$42,112	$161,221
	Change in annual average over 81 years relative to No Action	-$153	$146	-$29	-$36
	Annual average during 8 highest visitation years relative to No Action	$630	$1,355	$161	NA
	Annual average during 8 lowest visitation years relative to No Action	-$2,078	-$304	-$330	NA
Direct, Indirect, and Induced Sales	Annual Average over 81 years	$37,637	$275,515	$118,630	$431,781
	Change in average annual average over 81 years relative to No Action	-$457	$377	-$80	-$161
	Annual average during 8 highest visitation years relative to No Action	$1,886	$3,504	$452	NA
	Annual average during 8 lowest visitation years relative to No Action	-$6,218	-$787	-$929	NA

Note: The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir. Note that the totals may not exactly reflect the sum of the individual reservoirs due to rounding in the calculations.

Table 3-163. Summary of RED analysis for Variation 1B, 1932-2012 - partial or full flow release years only

Recreation RED Benefits	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Annual Average Jobs	436	2,528	1,169	4,133
Change in Average Annual Jobs from No Action	-10	+7	-1	-4

Annual Average Labor Income (thousands, 2020$)	$14,710	$118,226	$48,007	$180,943
Change in Average Annual Labor Income from No Action (thousands, 2020$)	-$335	+$322	-$51	-$64

a Flow action would be partially or fully implemented in 24 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

Similar to Alternative 1, the Fort Peck releases under Variation 1B would cause visitation to Fort Peck Lake to decrease in some of the years when a release would occur or the year following a release, when reservoir elevations are lower than under No Action. Reduced non-local visitation would result in a reduction in recreation RED benefits at Fort Peck Lake while these conditions persist. On average, there would be a reduction in 5 jobs compared to No Action at Fort Peck Lake and $153,000 in labor income. During the eight lowest visitation years relative to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 62 jobs and $2 million in labor income under Variation 1B, which is the same as under Alternative 1. In the year with the largest decrease in visitation compared to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 154 jobs and $5.2 million in labor income under Variation 1B (Table 3-164 and 3-165).

Sixty-two jobs represents 9 percent of recreation employment and 2 percent of all employment in the communities adjacent to Fort Peck Lake. Similar to Alternative 1, in years when the conditions adversely affect the fishery at Fort Peck Lake (typically when a release is implemented at the beginning of a relatively direr period), recreation visitor days and jobs and income would be reduced by up to 41 percent of average annual conditions. Although these effects as modeled would be temporary and fall within the range of visitation at Fort Peck Lake, they could have large and adverse impacts for tourism industries and businesses and small communities that support these recreational activities. The USACE would work with the natural resource specialists at the Lake and state fishery biologists in implementing the releases to minimize the adverse impacts to the fishery and visitation.

Table 3-164. Changes in RED benefits (Jobs) from flow releases under Variation 1B compared to No Action

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-154	-14	-13

	Highest Benefit Change	+3	+55	+6
Year after Partial of Full Flow Release	Lowest Benefit Change	-144	-3	-13
	Highest Benefit Change	+140	+37	+5
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-154	-14	-13
	Highest Benefit Change	+140	+55	+8

a Flow action would be partially or fully implemented in 24 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Table 3-165. Changes in RED benefits (Labor Income) from flow releases under Variation 1B compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-$5,180	-$676	-$541
	Highest Benefit Change	+$92	+$2,593	+$240
Year after Partial of Full Flow Release	Lowest Benefit Change	-$4,872	-$250	-$554
	Highest Benefit Change	+$4,731	+$2,686	+$225
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$5,180	-$676	-$554
	Highest Benefit Change	+$4,731	+$2,686	+$344

a Flow action would be partially or fully implemented in 24 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Other Social Effects

Variation 1B would be very similar to Alternative 1, with decreased lake elevations during some of the years and years after the flow releases at Fort Peck Lake. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse social impacts in the long-term. There would be negligible changes in OSE compared to No Action at the other reservoirs and in the inter-reservoir river reaches.

3.9.2.7 Conclusion – Alternative 1 including Variants 1A and 1B

Table 3-166 provides a summary of the NED impacts for Alternative 1 including variations 1A and 1B in years when a partial or full flow release would be simulated to occur. Over all locations, average annual recreation NED benefits would increase under Alternative 1 and Variation 1B between $14,000 and $115,000 (0.01 to 0.05 percent) relative to No Action. Variation 1A would result in a decrease in average annual NED benefits of $48,000 of -0.02 percent.

Visitation and recreation NED benefits would decrease at Fort Peck Lake compared to No Action during flow release years, ranging from a decrease of 14,000 to 16,000 visitors and decrease of $211,000 (-1.2%) to $450,000 (-2.6%) in recreation NED benefits. It appears that Variation 1A is slightly better for Fort Peck Lake relative to Alternative 1 and Variation 1B. While Fort Peck Lake would experience small adverse impacts in most years during a partial or full flow release, in some years the releases cause impacts to fishing success, specifically reducing a rising pool in the spring, with estimated reductions in visitation and recreation NED benefits of approximately 31 percent compared to No Action. In these years (three over the period of record under Alternative 1 and each of its variations), there could be the potential for large adverse impacts; the effects could persist as the lower lake conditions continue but would be short-term as hydrology and precipitation return the reservoir to relatively higher pool elevations and adequate fishing conditions.

At Lake Sakakawea, in most years there would be increased visitation and recreation NED benefits under Alternative 1 and its variations compared to No Action. Variation 1A would be least beneficial relative to No Action, while Alternative 1 would be most beneficial. Lake Oahe would experience slight decreases in visitation and recreation NED benefits during flow release years, while the inter-reservoir river reaches would experience slight increases in visitation and recreation NED benefits compared to No Action (with the exception of Garrison Reach under Variation 1B). In all locations aside from Fort Peck Lake, all impacts under Alternative 1 and its variations would be negligible and adverse or beneficial compared to No Action.

Table 3-166. Summary of NED analysis for Alternative 1, Variations 1A and 1B, 1932–2012, during partial or full release years (2020 dollars)

Recreation NED Benefits	Alternative 1	Variation 1A	Variation 1B	Range in Variation
All Locations				

Change in Ave. Annual Recreation Visitor Days from No Action	-2,831	-3,811	-5,136	2,305
Change in Ave. Annual NED from No Action	$114,964	-$48,460	$13,510	$163,424
Percent Change in Ave. Annual NED from No Action	0.05%	-0.02%	0.01%	0.07%
Fort Peck Lake				
Change in Ave. Annual Recreation Visitor Days from No Action	-16,473,	-7,714	-14,085	8,759
Change in Ave. Annual NED from No Action	-$450,487	-$210,962	-$385,185	$239,525
Percent Change in Ave. Annual NED from No Action	-2.62%	-1.23%	-2.23%	1.39%
Lake Sakakawea				
Change in Ave. Annual Recreation Visitor Days from No Action	13,390	4,005	10,498	9,385
Change in Ave. Annual NED from No Action	$556,765	$166,512	$436,498	$390,253
Percent Change in Ave. Annual NED from No Action	0.36%	0.11%	0.28%	0.25%
Lake Oahe				
Change in Ave. Annual Recreation Visitor Days from No Action	-88	-538	-1,502	1,414
Change in Ave. Annual NED from No Action	-$2,105	-$12,930	-$36,080	$33,975
Percent Change in Ave. Annual NED from No Action	-0.01%	-0.04%	-0.10%	0.09%
Fort Peck Dam to Lake Sakakawea				
Change in Ave. Annual Recreation Visitor Days from No Action	41	370	11	359
Change in Ave. Annual NED from No Action	$745	$6,677	$207	$6,470
Percent Change in Ave. Annual NED from No Action	0.06%	0.53%	0.02%	0.51%
Garrison Dam to Lake Oahe				
Change in Ave. Annual Recreation Visitor Days from No Action	299	67	-57	3663
Change in Ave. Annual NED from No Action	$10,046	$2,242	-$1,931	$11,977
Percent Change in Ave. Annual NED from No Action	0.25%	0.06%	-0.05%	0.30%

The regional economic benefits, specifically employment, associated with non-local visitation at the upper three reservoirs are summarized in Table 3-167. As described above, non-local visitor spending associated with the upper three reservoirs would support sales in local businesses, employment and labor income. The bulk of the jobs and income would be associated with Lake Sakakawea because of the relatively larger amount of visitation. Lake Sakakawea would experience both increases and decreases in regional economic effects although on average, there would be increased regional economic benefits, ranging from 1 to 3 additional jobs under Alternative 1 and its variations.

The Fort Peck releases under Alternative 1 and its variations would cause visitation to Fort Peck Lake to decrease in some of the years when a release would occur or the year following a release, when reservoir elevations are lower than under No Action. Reduced non-local visitation would result in a reduction in recreation RED benefits at Fort Peck Lake while these conditions persist. The changes in regional economic benefits at Fort Peck Lake under Alternative 1 and its variations compared to No Action are similar; Alternative 1 and Variation 1B are very similar and slightly worse than the changes under Variation 1A compared to No Action. On average, there would be a reduction in 2 to 5 jobs compared to No Action at Fort Peck Lake. During the eight lowest visitation years relative to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 59 to 62 jobs and $2 million in labor income under Alternative 1 and its variations.

In years when the conditions adversely affect the fishery at Fort Peck Lake (typically when a release is implemented at the beginning of a relatively direr period), recreation visitor days and jobs and income would be reduced by up to 41 percent of average annual conditions (simulated to occur in three years over the period of record for Alternative 1 and its variations). Although these effects as modeled, would be temporary and fall within the range of visitation at Fort Peck Lake, they could have large and adverse impacts for tourism industries and businesses and small communities that support these recreational activities. The fishing success metric (modeled as a dummy variable) has a large impact on visitation estimates in the regression analysis, with large changes from No Action (beneficial and adverse) with changes in the fishing success metric (0-1 variable). The USACE would work with the natural resource specialists at the Lake and state fishery biologist to help to minimize the adverse impacts to the fishery and visitation. Therefore, in reality, it is likely the changes would not as dramatic and possibly would take longer to be experienced and the ability of the fishery to recover to normal conditions may also be prolonged.

There would be very little changes in regional economic effects at Lake Oahe under Alternative 1 and its variations compared to No Action. On average, there would be a reduction of 0 to 1 jobs, and between $6,000 and $31,000 in labor income compared to No Action. In the eight worst years compared No Action, it appears that Variation 1B is slightly better than Alternative 1 and Variation 1A at Lake Oahe.

Table 3-167. Direct, indirect, and induced employment impacts from non-local visitor spending under the FPDTR-EIS alternatives

Reservoir	No Action	Alternative 1	Variation 1A	Variation 1B
Fort Peck Lake				
Lowest Visitation Year	0	0	0	0
Highest Visitation Year	535	535	535	536
Annual Average	378	373	375	373
Change in Annual Average	NA	-5	-2	-5
8 Best Years Relative to No Action	NA	19	40	19
8 Worst Years Relative to No Action	NA	-62	-59	-62
Lake Sakakawea				
Lowest Visitation Year	1,429	1,429	1,429	1,429
Highest Visitation Year	2,791	2,791	2,791	2,776
Annual Average	2,275	2,278	2,276	2,278
Change in Annual Average	NA	3	1	3
8 Best Years Relative to No Action	NA	32	20	29
8 Worst Years Relative to No Action	NA	-4	-15	-7
Lake Oahe				
Lowest Visitation Year	473	473	473	474
Highest Visitation Year	1,283	1,283	1,275	1,278
Annual Average	1,026	1,026	1,026	1,025
Change in Annual Average	NA	0	0	-1
8 Best Years Relative to No Action	NA	4	2	4
8 Worst Years Relative to No Action	NA	-3	-5	-8

Note: Estimated with the USACE RECONS model (USACE 2019b).

There would be negligible changes in OSE compared to No Action at Lake Oahe and Lake Sakakawea and in the inter-reservoir river reaches. At Fort Peck Lake, decreases in lake elevations during three years over the period of record would affect fishing success, visitation, and in turn, employment and income in the adjacent communities; these effects as modeled would be temporary and are within the range of variation under No Action, resulting in negligible to small adverse social impacts in the long-term.

3.9.2.8 Alternative 2

The parameters for Alternative 2 are the same as described for Alternative 1 except that the Attraction Flow Regime peak is 14,000 cfs (the maximum powerhouse capacity) rather than twice the average Fort Peck spring flow in the given year. The maximum amount of flow that can be run through the generators is 14,000 cfs. Any additional flow is run through the spillway and does not generate hydroelectricity. Additionally, releases as measured at Wolf Point gage are held at 14,000 cfs until the Spawning Cue release is initiated.

National Economic Development

Under Alternative 2, the UMR would support on average $191 million in recreation NED benefits per year, an increase of $137,000 (0.1 percent) compared to No Action (Table 3-168). The largest variations in recreational benefits would occur at Fort Peck Lake and Lake Sakakawea, where management actions under Alternative 2 would cause average annual NED benefits to decrease by 0.9 percent at Fort Peck Lake and increase by 0.2 percent at Lake Sakakawea. The flow releases would decrease Fort Peck Lake pool elevations affecting recreational access and fishing conditions, while visitation at Lake Sakakawea would increase from relatively higher pool elevations on average; there would be very little changes in visitation and recreation NED benefits at Lake Oahe and the inter-reservoir river reaches.

On average, Fort Peck Lake would experience a decrease in annual visitation of 4,800 recreation visitor days, with a decrease in average annual recreation NED benefits of $132,000 (-0.9%). On the other hand, on average, Lake Sakakawea would experience an increase in annual visitation of over 6,400 recreation visitor days, with an increase in average annual recreation NED benefits of $267,000 (+0.2%).

Table 3-168. Summary of NED analysis for Alternative 2, 1932–2012 (thousands of 2020 dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Annual Average Recreation Visitor Days	521,876	3,367,055	1,324,004	66,792	115,949	5,395,675
Change in Average Annual Recreation Visitor Days from No Action	-4,828	6,418	183	8	-81	1,700
Annual Average NED Benefits	$14,271	$140,004	$31,796	$1,204	$3,900	$191,175
Change in Average Annual NED Benefits from No Action	-$132	$267	$4	$0	-$3	$137

Percent Change in Average Annual NED Benefits from No Action	-0.92%	0.19%	0.01%	0.01%	-0.07%	0.07%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

When considering only the years when a partial or full release would be simulated to occur, on average, there would be decreased NED benefits at Fort Peck Lake and slightly higher benefits at Lake Sakakawea compared to the average results across all years in the period of record (Table 3-169). At Fort Peck Lake, years with a partial or full flow release would result in an average decrease in $353,000 or 2.1 percent compared to No Action. In other locations, there are negligible changes in the flow release years.

Table 3-169. Summary of NED analysis for Alternative 2, 1932–2012 – partial or full flow release years only (thousands of 2020 dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Annual Average Recreation Visitor Days	612,615	3,773,334	1,514,344	69,849	121,143	6,091,286
Change in Average Annual Recreation Visitor Days from No Action	-12,911	17,375	793	36	-77	5,215
Annual Average NED Benefits	$16,753	$156,897	$36,367	$1,259	$4,075	$215,351
Change in Average Annual NED Benefits from No Action	-$353	$722	$19	$1	-$3	$386
Percent Change in Average Annual NED Benefits from No Action	-2.06%	0.46%	0.05%	0.05%	-0.06%	0.18%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

Additional results of flow actions are summarized in Table 3-170. These results show the difference in annual recreation NED benefits by location during years when there would be an Attraction Flow release action. Changes are very small compared to No Action at Lake Oahe and the inter-reservoir river reaches. Results from the simulations at Fort Peck Lake show that relatively larger adverse effects would occur in some years when a partial or full release would occur or in the year following a release when the fishing success criteria is not met under Alternative 2 (simulated to occur in two years over the period of record). In addition, there is one year with a considerable increase in recreation NED benefits at Fort Peck Lake in the year following a release (when fishing success metric is met under Alternative 2 and not under No Action).

At Lake Sakakawea, the largest decreases in recreation NED benefits would occur during the full or partial release years and in the year following a release. The largest increases in recreation NED benefits would occur in both flow release years and in the years following a release year. There are six years when there would be impacts with greater than $500,000 reduction in recreation NED benefits at Lake Sakakawea compared to No Action, in full and partial release years and one year after a release. Many of the years over the period of record would result in beneficial effects, mostly occurring in full or partial release years and in years following a release. One notable year, as simulated in 1988, that results in an increase in recreation NED benefits of $4.8 million from higher reservoir elevations in Lake Sakakawea in 1987. At the remaining locations, annual changes are relatively small and the years with adverse effects are offset with years with beneficial effects.

Table 3-170. Changes in NED benefits from flow releases under Alternative 2 compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	All Locations
Partial or full flow release[a]	Lowest Benefit Change	-$6,122	-$949	-$418	-$66	-$280	-$5,572
	Highest Benefit Change	$189	$3,163	$760	$95	$245	$3,084
Year after Partial of Full Flow Release	Lowest Benefit Change	-$5,835	-$755	$16	-$64	-$130	-$978
	Highest Benefit Change	$5,286	$4,837	$214	$1	$0	$7,430
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$6,122	-$949	-$418	-$66	-$280	-$5,572
	Highest Benefit Change	$5,286	$4,837	$760	$95	$245	$7,430

[a] Flow action would be partially or fully implemented in 20 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation NED benefits compared to No Action, while positive values indicate an increase in recreation NED benefits compared to No Action.

Regional Economic Development

Under Alternative 2, non-local visitor spending associated with the upper three reservoirs would support sales in local businesses, 3,679 jobs, and $161 million in labor income on an annual basis. When compared to No Action, on average across all locations under Alternative 2, there would be no change in jobs, and $43,000 more in labor income across all locations. When compared to No Action, for the years when there would be a full or partial test release, there would be 3 more annual jobs, and an increase of $257,000 in average annual labor income across all locations. Tables 3-171 and 3-172 summarize the RED effects under Alternative 2.

Lake Sakakawea would experience mostly beneficial impacts in most years compared to No Action; on average, there would be an increase in 2 jobs compared to No Action. The average of the 8 highest visitation years would result in an increase in 42 jobs and $1.9 million in labor income, while the average of the 8 lowest visitation years would result in a decrease in 9 jobs and $440,000 in labor income.

Table 3-171. Economic benefits of non-local visitor spending for the reservoirs under Alternative 2 relative to No Action (thousands of 2020 dollars)

Economic Impact Parameter	Year	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Direct, Indirect, and Induced Jobs	Average annual over 81 years	376	3,277	1,026	3,679
	Change in annual average over 81 years relative to No Action	-2	2	0	0
	Annual average during 8 highest visitation years relative to No Action	19	42	6	NA
	Annual average during 8 lowest visitation years relative to No Action	-48	-9	-5	NA
Direct, Indirect, and Induced Labor Income	Annual average over 81 years	$12,651	$106,507	$42,112	$161,300
	Change in annual average over 81 years relative to No Action	-$82	$124	-$29	$43
	Annual average during 8 highest visitation years relative to No Action	$35	$1,919	$161	NA
	Annual average during 8 lowest visitation years relative to No Action	-$1,625	-$440	-$330	NA
Direct, Indirect, and Induced Sales	Annual Average over 81 years	$37,809	$275,534	$118,715	$432,058
	Change in average annual average over 81 years relative to No Action	-$285	$396	$5	$116
	Annual average during 8 highest visitation years relative to No Action	$1,954	$4,963	$749	NA
	Annual average during 8 lowest visitation years relative to No Action	-$4,863	-$1,139	-$576	NA

Note: The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir. Note that the totals may not exactly reflect the sum of the individuals reservoirs due to rounding in the calculations.

Table 3-172. Summary of RED analysis for Alternative 2, 1932–2012 – partial or full flow release years only

Recreation RED Benefits	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Annual Average Jobs	436	2,547	1,175	4,158
Change in Average Annual Jobs from No Action	-10	+12	+1	+3
Annual Average Labor Income (thousands, 2020$)	$14,721	$119,082	$48,263	$182,066
Change in Average Annual Labor Income from No Action (thousands, 2020$)	-$325	+$559	+$23	+$257

a Flow action would be partially or fully implemented in 20 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

Similar to the effects under Alternative 1 and its variations, the Fort Peck releases under Alternative 2 would cause visitation to Fort Peck Lake to decrease in some of the years when a release would occur or the year following a release, when reservoir elevations are lower than under No Action. Reduced non-local visitation would result in a reduction in recreation RED benefits at Fort Peck Lake while these conditions persist. On average, there would be a reduction in 2 jobs compared to No Action at Fort Peck Lake and $82,000 in labor income. During the eight lowest visitation years relative to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 48 jobs and $1.6 million in labor income under Alternative 2. In the year with the largest decrease in visitation compared to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 162 jobs and $5.5 million in labor income under Alternative 2 (Table 3-173 and 3-174).

Forty-eight jobs represents 7 percent of recreation employment and 2 percent of all employment in the communities adjacent to Fort Peck Lake. In years when the conditions adversely affect the fishery at Fort Peck Lake, as simulated in two years over the period of record (typically when a release is implemented at the beginning of a relatively direr period), recreation visitor days and jobs and income would be reduced by up to 43 percent of average annual conditions. Although these effects as modeled would be temporary and fall within the range of visitation at Fort Peck Lake, they could have large and adverse impacts for tourism industries and businesses and small communities that support these recreational activities. The

USACE would work with the natural resource specialists at the Lake and state fishery biologists in implementing the releases to minimize the adverse impacts to the fishery and visitation.

Table 3-173. Changes in RED benefits (Jobs) from flow releases under Alternative 2 compared to No Action

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-162	-16	-14
	Highest Benefit Change	+5	+51	+25
Year after Partial of Full Flow Release	Lowest Benefit Change	-154	-13	0
	Highest Benefit Change	+140	+78	+7
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-162	-16	-14
	Highest Benefit Change	+140	+78	+25

a Flow action would be partially or fully implemented in 20 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Table 3-174. Changes in RED benefits (Labor Income) from flow releases under Alternative 2 compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-$5,476	-$742	-$558
	Highest Benefit Change	+$169	+2,384	+$1,008
Year after Partial of Full Flow Release	Lowest Benefit Change	-$5,195	-$594	-$15
	Highest Benefit Change	+$4,730	+$3,665	+$282
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$5,476	-$742	-$558
	Highest Benefit Change	+$4,730	+$3,665	+$1,008

a Flow action would be partially or fully implemented in 20 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Other Social Effects

Alternative 2 would be very similar to Alternative 1 and its variations, with decreased lake elevations during some of the years and years after the flow releases at Fort Peck Lake. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse social impacts in the long-term. There would be negligible changes in OSE compared to No Action at the other reservoirs and in the inter-reservoir river reaches.

3.9.2.9 Alternative 2 – 2A Variation

Variation 2A is a test flow variation of Alternative 2. The parameters for Alternative 2A are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue flow would be initiated on May 21, rather than May 28. Again, moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

National Economic Development

Under Variation 2A, the UMR would support on average $191 million in recreation NED benefits per year, an increase of $175,000 (0.1 percent) compared to No Action (Table 3-175). The impacts would be very similar to Alternative 2, with adverse impacts to Fort Peck Lake and beneficial impacts at Lake Sakakawea compared to No Action. There would be slightly higher beneficial impacts to average annual recreation NED benefits at Lake Sakakawea ($311,000 or 0.2 percent increase from No Action) under Variation 2A compared to Alternative 2. The flow releases under Variation 2A would decrease Fort Peck Lake pool elevations affecting recreational access and fishing conditions, similar impacts as under Alternative 2, with a decrease in visitation of 4,900 and $133,000 in recreation NED benefits compared to No Action. There are very little changes in visitation and recreation NED benefits at Lake Oahe and the inter-reservoir river reaches.

Table 3-175. Summary of NED analysis for Variation 2A, 1932–2012 (thousands of 2020 dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Average Annual Recreation Visitor Days	521,830	3,368,111	1,323,600	66,995	115,994	5,396,531
Change in Average Annual Recreation Days from No Action	-4,874	7,474	-221	211	-35	2,556

Annual Average NED Benefits	$14,270	$140,047	$31,786	$1,208	$3,902	$191,213
Change in Average Annual NED Benefits from No Action	-$133	$311	-$5	$4	-$1	$175
Percent Change in Average Annual NED Benefits from No Action	-0.93%	0.22%	-0.02%	0.32%	-0.03%	0.09%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

When considering only the years when a partial or full release would be simulated to occur, on average, there would be decreased NED benefits at Fort Peck Lake and slightly higher benefits at Lake Sakakawea compared to the average effects over the period of record (Table 3-176). At Fort Peck Lake, in years with a partial or full flow release would result in an average decrease in $369,000 or 2.2 percent and an average annual increase of $869,000 or 0.6 percent at Lake Sakakawea compared to No Action in these years. In other locations, there are negligible changes in the flow release years.

Table 3-176. Summary of NED analysis for Variation 2A, 1932–2012 – partial or full flow release years only (thousands of 2020 dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Annual Average Recreation Visitor Days	608,518	3,768,117	1,509,921	70,227	121,130	6,077,913
Change in Average Annual Recreation Visitor Days from No Action	-13,509	20,890	-501	550	-100	7,330
Annual Average NED Benefits	$16,641	$156,680	$36,261	$1,266	$4,074	$214,922
Change in Average Annual NED Benefits from No Action	-$369	$869	-$12	$10	-$3	$494
Percent Change in Average Annual NED Benefits from No Action	-2.17%	0.56%	-0.03%	0.79%	-0.08%	0.23%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

Additional results of flow actions are summarized in Table 3-177. These results show the difference in annual recreation NED benefits by location during years when there would be an Attraction Flow release action. Results from the simulations at Fort Peck Lake show that relatively larger adverse effects would occur in some years when a partial or full release would occur or in the year following a release when the fishing success criteria is not met under Variation 2A (occurs in two years as simulated over the period of record). In addition, there is one year with a considerable increase in recreation NED benefits at Fort Peck Lake in the year following a release (when fishing success metric is met under Variation 2A and not under No Action).

At Lake Sakakawea, the largest increases and decreases in recreation NED benefits would occur during the years after a flow release. There is one year when there would be a $4.9 million increase in recreation NED benefits at Lake Sakakawea compared to No Action in a year after a release. Many of the years over the period of record would result in beneficial effects, mostly occurring in full or partial release years and in years following a release. One notable year, as simulated in 1988, would result in a decrease in recreation NED benefits of $3.4 million from lower reservoir elevations in Lake Sakakawea in 1987. At the remaining locations, annual changes are relatively small and the years with adverse effects are offset with years with beneficial effects.

Table 3-177. Changes in NED benefits from flow releases under Alternative 2 - Variation 2A compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	All Locations
Partial or full flow release[a]	Lowest Benefit Change	-$6,109	-$877	-$433	-$52	-$287	-$5,350
	Highest Benefit Change	$727	$3,353	$178	$95	$191	$3,237
Year after Partial of Full Flow Release	Lowest Benefit Change	-$5,821	-$3,427	-$23	-$64	-$143	-$3,368
	Highest Benefit Change	$5,301	$4,873	$235	$1	$20	$5,288
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$6,109	-$3,427	-$433	-$64	-$287	-$5,350
	Highest Benefit Change	$5,301	$4,873	$235	$95	$191	$5,288

Fiscal year 2020 prices.

a Flow action would be partially or fully implemented in 20 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represent the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation NED benefits compared to No Action, while positive values indicate an increase in recreation NED benefits compared to No Action.

Regional Economic Development

Under Variation 2A, non-local visitor spending associated with the upper three reservoirs would support sales in local businesses, 3,680 jobs, and $161 million in labor income on an annual basis. When compared to No Action, on average across all locations under Variation 2A, there would be an increase in 1 job and $43,000 more in labor income across all locations. On average across the period of record, there would be very little change in jobs and income in the communities surrounding Lake Oahe compared to No Action; decreases in reservoir elevations would be offset by increases in reservoir elevations, with very little change on average in visitation compared to No Action. When compared to No Action for the years when there would be a full or partial test release, there would be minimal changes in regional economic conditions when considering impacts across all locations. Tables 3-178 and 3-179 summarize the RED effects under Variation 2A.

Lake Sakakawea would experience mostly beneficial impacts in most years compared to No Action; on average, there would be an increase in 5 jobs compared to No Action. The average of the 8 highest visitation years would result in an increase in 45 jobs and $2.1 million in labor income, while the average of the 8 lowest visitation years would result in a decrease in 12 jobs and $564,000 in labor income.

Table 3-178. Economic benefits of non-local visitor spending for the reservoirs under Variation 2A relative to No Action (thousands of 2020 dollars)

Economic Impact Parameter	Year	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Direct, Indirect, and Induced Jobs	Average annual over 81 years	374	2,280	1,026	3,680
	Change in annual average over 81 years relative to No Action	-4	5	0	1
	Annual average during 8 highest visitation years relative to No Action	21	45	5	NA
	Annual average during 8 lowest visitation years relative to No Action	-48	-12	-6	NA
Direct, Indirect, and Induced Labor Income	Annual average over 81 years	$12,614	$106,612	$42,130	$161,356
	Change in annual average over 81 years relative to No Action	-$119	$229	-$11	$99
	Annual average during 8 highest visitation years relative to No Action	$697	$2,111	$190	NA
	Annual average during 8 lowest visitation years relative to No Action	-$1,619	-$564	-$252	NA
	Annual Average over 81 years	$37,739	$275,730	$118,679	$432,149

Direct, Indirect, and Induced Sales	Change in average annual average over 81 years relative to No Action	-$355	$592	-$31	$207
	Annual average during 8 highest visitation years relative to No Action	$2,085	$5,459	$534	NA
	Annual average during 8 lowest visitation years relative to No Action	-$4,845	-$1,458	-$709	NA

Note: The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir. Note that the totals may not exactly reflect the sum of the individual reservoirs due to rounding in the calculations.

Table 3-179. Summary of RED analysis for Variation 2A, 1932–2012 – partial or full flow release years only

Recreation RED Benefits	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Annual Average Jobs	431	2,553	1,171	4,155
Change in Average Annual Jobs from No Action	-15	+14	0	-1
Annual Average Labor Income (thousands, 2020$)	$14,543	$119,367	$48,089	$181,999
Change in Average Annual Labor Income from No Action (thousands, 2020$)	-$510	+$674	-$18	+$146

a Flow action would be partially or fully implemented in 20 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

Similar to the effects under Alternative 2, the Fort Peck releases under Variation 2A would cause visitation to Fort Peck Lake to decrease in some of the years when a release would occur or the year following a release, when reservoir elevations are lower than under No Action. Reduced non-local visitation would result in a reduction in recreation RED benefits at Fort Peck Lake while these conditions persist. On average, there would be a reduction in 4 jobs compared to No Action at Fort Peck Lake and $119,000 in labor income. During the eight lowest visitation years relative to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 48 jobs and $1.6 million in labor income under Variation 2A. In the year with the largest decrease in visitation compared to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 162 jobs and $5.5 million in labor income under Variation 2A (Table 3-180 and 3-181).

Forty-eight jobs represents 7 percent of recreation employment and 2 percent of all employment in the communities adjacent to Fort Peck Lake. In years when the conditions adversely affect the fishery at Fort Peck Lake, as simulated in two years over the period of record (typically when a release is implemented at the beginning of a relatively direr period), similar to Alternative 2 (and Variation 2B), recreation visitor days and jobs and income would be reduced by up to 43 percent of average annual conditions. Although these effects as modeled would be temporary and fall within the range of visitation at Fort Peck Lake, they could have large and adverse impacts for tourism industries and businesses and small communities that support these recreational activities. The USACE would work with the natural resource specialists at the Lake and state fishery biologists in implementing the releases to minimize the adverse impacts to the fishery and visitation.

Table 3-180. Changes in RED benefits (Jobs) from flow releases under Variation 2A compared to No Action

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-162	-15	-14
	Highest Benefit Change	+2	+54	+6
Year after Partial of Full Flow Release	Lowest Benefit Change	-154	-57	-1
	Highest Benefit Change	+141	+79	+8
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-162	-57	-14
	Highest Benefit Change	+141	+79	+8

a Flow action would be partially or fully implemented in 20 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Table 3-181. Changes in RED benefits (Labor Income) from flow releases under Variation 2A compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-$5,474	-$681	-$578
	Highest Benefit Change	+$62	+$2,526	+$236
Year after Partial of Full Flow Release	Lowest Benefit Change	-$5,183	-$2,658	-$34
	Highest Benefit Change	+$4,741	$3,692	+$309
	Lowest Benefit Change	-$5,474	-$2,658	-$578

Years with Greatest Range in Impacts Regardless of Flow Actions	Highest Benefit Change	+$4,741	$3,692	+$309

a Flow action would be partially or fully implemented in 20 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Other Social Effects

Variation 2A would be very similar to Alternatives 2 and 1 and the variations, with decreased lake elevations during some of the years and years after the flow releases at Fort Peck Lake. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse social impacts in the long-term. There would be negligible changes in OSE compared to No Action at the other reservoirs and in the inter-reservoir river reaches.

3.9.2.10 Alternative 2 – 2B Variation

Variation 2B is a test flow is another variation of Alternative 2. The parameters for Alternative 2B are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 23, rather than April 16, and the Spawning Cue flow is initiated on June 4, rather than May 21. Again, the difference in timing is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

National Economic Development

Under Variation 2B, the UMR would support on average $191 million in recreation NED benefits per year, an increase of $102,000 compared to No Action (Table 3-167). The largest variations in recreational benefits would occur at Fort Peck Lake and Lake Sakakawea, where management actions under Variation 2B would cause annual average NED benefits to decrease by 2.0 percent at Fort Peck Lake and increase by 0.3 percent at Lake Sakakawea. The flow releases would decrease Fort Peck Lake pool elevations affecting recreational access and fishing conditions, while visitation at Lake Sakakawea would increase from relatively higher pool elevations on average; there would be very little changes in visitation and recreation NED benefits at Lake Oahe and the inter-reservoir river reaches.

On average, Fort Peck Lake would experience a decrease in annual visitation of approximately 10,000 recreation visitor days, with a decrease in average annual recreation NED benefits of $282,000 (-2.0%). On the other hand, on average, Lake Sakakawea would experience an increase in annual visitation of over 8,900 recreation visitor days, with an increase in average annual recreation NED benefits of $371,000 (+0.3%).

Table 3-182. Summary of NED analysis for Variation 2B, 1932–2012 (thousands of 2020 dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Average Annual Recreation Visitor Days	516,380	3,369,558	1,324,432	66,795	115,998	5,393,162
Change in Average Annual Recreation Days from No Action	-10,324	8,920	611	11	-31	-813
Annual Average NED Benefits	$14,121	$140,108	$31,806	$1,204	$3,902	$191,141
Change in Average Annual NED Benefits from No Action	-$282	$371	$15	$0	-$1	$102
Percent Change in Average Annual NED Benefits from No Action	-1.96%	0.27%	0.05%	0.02%	-0.03%	0.05%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

When considering only the years when a partial or full release would be simulated to occur, on average, there would be lower NED benefits at Fort Peck Lake and slightly higher benefits at Lake Sakakawea compared to the average results across all years in the period of record (Table 3-168). At Fort Peck Lake, years with a partial or full flow release would result in an average decrease in $635,000 or 3.7 percent compared to No Action. In other locations, there are negligible changes in the flow release years.

Table 3-183. Summary of NED analysis for Variation 2B, 1932–2012 – partial or full flow release years only (thousands of 2020 dollars)

Recreation NED Benefits or Costs	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	Total
Annual Average Recreation Visitor Days	608,547	3,753,123	1,511,426	70,093	120,667	6,063,856
Change in Average Annual Recreation Visitor Days from No Action	-23,219	19,476	1,512	25	14	-2,191
Annual Average NED Benefits	$16,642	$156,056	$36,297	$1,264	$4,059	$214,317

Change in Average Annual NED Benefits from No Action	-$635	$810	$36	$0	$0	$212
Percent Change in Average Annual NED Benefits from No Action	-3.68%	0.52%	0.10%	0.04%	0.01%	0.10%

a Visitation benefits include all visitors at the upper three reservoirs and boat-accessed visitation in the inter-river reaches. Winter visitors are included for the reservoirs but are not included as plan-affected visitors in the river reaches.

Additional results of flow actions are summarized in Table 3-169. These results show the difference in annual recreation NED benefits by location during years when there would be an Attraction Flow release action. Changes are very small compared to No Action at Lake Oahe and the inter-reservoir river reaches. Results from the simulations at Fort Peck Lake show that relatively larger adverse effects would occur in some years when a partial or full release would occur or in the year following a release when the fishing success criteria is not met under Variation 2B (simulated to occur in three years over the period of record).

At Lake Sakakawea, the largest increases in recreation NED benefits would occur during the full or partial release years or in the year following a release. The largest decreases in recreation NED benefits would occur in full or partial release years. There are two years when there would be impacts with greater than $500,000 reduction in recreation NED benefits at Lake Sakakawea compared to No Action, in a full and partial release years and one during a non-release year. Many of the years over the period of record would result in beneficial effects, mostly occurring in full or partial release years and in years following a release at Lake Sakakawea. At the remaining locations, annual changes are relatively small and the years with adverse effects are offset with years with beneficial effects.

Table 3-184. Changes in NED benefits from flow releases under Variation 2B compared to No Action (thousands of 2020 dollars)

Flows Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Fort Peck Dam to Lake Sakakawea	Garrison Dam to Lake Oahe	All Locations
Partial or full flow release[a]	Lowest Benefit Change	-$6,109	-$750	-$422	-$100	-$124	-$5,601
	Highest Benefit Change	$154	$3,471	$441	$82	$119	$3,469
Year after Partial of Full Flow Release	Lowest Benefit Change	-$5,826	-$296	-$27	-$64	-$124	-$2,278

	Highest Benefit Change	$11	$3,520	$745	$0	$0	$2,927
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$6,109	-$750	-$422	-$100	-$124	-$5,601
	Highest Benefit Change	$154	$3,520	$745	$82	$119	$3,469

[a] Flow action would be partially or fully implemented in 24 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represent the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation NED benefits compared to No Action, while positive values indicate an increase in recreation NED benefits compared to No Action.

Regional Economic Development

Under Variation 2B, non-local visitor spending associated with the upper three reservoirs would support sales in local businesses, 3,677 jobs, and $161 million in labor income on an annual basis. When compared to No Action, on average across all locations under Variation 2B, there would be a decrease in 2 jobs, and an increase $39,000 in labor income across all locations. When compared to No Action, for the years when there would be a full or partial test release, there would be minimal changes in regional economic conditions, when considering impacts across all locations. Tables 3-185 and 3-186 summarize the RED effects under Variation 2B.

Lake Sakakawea would experience mostly beneficial impacts in most years compared to No Action; on average, there would be an increase in 6 jobs compared to No Action. The average of the 8 highest visitation years would result in an increase in 41 jobs and $1.9 million in labor income, while the average of the 8 lowest visitation years would result in a decrease in 4 jobs and $199,000 in labor income.

Table 3-185. Economic benefits of non-local visitor spending for the reservoirs under Alternative 2B relative to No Action (thousands of 2020 dollars)

Economic Impact Parameter	Year	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Direct, Indirect, and Induced Jobs	Average annual over 81 years	370	2,281	1,026	3,677
	Change in annual average over 81 years relative to No Action	-7	6	0	-2
	Annual average during 8 highest visitation years relative to No Action	1	41	5	NA
	Annual average during 8 lowest visitation years relative to No Action	-67	-4	-6	NA
	Annual average over 81 years	$12,481	$106,658	$42,157	$161,296

Direct, Indirect, and Induced Labor Income	Change in annual average over 81 years relative to No Action	-$252	$275	$16	$39
	Annual average during 8 highest visitation years relative to No Action	$35	$1,915	$330	NA
	Annual average during 8 lowest visitation years relative to No Action	-$2,247	-$199	-$165	NA
Direct, Indirect, and Induced Sales	Annual Average over 81 years	$37,341	$275,850	$118,754	$431,945
	Change in average annual average over 81 years relative to No Action	-$753	$712	$44	$3
	Annual average during 8 highest visitation years relative to No Action	$106	$4,952	$534	NA
	Annual average during 8 lowest visitation years relative to No Action	-$6,724	-$516	-$464	NA

Note: The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir. Note that the totals may not exactly reflect the sum of the individual reservoirs due to rounding in the calculations.

Table 3-186. Summary of RED analysis for Variation 2B, 1932–2012 – partial or full flow release years only

Recreation RED Benefits	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Total
Annual Average Jobs	430	2,534	1,171	4,135
Change in Average Annual Jobs from No Action	-16	+13	+1	-2
Annual Average Labor Income (thousands, 2020$)	$14,491	$118,509	$48,089	$181,089
Change in Average Annual Labor Income from No Action (thousands, 2020$)	-$554	+$606	+$45	+97

a Flow action would be partially or fully implemented in 24 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

Similar to the effects under Alternative 1 and 2, the Fort Peck releases under Variation 2B would cause visitation to Fort Peck Lake to decrease in some of the years when a release would occur or the year following a release, when reservoir elevations are lower than under No Action. Reduced non-local visitation would result in a reduction in recreation RED benefits at Fort Peck Lake while these conditions persist. On average, there would be a reduction in 7 jobs compared to No Action at Fort Peck Lake and $252,000 in labor income. During the eight lowest visitation years relative to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 67 jobs and $2.2 million in labor income under Variation 2B. In the year with the largest decrease in visitation compared to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 162 jobs and $5.5 million in labor income under Variation 2B (Table 3-187 and 3-188).

Sixty-seven jobs represents 10 percent of recreation employment and 2 percent of all employment in the communities adjacent to Fort Peck Lake. In years when the conditions adversely affect the fishery at Fort Peck Lake, as simulated in three years over the period of record (typically when a release is implemented at the beginning of a relatively direr period), recreation visitor days and jobs and income would be reduced by up to 43 percent of average annual conditions. Although these effects as modeled would be temporary and fall within the range of visitation at Fort Peck Lake, they could have large and adverse impacts for tourism industries and businesses and small communities that support these recreational activities. The USACE would work with the natural resource specialists at the Lake and state fishery biologists in implementing the releases to minimize the adverse impacts to the fishery and visitation.

Table 3-187. Changes in RED benefits (Jobs) from flow releases under Variation 2B compared to No Action

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-162	-13	-14
	Highest Benefit Change	+4	56	+14
Year after Partial of Full Flow Release	Lowest Benefit Change	-143	-5	-1
	Highest Benefit Change	0	+57	+24
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-162	-13	-14
	Highest Benefit Change	+4	+57	+24

a Flow action would be partially or fully implemented in 24 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Table 3-188. Changes in RED benefits (Labor Income) from flow releases under Variation 2B compared to No Action (thousands of 2020 dollars)

Flow Type	Type of Benefit	Fort Peck Lake	Lake Sakakawea	Lake Oahe
Partial or full flow release[a]	Lowest Benefit Change	-$5,464	-$590	-$564
	Highest Benefit Change	+$138	+$2,617	+$580

Year after Partial of Full Flow Release	Lowest Benefit Change	-$5,187	-$233	-$36
	Highest Benefit Change	0	+$2,663	+$987
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest Benefit Change	-$5,464	-$590	-$564
	Highest Benefit Change	+$138	+$2,663	+$987

a Flow action would be partially or fully implemented in 24 years of the period of record. A partial release year is defined as a year when test flows are abandoned before completion. A full release year is defined as a year when test flows are completed. Data represents the lowest and highest dollar impacts in the years the flow was fully or partially implemented. Negative values indicate a decrease in recreation RED benefits compared to No Action, while positive values indicate an increase in recreation RED benefits compared to No Action.

The lowest visitation year and highest visitation years would not necessarily be the same year at each reservoir.

Other Social Effects

Variation 2B would be very similar to Alternative 1 and 2, with decreased lake elevations during some of the years and years after the flow releases at Fort Peck Lake. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse social impacts in the long-term. There would be negligible changes in OSE compared to No Action at the other reservoirs and in the inter-reservoir river reaches.

3.9.2.11 Conclusion – Alternative 2 including Variations 2A and 2B

Table 3-171 provides a summary of the NED impacts for Alternative 2 including Variations 2A and 2B in years when a partial or full flow release would be simulated to occur. Over all locations, average annual recreation NED benefits would increase under Alternative 2 and the variations between $212,000 and $494,000 (0.1 to 0.2 percent) relative to No Action.

Average annual visitation and recreation NED benefits would decrease at Fort Peck Lake compared to No Action during flow release years, ranging from a decrease of 13,000 to 23,000 visitors, a decrease between $353,000 (-2.1%) to $635,000 (-3.7%) in recreation NED benefits. It appears that Alternative 2 and Variation 2A are slightly better for Fort Peck Lake relative to Variation 2B. While Fort Peck Lake would experience small adverse impacts in most years during a partial or full flow release, in some years the releases cause impacts to fishing success, specifically reducing a rising pool in the spring, with estimated reductions in visitation and recreation NED benefits of approximately 33 percent compared to No Action. In these years (two over the period of record under Alternative 2 and Variation 2A and three years under Variation 2B), there could be the potential for large adverse impacts; the effects could persist as the lower lake conditions continue but would be short-term as hydrology and precipitation return the reservoir to relatively higher pool elevations and adequate fishing conditions.

At Lake Sakakawea, in most flow release years, there would be increased visitation and recreation NED benefits under Alternative 2 and its variations, ranging from $722,000 (0.5%) and $869,000 (0.6%) compared to No Action. Lake Oahe would experience slight decreases in average annual visitation and recreation NED benefits during flow release years under Variation 2A and slight increases under Alternative 2 and Variation 2B. The Fort Peck Dam to Lake Sakakawea river reaches would experience slight increases in visitation and recreation NED benefits compared to No Action on average in flow release years, while Garrison Dam to Lake Oahe would have varied changes from No Action. In all locations aside from Fort Peck Lake, all impacts under Alternative 2 and its variations would be negligible and adverse or beneficial compared to No Action.

Table 3-189. Summary of NED analysis for Alternative 2, Variations 2A and 2B, 1932–2012, during partial or full release years (2020 dollars)

Recreation NED Benefits	Alternative 2	Variation 2A	Variation 2B	Range in Variation
All Locations				
Change in Ave. Annual Recreation Days from No Action	5,215	7,330	-2,191	9,521
Change in Average Annual NED Benefits from No Action	$386,467	$493,705	$212,112	$281,593
Percent Change in Average Annual NED Benefits from No Action	0.18%	0.23%	0.10%	0.13%
Fort Peck Lake				
Change in Ave. Annual Recreation Days from No Action	-12,911	-13,509	-23,219	10,308
Change in Average Annual NED Benefits from No Action	-$353,059	-$369,425	-$634,952	$281,893
Percent Change in Average Annual NED Benefits from No Action	-2.06%	-2.17%	-3.68%	1.61%
Lake Sakakawea				
Change in Ave. Annual Recreation Days from No Action	17,375	20,890	19,476	3,515
Change in Average Annual NED Benefits from No Action	$722,451	$868,620	$809,807	$146,169
Percent Change in Average Annual NED Benefits from No Action	0.46%	0.56%	0.52%	0.1%
Lake Oahe				
Change in Ave. Annual Recreation Days from No Action	793	-501	1,512	2,013

Change in Average Annual NED Benefits from No Action	$19,036	-$12,030	$36,319	$48,349
Percent Change in Average Annual NED Benefits from No Action	0.05%	-0.03%	0.10%	0.13%
Fort Peck Dam to Lake Sakakawea River Reach				
Change in Ave. Annual Recreation Days from No Action	36	550	25	525
Change in Average Annual NED Benefits from No Action	$645	$9,910	$455	$9,455
Percent Change in Average Annual NED Benefits from No Action	0.05%	0.79%	0.04%	0.75%
Garrison Dam to Lake Oahe River Reach				
Change in Ave. Annual Recreation Days from No Action	-77	-100	14	114
Change in Average Annual NED Benefits from No Action	-$2,606	-$3,370	$483	$3,853
Percent Change in Average Annual NED Benefits from No Action	-0.06%	-0.08%	0.01%	0.09%

The regional economic benefits, specifically employment, associated with non-local visitation at the upper three reservoirs are summarized in Table 3-172. As described above, non-local visitor spending associated with the upper three reservoirs would support sales in local businesses, employment and labor income. The bulk of the jobs and income would be associated with Lake Sakakawea due to the relatively larger amount of visitation at the Lake. Lake Sakakawea would experience both increases and decreases in regional economic effects over the period of record although on average, there would be increased regional economic benefits, ranging from 2 to 6 additional jobs under Alternative 2 and its variations.

The Fort Peck Dam releases under Alternative 2 and its variations would cause visitation to Fort Peck Lake to decrease in some of the years when a release would occur or the year following a release, when reservoir elevations are lower than under No Action. Reduced non-local visitation would result in a reduction in recreation RED benefits at Fort Peck Lake while these conditions persist. The changes in regional economic benefits at Fort Peck Lake under Alternative 2 and its variations compared to No Action are similar; Alternative 2 and Variation 2A are very similar and slightly better than the changes under Variation 2B compared to No Action. On average, there would be a reduction in 2 to 7 jobs compared to No Action at Fort Peck Lake. During the eight lowest visitation years relative to No Action, average annual RED benefits supported by Fort Peck Lake would be reduced by 48 to 67 jobs and $1.6 to $2.2 million less in labor income under Alternative 2 and its variations.

Table 3-190. Direct, indirect, and induced employment impacts from non-local visitor spending under Alternative 2 and its variations

Reservoir	No Action	Alternative 2	Variation 2A	Variation 2B
Fort Peck Lake				
Lowest Visitation Year	0	0	0	0
Highest Visitation Year	535	535	536	535
Annual Average	378	376	374	370
Change in Annual Average	NA	-2	-4	-7
8 Best Years Relative to No Action	NA	19	21	1
8 Worst Years Relative to No Action	NA	-48	-48	-67
Lake Sakakawea				
Lowest Visitation Year	1,429	1,429	1,429	1,429
Highest Visitation Year	2,791	2,791	2,776	2,791
Annual Average	2,275	2,277	2,280	2,281
Change in Annual Average	NA	2	5	6
8 Best Years Relative to No Action	NA	41	45	41
8 Worst Years Relative to No Action	NA	-9	-12	-4
Lake Oahe				
Lowest Visitation Year	473	473	218	219
Highest Visitation Year	1,283	1,276	1,275	1,275
Annual Average	1,026	1,026	1,026	1,026
Change in Annual Average	NA	0	0	0
8 Best Years Relative to No Action	NA	6	5	8
8 Worst Years Relative to No Action	NA	-5	-6	-4

Note: Estimated with the USACE RECONS model (USACE 2019b)

In years when the conditions adversely affect the fishery at Fort Peck Lake (typically when a release is implemented at the beginning of a relatively dryer period), recreation visitor days and jobs and income would be reduced by up to 43 percent of average annual conditions (simulated to occur in two years under Alternative 2 and Variation 2A and three years under Variation 2B). Although these effects as modeled, would be temporary and fall within the range of visitation at Fort Peck Lake, they could have large and adverse impacts for tourism industries and businesses and small communities that support these recreational activities. The fishing success metric (modeled as a 0-1 dummy variable) has a large impact on visitation estimates in the regression analysis, with large changes from No Action (beneficial and adverse). The USACE would work with the natural resource specialists at the Lake and state fishery biologist to help to minimize the adverse impacts to the fishery and visitation. Therefore, in reality, it is likely the changes would not as dramatic and possibly would take longer to be experienced and the ability of the fishery to recover to normal conditions may also be prolonged.

There would be very little changes in regional economic effects at Lake Oahe under Alternative 2 and its variations compared to No Action. On average, there would be no change in jobs compared to No Action. In the eight worst years compared No Action, the average annual reduction in employment would range from 4 to 6 jobs at Lake Oahe, and in the eight best years compared to No Action, the average annual increase in jobs would range from 5 to 8 jobs. There would be negligible changes in OSE compared to No Action at Lake Oahe and Lake Sakakawea and in the inter-reservoir river reaches. At Fort Peck Lake, decreases in lake elevations during two to three years over the period of record would affect fishing success, visitation, and in turn, employment and income in the adjacent communities; these effects as modeled would be temporary and are within the range of variation under No Action, resulting in negligible to small adverse social impacts in the long-term.

3.9.2.12 Tribal Impacts

Impacts on Tribal recreation resources would depend on the location of Tribes and reservations. Changes in recreation NED benefits to reservations and their residents vary depending on hydrologic conditions, but generally include large NED benefits to visitors and residents under all alternatives. RED benefits to Tribes from non-local visitor spending at the reservoirs may be small in the context of the broader regional economy under the FPDTR-EIS alternatives, but could be important to Tribes, especially where opportunities for employment and income are limited. Changes in Tribal NED and RED benefits compared to No Action at Lake Oahe and in the river reaches would be negligible.

Impacts to Tribal recreation under the FPDTR-EIS alternatives would be similar to those described above in Sections 3.9.2.4 and 3.9.2.5 where the NED, RED, and OSE results are described. In most years and locations, there would be negligible impacts under FPDTR-EIS alternatives relative to No Action. Flow releases under Alternatives 1 and 2 and the variations would, however, draw down the reservoir elevations at Fort Peck Lake impacting recreational access and fishing opportunities in two to three years over the period record, causing temporary, large, adverse decreases in recreation NED values and RED effects. Adverse impacts on recreation NED, RED, and OSE benefits during these conditions at Fort Peck Lake may adversely affect Tribal communities and lifestyles during these conditions to the extent that Tribes are dependent on recreation at this Lake. Recreational opportunities associated with reservations and Tribes near and/or adjacent to Lake Sakakawea would experience negligible or small beneficial effects from increased pool elevations associated with the Fort Peck Dam test releases.

3.9.2.13 Climate Change

A discussion on the influence of climate change on the alternatives is included in Section 3.2 River Infrastructure and Hydrologic Processes. Earlier snowmelt may cause spring System storage targets at the upper three reservoirs to be met more frequently which may alter releases under the No Action and alternatives. Drought conditions may affect recreation access and fishing opportunities at Fort Peck Lake from lower reservoir elevations and could also reduce river access and recreation opportunities. Increased runoff may raise reservoir levels and Fort Peck releases that could benefit recreation opportunities.

More sporadic large rain events and flooding could adversely impact access to recreation resources. These impacts could be exacerbated during the test flow releases. In contrast, some river boating recreation opportunities will benefit from high river levels and risk to large rain events will be reduced following the alternatives peak flow period. Since the No Action and alternatives have negligible difference in volume, no significant difference in recreation opportunities is expected.

3.9.2.14 Cumulative Impacts

Past, present, and future construction projects, including those to maintain the mainstem dams, roads, develop recreational areas, and construction of native fish and wildlife habitat areas, can cause temporary localized adverse impacts to the quality and quantity of recreational visits as a result of construction-related noise, vibration, fugitive emissions, deterioration in water quality, decreased visual aesthetics, and access limitations. However, many of these actions result in recreational benefits over the long-term by increasing access and providing a range of recreational opportunities available to a variety of users.

Continued management of recreation, wildlife, and natural areas by USFWS, NPS, and agencies that manage these resources at the state and local level generally benefit recreation along the river because they promote conservation and are focused on safeguarding and enhancing wildlife and recreational resources for current and future users. In addition, land easements and agricultural technical and financial programs administered by NRCS support restoring or maintaining natural habitats, with potential benefits to fish and wildlife and associated recreational opportunities.

Variability in natural hydrologic conditions (precipitation and snowmelt, which include periods of drought and high runoff) and the “rules” governing System operation would continue to dominate the flows in the Missouri River into the future. Natural flow variability and the requirement to operate for all authorized purposes under the Master Manual would continue to be the primary drivers of impacts to recreation opportunities and access of the Missouri River. However, other actions, such as water depletions or withdrawals for agriculture, municipal, and industrial uses have and would continue to have adverse impacts to recreational access and opportunities, as they could affect the reservoir elevations and river stages.

Future aggradation and degradation trends would have similar effects under all of the alternatives. HEC-RAS modeling indicates that the action alternatives would not significantly contribute to aggradation or degradation (Section 3.2.2.4, Impacts on Hydrology). The elevations in the upper three reservoirs would increase slightly (1 to 2 feet) over the next 19 years. The change in stage in the riverine areas in the upper river over time relative to No Action would be nearly the same for all alternatives. The aggradation effect from sediment captured by the reservoirs would also be similar across all alternatives over the next 15 years. Past, present, and future actions that would affect bed degradation or aggradation of the Missouri River can impact the accessibility of recreational areas, including boat ramps, when water surface elevations and river stages increase or decrease, causing boat ramp and recreation areas to become inaccessible. It is possible that sediment deposition in the reservoirs may benefit recreational access during relatively drier conditions because reservoir elevations would increase slightly providing more access to boat ramps. In addition, any resulting changes in aggradation, degradation, and sediment deposition in the reservoirs would increase the need for investment in infrastructure (i.e., boat ramps or recreational access infrastructure) repairs and/or upgrades to mitigate these impacts.

Although recreational experiences supported by the river are cumulatively impacted by human actions, visitation is largely influenced by a number of other factors, including the health of the economy and the price of gasoline. Many recreational areas along the river are destination locations that attract hunters, anglers, boaters, and other outdoor enthusiasts from across the country. When gas prices are low and economic conditions are favorable, households have greater disposable income and are more likely to travel for recreational activities. As gas prices rise or households face greater economic uncertainty, recreationists often take trips closer to home. These factors can have mixed effects on visitation to reservoirs, where destination recreation increases during more prosperous periods and visitation by local residents increases during periods of high gas prices or economic downturns.

With the variable hydrology and precipitation within the System and its interaction with the past, present and foreseeable actions, cumulative impacts under No Action would be long-term, large, and beneficial, with recreation resources supporting diverse recreational activities and opportunities to visitors and residents, jobs and income in local economies, and quality of life and social connectedness for surrounding communities. However, over time, the cumulative actions, variability in hydrology, and geomorphic processes and trends (e.g., aggradation, degradation, reservoir sediment deposition) can have both adverse or beneficial impacts on recreation; adverse and beneficial impacts to recreation are influenced by natural cycles of dry and wet periods (including snowpack and precipitation), and lesser so, by the price of gas, the state of the national and regional economy, trends in outdoor recreation use, and other public land management, programs, and activities. The management actions under No Action would provide a small contribution to these cumulative impacts.

Alternatives 1 and 2 and the variations could reduce visitation, recreation NED benefits, and regional economic benefits at Fort Peck Lake in a few years when a flow release would occur or in the years following a release when fishing conditions are diminished. Although in most years, the contribution to cumulative impacts would be negligible or small and adverse at Fort Peck Lake, in some years, there could be a large contribution to cumulative adverse effects when fishing opportunities are affected by lower pool elevations. In other locations, implementation of Alternatives 1, 2, and the variations would have a negligible contribution to cumulative impacts because of the small change in river stages and reservoir elevations impacting recreational access in these areas.

3.10 Fish and Wildlife

3.10.1 Affected Environment

Over the past 150 years humans have altered the Missouri River from its natural form through channelization, impoundment from dams and levees, bank stabilization, dredging, disconnection of the river and floodplain, and modified geomorphology and hydrology, creating numerous changes to river and floodplain fish and wildlife habitat. During this timeframe, large portions of fish and wildlife habitat have been converted to agriculture, urban areas, and open water reservoirs. Despite these changes, the Missouri River continues to support a diverse assemblage of fish and wildlife including both native and non-native species.

3.10.1.1 River Habitat Types and Associations

River-floodplain connectivity and the related flooding and inundation of fish and wildlife habitats can influence the amount, quality, distribution, and variety of habitats available to fish and wildlife. Flows and channel geometry, or other physical components of the river can positively or negatively impact the availability of habitat. Low flows can increase habitat availability for terrestrial and aquatic species that use either exposed shoreline habitats or the shallows. High flows can create new habitat or condition other habitat for species to use the next year. Diverse river channel morphology and channel dimensions provide a variety of conditions in the river, such as varying depths and water velocities that support life processes for many species.

Open water habitats (i.e., main channel, secondary channels, chutes, open water sloughs, backwaters, oxbows, and pools) provide a diverse range of flows and depths that provide habitat for various assemblages including large river fish (e.g., sauger [*Sander canadensis*]) and macroinvertebrates (e.g., mayfly [*Pseudocloeon* spp.]), spawning and juvenile fish, shorebirds, turtles (e.g., snapping turtle [*Chelydra serpentina*]), migratory birds, and furbearers (e.g., muskrat [*Ondatra zibethicus*]). Habitat needs encompassed under the open water habitat class include fish spawning habitat; feeding and breeding habitat for migratory birds and furbearers; breeding, nesting, and foraging habitat for shorebirds; and habitat for macroinvertebrates consumed by aquatic and terrestrial species.

A variety of species, including avian species, forage in open water habitat along the river (Owen, 2014). Off-Channel habitats such as backwaters and side channels provide important nursery and feeding habitats for native fishes of the Missouri River. Some off-channel habitats, like abandoned channels and oxbow lakes, may be connected to the main river channel only during flooding. Other off-channel habitats like backwaters and side channels, remain connected to the main channel during base flows and serve as habitat for fish and other aquatic fauna throughout the year. These habitats are characterized by shallow, slow moving water with higher water temperatures than the main channel, and silt-dominated substrates (Sheaffer & Nickum, 1986). Backwaters and side channels provide important shallow water spawning and nursery habitats to the native fishes of the Missouri River downstream of Fort Peck Dam (Dryer & Sandovl, 1993). These habitats provide important benefits to aquatic ecosystems, refuge from predators, protection from high river discharge, and increased macroinvertebrate production and density compared to the main river channel. In addition, backwater habitats may have an abundance of woody debris that provides important foraging and spawning sites (Owen, 2014). A 2014 study found that off-channel habitats such as backwaters and side channels below Fort Peck dam had decreased in the period from 1956-2013, potentially reducing habitat for native fish in the Missouri River below Fort Peck Dam.

Emergent wetland habitat provides foraging, breeding, rearing, nesting, and shelter habitat for assemblages of species including intermittent/permanent pool species (e.g., northern leopard frog [*Rana pipiens*]), fish and amphibians that require emergent wetlands during spawning/nursery and breeding periods, and waterfowl that forage in emergent wetlands. Fringe wetlands and vegetated mudflats provide a link between the channel and backwaters and provide a refuge for young of the year fish as currents are slow and predators are less abundant.

The riparian woodland/forested wetland, scrub-shrub wetland, and forest habitats provide habitat directly and indirectly for assemblages of species that utilize woody debris either on the floodplain or woody debris that is washed into the river (e.g., channel catfish [*Ictalurus punctatus*], early successional woody habitat (e.g., prairie warbler [*Dendroica discolor*]), cavities for nesting (e.g., barred owl [*Strix varia*]), standing snags (e.g., herons and egrets [*Ardea* and *Egretta* spp.]), and berry, seed, fruit, and mast food sources (e.g., bur oak (*Quercus macrocarpa*]). The presence of woody debris in the river is an important habitat (e.g., cover, nursery habitat, basking areas) for the life history of many species and is used by many species on the floodplain for various life history requirements (e.g., shelter, laying eggs). The variable canopy structure and diversity of understory within these habitat classes provide a variety of different habitats and food sources specific to individuals and assemblages of species. These habitat classes provide nesting, denning, roosting, basking, breeding, shelter, and foraging habitat for many wildlife species.

Upland grassland habitat provides for the needs of assemblages including grazing and browsing species (e.g., deer [*Odocoileus* spp.]), grassland birds (e.g., long-billed curlew [*Numenius americanus*]), rodents, snakes (western hog-nosed snake [*Heterodon nasicus]*), and insects that require short, mid, and tall grass prairie habitats for breeding, nesting, and foraging.

3.10.1.2 Reservoir Habitats

Size, depth, thermal stratification, and water exchange rates vary among the reservoirs. The upper reservoirs, Fort Peck Lake, Lake Sakakawea, and Lake Oahe, are the largest and deepest. They have pronounced summer thermoclines and water exchange rates less than once per year. The reservoirs contain a diverse community of native and nonnative, cold-, cool- and warm-water fishes. The upper three reservoirs are stocked with nonnative, cold-water game and forage fish species to take advantage of the cold-water habitat that forms in these thermally stratified reservoirs. These species include chinook salmon, brown and rainbow trout, lake trout (Fort Peck Lake and Lake Oahe only), cisco (to provide forage for game fish in Fort Peck Lake), and rainbow smelt. Species in the warmer water of the upper reservoirs include native and nonnative riverine species that have adapted lacustrine conditions. Some of the most common of these species are walleye, northern pike, sauger, goldeye, carp, shovelnose sturgeon, river carpsucker, white and black crappie, gizzard shad, and emerald shiner. In addition to game and forage species there are also native river species including pallid sturgeon, paddlefish, sicklefin chub, sturgeon chub, and blue suckers. The availability of spawning and juvenile rearing habitat limits the natural reproduction of native and non-native fishes. The availability of spawning and juvenile rearing habitat limits the natural reproduction of native and nonnative fishes. The cold-water species generally lack spawning habitat, and thus are primarily supported by hatcheries. An exception is the lake trout of Fort Peck, which spawn in the rock riprap along the dam face. Most of the warm- and cool-water reservoir species spawn in shallow habitats of the reservoir margins, in the river above the reservoir, or in tributary streams. Walleye, and to a lesser degree, sauger require clean rock in shallow water to spawn, and northern pike typically spawn in submerged vegetation as do some important forage species. White bass, sturgeon, blue suckers, some walleye and sauger, and paddlefish spawn in in the river above the reservoirs. Existing Habitat Conditions

The fish and wildlife habitat analysis focuses on the Missouri River between Fort Peck Lake and Garrison Dam as there is little change in river stage or flow that would likely be of consequence to fish and wildlife below Garrison Dam in each of the test flow years that were examined. The discussion of fish and wildlife habitat is organized into the following reaches:

- Fort Peck Lake
- Missouri River from Fort Peck Dam to Headwaters of Lake Sakakawea
- Lake Sakakawea

Fort Peck Lake

The native vegetation around the Fort Peck project consists primarily of short grasses, pine, juniper, and sagebrush. Most of the immediate vicinity of the lake is occupied by plant communities whose extent is controlled more by local characteristics of topography and soils than by the regional climate. In general, trees flourish in areas protected ravines and tributary valley where moisture is more available. The short-grass prairie community around the project area is intermixed with sagebrush and has occasional intermittent streams traversing the landscape. In the areas where grassland predominates, the key species are perennial grasses such as bluebunch wheatgrass (*Pseudorroegneria spicata*), western wheatgrass (*Pasopyrum smithii*), and green needlegrass (*Nassella viridula*). During periods of low water, barren beaches fringe most of the lake.

Wetland vegetation becomes established in isolated areas that provide protection from waves. Species include willows, cottonwoods, and cattails. Reservoir deltas have formed at the upstream end of each of the six mainstem reservoirs where water velocity decreases and suspended particulates settle. Deltas of the upper three reservoirs, Fort Peck Lake, Lake Sakakawea, and Lake Oahe, are extensive (USACE, 1994). The majority of palustrine wetland acreage in the Fort Peck Lake delta consists of seasonally flooded palustrine scrub shrub and temporarily flood palustrine emergent wetlands. Delta wetlands generally expand during drought periods, colonizing sediments exposed by receding water levels. Missouri River deltas typically support fewer palustrine wetland types than riverine reaches primarily because fluctuating water levels preclude the establishment of trees and species that re intolerant of long periods of inundation. Reservoir shorelines are highly erodible because the river valley slopes are terraced and the soils are comprised of erodible sands, silts, clays, gravels, and shales (USACE, 2006a).

Fort Peck Reservoir is managed as a recreational fishery resource and common sport fish include northern pike, walleye, lake trout, smallmouth bass, Chinook salmon, burbot, paddlefish, and channel catfish. Fisheries management includes stocking operations from State and Federal hatcheries (USACE 2006a). Cisco (lake herring) are well established in Fort Peck Lake and provide the main forage for many game species.

Missouri River between Fort Peck Dam and Lake Sakakawea

The Missouri River area between Fort Peck Dam and the Yellowstone River confluence consists of badlands, breaks, coulees, and gently rolling hills. The section of the river from the dam to the town of Wolf Point is uncharacteristically cool and clear, as water discharged from the bottom of the reservoir is devoid of sediment and very cold. Along with many native fish species, this area is occupied by non-native trout species. Even with flows from the Milk River, this section does not return to warmwater habitat until it reaches the town of Wolfpoint, approximately 70 river miles downstream. From here to the North Dakota border the Missouri remains warm, with warmwater tributaries like the Poplar River, Red Water River, and Big Muddy Creek. The adjacent land along the Lower Missouri is primarily cottonwood-willow bottomlands and irrigated cropland. As with the area immediately below Fort Peck Dam, this area supports paddlefish, pallid sturgeon, shovelnose sturgeon, sauger, goldeye, and blue sucker, along with many other native species (MTFWP, 2005)

Although river flows are regulated in the 192 mile long reach between Fort Peck Dam and the headwaters of Lake Sakakawea, the reach remains in a semi-natural state partly because of the influence of unregulated tributaries such as the Milk and Yellowstone Rivers (Gardner and Stewart 1987). The Milk River enters the Missouri River 10 miles below Fort Peck Dam. The Yellowstone River flows into the Missouri River about 5 miles upstream of the headwaters of Lake Sakakawea. Off-channel riverine features are abundant in this reach except in the 10-mile area below Fort Peck Dam where the banks are eroded and the streambed is degraded because of the low sediment load in the river. The river below Fort Peck Dam is cold and clear and has little cover (Gardner & Stewart, 1987). The low sediment load in this section contributes to erosion of the streambed and is responsible for the gravel substrate throughout the area. In the tailrace area, a 2-mile long side channel developed during dam construction provides spawning and rearing habitat for rainbow trout; two dredge cuts in the same area provide 860 acres of lake-type habitat (Bragg & Tatschi, 1977).

As the river progresses downstream from Fort Peck, it gradually changes in character. Ten miles below Fort Peck Dam, the Milk River contributes warm turbid water, which partially restores natural characteristics (Bragg & Tatschi, 1977). The 40-mile section downstream of the Milk River continues to have numerous gravelly riffle areas. Farther downstream, the poplar and Redwater Rivers contribute additional sediment and warm water, causing the River to take on a more natural character with a sandy-silty bottom and warmer, muddier water (Bragg & Tetschi, 1977; Gerdner & Stewart, 1987). In the lower 140 miles of the reach, sand bars are common, and a few old oxbow channels remain (Gardner & Stewart, 1987).

The tailwater area of the reach has high recreational use because of good access and quality sauger, walleye and rainbow trout fishery (Bragg & Tatschi, 1977). Other popular game species in the area include shovelnose sturgeon, northern pike, channel catfish, burbot, chinook salmon, lake trout, and lake whitefish (Gardner & Stewart, 1987).

Montana has some of the largest paddlefish populations left in the Missouri River (Gardner & Stewart, 1987). Paddlefish move out of Lake Sakakawea upriver in late April through June in response to rising water levels. They stage near the confluence of the Missouri and Yellowstone Rivers until temperatures, photoperiods, flows, and turbidity rise, and then they mover farther upstream to spawn. Most of these paddlefish spawn in the Yellowstone River although some also spawn in the Milk River and the main channel Missouri River (USACE, 2004). Shovelnose sturgeon, channel catfish, sauger, and walleye also mover between Lake Sakakawea and the Yellowstone River (Gardner & Stewart, 1987). Sauger spawn in the lower end of the reach in the Milk River and at the confluence of the Milk and Missouri Rivers. Young sauger rear in off-channel pools, primarily in the lower end of this reach.

Lake Sakakawea

The Lake Sakakawea project contains a variety of habitat types, including woodlands, grasslands, open fields, shorelines, and wetlands. The land area surrounding the lake includes woody draws and upland grasslands on the east side of the reservoir transitioning into rolling grasslands towards the west. Prior to the filling of the reservoir, the Missouri River flood plain was covered by large stands native vegetation around the Lake. Most of the area in the vicinity of the Garrison Dam/Lake Sakakawea project is devoted to farming or ranching. Because of the proximity of the lake, a number of small housing subdivisions with a large proportion of seasonal residents have developed adjacent to project lands.

The vegetation around the lake varies by area; however, the regional vegetation association is classified as Wheatgrass-Needlegrass, or Mixed-grass Prairie. Lowland grasslands typically occur where there is generally low, level to rolling terrain with minimum erosion down to the lakeshore. Slopes are normally gentle, and extensive subirrigated areas are evident. Major species include prairie cordgrass (*Spartina alterniflora*), long-rooted smartweed (*Polygonum lapathifolium*), wild barley (*Hordeum spontaneum*), salt meadowgrass (*Leptochloa fusca*), quackgrass (*Elytrigia repens*), lady's thumb (*Polygonum persicaria*), giant reedgrass (*Phragmites australis*), big bluestem and several species of dock (*Rumex spp.*) (USACE, 1978). Lacustrine fringe wetlands are located along some wave and wind protected Lake Sakakawea lakeshores and back bays. Here, the water elevation of the lake determines the water table of the adjacent wetland area.

The majority of the Lake Sakakawea delta is palustrine wetland (dominated by grasses and reeds) with scrub shrub wetlands about one-third of the acreage followed by palustrine emergent, seasonally flooded type. Dense stands of sandbar willow colonize mudflats exposed by lower water.

Lake Sakakawea is managed primarily for walleye, sauger, and chinook salmon, and northern pike and smallmouth bass. The walleye fishery is the most popular fishery in Lake Sakakawea and is renowned as one of the foremost trophy-sized walleye fisheries in North America. Rainbow smelt are well established in Lake Sakakawea and are the primary forage for walleye, chinook salmon, and other game fish species. Smelt in the upper reservoir spawn in flowing water of the river and the tributaries. In the lower reservoir, the smelt populations spawn along the reservoir shoreline.

3.10.1.3 Invasive Species

In the Missouri River basin, a number of invasive plant and animal species have encroached upon the native habitat of the Missouri River and its floodplain.

Major invasive aquatic plants in the Missouri River mainstem in the study area include curlyleaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*). Major invasive terrestrial plants in the Missouri River floodplain include saltcedar (*Tamarix* spp.), Canada thistle (*Cirsium arvense*), knapweeds (*Centaurea* spp.), and leafy spurge (*Euphorbia esula*). Invasive plants in emergent wetlands include purple loosestrife (*Lythrum salicaria*) and flowering rush (*Butomus umbellatus*).

Major invasive animals and fish in the Missouri River mainstem include Asian carp, common carp (*Cyprinus carpio*), rusty crawfish (*Orconectes rusticus*), New Zealand mudsnail (*Potamopyrgus antipodarum*), and zebra mussels (*Dreissena polymorpha*). Asian carp are various species of carp in the family Cyprinidae. Bighead carp (*Hypophthalmichthys nobilis*), black carp (*Mylopharyngodon piceus*), grass carp (*Ctenopharyngodon idella*), and silver carp (*Hypophthalmichthys molitrix*) are the main species of Asian carp that inhabit the Missouri River as invasive species (Galat et al., 2005). Common carp are also a main invasive species. Asian carp are planktivorous and may compete with native planktivores for food, particularly considering that Asian carp are highly efficient feeders (Nico & Fuller, 2010). Native species oc conerninclude paddlefish (*Polydon spathula*), bigmouth buffalo (*Ictiobus cyprinellus*), and gizzard shad (*Dorosoma pretenense*), as well as several others (Nico & Fuller, 2010).

3.10.1.4 Special Status Species

Least Tern and Piping Plover

The piping plover was listed as threatened outside of the Great Lakes watershed on December 11, 1985, under provisions of the ESA (USFWS, 1985). Critical habitat was designated on the Northern Great Plains breeding grounds on September 11, 2002 (USFWS, 2015). The breeding population of the Northern Great Plains piping plover extends from Nebraska north along the Missouri River through South Dakota, North Dakota, and eastern Montana, and on alkaline lakes along the Missouri River Coteau (a large plateau extending north and east of the Missouri River) in North Dakota, Montana, and extending into Canada. Interior least terns were listed as endangered under the ESA in 1985 (USFWS, 2013). The breeding population of least terns extended across the interior of the United States along the Mississippi, Missouri, and Rio Grande Rivers and their tributaries. In 2013, the USFWS concluded that the interior least tern is biologically recovered. Prior to formal delisting the USFWS is conducting a delisting process including preparing a range-wide monitoring strategy and plan. Although delisted from the ESA, the interior least tern will continue to be protected under the Migratory Bird Treaty Act (MBTA) and Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds). The ESA also requires the FWS and partners to monitor the status of least terns (post-delisting monitoring plan) to ensure that populations remain stable.

While the geographic scope of the MRRP includes the Missouri River within the meander belt from Fort Peck Dam, Montana to the confluence with the Mississippi River in St. Louis, Missouri, the USFWS recommends that tern and plover management "prioritizes creation and maintenance of habitat within the unchannelized river below Garrison, Fort Randall and Gavins Point Dams (USFWS, 2018) The habitats addressed by the MRRP are divided into three riverine segments, the shorelines of two reservoirs, and the delta of another reservoir, extending from Lake Sakakawea in North Dakota to river mile 754 near Ponca, Nebraska (Figure 3-38). These segments are grouped into the Northern Region (Lake Sakakawea, Garrison, Lake Oahe) and the Southern Region (Fort Randall, Lewis and Clark Lake, and Gavins Point) (Table 3-191). Piping plovers using the Missouri River habitats are a sub-population or demographic unit of the larger Northern Great Plains (NGP) piping plover metapopulation. Use of the term "population" in AMCR and these appendices is in reference to the birds using habitats within the MRRP geographic scope unless otherwise noted.

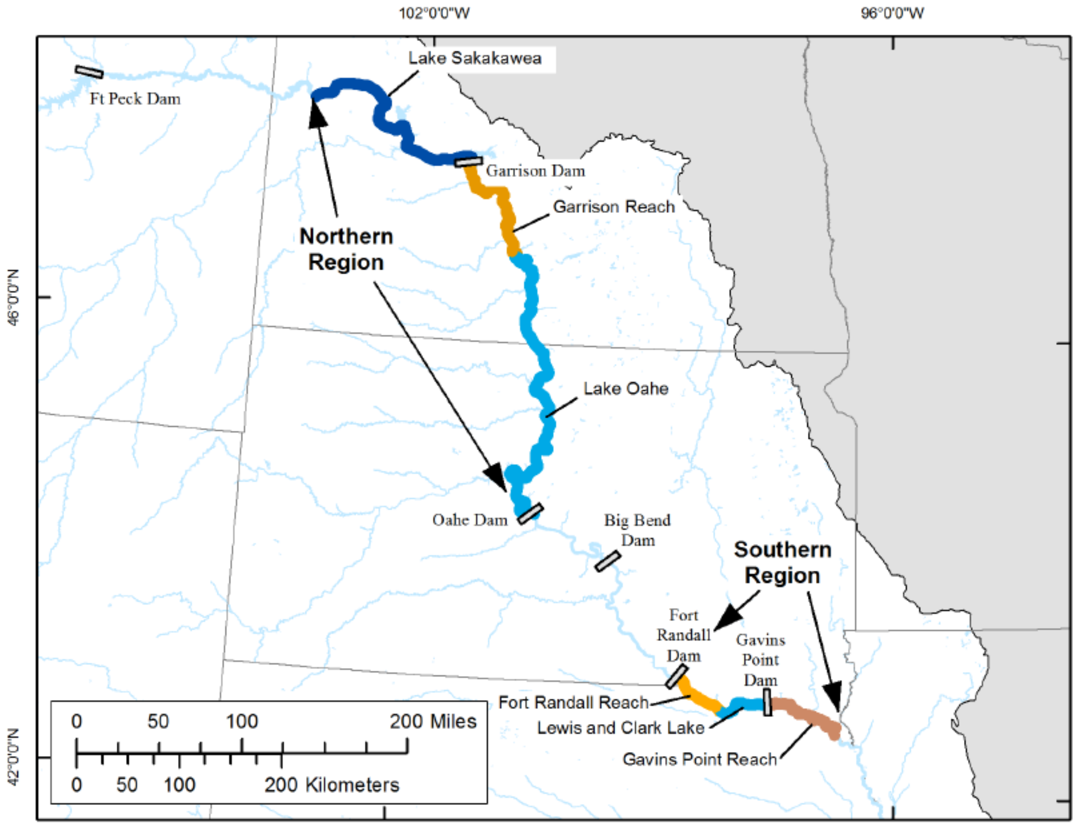

Figure 3-38. Piping Plover and Least Tern Management Areas

Annual adult tern and plover surveys are conducted in the Northern region in June on all segments although Fort Peck Reservoir and Fort Peck riverine segments are excluded from productivity monitoring because the habitat, and use by nesting birds are very limited.

Table 3-191. UMR bird habitat segments and types

Segment	Habitat Type	River Miles (RM)	Length (RM)
Lake Sakakawea	Reservoir shoreline	1568-1389.9	178.1
Garrison	Emergent Sandbars	1389.9-1304	85.9
Lake Oahe	Reservoir Shoreline	1304-1072.3	231.7

Adult plover numbers from 1993-2018 in these segments are provided in Figure 3-39. Adult least tern numbers in these segments from 1993-2018 are provided in Figure 3-40.

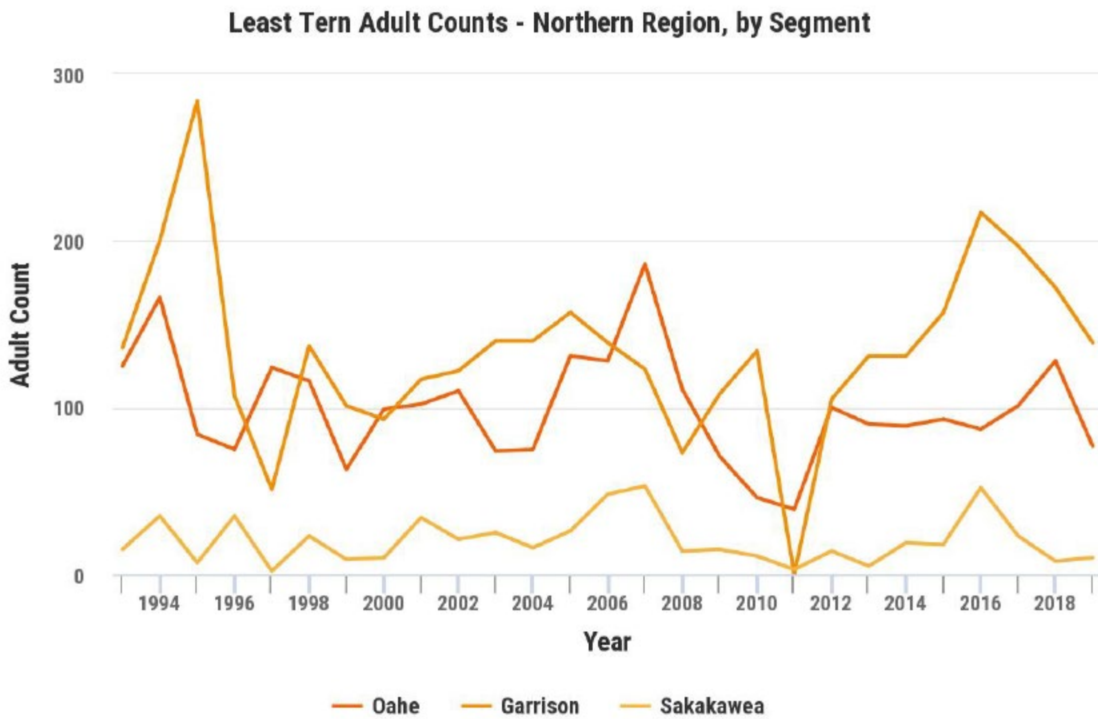

Figure 3-39. Least tern adult counts – northern region by segment

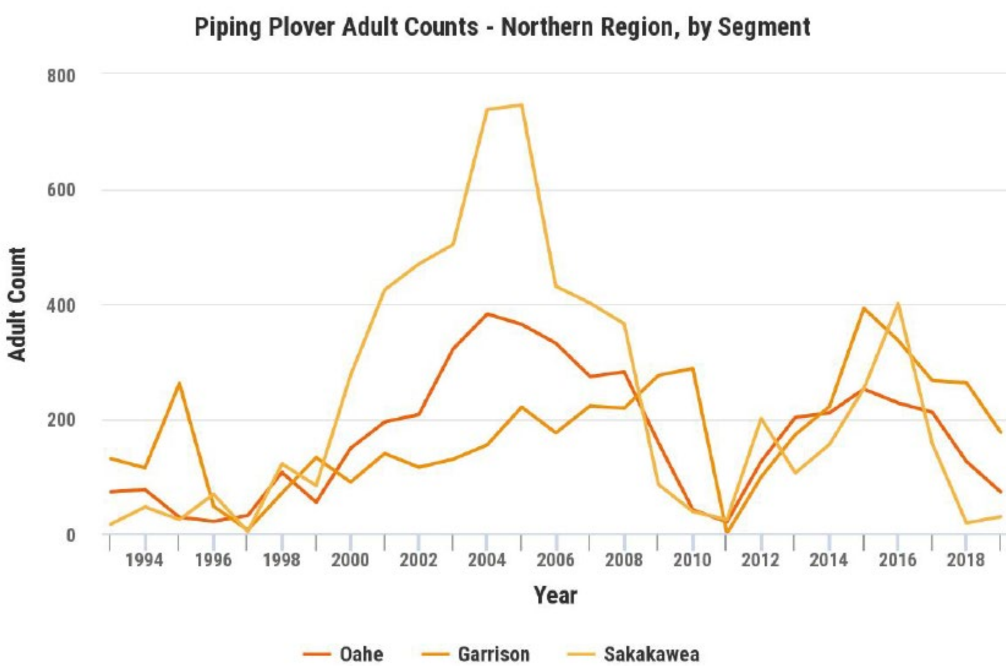

Figure 3-40. Plover tern adult counts – northern region by segment

The following bird objectives and metrics were defined by the USFWS (USFWS, 2018). The objectives consist of a fundamental objective and four sub-objectives. In some cases, means objectives have been specified to provide measurable performance metrics. Quantitative performance metrics, targets, and time-frames have been specified for each sub-objective. Other than the fundamental objective, all objectives and targets apply only apply to piping plovers. USFWS determined that by meeting plover objectives tern objectives would also be met.

Fundamental Objective: Avoid jeopardizing the continued existence of piping plovers and least terns due to the USACE actions on the Missouri River

Sub-objective 1 (Distribution): Maintain a geographic distribution of plovers in the river and reservoirs in which they currently occur in both the Northern Region (Missouri River from Fort Peck Lake, to Fort Randall Dam, including reservoir shorelines) and Southern Region (Missouri River from Fort Randall to Ponca, Nebraska. Means Objective: Meet sub-objectives 2, 3, and 4 in both the Northern and southern regions.

Sub-objective 2 (Population): Maintain a population of Missouri River ripping plovers with a modeled 95% probability that at least 50 individuals will persist for at least 50 years in both the Northern and Southern Regions. Means objective (ESH): Provide sufficient ESH on the Missouri River to meet the persistence target.

Metric: Number of standardized and available ESH acres estimated annually.

Target acreage distributions for standardized and available ESH acres for the Northern regions (Table 3-192). Available targets are presented as values that must be exceeded for the specified percentage of years. Performance metrics are focused on the median values; the 95% confidence interval is also provided to support management planning.

Table 3-192. Bird habitat standardized and available ESH targets by region

		Acres of ESH					
		Northern Region			Southern Region		
		2.5%ile	**Median**	97.5%ile	2.5%ile	**Median**	97.5%ile
Standardized ESH Acres		190	**450**	2160	330	**1180**	4720
Available ESH Acres Exceeded for Percentage of Years	75%	170	**270**	555	300	**430**	720
	50%	420	**680**	1295	500	**740**	1550
	25%	960	**1920**	2670	750	**1410**	3075
	10%	1965	**3000**	5165	1125	**2240**	4945

Timeframe: Median standardized ESH targets must be met for three out of four years. Median available acres must be met or exceeded for the specified percentage of years over a running 12 year interval.

Other Special-Status Species

In addition to the pallid sturgeon, least tern, and piping plover, other special status species that may be present within the geographic scope of potential effects have been identified. These include other federally listed species and other special status species. Although delisted from the ESA, the interior least tern will continue to be protected under the Migratory Bird Treaty Act (MBTA) and Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds). The ESA also requires the FWS and partners to monitor the status of least terns (post-delisting monitoring plan) to ensure that populations remain stable.

At total of 69 additional species that may occur in the area have been given a special status designation at the federal or state level. These species include 6 plants, 22 birds, 6 mammals, 6 reptiles and amphibians, 16 fish, 9 mussels and gastropods, and 4 insects (Appendix I: Other Special Status Species). Four species listed in Appendix I are ESA-listed. The bald eagle and golden eagle are not listed under the ESA, but are protected at the federal level under the Bald and Golden Eagle Protection Act (BGEPA). Many of the migratory bird species are protected at the federal level under the Migratory Bird Treaty Act (MBTA). All other species in Appendix E are listed in one or more of the states within the area.

The special-status species lists for Montana and North Dakota were examined to determine the state-listed species that are known to occur or may occur within the area potentially affected by test flows. It is not anticipated that species downstream of Garrison Dam would be impacted by test flows given the small difference in flows compared to the No Action Alternative below Garrison Dam. County-level data were used where available. The criteria for identifying species and how these species are organized vary from state to state. These species are listed in Appendix E along with a description of how each state identifies their respective special status species.

The Fort Peck EIS considers and assesses the potential impacts to all special-status species that may occur within the geographic scope of the MRRMP-EIS. Species were evaluated to determine if they would be analyzed in detail. An analysis of those species is provided in Appendix I. In this appendix, the potential impacts to each special stats species are listed.

3.10.1.5 Tribal Resources

Many of the plant and animal species associated with the habitat types described above (including special status species) are of great importance to Tribes. The importance of these species varies but includes use in ceremonies, medicines, and subsistence. Species include cottonwood trees, sage, chokecherries, willow trees, and others. Hunting and fishing were common practices by Tribes and still continue to a lesser degree.

3.10.2 Environmental Consequences

This section considers the actions included under each alternative and their impacts to fish and wildlife habitats. This section also includes the methodology for analyzing impacts on fish and wildlife and the results of the analysis.

3.10.2.1 Impacts Assessment Methodology

Impacts to fish and wildlife were analyzed based on potential changes in aquatic and terrestrial habitat under each alternative compared to habitat conditions under the No Action Alternative. River stage information at four gage locations along with inundation mapping were used to evaluate potential changes in fish and wildlife habitat that could occur from a test flow release from Fort Peck Dam.

The fish and wildlife species that depend on aquatic and terrestrial habitats are evaluated based on assemblages or groups of species associated with the individual or multiple aquatic and terrestrial habitat classes, and wetland classes. Impacts from invasive species are assessed based on the potential for their introduction or spread from any of the management actions. Impacts to least terns and piping plovers were modeled quantitatively.

The No Action Alternative is considered the baseline against which the other alternatives are measured. Under the No Action Alternative, the Missouri River Recovery Program would continue to be implemented as it is currently and no test release from Fort Peck Dam would occur. As noted in Section 3.1.1, Impact Assessment Methodology, the No Action Alternative does not reflect actual past or future conditions but serve as a reasonable basis or “baseline” for comparing the impacts of the action alternatives on resources.

Table 3-193 summarizes the impacts of each alternative to fish and wildlife.

Table 3-193. Summary of fish and wildlife effects

Alternative	Impacts to Riverine Aquatic and Terrestrial Habitat
No Action Alternative	Negligible change to riverine aquatic and terrestrial habitat from the existing conditions as described in the Affected Environment.

Alternative	Impacts to Riverine Aquatic and Terrestrial Habitat
Alternative 1 and variations	Overall, there would be temporary large benefits to the riverine ecosystem between Fort Peck Dam and the Lake Sakakawea headwaters compared to the No Action Alternative from increased floodplain and side channel connectivity. Variation 1A would have less of a benefit than other Alternative 1 flows due to lower magnitude and duration of floodplain and side-channel connectivity. The benefits are considered to be temporary rather than long-term because the test flows would occur approximately 3-5 times. There would be temporary small adverse and beneficial impacts to reservoir shoreline terrestrial habitats and fisheries during test flow years depending on location and species
Alternative 2 and variations	Overall, there would be temporary large benefits to the riverine ecosystem between Fort Peck Dam and the Lake Sakakawea headwaters compared to the No Action Alternative from increased floodplain and side channel connectivity. The benefits are considered to be temporary rather than long-term because the test flows would occur approximately 3-5 times. There would be temporary small adverse and beneficial impacts to reservoir terrestrial habitats and fisheries during test flow years depending on location and species

Figures 3-41 through 3-50 show the flow and stage at five different gage stations between Fort Peck Lake and Garrison Dam: Fort Peck, Wolf Point, Culbertson, Williston, and Garrison. Figures 3-51 through 3-58 show modeled inundation near the same locations for Fort Peck releases of 9kcfs, 20kcfs, and 30kcfs to provide a visualization of floodplain connectivity and side channel connectivity in the reach between Fort Peck Dam and Williston during a test flow release year.

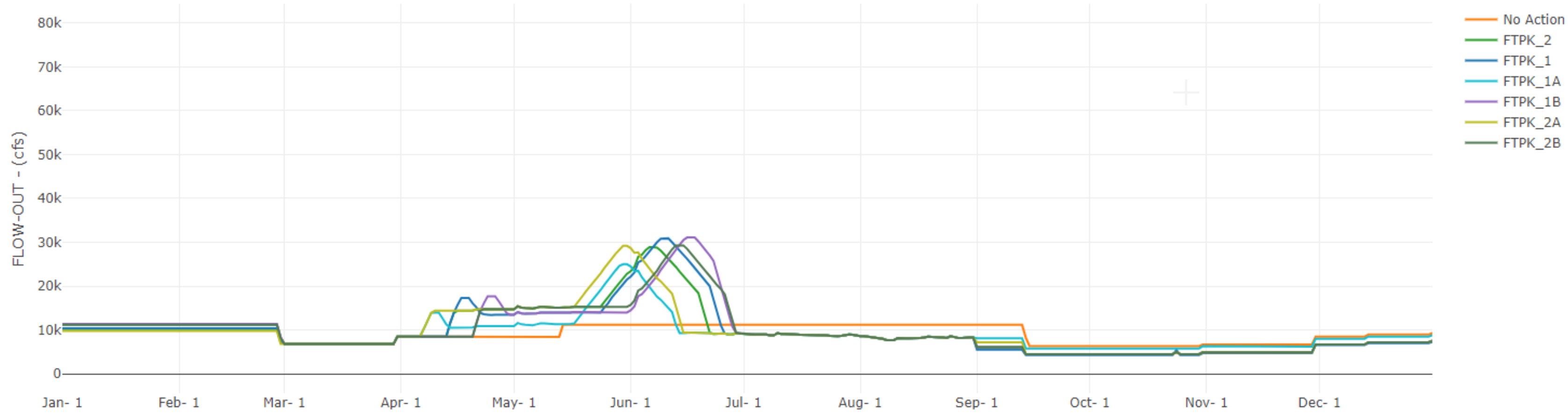

Figure 3-41. Fort Peck Dam releases during test flow year

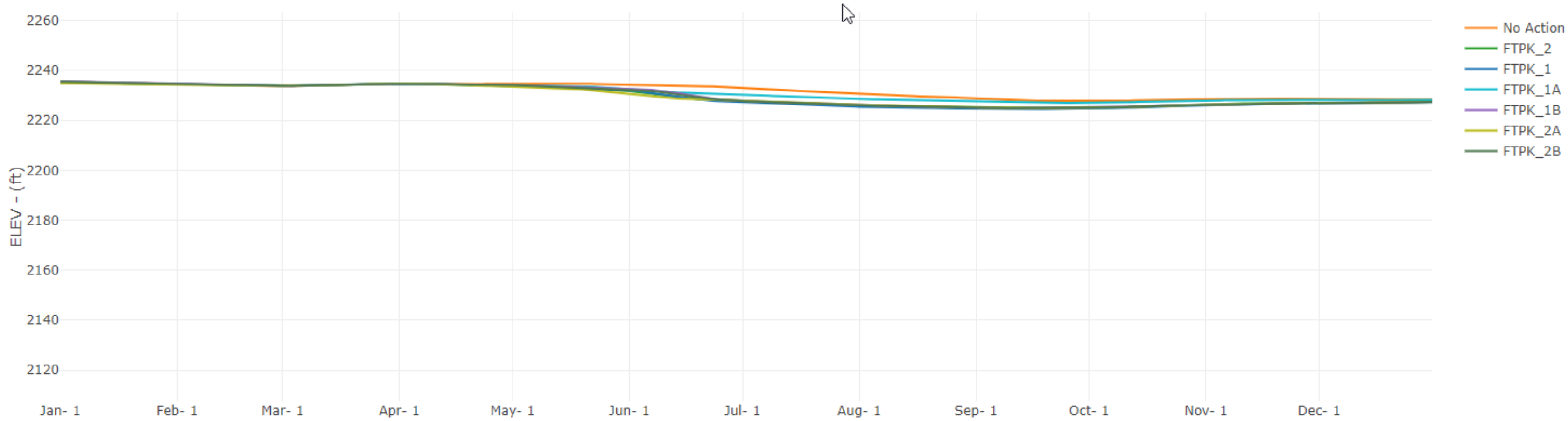

Figure 3-42. Fort Peck Lake elevations during test flow year

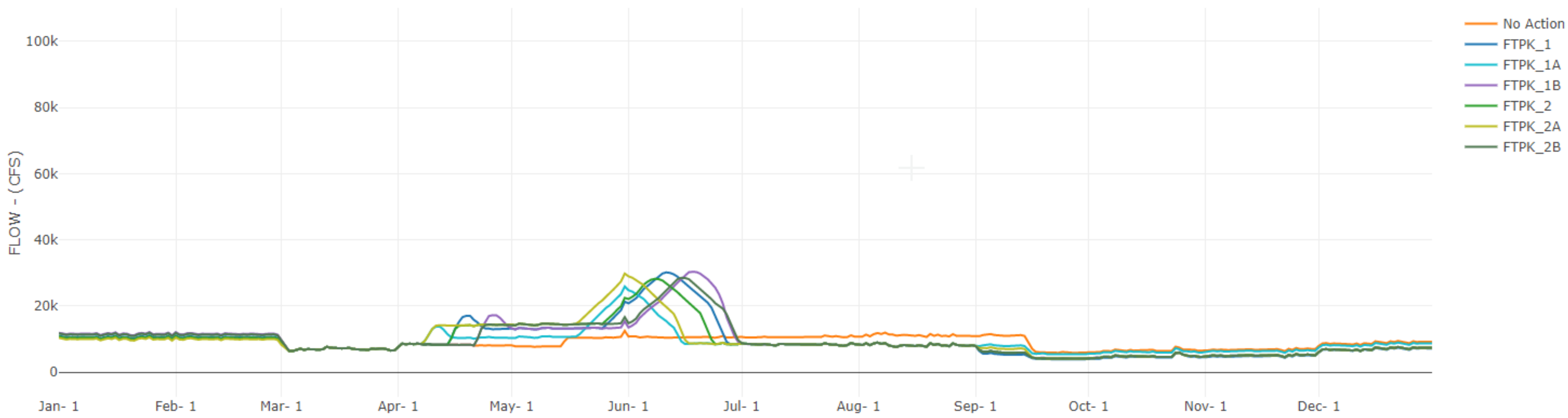

Figure 3-43. Wolf Point gage flows during test flow year

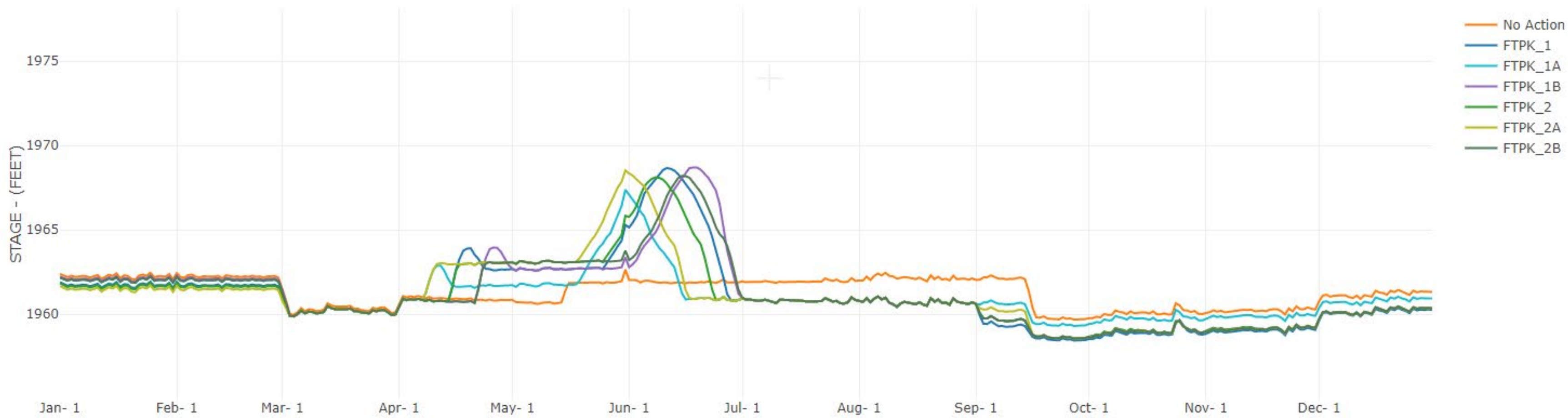

Figure 3-44. Wolf Point gage stage during test flow year

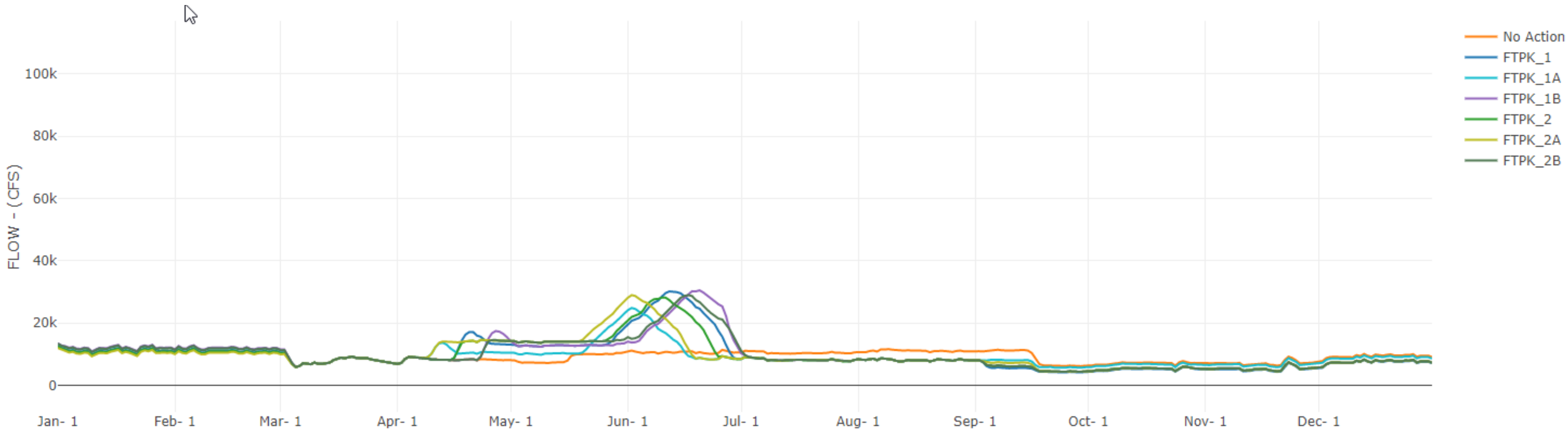

Figure 3-45. Culbertson gage flows during test flow year

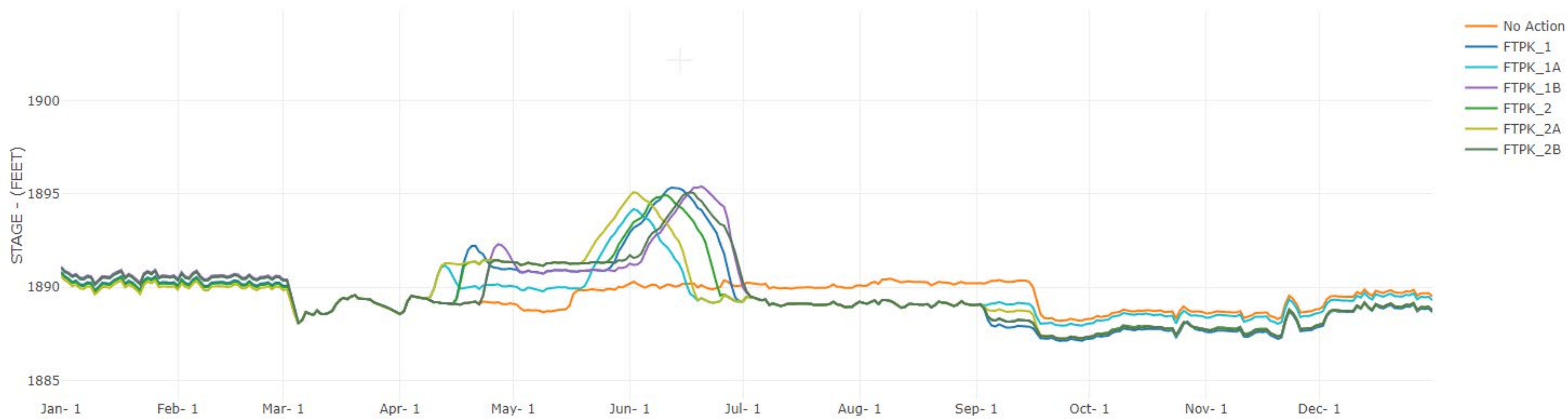

Figure 3-46. Culbertson gage stages during test flow year

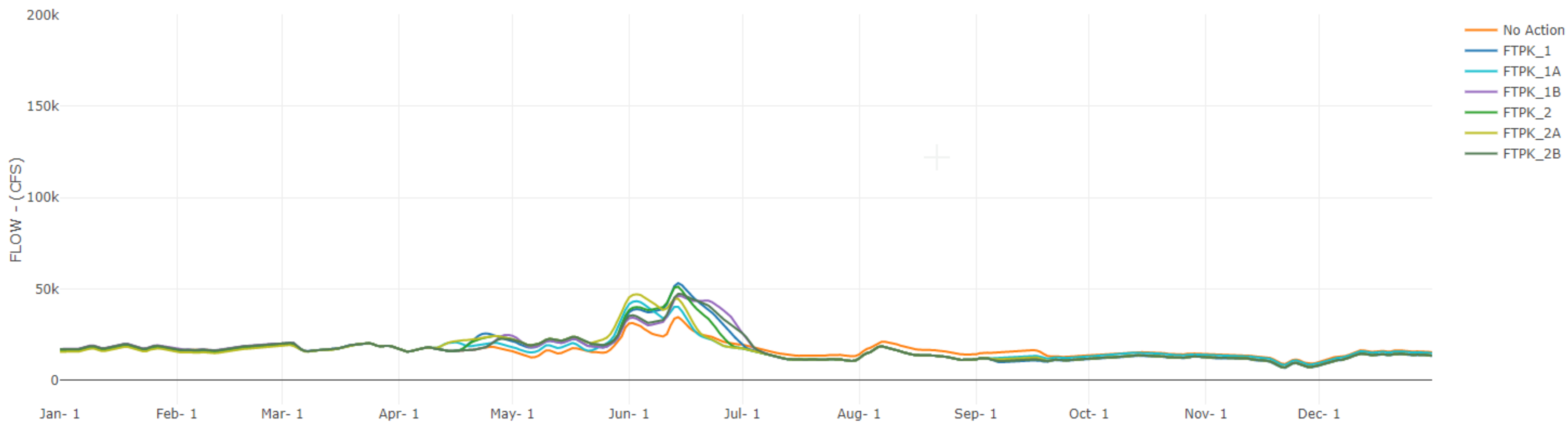

Figure 3-47. Williston gage flows during test flow year

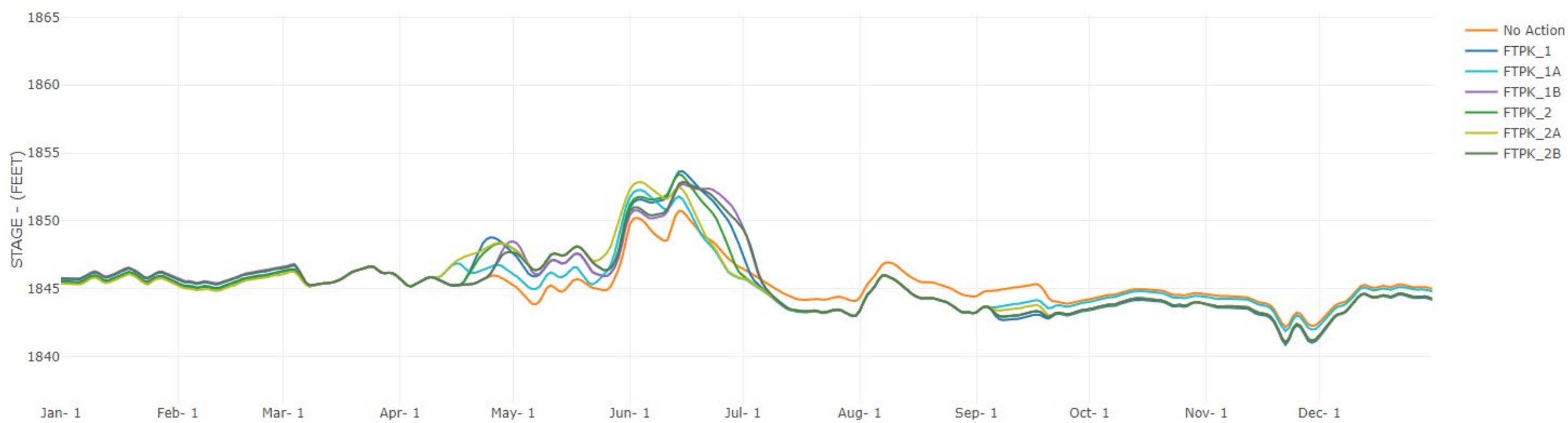

Figure 3-48. Williston gage stages during test flow years

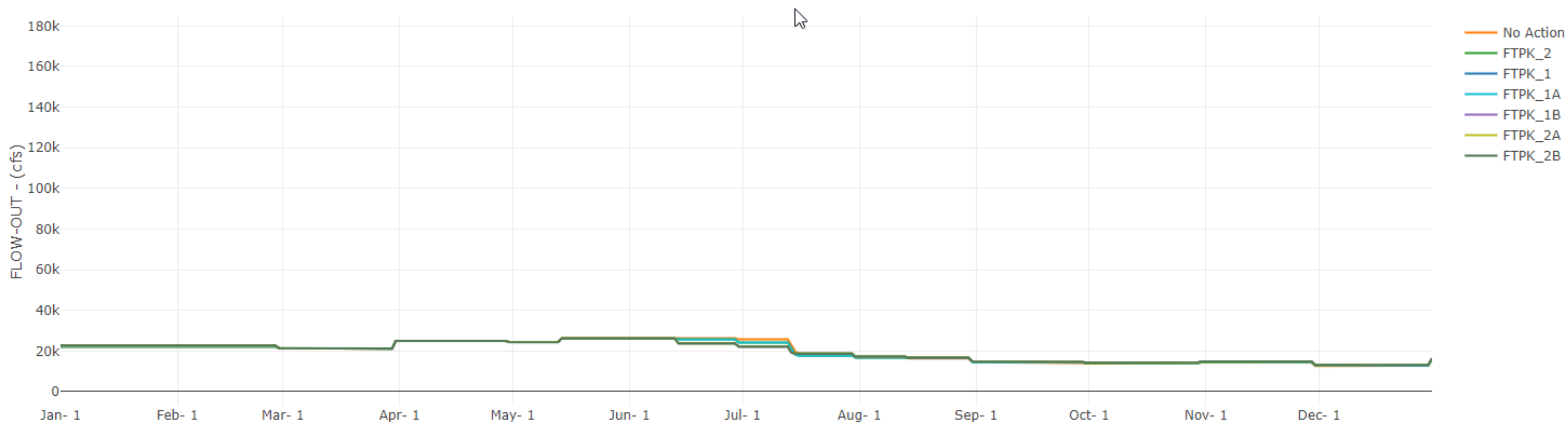

Figure 3-49. Garrison Dam releases during test flow year

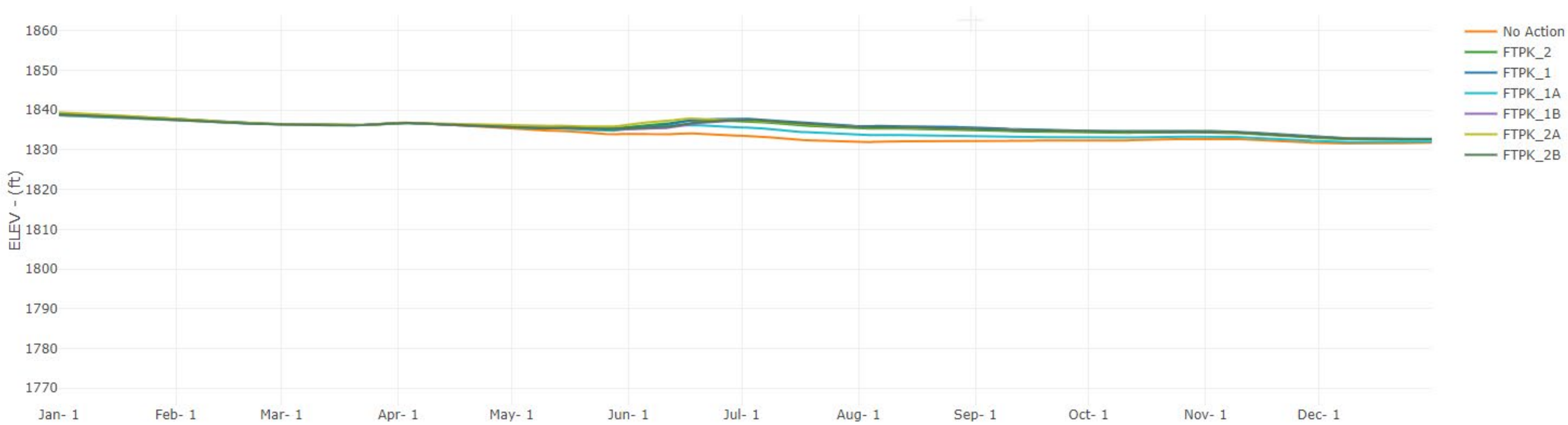

Figure 3-50. Lake Sakakawea elevations during test flow year

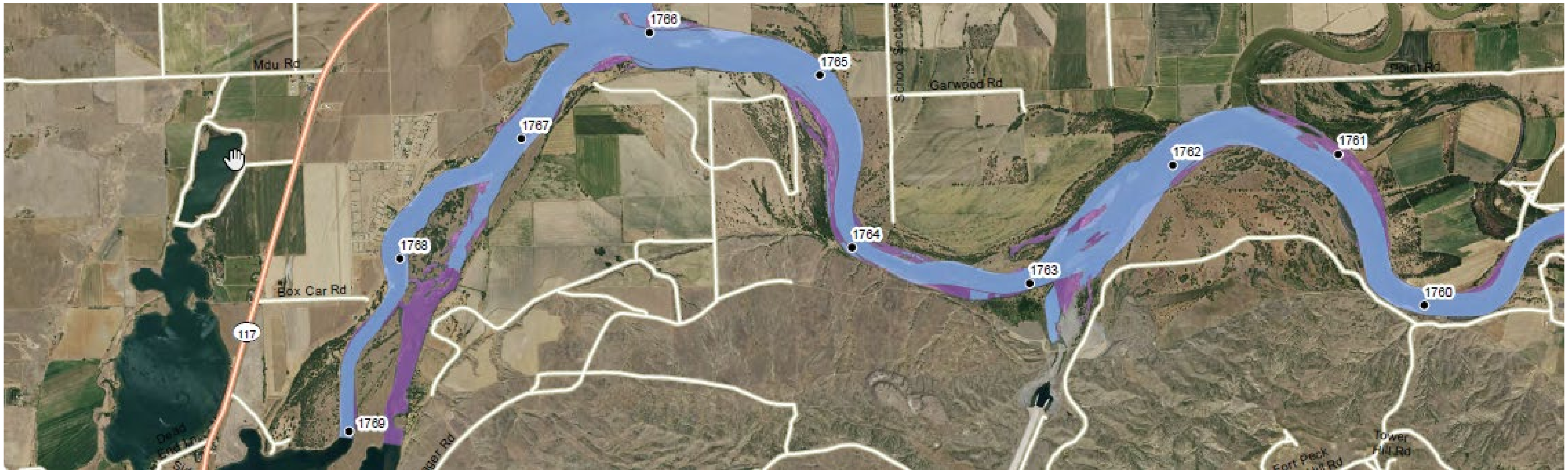

Figure 3-51. Area below Fort Peck Dam inundated at 9kcfs (blue) and 20kcfs (purple) releases from Fort Peck Dam

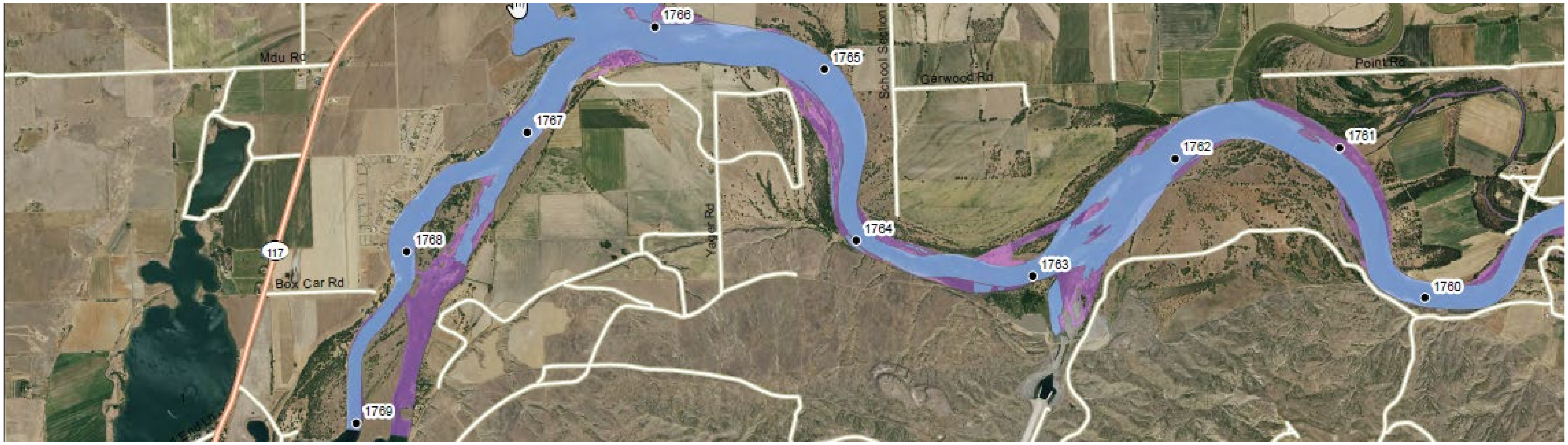

Figure 3-52. Area below Fort Peck Dam inundated at 9kcfs (blue) and 30kcfs (purple) releases from Fort Peck Dam

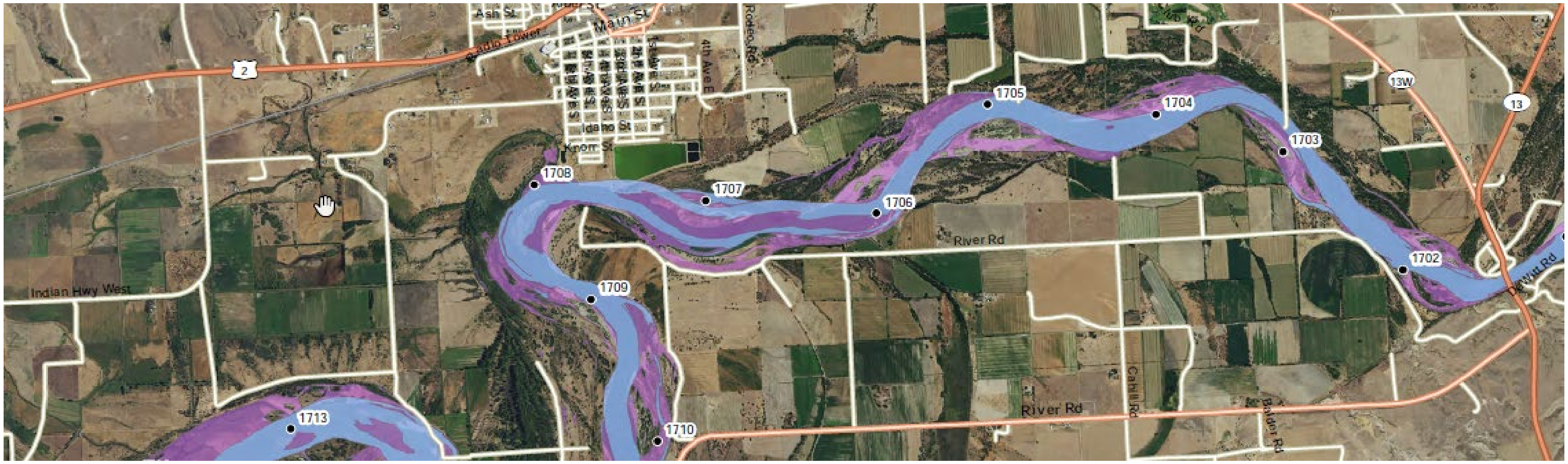

Figure 3-53. Area near Wolf Point inundated at 9kcfs (blue) and 30kcfs (purple) releases from Fort Peck Dam

Figure 3-54. Area near Wolf Point Inundated at 9kcfs (blue) and 20kcfs (purple) releases from Fort Peck Dam

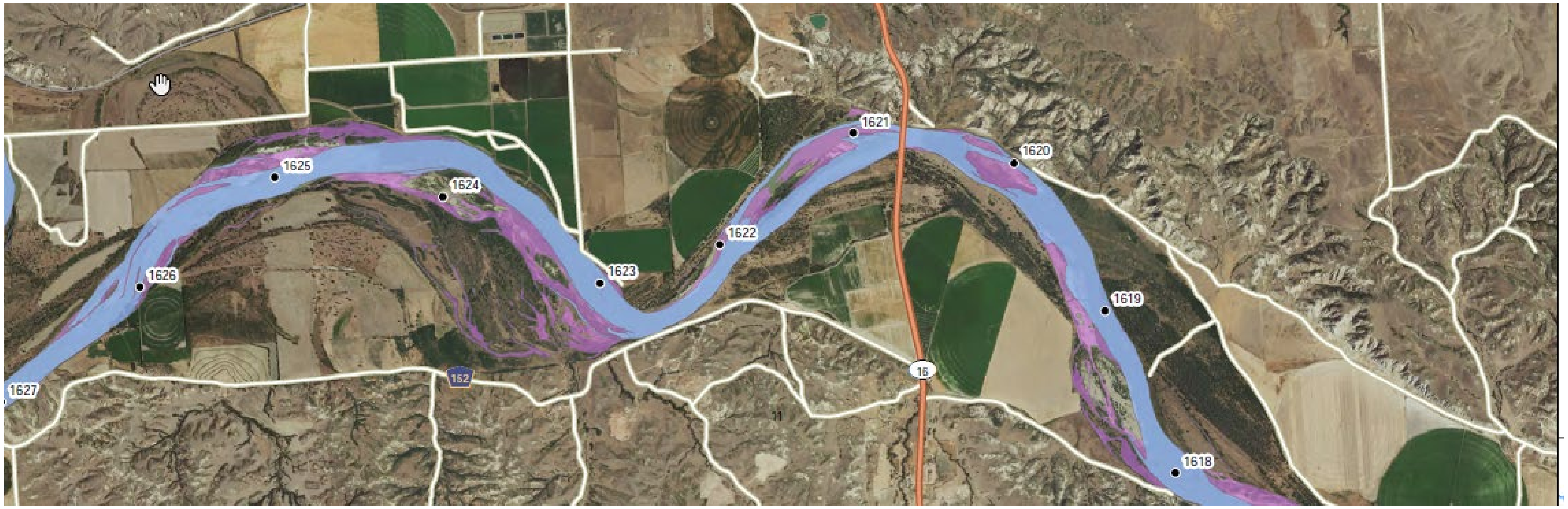

Figure 3-55. Area near Culbertson inundated at 9kcfs (blue) and 30kcfs (purple) releases from Fort Peck Dam

Figure 3-56. Area near Culbertson inundated at 9kcfs (blue) and 20kcfs (purple) releases from Fort Peck Dam

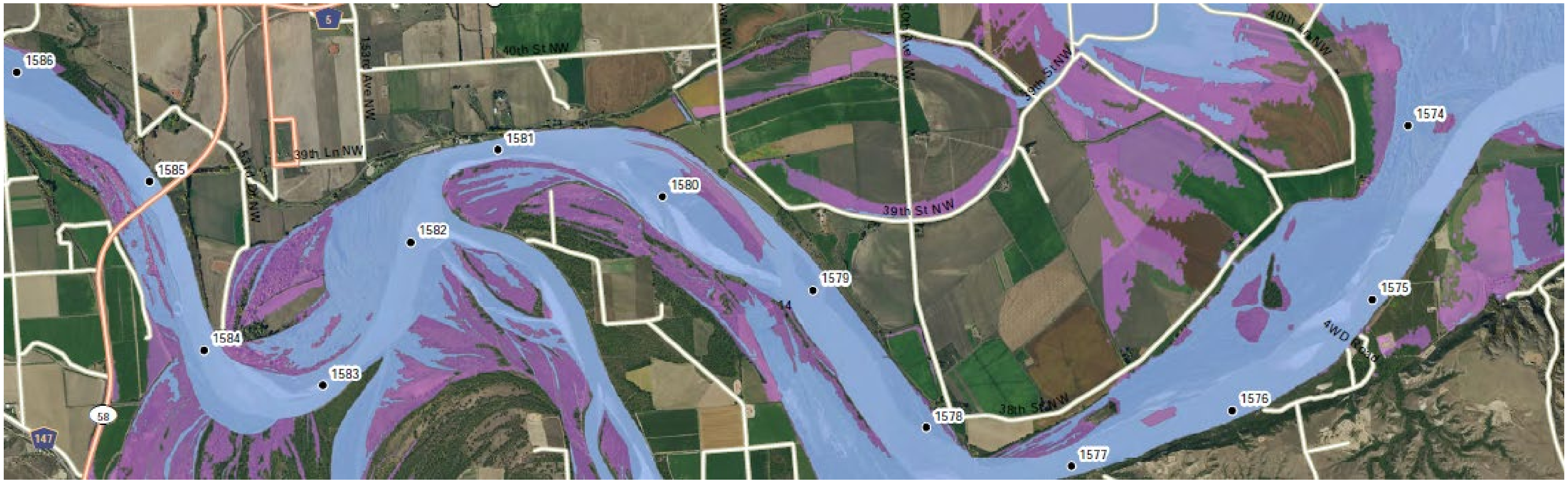

Figure 3-57. Area near Williston inundated at 9kcfs (blue) and 30kcfs (purple) releases from Fort Peck Dam

Figure 3-58. Area near Williston inundated at 9kcfs (blue) and 20kcfs (purple) releases from Fort Peck Dam

The above flow, stage, and inundation mapping (Figures 3-42 to 3-59) show that flow peaks in a normal year, represented by 9kcfs, do not provide as much floodplain or side-channel connectivity as higher flows at 20kcfs or 30kcfs. In the reach between Fort Peck Dam to Williston, for example, a flow of 9 kcfs has limited floodplain and side-channel connectivity and inundates approximately 48,250 acres. A 20kcfs release from Fort Peck would inundate approximately 56,580 acres and a release of 30kcfs from Fort Peck would inundate approximately 65,100 acres.

Table 3-194. Area of inundation at different Fort Peck Dam releases

	Area (acres)		
Reach	9,000 cfs	20,000 cfs	30,000 cfs
Fort Peck to Wolf Point	6,601	8,427	9,878
Wolf Point to Culbertson	7,027	9,211	12,271
Culbertson to Williston	34,628	38,951	43,029
Total	48,256	56,589	65,177

From the inundation mapping it is apparent that much of the additional inundation with 20 and 30kcfs flows is occurring in remnant floodplains and side channels. Each of the Alternatives and their variations would include releases above 20kcfs and all but variation 1A of Alternative 1 would peak at or just above 30kcfs. More naturalized flows would be anticipated to benefit large river obligate aquatic and terrestrial fauna. Long-term studies of naturally variable systems show that some species do best in wet years, and that other species do best in dry years, and that overall biological diversity and ecosystem function benefit from these variations in species success (Tilman et al., 1994). It is known that a range of flows in necessary to scour and revitalize river channels, to import wood and organic matter from the floodplain, and to provide access to productive riparian wetlands. Inter-annual variation in these flow peaks is also important for maintaining channel and riparian dynamics (Poff et al., 1997).

3.10.2.2 No Action Alternative (Current System Operation and Current MRRP Implementation)

Flows and stages and floodplain and side channel connectivity under the No Action Alternative would remain similar to existing conditions. Therefore it is anticipated that there would be no or very little change to habitats under the No Action Alternative.

Riverine Aquatic and Terrestrial Habitat

The type and amount of riverine aquatic and terrestrial habitat under the No Action Alternative would be similar to existing conditions as described in Section 3.10.1.3.

Reservoir Aquatic and Terrestrial Habitat

The type and amount of reservoir aquatic and terrestrial habitat under the No Action Alternative would be similar to existing conditions as described in Section 3.10.1.3 because the operation of the System would be the same as existing under the No Action Alternative.

Special Status Species

Impacts to special status species under the No Action Alternative are provided in Appendix I. It is anticipated that impacts would be the same or similar to existing conditions for all of the species discussed in Appendix I.

Conclusion

Overall, the condition of Fish and Wildlife and their habitats under the No Action Alternative would be the same or similar to existing conditions because operation of the System is anticipated to remain the same or similar to current operations.

3.10.2.3 Alternative 1

Compared to the No Action Alternative, Alternative 1 would include higher flow and stages from approximately mid-April to July 1 in test flow years. Variation 1A would start 1 week earlier and would peak at 25kcfs in late June. Variation 1B is very similar to the base Alternative 1 except that the first and second peaks would occur one week later. The base Alternative 1 and Variation 1B would both peak at just over 30kcfs.

Riverine Aquatic and Terrestrial Habitat

Under Alternative 1 there would be more floodplain and side-channel connectivity in the Fort Peck Dam to Lake Sakakawea headwaters reach in comparison to the No Action Alternative. This floodplain connectivity would occur during the first part of the growing season which would be beneficial for establishing wetland and riparian vegetation early in the growing season. In general the greater amount of floodplain connectivity would favor increased establishment of emergent wetlands, and scrub-shrub wetlands in test flow years. This would provide a benefit to species that rely on wetland habitats as described in Section 3.10.1. The increased amount of inundation may decrease the amount of upland grassland and other drier habitats in the floodplain during test flow years. The increase in off-channel aquatic habitat connectivity such as abandoned channels and oxbow lakes, would benefit native fish species that use these areas for spawning or as nursery areas as juveniles. Variation 1A would have smaller peaks than Alternative 1 or variation 1B and would provide less side-channel and floodplain connectivity.

Reservoir Aquatic and Terrestrial Habitat

The type and amount of reservoir aquatic and terrestrial habitat under Alternative 1 and its variations would be similar to the No Action Alternative although there would be a decrease in Fort Peck Reservoir elevations and an increase in Lake Sakakawea elevations during test flow years. The Fort Peck Lake gage shows a drop in elevation starting near the end of April with approximately 3 feet less elevation by May 1 and 5 feet less by July 1. Under Variation 1A flows would be lower out of Fort Peck Dam so Fort Peck Lake would only drop 1-3 feet rather than the 3-5 feet experienced under Alternative 1 or Variation 1B. Overall, elevations at Fort Peck Lake during test flow years would be 1-5 feet less than the No Action Alternative over the year with the largest differences occurring mid-June to September. Stages become very similar to the No Action Alternative again by approximately January 1. The Lake Sakakawea hydrograph shows higher water starting in approximately mid-May with reservoir levels approximately 3-5 feet higher from mid-June to September. Variation 1A is the exception, where stages are only approximately 1-3 feet higher.

The decrease in Fort Peck Lake elevations during test flow years may cause temporary adverse impacts from loss of spawning habitat such as flooded riprap/rock and flooded vegetation; however, it is expected that these same species may see a benefit from lower flows allowing vegetation to establish on bare shorelines and becoming flooded the following year. The lower reservoir elevations could cause an increase in scrub-shrub and emergent wetlands that establish on mudflats exposed during test flow years. The increase in water levels at Lake Sakakawea may benefit fish that spawn along the shorelines in flooded vegetation or submerged rock/riprap. Shorebirds and other species that utilize bare sand areas may experience less habitat in test flow years due to higher water levels.

Special Status Species

Impacts to special status species under the Alternatives are provided in Appendix I. Impacts to special status species were estimated based on their general habitat preferences. No adverse impacts are anticipated to any special status species from implementation of the test flows.

Conclusion

Overall, there would be temporary large benefits to the riverine ecosystem between Fort Peck Dam and the Lake Sakakawea headwaters compared to the No Action Alternative from increased floodplain and side channel connectivity. The benefits are considered to be temporary rather than long-term because the test flows would occur approximately 3-5 times.

There would be temporary small adverse and beneficial impacts to reservoir terrestrial habitats and fisheries during test flow years depending on location and species habitat preferences.

3.10.2.4 Alternative 2

Compared to the No Action Alternative, Alternative 2 would include higher flow and stages from approximately mid-April to July 1 in test flow years. Variation 2A would start 1 week earlier and Variation 2B would start 1 week later than 2. Alternative 2 and its variations would peak at 15kcfs in April and would peak at 30kcfs in June/July depending on the variation.

Riverine Aquatic and Terrestrial Habitat

Under Alternative 2 there would be more floodplain and side-channel connectivity in the Fort Peck Dam to Lake Sakakawea headwaters reach in comparison to the No Action Alternative. This floodplain connectivity would occur during the first part of the growing season which would be beneficial for establishing wetland and riparian vegetation early in the growing season. In general the greater amount of floodplain connectivity would favor increased establishment of emergent wetlands, and scrub-shrub wetlands in test flow years. This would provide a benefit to species that rely on wetland habitats as described in Section 3.10.1. The increased amount of inundation may decrease the amount of upland grassland and other drier habitats in the floodplain during test flow years. The increase in off-channel aquatic habitat connectivity such as abandoned channels and oxbow lakes, would benefit native fish species that use these areas for spawning or as nursery areas as juveniles.

Reservoir Aquatic and Terrestrial Habitat

The type and amount of reservoir aquatic and terrestrial habitat under Alternative 2 and its variations would be similar to the No Action Alternative although there would be a decrease in Fort Peck Reservoir elevations and an increase in Lake Sakakawea elevations during test flow years. The Fort Peck Lake gage shows a drop in elevation starting near the end of April with approximately 3 feet less elevation by May 1 and 5 feet less by July 1. Overall, elevations at Fort Peck Lake during test flow years would be 1-5 feet less than the No Action Alternative over the year with the largest differences occurring mid-June to September. Stages become very similar to the No Action Alternative again by approximately January 1. The Lake Sakakawea shows higher water starting in approximately mid-May with reservoir levels approximately 3-5 feet higher from mid-June to September.

The decrease in Fort Peck Lake elevations during test flow years may cause temporary adverse impacts from loss of spawning habitat such as flooded riprap/rock and flooded vegetation; however, it is expected that these same species may see a benefit from lower flows allowing vegetation to establish on bare shorelines and becoming flooded the following year. The lower reservoir elevations could cause an increase in scrub-shrub and emergent wetlands that establish on mudflats exposed during test flow years. The increase in water levels at Lake Sakakawea may benefit fish that spawn along the shorelines in flooded vegetation or submerged rock/riprap. Shorebirds and other species that utilize bare sand areas may experience less habitat in test flow years due to higher water levels.

Special Status Species

Impacts to special status species under the Alternatives are provided in Appendix I. Impacts to special status species were estimated based on their general habitat preferences.

Conclusion

Overall, benefits and impacts to fish and wildlife would be similar to those described for Alternative 1 and its variations although Alternative 2 would have slightly lower peaks and slightly less floodplain and off-channel habitat connectivity. There would be temporary large benefits to the riverine ecosystem between Fort Peck Dam and the Lake Sakakawea headwaters compared to the No Action Alternative from increased floodplain and side channel connectivity. The benefits are considered to be temporary rather than long-term because the test flows would occur approximately 3-5 times.

There would be temporary small adverse and beneficial impacts to reservoir terrestrial habitats and fisheries during test flow years.

3.10.2.5 Invasive Species

The introduction or establishment of invasive species could adversely impact fish and wildlife habitat classes and associated assemblages and taxa. These types of impacts could occur under any of the alternatives where there is disturbed substrate but the level of impact would vary depending on the amount of disturbance at each site.

In areas where there is newly deposited or disturbed substrate following test flow releases, invasive plant species could colonize and spread into adjacent areas that provide habitat for fish and wildlife. The higher flows may also serve to flood existing areas of invasive plants which may allow an opportunity for other species to colonize. These impacts would be small compared to the amount of fish and wildlife habitat available. It is not expected that any invasive aquatic wildlife species would spread because of any of the management actions due to site-specific best management practices that would be followed. Overall, under the No Action Alternative there would be years where higher flows occur even without the implementation of test releases. Also, the test releases are anticipated to occur only 3-5 times. Therefore, there would be negligible adverse impacts in comparison to the No Action Alternative related to invasive species from any of the test flow alternatives.

3.10.2.6 Least Terns and Piping Plovers

The Fort Peck alternatives were evaluated for birds by comparing the 50-year quasi-extinction risk between alternatives. The quasi-extinction risk refers to the likelihood of falling below 50 adults at any time during the 50-year timeframe for the northern and southern region separately. The USFWS set the 50-year quasi-extinction risk at <5%; with a 95% probability of persistence which represented a tolerable risk of security and uncertainty. A 5% probability of extinction is widely applied in academic population viability analyses and other recovery plans to guide measurable criteria. The 50-year timeframe was selected by the USFWS to balance security (lower risk) and the potential for an altered environmental regime. Because plover habitat, and thus the plover population, is largely driven by long-term wet and dry climatic cycles, the USFWS determined the 50-year timeframe was long enough to cover an entire cycle. This metric is the plover objective criteria used to calculate the ESH target numbers, by determining how much ESH is necessary (created by flow or construction) to meet that target. Because of the greater ESH acreage needs for piping plovers which defend territories for nesting and foraging, compared to colonially-nesting least terns, USFWS has determined that meeting the plover habitat targets will also fulfill habitat needs for least terns on the Missouri River. In general, plovers nest earlier and have a longer nesting cycle than terns. Terns re-nest more often and also can nest later in the season and still can be successful. It is likely that the timing of test flows would impact plovers more than terns given their ecological differences. Therefore, habitat targets for least terns have not been specified at this time. It is assumed that by meeting plover objectives, tern objectives will also be met.

ESH models, developed for the MRRMP-EIS and associated ESA consultation, were run from 2018 to 2068, using the ESH piping plover population model (bird model) parameters last updated in 2018. These parameters are recorded in the 2018 Adaptive Management Compliance Report. The hydrology for each alternative was supplied to the model. For each of 5,000 model replicates, the model randomly selected a year of the hydrological time series and used the consecutive series of years following that initial year. In that way the entire hydrology was sampled from without losing the correlation of flows between years.

It was assumed that vegetation management was conducted each year and preserved 12% of the annual standard ESH area that would otherwise have been lost to vegetation. This is the standard that has been applied in the Management Plan EIS and in ensuing model analyses. The model did not apply any ESH construction. It can be inferred that lower 50-year extinction risks result in less construction required annually.

As shown in Table 3-195, the no-action alternative quasi-extinction probability for the Northern Region was 0.131. The probabilities for the alternatives ranged from 0.129 to 0.143. This range was smaller than the range of typical variability in probabilities when calculated multiple times. For this analysis, the quasi-extinction probabilities exceed 5% because none of the modeling scenarios assumed management intervention (e.g., construction of emergent sandbar habitat). The models were run to determine what the effect of the test flows would be compared to the No Action Alternative.

These results suggest that there is no statistical difference between alternatives, nor is there a meaningful biological difference. The results for the southern region are also very similar across alternatives. The No Action alternative had a modeled probability of 0.214 and the alternatives ranged from 0.207 to 0.221. These differences were also well within the range of variability in extinction risk calculations and suggest no difference between alternatives.

Table 3-195. Quasi-extinction probabilities calculated by the bird model

Alternative	Northern Region	Southern Region
No Action	0.131	0.214
Alternative 1	0.133	0.219

variation1a	0.129	0.221
variation 1b	0.135	0.216
Alternative 2	0.141	0.207
variation 2a	0.140	0.216
variation 2b	0.143	0.215

Conclusion

The impact of Fort Peck alternatives on piping plovers and least terns relative to the No Action Alternative is negligible.

3.10.2.7 Tribal Resources

Fish, wildlife, and plant species important to Tribes could be flooded temporarily in localized areas in test-release years causing small adverse impacts. Short-term beneficial impacts could occur from an increase in flood plain connectivity and side-channel connectivity that would support species important to Tribes.

3.10.2.8 Climate Change

Despite the many unknowns related to the effects of climate change, understanding how ecosystems and habitats will respond to climate change is important to evaluating the potential effects of the alternatives on fish and wildlife habitat. An increase in the frequency of spring flows or flooding that would inundate fish and wildlife habitat more frequently could cause changes in the acres of individual habitat classes with increases in wetter habitats (i.e., open water, emergent wetland, scrub shrub wetland, and riparian woodland/forested wetland) and decreases in drier habitats (i.e., forest and upland grassland) if precipitation and streamflow increase. Maintenance of aquatic habitats could also occur more frequently for sustaining important breeding and foraging habitat for fish and wildlife species. Decreases in the frequency of spring flows, increased drought conditions, or decreased frequency of all flows due to decreased System storage from increased sedimentation could have the opposite effect (i.e., increases in drier habitats and decreases in wetter habitats). Since the No Action and alternatives have negligible difference in volume, no significant difference is expected.

3.10.2.9 Cumulative Impacts

Past and present actions that have adversely impacted fish and wildlife and their habitat include any actions which resulted in the loss, degradation, or fragmentation of habitat along the Missouri River mainstem and the floodplain. These actions include past construction, operation, and maintenance of the mainstem reservoir system, construction of levees, conversion of habitat to agriculture (e.g., crop production, animal pasturing/grazing), and other land uses (e.g., urban, residential, commercial, and industrial), and Missouri River bed degradation and aggradation. These actions have altered natural river flow, floodplain inundation, and sediment regimes, and adversely impacted habitat for many native fish and other aquatic species in the Missouri River. Any past or present actions which involve construction or use of heavy equipment for maintenance may have impacted fish and wildlife species temporarily due to noise and visual disturbances.

As a result of sediment deposited in the upper ends of the reservoirs, the river channel downstream of the dams deepen (degrades) as sediment that erodes from the channel floor is not replenished with sediment from upstream sources (USACE, 2014e). In some stretches of the river, the degradation rates have decreased substantially since reservoir construction, while in other stretches degradation continues to shape the river as it seeks its dynamic equilibrium. Degradation has led to increased erosion of streambanks and the riverbed, aquatic habitat degradation, lowering of the groundwater table in the floodplain, potential conversion of some wetland to upland, and reduced fish access up some of the affected tributaries.

Water depletions from the Missouri River for agriculture, municipal, and industrial use may have adversely impacted fish and wildlife species that use wetland habitat by reducing groundwater elevations needed to maintain healthy wetland habitats along the Missouri River floodplain. Construction of the mainstem reservoir system has created barriers to fish passage and reduced downstream drift of embryos and invertebrates. Channelization and bank stabilization infrastructure replaces natural river banks and has cut off access by some species from the banks which are used for various stages of their life history; fragmented suitable habitats; and created unnatural shorelines.

Some of the Missouri River reservoirs are stocked artificially with various species of fishes, some nonnative, to support sport fisheries (USACE 2006a). Past fishery stocking and management has caused a reduction in the abundance of native fishes from competition and inadequate amounts of biological resources available to support both populations; reworking of the food web; and harboring and introducing pathogens.

Reasonably foreseeable future actions which may adversely impact fish and wildlife and their habitat include future transportation and utility corridor development, conversion of habitat for agriculture and other land uses, continued degradation, and water table depletion due to withdrawals from the Missouri River. These ongoing actions may result in continued loss, degradation, or fragmentation of habitat within the Missouri River basin. Impacts of these reasonably foreseeable future actions would depend on the timing and location of specific actions. These actions are expected to result in a long-term small adverse impact to fish and wildlife and their habitat.

Past, present, and reasonably foreseeable future projects and actions that create, develop, and/or manage fish and wildlife habitat have benefited or may benefit fish and wildlife species. These actions include the USACE Continuing Authority Programs, USFWS National Wildlife Refuge System Lands Management, USFWS Partners for Fish and Wildlife Program, NRCS Easement Programs, NRCS Technical and Financial Assistance Programs, EPA Section 319 Non-Point Source Grant Program, and Tribal programs and actions. The Yellowstone River bypass channel at Intake Montana is also anticipated to be constructed within the planning horizon for the Fort Peck EIS. These actions are expected to have long-term beneficial impacts to fish and wildlife and their habitat.

Cumulative impacts from other past, present, and reasonably foreseeable future actions would be the same for all alternatives. The combined adverse impacts of all past, present, and reasonably foreseeable projects to fish and wildlife and habitat are significant. Overall, Alternatives 1 and 2 would not add to adverse cumulative impacts, but they would provide a temporary incremental benefit in context of these cumulative effects.

3.11 Cultural Resources

3.11.1 Affected Environment

USACE has a federal compliance and stewardship responsibility to ensure the preservation and protection of cultural resource sites located on federal lands and for historic properties that may be affected by USACE undertakings, as outlined in the National Historic Preservation Act of 1966 (NHPA) (54 USC 306108), its implementing regulations (36 CFR 800), and other pertinent laws, regulations, and policies, as described in Chapter 6 of this EIS.

The USACE Planning Guidance Notebook (ER 1105-2-100) and 36 CFR Part 800 define cultural resources in terms of “historic properties” as follows:

A historic property is any prehistoric or historic district, site, building, structure or object included in or eligible for inclusion on the National Register of Historic Places (National Register). Such properties may be significant for their historic, architectural, engineering, archeological, scientific, or other cultural values, and may be of national, regional, state, or local significance. The term includes artifacts, records, and other material remains related to such a property or resource. It may also include sites, locations, or areas valued by Native Americans, Native Hawaiians, and Alaska Natives because of their association with traditional religious or ceremonial beliefs or activities. Traditional Cultural Properties (TCP) are a type of cultural resources property that is based on its cultural significance to a living community. A TCP can be defined generally as on that is significant because of its association with cultural practices or beliefs of a living community that (1) are rooted in that community's history, and (2) are important in maintaining the continuing cultural identify of the community.

Data for the cultural resources analysis were obtained from USACE records, State Historic Preservation Offices (SHPOs), and from Tribes within the basin. The USACE cultural resources records primarily contain information on federally owned lands within the basin, recorded as a result of the aforementioned federal cultural resources laws. Much of the federal land in the Mainstem Reservoir System have been surveyed for historic properties, and a program to identify other important cultural resources is ongoing.

The information for survey and management of the Omaha District Mainstem Projects/Reservoirs was obtained from the Cultural Resource Management Plans (CRMPs): Fort Peck Dam / Fort Peck Lake; Final Plan November 2004, Garrison Dam / Lake Sakakawea; Final Plan April 2006, Oahe Dam / Lake Oahe Final Plan September 2004. These CRMPs were developed with cultural resource partners and are a management tool that not only identify historic properties and site survey reports but also establish a framework for compliance with the National Historic Preservation Act. The Omaha District has continued to identify historic properties after the CRMPs were finalized. A list of identification and preservation efforts since 2004 can be found in the "Omaha District Cultural Resource Program Final Annual Report for Calendar 2017" located at: http://www.nwo.usace.army.mil/Missions/Civil-Works/Cultural-Resources/Documents/.

The inventory data for cultural resources in the riverine reaches between the Mainstem reservoirs came from the pertinent SHPOs. These inventories of cultural resource sites in riverine settings (developed largely through an accumulation of site-specific compliance with NHPA and recordation by archeologists) are less thorough than the inventories at the reservoirs. Additionally, the vast majority of this land is privately owned and not subject to federal stewardship requirements or protections. Table 3-196 summarizes the number of recorded cultural resource sites that have been identified within the area of Fort Peck Lake, Lake Sakakawea, and Lake Oahe as well as the inter-reservoir riverine bluff-to-bluff reaches between these reservoirs. Most of these cultural resources were identified as archaeological sites, burials, and/or historic buildings or structures. Further discussion of how these sites were selected and how data was obtained can be found in the Cultural Resources Environmental Consequences Analysis Technical Report (Appendix F).

Table 3-196. Recorded cultural resource sites in analysis

Geographic Area	Number of Sites
Fort Peck Lake	53
Montana Riverine Sections	136
North Dakota Riverine Sections	444
Lake Sakakawea	838
Lake Oahe	1,066

Note: This is the total of recorded cultural resources sites within the meander belt of the Missouri River System. Sites without reliable elevation and/or location information were excluded from further hydrologic analysis, as were sites determined ineligible for inclusion in the National Register of Historic Places, except if human remains were associated with the sites. See the "Cultural Resources Environmental Consequences Analysis Technical Report" (Appendix F).

Modeling efforts that aided this analysis utilized archaeological geospatial data along with hydrologic data based on rainfall and flood records, produced using the HEC-RAS modeling of the river and HEC-ResSim modeling of the reservoir System, to estimate impacts to these cultural resources. USACE acknowledges that this inventory is incomplete, and numerous unidentified cultural resources still exist on the landscape. However, this inventory serves as a representative sample of cultural resources, indicating which alternatives have greater or lower impacts to cultural resources in general, and is therefore used to account for the effects of impacts to all cultural resources by the actions proposed in the FPDTF-EIS.

The analysis of effects on cultural resources differentiated two categories of cultural resource sites. "Reservoir sites" were sites located on federal fee-titled lands of the Fort Peck, Sakakawea, and Oahe. "Riverine sites" were all sites located within the bluff-to-bluff Missouri River floodplain that were not already included in the inventories of USACE-managed Missouri River Mainstem reservoir sites from Fort Peck to Oahe. These riverine sites are located in the Missouri River floodplain on sections of the river between the Mainstem reservoirs. Figure 3-59 shows the upper Mainstem reservoir reaches, where the reservoir sites are located. The map also shows the UMR floodplain, which represents the locations of riverine sites, between the Mainstem reservoirs in the Upper Basin.

Reservoir sites were then subdivided into three classes based on normal pool elevation. These were sites that were above normal pool elevations, sites that were below normal pool elevations and sites that were located within the range of normal pool elevations. Riverine sites were not subdivided. Further discussion of the methodology for selection, modeling, and analysis of these cultural resources may be found in the Cultural Resources Environmental Consequences Analysis Technical Report (Appendix F).

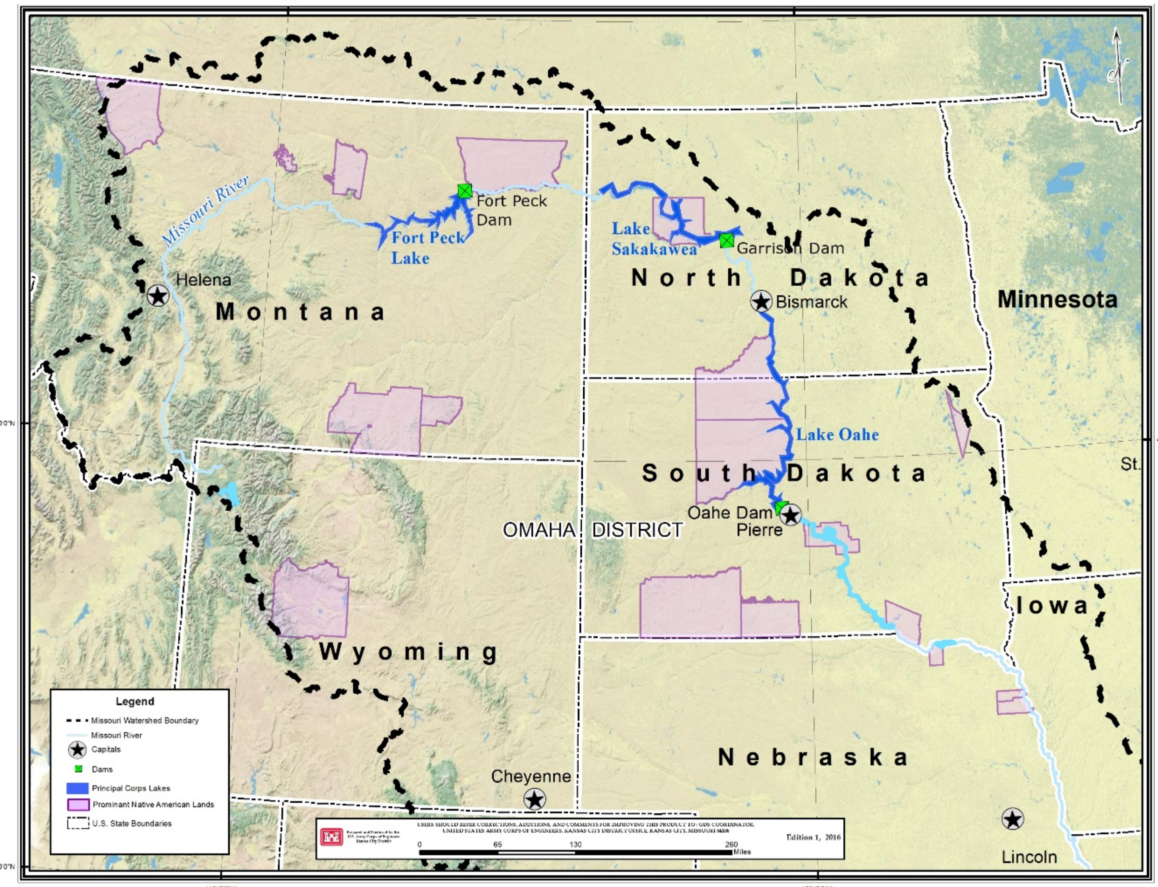

Figure 3-59. UMR basin reservoirs and river

3.11.1.1 Cultural Context

The Missouri River floodplain contains a wide variety of cultural resource types that span from the earliest recorded Native American inhabitants dating to the Paleo-Indian period (approximately 11,000 years ago or earlier) through modern historic times. Prehistoric cultural resource sites differ somewhat depending on the culture inhabiting a specific segment of the Missouri River. These differences become pronounced in more-recent sites and are generally manifested in the archeological record by differences in habitation structure styles and construction, site size, and types of artifacts. However, there are general site types that occur along the entire river, including habitation sites, processing sites, lithic scatters, human burial sites, and rock art. Habitation sites range from long-term, permanently occupied village sites to very short-term camp sites associated with resource procurement activities. Typical burial sites on the Missouri River include rock cairns and burial mounds associated with late prehistoric populations. Rock art such as petroglyphs, although uncommon in the floodplain, have been found on bluff faces along the floodplain peripheries. Typical historic cultural resource sites include: Native American village sites, burial locations, trails, and traditional cultural properties; homesteads, cemeteries, landings, roads, and bridges; and sites and structures related to military exploration and activities including Lewis and Clark camp sites, forts, trails, and battlefields.

3.11.1.2 Cultural Resources in Reservoir Settings

Cultural resources located within reservoir settings are particularly susceptible to impacts from water-surface elevation fluctuations and wind/wave action. Cultural resource sites located below the minimum normal pool elevation were subject to dramatic changes during the initial filling of the reservoir; however, the water column and subsequent siltation have since provided these sites with some protection from further erosion and looting. Submerged cultural resource sites that are located near the minimum-normal pool elevation (i.e., the elevation of the top of each reservoir's "Carryover Multiple Use Zone" as defined in the Master Manual were determined to be at increased risk during periods of low water from droughts or emergency maintenance activities. This risk was the result of direct impacts from wave erosion and vegetation loss as well as greater access via boat that would put these sites at increased risk for looting and vandalism.

Cultural resource sites located above maximum-normal pool elevation (i.e., the elevation of the top of each reservoir's "Carryover Multiple Use Zone") have been subject to fewer direct impacts related to reservoir construction and operation than the sites within or below normal pool elevations. However, these sites located above the maximum-normal pool elevation have since been subject to risk from increased activity/access related to recreation, though also subject to protection through additional federal regulations (Lenihan et al., 1981). These sites located above the maximum-normal pool elevation may also be impacted by erosion during periods of higher-than-normal water levels (e.g., high reservoir levels due to flood risk management). In these instances, a site may become inundated, resulting in greater risk of erosion along the water line, particularly if the pool elevation remains high enough and long enough to eliminate existing vegetation. These sites were determined to be at increased risk when reservoir levels came within three feet of the recorded elevation of the cultural resource site. This risk is the result of direct impacts from wave erosion and vegetation loss as well as greater access via boat that would put these sites at increased risk for looting and vandalism (Lenihan et al. 1981; Dunn 1996).

Cultural resource sites located within the normal range of pool elevations are subject to "continual-to-intermittent erosion due to nearshore wave action and wave-induced currents…enhanced by the absence of protective vegetation cover" (Lenihan et al., 1981). Further, these sites are easily accessible by watercraft, placing them at a greater risk of looting and vandalism compared to sites either above or below normal pool levels. Because these sites located within the normal range of pool elevations are subject to near-continuous risk, they are considerably less sensitive to fluctuations in pool elevation that are outside the normal range. In other words, these sites are always at high risk, although, local micro-environmental factors may contribute greater or lesser impacts to these cultural resources. Current and ongoing stewardship activities on the Mainstem reservoirs seek to monitor impacts to all sites, but are particularly focused on this category of historic properties located within the normal range of pool elevations. Ongoing preservation actions can be found online in the "Omaha District Cultural Resource Program Final Annual Report for Calendar Year 2017" located at: http://www.nwo.usace.army.mil/Missions/Civil-Works/Cultural-Resources/Documents/. While imperfect, the use of these assumptions allows for an analysis of changes in risk to cultural resources from the alternatives.

3.11.1.3 Cultural Resources in Riverine Settings

Similar to cultural resource sites located above maximum-normal pool elevation at a reservoir, cultural resource sites located along river banks or in riverine floodplains are also subject to increased risk of erosion when river elevations rise during flood events. Unlike reservoir sites, which are all located on federal fee owned land, most of the sites in riverine settings are on land that is non-federally owned, and as such are not subjected to the same federal heritage management policies.

Cultural resource sites located close to river banks are subject to the most risk of erosion, relative to other riverine sites. Depending on their proximity, these sites may be subject to erosion on a daily basis or during relatively minor high-water events. Erosion can impact these cultural resources by destroying cultural materials and degrading intact cultural deposits. The exposure of these sites along shorelines may lead to both intentional and unintentional damage. Cultural materials exposed by erosion may be more obvious to the public and could lead to greater risk of vandalism and looting. The majority of the pre-historic cultural resources in riverine settings are located near the bluffs, and are rarely subject to direct flood impacts except during extreme flood events. Similar to the cultural resources sites in reservoir settings, the assumptions used to assess impacts to cultural resources in riverine settings is imperfect but allows for an analysis of changes in risk to cultural resources from the alternatives.

3.11.2 Environmental Consequences

Two action alternatives, each including three variations, were developed to meet the pallid sturgeon objectives. Each alternative and its variations are evaluated for their effects on access to cultural resources. The alternatives evaluated include management actions with potential to affect river flows, reservoir elevations, and river stage. The cultural resources analysis focuses on determining if changes in river and reservoir conditions associated with each of the FPDTR-EIS alternatives could result in an impact to cultural resources sites. This section summarizes the cultural resources methodology and presents the results of the assessment. A detailed description of the methods used for the analysis of cultural resources including data sources and assumptions can be found in the Cultural Resources Environmental Consequences Analysis Technical Report (Appendix F).

3.11.2.1 Impacts Assessment Methodology

The primary impacts to cultural resource sites located in reservoir settings from the FPDTR-EIS alternatives would be related to modifications of flows and changes in reservoir pool elevations. These changes could result in increased risk of impacts to cultural resource sites through erosion and/or vandalism and looting of the sites. The measures used in this analysis attempt to quantify these increases or decreases in risk to cultural resource sites. These measures included assessing the number of days, the number of sites, and the number of sites times days (this is the basis for the term “site-days” which is further defined below) that cultural or historic resources were inundated or exposed based on their relative location to the normal operating elevations of the reservoirs. Normal operations were assumed to be System operations as described in the Master Manual (USACE, 2018). The analysis was based on an assumption that cultural resource sites that are typically submerged face a greater risk of exposure to vandalism and looting as well as erosion when river/pool elevations decrease leading to exposure of all or a portion of a site. Additionally, sites below normal pool elevations are often protected by sediment layers, and generally lower-elevation sites have deeper sediment layers offering greater levels of protection (Lenihan et al., 1981).

Modeled impacts to cultural resource sites that are typically above the normal river/reservoir surface level elevation are subject to increased risk of erosion when river/pool elevations increase covering all or a portion of a site. However, Lenihan et al. (1981) noted that cultural resource sites that are not inundated long enough to harm vegetation remain protected from erosion. The amount of protection provided depends on the species of vegetation, but most species of grass will begin to die off after approximately three to five days of high water. More simply, cultural resource sites (whether located on reservoirs or riverine reaches) are sensitive to changes in water-surface elevations. Table 3-197 describes the normal minimum (the top of the carryover multiple use zone) and maximum (top of the annual flood control and multiple use zone) reservoir pool elevations as identified in the Master Manual for each of the three UMR Mainstem reservoirs.

Table 3-197. Maximum and minimum normal reservoir pool elevations

Reservoir	Minimum Normal Pool Elevation (FAMSL)	Maximum Normal Pool Elevation (FAMSL)
Fort Peck Lake	2,234.0	2,246.0
Lake Sakakawea	1,837.5	1,850.0
Lake Oahe	1,607.5	1,617.0

Note: FAMSL is Feet Above Mean Sea Level

Riverine sites are assumed to be at increased risk when modeled water levels reached the site's lowest elevation. These sites would normally only be impacted during flood events. The same measures used in the reservoir analysis above were used in the riverine analysis. Impacts to sites due to low flows are not analyzed[18]. The estimate of risk was adjusted for sites that would not typically be below water surface elevations as once water elevations are at or above the bottom of a riverine cultural resource site, then the site is considered to be at increased risk for erosion.

All modeling results in this section are based on calculations from information on known cultural resources site information. USACE recognizes that numerous unidentified cultural resource sites are within proximity to the Missouri River and its Mainstem reservoirs. The inventory of known cultural resource sites used in this analysis is intended to serve as a representative sample, indicating which FPDTR-EIS alternatives have the potential for increased risk to cultural resources in general. The analysis has used the best available information and research to assess reasonably foreseeable impacts to cultural resources. USACE acknowledges that the data used does not represent all cultural resources that could be impacted by the FPDTR-EIS action alternatives; however, additional sites not captured within the available cultural resources data sets are assumed to be affected similarly to the

[18] Impacts to sites that are normally below river flows are not considered in this analysis. These types of sites have either been eroded over time or are buried so deep below the river bed that they would not be impacted by low river flows and are therefore not considered.

representative sample provided in this analysis. USACE used the most current site data (2019) received from SHPOs and Tribal Historic Preservation Officers (THPOs) in the project area for this analysis. The CEQ NEPA regulations discuss the assessment of impacts when incomplete information exists (40 CFR 1502.22).

Risks to sites were modeled with HEC-RAS hydraulic and HEC-ResSim modeling software to determine the effect of changing river stages and reservoir elevations on these sites by calculating the number of days that a river stage or elevation of a reservoir was within a certain elevation of cultural resource sites. The primary metric used to compare alternatives was site-days, which were estimated by counting each day that each cultural resource site would have the potential to experience increased risk, then summing these counts across all cultural resource sites for a given area, such as a reservoir or section of the Missouri River within a state. Increased risk is defined as a site experiencing a greater risk for erosion or vandalism than it would when reservoir conditions are within normal pool elevations as defined in Table 3-162 or when riverine levels exceed more than a few feet from the bottom of the site.

Risk levels are assumed to change with changes in water surface elevations. For the purposes of simplifying the terminology in this analysis, the term “site-days” was used to reflect the number of days that each site would have the potential to experience increased risk of erosion or vandalism due to changing water elevations either inundating or exposing a site. See the Cultural Resources Environmental Consequences Analysis Technical Report (Appendix F) for a full discussion of the methods used to evaluate impacts to cultural resources based on changes in flow management.

Due to the size and scope of the FPDTR-EIS, specific impacts on individual sites were not evaluated. NHPA and its implementing regulation at 36 CFR 800 will be followed as the actions outlined in this EIS are implemented. The Programmatic Agreement for the Operation and Management of the Missouri River Mainstem System for Compliance with the NHPA, as amended (Programmatic Agreement), will be followed for recommended actions in the states of Montana, North Dakota, and South Dakota, available online (https://www.nwo.usace.army.mil/Missions/Civil-Works/Cultural-Resources/Programmatic-Agreement/).

3.11.2.2 Summary of Environmental Consequences

The primary differences between the FPDTR-EIS alternatives and their variations were changes in total days when sites were subject to greater risk, rather than disparities in the number of sites affected. Impacts to sites are related to fluctuations in water levels which would result in increased risk, either from erosion or access that correlates to greater likelihood of vandalism or looting. In general, the longer water surface elevations in proximity to sites remain at levels that either inundate normally dry sites or expose normally wet sites, the greater the change in risk to cultural resource sites.

Changes in risk to cultural resource sites focused on changes in the number of site-days for each FPDTR-EIS alternative relative to No Action. Table 3-180 summarizes the maximum number of sites that could potentially be impacted under each alternative over the period of record. All alternatives impact the same sites and the same number of sites with most of the variation in impacts between alternatives occurring as a result of changes in the timing, frequency and length of impacts to sites. Tables 3-198 and 3-199 summarize the differences in average site-days, the primary measure of changes in risk across each alternative, over the entire POR and during full and partial flow years, respectively. Alternative 2 and Variation 2B are the only alternative or variation with a decrease in the average annual number of site-days for sites at reservoirs sites on average annually and during full or partial flow years. Alternative 1 and Variations 1A, 1B, and Alternative 2, Variation 2A would result in an increase in the average number of site-days for reservoir sites. There are no differences amongst the impacts for any alternative or variation for riverine sites, and the maximum number of impacted riverine sites (5 sites) is the same under No Action, and all alternatives and variations.

Table 3-198. Maximum number of affected reservoir sites over the POR (outside normal pool elevation)

Location	**Location Relative to Normal Pool Elevation**	**Number of Sites Affected**						
		NA	Alt 1	Var 1A	Var 1B	Alt 2	Var 2A	Var 2B
Fort Peck Lake	Above	22	22	22	22	22	22	22
	Below	6	6	6	6	6	6	6
Lake Sakakawea	Above	405	405	405	405	405	405	405
	Below	63	63	63	63	63	63	63
Lake Oahe	Above	217	217	217	217	217	217	217
	Below	196	196	196	196	196	196	196
Total	Above	646	646	646	646	646	646	646
	Below	265	265	265	265	265	265	265

Table 3-199. Summary of average number of site-days over the POR in All Years

Location	**Average Annual Site-Days Under No Action**	**Difference Relative to No Action**					
		Alt 1	Var 1A	Var 1B	Alt 2	Var 2A	Var 2B
Reservoir Sites (number)	43,319	26	75	69	(17)	27	(175)

Fort Peck Lake	Above	15	-	(0)	0	-	-	(0)
	Below	358	3	3	3	5	8	7
Lake Sakakawea	Above	924	98	54	86	73	118	111
	Below	8,088	(85)	(38)	(63)	(87)	(109)	(117)
Lake Oahe	Above	829	(2)	8	16	11	4	(62)
	Below	33,105	12	49	27	(18)	7	(113)
Percent Change from No Action (percent)		NA	0.1%	0.2%	0.2%	0.0%	0.1%	-0.4%
Fort Peck Lake	Above	NA	0.0%	-0.9%	1.7%	0.0%	0.0%	-0.9%
	Below	NA	1.0%	0.9%	0.9%	1.5%	2.1%	1.9%
Lake Sakakawea	Above	NA	10.6%	5.8%	9.4%	7.9%	12.8%	12.0%
	Below	NA	-1.1%	-0.5%	-0.8%	-1.1%	-1.3%	-1.4%
Lake Oahe	Above	NA	-0.3%	1.0%	1.9%	1.3%	0.4%	-7.5%
	Below	NA	0.0%	0.1%	0.1%	-0.1%	0.0%	-0.3%
Riverine Sites		1.6	0	0	0	0	0	0
Percent Change from No Action		NA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3-200. Summary of average number of site-days over the POR in Full and Partial Flow Years

Location		Average Annual Site-Days Under No Action	Difference Relative to No Action					
			Alt 1	Var 1A	Var 1B	Alt 2	Var 2A	Var 2B
Reservoir Sites (number)		NA	38	180	113	(53)	66	(416)
Fort Peck Lake	Above	NA	-	-	-	-	(0)	-
	Below	NA	9	8	7	15	22	15
Lake Sakakawea	Above	NA	250	143	178	213	356	218
	Below	NA	(218)	(101)	(144)	(241)	(309)	(268)
Lake Oahe	Above	NA	(8)	19	23	18	(5)	(138)
	Below	NA	7	112	50	(57)	1	(242)
Percent Change from No Action (percent)		NA	0.2%	0.8%	0.5%	-0.2%	0.3%	-1.7%
Fort Peck Lake	Above	NA	0.0%	0.0%	0.0%	0.0%	-2.9%	0.0%
	Below	NA	6.7%	6.3%	4.8%	12.5%	18.2%	10.6%
Lake Sakakawea	Above	NA	30.6%	16.9%	25.2%	28.5%	46.2%	30.9%
	Below	NA	-5.0%	-2.3%	-3.2%	-5.6%	-7.2%	-5.9%
Lake Oahe	Above	NA	-1.3%	2.8%	4.1%	4.5%	-1.3%	-24.9%

	Below	NA	0.0%	0.7%	0.3%	-0.3%	0.0%	-1.3%
Riverine Sites		NA	0	0	0	0	0	0
Percent Change from No Action		NA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

The Programmatic Agreement contains stipulations designed to avoid, minimize, or mitigate adverse effects and satisfy the USACE's responsibilities for System operations. The Fort Peck test flows would be implemented within the framework of Programmatic Agreement. The USACE consults with affected Tribes, SHPOs, the ACHP, and other consulting parties on draft Annual Operating Plans for the Missouri River Mainstem Reservoirs. The likelihood of Fort Peck test flow implementation in a given year would be discussed as part of the MRBWM Annual Operating Plan public meetings each fall and spring. In the past, to comply with the stipulations of the Programmatic Agreement, the district has pursued efforts such as reservoir bank stabilization, data recovery or excavation, protective signage or fencing, or other types of alternative treatments to mitigate the adverse effects of operations to cultural resources. It is anticipated activities such as these will continue into the future based on a case by case need as determined through discussions and consultations with the region's SHPO's, THPO's, tribes, and other consulting parties.

3.11.2.3 Impacts Common to all Alternatives

No known cultural resources sites were impacted during the modeled POR in riverine reaches of North Dakota or South Dakota. Screening efforts indicated that Montana had only five riverine sites that could be affected during the highest flooding or high flow periods. These five sites would only be impacted for a total of 27 days in a year such as 2011, resulting in an average annual impact of 1.6 site-days over the modeled POR. While riverine sites may be at higher risk of impacts during flood events, these impacts are the same under the No Action Alternative, Alternatives 1 and 2 and their variations. As impacts would be the same under all alternatives no further analysis of impacts to cultural resources located along riverine sites is undertaken below. The remaining analysis focuses only on impacts to reservoir sites in the upper three reservoirs of the Missouri River.

3.11.2.4 No Action

Under the No Action Alternative, operations at Fort Peck are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. As noted above, it is considered the baseline against which the other alternatives are measured.

System operations under the No Action Alternative would be consistent with current operations. However, as described in Section 3.1, Introduction, the impacts modeled do not account for what activities may be implemented in the future relative to bed degradation which may be influencing model results. This is because the 2012 river geometry used in HEC-RAS modeling reflects a level of bed degradation that was not present in prior years included in the POR analysis. These impacts are discussed in more detail in Section 3.2, River Infrastructure and Hydrologic Processes.

The amount of risk to cultural resource sites at a particular reservoir is a function of the number of sites and the frequency and duration of fluctuations in reservoir pool elevations. In general, most reservoirs have a greater number of affected sites above normal pool level, but these sites would generally be affected less frequently and for shorter durations than sites below the normal pool level. Of the three upper Mainstem reservoirs, Lake Oahe and Lake Sakakawea have the greatest number of sites that would have the potential to experience risks of vandalism, looting, and erosion as modeled over the POR, with 196 and 63 maximum sites at risk during low water years (sites below the normal pool level) and 217 and 405 maximum sites at risk during high water years (sites above the normal pool level), respectively. However, from year to year, the number of exposed sites varies. Under the No Action Alternative, cultural resources at Lake Oahe and Lake Sakakawea would experience the greatest number of average annual site-days for sites located below the normal pool levels with 33,105 and 8,088 site-days, respectively. Fort Peck Lake has a relatively low number of impacted sites as shown in Table 3-182 below.

Lake Sakakawea has the largest number of sites located above normal pool elevation that would have the potential to experience risks under the No Action Alternative. During the modeled POR, there would be one year with 405 of Lake Sakakawea's sites at risk of erosion during high water periods, three years with approximately 250 sites, eight years with approximately 65 sites at risk from high water, and 70 years with no sites at risk from water levels above normal pool elevations. However, there would be on average 29 sites impacted annually during 80 years of the 82-year period of record from low water elevations while there would be no impacts to sites in two years over this period. Lake Oahe would have up to 217 sites that would have the potential to experience risks from high flows each year during the modeled POR, with an average of 146 sites at risk each year. High water years such as 1997 or 2011 produced the largest risk of impacts to sites at Lake Sakakawea and Lake Oahe with relatively higher reservoir elevations occurring in these years (Table 3-201).

Table 3-201. Change in risk to sites within the Mainstem Reservoir System under No Action (modeled over POR)

Location		Maximum Number of Sites Affected	Average-Annual Site-Days	Number of Years Impacts Would Occur over the POR
Fort Peck Lake	Above	22	15	3
	Below	6	358	70
Lake Sakakawea	Above	405	924	12
	Below	63	8,088	80
Lake Oahe	Above	217	829	57
	Below	196	33,105	82

Conclusion

The No Action Alternative primarily serves as a baseline condition allowing for a comparison with the action alternatives and variations. This analysis indicates that many cultural resource sites would continue to have the potential to experience risks under the No Action Alternative from low and high water conditions due to fluctuations in the hydrologic and climatic cycles and their associated influence on river hydrology and reservoir storage. Actual impacts, which cannot be determined by modeling, would depend on the specific timing and location of a physical change in conditions, the physical damage to the site, and the cultural significance of the site.

3.11.2.5 Alternative 1

System operations under Alternative 1 are based on those described under the No Action Alternative except that this alternative includes a flow release regime from Fort Peck Dam to benefit pallid sturgeon. An Attraction Flow Regime would begin on April 16 and the peak flow would be twice as large as the spring release from Fort Peck Dam in a given year. The Spawning Cue Flow Regime under Alternative 1 would begin on May 28 and would be 3.5 times the Fort Peck Dam spring flow release in the given release year. A further description of Alternative 1 is detailed in Chapter 2, Section 2.5, Alternatives Carried Forward for Further Evaluation.

Table 3-202summarizes the change in risk to cultural resources under Alternative 1 as compared to the No Action Alternative. Full and partial flow releases under Alternative 1 would draw down the reservoir elevations at Fort Peck Lake and increase reservoir elevations at Lake Sakakawea in the years during and some years following flow releases. There would be an increase in the number of cultural resource sites located above the normal pool elevation at Lake Sakakawea and below the normal pool elevation at Lake Oahe that would experience increased risks compared to the No Action Alternative. This would occur because of a partial flow release in the modeled year 1999 impacting 64 sites at Lake Sakakawea and because of system rebalancing in the modeled year 1974 at Lake Oahe impacting 3 sites that would otherwise not be impacted under the No Action Alternative.

Sites at Lake Sakakawea located above the normal reservoir operating elevations would experience an increase of 98 average annual site-days compared to the No Action Alternative, while sites at Fort Peck Lake and Lake Oahe located below the normal operating elevations of the reservoir would experience an increase of 4 and 8 average annual site-days compared to the No Action Alternative, respectively, over the POR. The percentage change in impacts to sites at Lake Sakakawea is 11 percent over the POR relative to the No Action Alternative, increasing to 31 percent on average annually during full and partial flow release years. This relative increase in site-days (98 site-days) to cultural resource sites located above normal operating elevation is accompanied by a decrease in site-days (85 site-days) to cultural resources sites located below the normal operating elevation of the reservoir over the POR. As shown in Table 3-183 below, these changes are primarily driven by flows during full and partial flow release years. The change in impacts to sites below and above the normal operating elevations of the reservoir are magnified in full and partial flow years as there is a relative increase in site-days (250 site-days) to sites located above the normal operating elevation of the reservoir and a further decrease in site-days (218 site-days) to sites located below the normal operating elevation of the reservoir during these flow release years. Most other sites located above or below the normal operating elevations of the three upper reservoirs would have a negligible percentage change in impacts from the No Action Alternative.

Table 3-202. Change in risk to sites within the Mainstem Reservoir System for Alternative 1, compared to No Action (modeled over all years and full and partial flow years over the POR)

Location		Number of Years impacts would occur over the POR		Average-Annual Site-Days Over All Years in the POR		Average-Annual Site-Days Over Full and Partial Flow Years in the POR
		No Action	Alternative 1	No Action	Alternative 1 (Percent Change from No Action)	Alternative 1 (Percent Change from No Action)[1]
Fort Peck Lake	Above	3	3	15	15 (0%)	12 (0%)
	Below	70	70	358	362 (1%)	135 (7%)
Lake Sakakawea	Above	12	13	924	1,022 (11%)	1,065 (31%)
	Below	80	80	8,088	8,003 (-1%)	4,133 (-5%)
Lake Oahe	Above	57	57	829	827 (0%)	628 (-1%)

Location		Number of Years impacts would occur over the POR		Average-Annual Site-Days Over All Years in the POR		Average-Annual Site-Days Over Full and Partial Flow Years in the POR
		No Action	Alternative 1	No Action	Alternative 1 (Percent Change from No Action)	Alternative 1 (Percent Change from No Action)[1]
	Below	82	82	33,105	33,116 (0%)	15,483 (0%)

[1]Note: The No Action average annual site-days value used to calculate the percentage change for these values differs from the No Action value expressed in the "…Over All Years in the POR" column. This is due to the fact that the No Action value used for full and partial release years changes with each alternative and variation given that each alternative and variation uses a different set of years for full and partial flow releases, and the percentage's denominator only uses site-days of impacts from the No Action Alternative for years in which a full or partial flow release is run for this alternative or variation.

Conclusion

Under Alternative 1 cultural resource sites located below the normal operating elevation of Fort Peck Lake and above the normal operating elevation of Lake Sakakawea would experience increases in risk of impacts relative to the No Action Alternative due to decreasing reservoir elevations at Fort Peck Lake and increasing reservoir elevations at Lake Sakakawea during full and partial flow release years. The greatest percentage increase in average annual site-days relative to the No Action Alternative would occur above normal operating elevations at Lake Sakakawea (+11%) and below normal operating elevations at Fort Peck Lake (+1%) over the POR, increasing to 31% and 7%, respectively for each reservoir, in full and partial flow release years. The adverse impacts to sites located above the normal operating elevation of Lake Sakakawea would be accompanied by beneficial decrease in impacts to sites below the normal operating elevation of the reservoir. There would be negligible changes in risk to cultural resources sites above the normal operating elevations of Fort Peck Lake and Lake Oahe.

In considering the significance of impacts, CEQ states that federal agencies should consider both context and intensity (40 CFR 1508.27). The evaluation of intensity should consider the degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the NRHP or may cause loss or destruction of significant scientific, cultural, or historical resources. Modeling performed for cultural resources impacts assessment cannot determine with certainty that a specific cultural resource site would be adversely impacted; however, it indicates where there is an increase in risk that sites could be impacted. The Programmatic Agreement contains stipulations designed to avoid, minimize, or mitigate adverse effects and satisfy the USACE's responsibilities for System operations. All of the Fort Peck test flows would be implemented within the framework of Programmatic Agreement. The USACE consults with affected Tribes, SHPOs, the ACHP, and other consulting parties on draft Annual Operating Plans for the Missouri River Mainstem Reservoirs. The likelihood of Fort Peck test flow implementation in a given year would be discussed as part of the MRBWM Annual Operating Plan public meetings each fall and spring.

3.11.2.6 Alternative 1 – 1A Variation

Variation 1A is a test flow variation of Alternative 1. The parameters for 1A are the same as described for Alternative 1 except that the Attraction Flow would be initiated on April 9, rather than April 16, and the Spawning Cue Flow Regime would be initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

Table 3-203 summarizes the change in risk to cultural resources under Variation 1A as compared to the No Action Alternative. Full and partial flow releases under Variation 1A would draw down the reservoir elevations at Fort Peck Lake and increase reservoir elevations at Lake Sakakawea and Lake Oahe in the years during and some years following flow releases. There would be an increase in the number of cultural resource sites located above the normal pool elevation at both Lake Sakakawea and Lake Oahe that would experience increased risks compared to the No Action Alternative. This would occur in a full release year in the modeled year 1986 impacting 7 sites at Lake Sakakawea and in a full release year in the modeled year 1994 impacting 10 sites at Lake Oahe that would otherwise not be impacted under the No Action Alternative.

Sites at Lake Sakakawea located above normal reservoir operating elevations would experience an increase of 53 average annual site-days compared to the No Action Alternative, while sites at Fort Peck Lake and Lake Oahe located below the normal operating elevations of the reservoirs would experience an increase of 4 and 48 average annual site-days compared to the No Action Alternative, respectively, over the POR. Most of the impacts at Lake Oahe are being driven by an increase in reservoir elevations during three years over the modeled POR, two of these years are full release years and the third is the year after a full release. The percentage change increase impacts to sites at Lake Sakakawea is 6 percent over the POR, increasing to 17 percent during full and partial flow release years. This relative increase in site-days (53 site-days) to cultural resource sites located above normal operating elevation is accompanied by a decrease in site-days (38 site-days) to cultural resources sites located below the normal operating elevation of the reservoir over the POR. As shown in Table 3-184 below, these changes are primarily driven by flows during full and partial flow release years. The change in impacts to sites below and above the normal operating elevations of the reservoir are magnified in full and partial flow years as there is a relative increase in site-days (143 site-days) to sites located above the normal operating elevation of the reservoir and a further decrease in site-days (101 site-days) to sites located below the normal operating elevation of the reservoir during these flow release years.

There is an increase in the number of site-days for cultural resources sites located below the normal operating elevation of Lake Oahe (49 site-days); this increase represents a negligible percentage change in site-days at this reservoir over the POR. However, this impact increases to 112 site-days (+1%) on average annually during full and partial flow release years relative to the No Action Alternative. Sites located above the normal operating elevation of Fort Peck Lake would experience no impacts relative the No Action Alternative while there would be a negligible beneficial impact to sites located below the normal operating elevation of Lake Sakakawea due to a decrease in the number of site-days at this location relative to the No Action Alternative.

Table 3-203. Change in risk to sites within the Mainstem Reservoir System for Variation 1A, compared to No Action (modeled over the POR)

Location		Number of Years impacts would occur over the POR		Average-Annual Site-Days Over All Years in the POR		Average-Annual Site-Days Over Full and Partial Flow Years in the POR
		No Action	Variation 1A	No Action	Variation 1A (Percent Change from No Action)	Variation 1A (Percent Change from No Action)
Fort Peck Lake	Above	3	3	15	15 (0%)	12 (0%)
	Below	70	70	358	362 (1%)	139 (6%)
Lake Sakakawea	Above	12	12	924	977 (6%)	984 (17%)
	Below	80	80	8,088	8,050 (0%)	4,285 (-2%)
Lake Oahe	Above	57	58	829	837 (1%)	675 (3%)
	Below	82	82	33,105	33,153 (0%)	16,069 (1%)

[1]Note: The No Action average annual site-days value used to calculate the percentage change for these values differs from the No Action value expressed in the "…Over All Years in the POR" column. This is due to the fact that the No Action value used for full and partial release years changes with each alternative and variation given that each alternative and variation uses a different set of years for full and partial flow releases, and the percentage's denominator only uses site-days of impacts from the No Action Alternative for years in which a full or partial flow release is run for this alternative or variation.

Conclusion

Under Variation 1A cultural resource sites located below the normal operating elevations of Fort Peck Lake and above the normal operating elevations of Lake Sakakawea and Lake Oahe would experience increases in risk of impacts relative to the No Action Alternative due to decreasing reservoir elevations at Fort Peck Lake and increasing reservoir elevations at Lake Sakakawea and Lake Oahe during full and partial flow release years. The greatest percentage increase in average annual site-days relative to the No Action Alternative would occur above the normal operating elevation at Lake Sakakawea (+6%) over the POR, increasing to 17% in full and partial flow release years. The adverse impacts to sites located above the normal operating elevation at Lake Sakakawea would be accompanied by a decrease in impacts to sites located below the normal operating elevation of the reservoir. There would be negligible changes in risk to cultural resources sites above the normal operating elevation of Fort Peck Lake and Lake Oahe.

3.11.2.7 Alternative 1 – 1B Variation

Variation 1B is another test flow variation of Alternative 1. The parameters for Variation 1B are the same as described for Alternative 1 except that the Attraction Flow would be initiated on April 23 and the Spawning Cue Flow would be initiated on June 4. Similar to the concept described in Variation 1A, the later initiation date is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

Table 3-204 summarizes the change in risk to cultural resources under Variation 1B as compared to the No Action Alternative. Full and partial flow releases under Variation 1B would draw down the reservoir elevation at Fort Peck Lake and increase reservoir elevations at Lake Sakakawea and Lake Oahe in the years during and some years following flow releases. Cultural resource sites located above the normal operating elevations of each of the three upper reservoirs and below the normal operating elevation of Fort Peck Lake would experience increased risks compared to the No Action Alternative. Over the modeled POR, sites located above the normal operating elevation of Lake Oahe would have one more year during the POR in which risk of impacts to sites increased relative to the No Action Alternative. This would occur because of a full flow release in the modeled year 1994 impacting 10 sites at Lake Oahe that would otherwise not be impacted under the No Action Alternative. Additionally, over this same period, sites located above the normal pool elevation at Lake Sakakawea would have several more years in which a number of sites are at increased relative to the No Action Alternative. The largest of these impacts would occur because of a partial flow release in the modeled year 1999 impacting 64 sites that would otherwise not be impacted under the No Action Alternative. There would be no change to the number of sites impacted at Fort Peck Lake.

Sites above the normal operating elevations of all three reservoirs would experience an increase in annual site-days compared to the No Action Alternative. Most of the impacts at Lake Oahe are being driven by an increase in reservoir elevations during two years over the modeled POR, a full release year and a year after a full release. The percentage change in impacts to sites at Lake Sakakawea is 9 percent over the POR relative to the No Action

Alternative, increasing to 25 percent on average annually during full and partial flow release years. This relative increase in site-days (86 site-days) to cultural resource sites located above the reservoir's normal operating elevation is accompanied by a decrease in site-days (63 site-days) to cultural resource sites located below the normal operating elevation of the reservoir over the POR. As shown in Table 3-185 below, these changes are primarily driven by flows during full and partial flow release years. The change in impacts to sites below and above the normal operating elevations of the reservoir are magnified in full and partial flow years as there is a relative increase in site-days (178 site-days) to sites located above the normal operating elevation of the reservoir and a further decrease in site-days (144 site-days) to sites located below the normal operating elevation of the reservoir during these flow release years.

Although the percentage increase in site-days is 7 percent for cultural resource sites located above the normal operating elevation of Fort Peck Lake the absolute change in site-days is 1 on average annually over the modeled POR, relatively small compared to changes occurring at the other reservoirs. This occurs as a result of increased reservoir elevations in the modeled year 1997, a non-release flow year, which has an increase of 22 site-days relative to the No Action Alternative for sites located above the normal operating elevation of the reservoir. Most other sites located above or below the normal operating elevations of the three upper reservoirs would have a negligible change in impacts from the No Action Alternative.

Table 3-204. Change in risk to sites within the Mainstem Reservoir System for Variation 1B, compared to No Action (modeled over the POR)

Location		Number of Years impacts would occur over the POR		Average-Annual Site-Days Over All Years in the POR		Average-Annual Site-Days Over Full and Partial Flow Years in the POR
		No Action	Variation 1B	No Action	Variation 1B (Percent Change from No Action)	Variation 1B (Percent Change from No Action)
Fort Peck Lake	Above	3	3	15	16 (7%)	10 (0%)
	Below	70	70	358	362 (1%)	150 (5%)
Lake Sakakawea	Above	12	12	924	1,010 (9%)	883 (25%)
	Below	80	80	8,088	8,025 (-1%)	4,424 (-3%)
Lake Oahe	Above	57	58	829	845 (2%)	579 (4%)
	Below	82	82	33,105	33,132 (0%)	18,706 (0%)

[1]Note: The No Action average annual site-days value used to calculate the percentage change for these values differs from the No Action value expressed in the "…Over All Years in the POR" column. This is due to the fact that the No Action value used for full and partial release years changes with each alternative and variation given that each alternative and variation uses a different set of years for full and partial flow releases, and the percentage's denominator only uses site-days of impacts from the No Action Alternative for years in which a full or partial flow release is run for this alternative or variation.

Conclusion

Under Variation 1B, cultural resource sites located above the normal operating elevations at all reservoirs and below the normal operating elevations of Fort Peck Lake and Lake Oahe would experience increases in risk of impacts relative to the No Action Alternative. Impacts at Fort Peck Lake and Lake Sakakawea are primarily due to decreasing reservoir elevations at Fort Peck Lake and increasing reservoir elevations at Lake Sakakawea during full and partial flow release years. The reason for impacts to sites at Lake Oahe is mixed with impacts to sites both above and below the normal operating elevation of the reservoir occurring under all types of flow years when the elevation of the reservoir is fluctuating. The greatest percentage increase in average annual site-days relative to the No Action Alternative would occur above normal operating elevations at Lake Sakakawea (+9%) over the POR, increasing to 25% in full and partial flow years. The adverse impacts to sites located above the normal operating elevations at Lake Sakakawea would be accompanied by a beneficial decrease in impacts to sites located below the normal operating elevation of this reservoir. The increase in adverse impacts to sites at Fort Peck Lake is relatively small (+1 site-day) on average annually relative to the No Action Alternative over the POR. There would be negligible changes in risk to cultural resources sites above the normal operating elevation of Lake Oahe.

3.11.2.8 Alternative 2

The parameters for Alternative 2 are the same as described for Alternative 1 except that the Attraction Flow Regime peak would be 14,000 cfs (the maximum powerhouse capacity) rather than twice the average Fort Peck spring flow in a given year. The maximum amount of flow that can be run through the generators is 14,000 cfs. Any additional flow would be run through the spillway and would not generate hydroelectricity. Additionally, releases as measured at the Wolf Point gage would be held at 14,000 cfs until the Spawning Cue release is initiated. A further description of Alternative 2 is detailed in Chapter 2, Section 2.5, Alternatives Carried Forward for Further Evaluation.

Table 3-205 summarizes the change in risk to cultural resources under Alternative 2 as compared to the No Action Alternative. Full and partial flow releases under Alternative 2 would draw down the reservoir elevations at Fort Peck Lake and increase reservoir elevations at Lake Sakakawea and Lake Oahe in the years during and some years following flow releases. Cultural resource sites located above the normal operating elevation at Lake Sakakawea and Lake Oahe and below the normal operating elevation at Fort Peck Lake would experience increased risks compared to the No Action Alternative. While there are increases in risk relative to the No Action Alternative in multiple years over the modeled POR, sites located above the normal operating elevation at Lake Sakakawea and below the normal operating elevation at Fort Peck Lake would have one additional year in which risk of impacts to sites increased relative to the No Action Alternative. This would occur because of a partial flow release in the modeled year 1984 impacting 64 sites at Lake Sakakawea and a full release in the modeled year 1998 impacting one site at Fort Peck Lake that would otherwise not be impacted under the No Action Alternative. Lake Oahe would have no additional years of these impacts.

Sites at Lake Sakakawea and Lake Oahe located above normal reservoir operating elevations would experience an increase of 73 and 11 average annual site-days compared to the No Action Alternative, respectively, while sites at Fort Peck Lake located below the normal operating elevations of the reservoir would experience an increase of 5 average annual site-days compared to the No Action Alternative over the POR. During full and partial release flow years there would be 213 and 18 average annual site-days compared to the No Action Alternative for sites at Lake Sakakawea and Lake Oahe located above normal reservoir operating elevations, respectively. There would be an increase of 15 site-days on average annually for sites at Fort Peck Lake located below the normal operating elevations of the reservoir during these flow years. There would be a decrease of 87 and 18 average annual site-days at Lake Sakakawea and Lake Oahe, respectively, for sites located below the normal operating elevations of these reservoirs during the POR. This beneficial decrease in impacts would rise to 241 and 57 site-days on average annually for Lake Sakakawea and Lake Oahe, respectively during flow years. Sites located above the normal operating elevations of Fort Peck Lake would be negligibly impacted under this alternative relative to the No Action Alternative over both the POR and during flow years.

Table 3-205. Change in risk to sites within the Mainstem Reservoir System for Alternative 2, compared to No Action (modeled over the POR)

Location		**Number of Years impacts would occur over the POR**		**Average-Annual Site-Days Over All Years in the POR**		**Average-Annual Site-Days Over Full and Partial Flow Years in the POR**
		No Action	**Alternative 2**	**No Action**	**Alternative 2 (Percent Change from No Action)**	**Alternative 2 (Percent Change from No Action)**
Fort Peck Lake	Above	3	3	15	15 (0%)	12 (0%)
	Below	70	70	358	364 (2%)	134 (13%)
Lake Sakakawea	Above	12	12	924	996 (8%)	959 (29%)
	Below	80	80	8,088	8,001 (-1%)	4,035 (-6%)
Lake Oahe	Above	57	58	829	840 (1%)	410 (5%)

Location		Number of Years impacts would occur over the POR		Average-Annual Site-Days Over All Years in the POR		Average-Annual Site-Days Over Full and Partial Flow Years in the POR
		No Action	Alternative 2	No Action	Alternative 2 (Percent Change from No Action)	Alternative 2 (Percent Change from No Action)
	Below	82	82	33,105	33,086 (0%)	16,355 (0%)

[1]Note: The No Action average annual site-days value used to calculate the percentage change for these values differs from the No Action value expressed in the "…Over All Years in the POR" column. This is due to the fact that the No Action value used for full and partial release years changes with each alternative and variation given that each alternative and variation uses a different set of years for full and partial flow releases, and the percentage's denominator only uses site-days of impacts from the No Action Alternative for years in which a full or partial flow release is run for this alternative or variation.

Conclusion

Under Alternative 2, cultural resource sites located below the normal operating elevations of Fort Peck Lake and above the normal operating elevations of Lake Sakakawea and Lake Oahe would experience increases in risk of impacts relative to the No Action Alternative due to decreasing reservoir elevation at Fort Peck Lake and increasing reservoir elevation at Lake Sakakawea and Lake Oahe during full and partial flow release years. The greatest percentage increase in average annual site-days relative to the No Action Alternative would occur above normal operating elevations at Lake Sakakawea (+8%) and below normal operating elevations at Fort Peck Lake (+2%) over the POR, increasing to 29% and 13%, respectively for each reservoir, in full and partial flow release years. The adverse impacts to sites located above the normal operating elevation of Lake Sakakawea would be accompanied by a beneficial decrease in impacts to sites located below the normal operating elevation of this reservoir. There would be negligible changes in risk to cultural resources sites located above the normal operating elevation of Lake Oahe.

3.11.2.9 Alternative 2 – 2A Variation

Variation 2A is a test flow variation of Alternative 2. The parameters for Variation 2A are the same as described for Alternative 2 except that the Attraction Flow would be initiated on April 9, rather than April 16, and the Spawning Cue Flow would be initiated on May 21, rather than May 28. The difference in timing is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

Table 3-206 summarizes the change in risk to cultural resources under Variation 2A as compared to the No Action Alternative. Full and partial flow releases under Variation 2A would draw down the reservoir elevations at Fort Peck Lake and increase reservoir elevations at Lake Sakakawea and Lake Oahe in the years during and some years following flow releases. Cultural resource sites located above the normal operating elevation of Lake Sakakawea and below the normal operating elevation of Fort Peck Lake would experience increased risks compared to the No Action Alternative. There would be an increase in the number of cultural resource sites located above the normal operating elevation of Lake Sakakawea and below the normal operating elevation of Fort Peck Lake would experience increased risks compared to the No Action Alternative. This would occur because of a partial flow release in the modeled year 1984 impacting 64 sites at Lake Sakakawea and a full release in the modeled year 1998 impacting one site at Fort Peck Lake that would otherwise not be impacted under the No Action Alternative.

Sites at Lake Sakakawea and Lake Oahe located above normal reservoir operating elevations would experience an increase of 118 and 4 average annual site-days compared to the No Action Alternative, respectively, while sites at Fort Peck Lake and Lake Oahe located below the normal operating elevations of these reservoirs would experience an increase of 8 and 7 average annual site-days compared to the No Action Alternative, respectively, over the POR. These impacts would change in full and partial flow release years to 356 average annual site-days for sites at Lake Sakakawea located above normal reservoir operating elevations and 22 and 1 average annual site-days for sites at Fort Peck Lake and Lake Oahe located below the normal operating elevations, respectively. There would be a decrease of 5 average annual site-days relative to the No Action Alternative for sites located above the normal operating elevation of Lake Oahe in full and partial release years.

The percentage change in impacts to sites at Lake Sakakawea is 13 percent over the POR, increasing to 46 percent in full and partial flow release years. The relative increase in site-days (118 site-days) to cultural resource sites located above normal operating elevation is accompanied by a decrease in site-days (109 site-days) to cultural resources sites located below the normal operating elevation of the lake over the POR. The change in impacts to sites below and above the normal operating elevations of the reservoir are magnified in full and partial flow years as there is a relative increase in site-days (356 site-days) to sites located above the normal operating elevation of the reservoir and a further decrease in site-days (309 site-days) to sites located below the normal operating elevation of the reservoir during these flow release years. Sites located above the normal operating elevation of Fort Peck Lake would be negligibly impacted under this alternative relative to the No Action Alternative over the entire POR and in full and partial flow release years. However, there would be a change in impacts to sites located below the normal operating elevations of Fort Peck Reservoir in full and partial flow release years with an increase of 18 percent of site-days relative to the No Action Alternative in these flow years compared to an increase of 2 percent over the entire POR.

Table 3-206. Change in risk to sites within the Mainstem Reservoir System for Variation 2A, compared to No Action (modeled over the POR)

Location		Number of Years impacts would occur over the POR		Average-Annual Site-Days Over All Years in the POR		Average-Annual Site-Days Over Full and Partial Flow Years in the POR
		No Action	Variation 2A	No Action	Variation 2A (Percent Change from No Action)	Variation 2A (Percent Change from No Action)
Fort Peck Lake	Above	3	3	15	15 (0%)	13 (-3%)
	Below	70	71	358	366 (2%)	145 (18%)
Lake Sakakawea	Above	12	13	924	1,042 (13%)	1,128 (46%)
	Below	80	80	8,088	7,980 (-1%)	4,002 (-7%)
Lake Oahe	Above	57	57	829	833 (0%)	401 (-1%)
	Below	82	82	33,105	33,111 (0%)	16,959 (0%)

[1]Note: The No Action average annual site-days value used to calculate the percentage change for these values differs from the No Action value expressed in the "…Over All Years in the POR" column. This is due to the fact that the No Action value used for full and partial release years changes with each alternative and variation given that each alternative and variation uses a different set of years for full and partial flow releases, and the percentage's denominator only uses site-days of impacts from the No Action Alternative for years in which a full or partial flow release is run for this alternative or variation.

Conclusion

Under Variation 2A cultural resource sites located below the normal operating elevations of Fort Peck Lake and Lake Oahe and sites located above the normal operating elevations of Lake Sakakawea and Lake Oahe would experience increases in risk of impacts relative to the No Action Alternative due to fluctuations in reservoir elevations during full and partial flow release years. The greatest percentage increase in average annual site-days relative to the No Action Alternative would occur above normal operating elevations at Lake Sakakawea (+13%) and below normal operating elevations at Fort Peck Lake (+2%) over the POR. These impacts would increase to 46% and 18%, respectively, at Lake Sakakawea and Fort Peck Lake during full and partial flow release years relative to the No Action Alternative. The adverse impacts to sites located above the normal operating elevation of Lake Sakakawea would be accompanied by a beneficial decrease in impacts to sites located below the normal operating elevation of this reservoir. There would be negligible changes in risk to cultural resources sites above the normal operating elevation of Fort Peck Lake.

3.11.2.10 Alternative 2 – 2B Variation

Variation 2B is another test flow variation of Alternative 2. The parameters for Variation 2B are the same as described for Alternative 2 except that the Attraction Flow would be initiated on April 23, rather than April 16, and the Spawning Cue Flow would be initiated on June 4, rather than May 28. The difference in timing is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

Table 3-207 summarizes the change in risk to cultural resources under Variation 2B as compared to the No Action Alternative. Full and partial flow releases under Variation 2B would draw down the reservoir elevations at Fort Peck Lake and increase reservoir elevations at Lake Sakakawea in the years during and some years following flow releases. There would be an increase in the number of cultural resource sites located above the normal operating elevation of Lake Sakakawea and Lake Oahe that would experience increased risks compared to the No Action Alternative. This would occur because of a partial flow release in the modeled year 1999 impacting 64 sites at Lake Oahe and because of a partial release in the modeled year 1994 impacting 10 sites at Lake Oahe that would otherwise not be impacted under the No Action Alternative.

Sites below the normal operating elevation at Fort Peck Lake and above the normal operating elevation at Lake Sakakawea would experience an increase of 7 and 110 average annual site-days compared to the No Action Alternative, respectively, over the POR, increasing to 15 and 218 average annual site-days, respectively, in full and partial flow years. The percentage change in impacts to sites at Lake Sakakawea is 12 percent over the POR, increasing to 31 percent in flow years. The relative increase in site-days (111 site-days) to cultural resource sites located above normal operating elevation at Lake Sakakawea is accompanied by a decrease in site-days (117 site-days) at risk to cultural resources sites located below the normal operating elevation of the lake. The change in impacts to sites below and above the normal operating elevations of the reservoir are magnified in full and partial flow years as there is a relative increase in site-days (218 site-days) to sites located above the normal operating elevation of the reservoir and a further decrease in site-days (268 site-days) to sites located below the normal operating elevation of the reservoir during these flow release years. Sites located above and below the normal operating elevations at Lake Oahe would experience a decrease of 62 and 113 average annual site-days, respectively, over the modeled POR under Variation 2B, decreasing to 138 and 242 in full and partial flow years. There would be negligible changes in risk to cultural resources sites above the normal operating elevation at Fort Peck Lake.

Table 3-207. Change in risk to sites within the Mainstem Reservoir System for Variation 2B, compared to No Action (modeled over the POR)

Location		Number of Years impacts would occur over the POR		Average-Annual Site-Days Over All Years in the POR		Average-Annual Site-Days Over Full and Partial Flow Years in the POR
		No Action	Variation 2B	No Action	Variation 2B (Percent Change from No Action)	Variation 2B (Percent Change from No Action)
Fort Peck Lake	Above	3	3	15	15 (0%)	10 (0%)
	Below	70	70	358	365 (2%)	159 (11%)
Lake Sakakawea	Above	12	13	924	1,034 (12%)	923 (31%)
	Below	80	80	8,088	7,971 (-1%)	4,300 (-6%)
Lake Oahe	Above	57	58	829	767 (-7%)	418 (-25%)
	Below	82	82	33,105	32,992 (0%)	18,414 (-1%)

[1]Note: The No Action average annual site-days value used to calculate the percentage change for these values differs from the No Action value expressed in the "…Over All Years in the POR" column. This is due to the fact that the No Action value used for full and partial release years changes with each alternative and variation given that each alternative and variation uses a different set of years for full and partial flow releases, and the percentage's denominator only uses site-days of impacts from the No Action Alternative for years in which a full or partial flow release is run for this alternative or variation.

Conclusion

Under Variation 2B cultural resource sites located below the normal operating elevation of Fort Peck Lake and above the normal operating elevation of Lake Sakakawea would experience increases in risk of impacts relative to the No Action Alternative due to decreasing reservoir elevations at Fort Peck Lake and increasing reservoir elevation at Lake Sakakawea during full and partial flow release years. The greatest percentage increase in average annual site-days relative to the No Action Alternative would occur above Lake Sakakawea (+12%) and below Fort Peck Lake (+2%) over the POR, increasing to 31% and 11%, respectively for each reservoir, in full and partial flow release years. The adverse impacts to sites located above the normal operating elevations at Lake Sakakawea would be accompanied by a beneficial decrease in impacts to sites located below the normal operating elevation of the reservoir. There would be a decrease in average annual sites-days to cultural resources sites at Lake Oahe and a negligible change in risk to sites above the normal operating elevation of Fort Peck Lake.

3.11.2.11 Climate Change

A discussion on the influence of climate change on the alternatives is included in Section 3.2, River Infrastructure and Hydrologic Resources. The more extreme flood and drought periods may result in difficulties forecasting runoff and System storage. Higher spring runoff would result in higher spring System storage, leading to early spring releases in order to meet System criteria and resulting in relatively lower late summer and fall river flows. Given a possibility for longer, drier periods, cultural resources sites located below the normal reservoir operating elevations of reservoirs could be affected by decreasing reservoir elevations. Impacts of climate change under Alternatives 1 and 2 and their variations would be similar to those under No Action.

3.11.2.12 Cumulative Impacts

Past, present, and reasonably foreseeable future actions have adversely affected cultural resources within the floodplain and Mainstem Reservoir System. Impacts to cultural resources can result directly from changes in water levels or changes to river channels resulting in increased erosion and/or exposure, as well as impacts from changes in existing land ownership, as well as agriculture, oil and gas development, urban and infrastructure development, transportation and utility corridor development and associated policy changes. Actions that would affect bed degradation also would impact cultural resources as degradation results in increases in erosion and exposure of cultural resource sites within the floodplain and along tributaries, which can damage cultural resources. Ongoing development on lands within the floodplain, including oil and gas development and transportation and utility corridor development, can directly impact cultural resources. Construction can directly impact a historic property in terms of its integrity and condition, or indirectly from changes to the historic sense and feel of the location and/or increased access to the property resulting in increased risk of looting and vandalism (Dunn, 1996). The impacts from other past, present, and reasonably foreseeable actions would be similar across all of the alternatives. The contribution to impacts from Alternatives 1 and 2, when compared to the No Action Alternative, would be negligible to small.

Under the No Action Alternative, existing geomorphological processes and trends would continue, consisting primarily of river degradation and bank erosion, reservoir sediment deposition and aggradation, shoreline erosion in reservoirs, and ice dynamics. Cultural resource sites would continue to have the potential to experience risks from low and high water conditions due to fluctuations in the hydrologic and climatic cycles and the associated influence on river hydrology and reservoir storage. When combined with other past, present, and reasonably foreseeable future actions, the cumulative impacts to cultural resources would continue to be long term, large and adverse. The implementation of the No Action Alternative would provide a negligible contribution to these cumulative impacts to cultural resources.

Under Alternative 1, including Variations 1A and 1B, the Fort Peck test flow releases would modify reservoir releases and river flows to some extent, but would overall have a negligible to small adverse impact on cultural resources. For the most part, these impacts would be due to lower water surface elevations in Fort Peck Lake and higher water surface elevations in Lake Sakakawea and Lake Oahe in flow years and years following flow years. When combined with past, present, and reasonably foreseeable future actions, cumulative impacts under Alternative 1 would be adverse. The contribution to adverse impacts from Alternative 1 and its variants in context of other past, present, and reasonably foreseeable future actions is anticipated to result in small increased risks to cultural resources that could be large depending on the actual physical impact on the site and the cultural significance of the site.

Under Alternative 2, including Variations 2A and 2B, the Fort Peck test flow releases would modify reservoir releases and river flows to some extent, but would overall have a negligible to small adverse impact on cultural resources. For the most part, these impacts would be due to lower water surface elevations in Fort Peck Lake and higher water surface elevations in Lake Sakakawea and Lake Oahe in flow years and years following flow years. As in Alternative 1 and Variations 1A and 1B, when combined with past, present, and reasonably foreseeable future actions, cumulative impacts under Alternative 2 and Variations 2A and 2B would be adverse. The contribution to adverse impacts from Alternative 2 and its variants in context of other past, present, and reasonably foreseeable future actions is anticipated to result in small increased risks to cultural resources that could be large depending on the actual physical impact on the site and the cultural significance of the site.

3.12 Environmental Justice

3.12.1 Affected Environment

Executive Order 12898, issued in 1994, directs federal agencies to incorporate environmental justice as part of their mission by identifying and addressing the effects of programs, policies, and activities on minority and low-income populations. The fundamental principles of Executive Order 12898 are as follows:

- Ensure full and fair participation by potentially affected communities in the decision-making process.
- Prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority or low-income populations.

- Avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations.
- Encourage meaningful community representation in the NEPA process through the use of effective public participation strategies and special efforts to reach out to minority and low-income populations.
- Identify mitigation measures that address the needs of the affected low-income and minority populations.

An environmental justice assessment requires an analysis of whether minority and low-income populations (i.e., "populations of concern") would be disproportionately adversely affected by a proposed federal action. Of primary concern is whether adverse impacts fall disproportionately on minority and/or low-income members of the community compared to the larger community and, if so, whether they meet the threshold of "disproportionately high and adverse." If disproportionately high and adverse effects are evident, then EPA guidance advises that it should initiate consideration of alternatives and mitigation actions in coordination with extensive community outreach efforts (EPA, 1998).

EPA defines a community with potential populations of concern as one that has a greater percentage of minority and/or low-income populations than does an identified reference area. Areas can be determined to have a high proportion of minority residents if either (1) 50 percent or more of the population identifies themselves as a minority; or (2) there a significantly greater minority population than the reference area (EPA, 1998). Individuals are considered to be of a minority if they are identified as a race and ethnicity other than Non-Hispanic White Alone. Low-income populations are defined as those families living below the poverty line, as defined by the U.S. Census Bureau.

The project team took a conservative approach (number 2 above) in evaluating areas with potential populations of concern. Because EPA does not specify any percentage of the population characterized as "significant" in order to identify the presence of minority populations in an area, the project team assumed that if the affected area has a minority population more than ten percentage points higher than the reference area, then a population of concern exists. For this analysis, the state and/or county in which the block group is located were used as the reference area. Therefore, census block groups whose minority population is ten percentage points higher than the state or county average in which it is located are identified as a population of concern. According to the U.S. Census Bureau, guidelines for a poverty area consist of 20 percent of families living below the poverty level (U.S. Census Bureau, 2016).

Thus, block groups with more than 20 percent of their families living below the poverty level were identified as a potential population of concern.

U.S. Census block groups containing a portion of land within the floodplain were included in the analysis. Block group data from the U.S. Census Bureau American Community Survey, 5-year averages from 2013 to 2017, were used to identify the percentages of families in poverty and minority populations. While the identification of potential populations of concern focused on areas within the floodplain of the Missouri River from Fort Peck Lake to Lake Oahe, there were other minority populations that are dependent on resources from the river but not physically located within the floodplain. These groups, including Tribal populations, were considered in the evaluation of impacts to environmental justice populations. This section describes the locations of potential populations of concern within the floodplain of three states along the Mainstem of the Missouri River from Fort Peck Lake to Lake Oahe: Montana, North Dakota and South Dakota. Table 3-208 summarizes the racial and ethnic composition for each state along the Missouri River from Fort Peck Lake to Lake Oahe. Table 3-208 summarizes the poverty levels for the states located along the Missouri River from Fort Peck Lake to Lake Oahe. Populations of concern block groups are summarized by state.

Table 3-208. Missouri River Basin states racial composition and minority presence, 2013–2017 5-year estimates

	State		
Race and Ethnicity	**Montana**	**North Dakota**	**South Dakota**
Non-Hispanic, White Alone	86.6%	85.7%	82.7%
Non-Hispanic, Black or African American Alone	0.4%	2.3%	1.7%
Non-Hispanic, American Indian and Alaskan Native Alone	6.2%	5.2%	8.3%
Non-Hispanic, Asian Alone	0.7%	1.3%	1.4%
Non-Hispanic, Native Hawaiian and Other Pacific Islander Alone	0.1%	0.0%	0.0%
Non-Hispanic, Two or More Races Alone	2.4%	2.0%	2.4%
Non-Hispanic, Some Other Race	0.0%	0.1%	0.1%
Hispanic	3.6%	3.3%	3.5%
Total	1,029,862	745,475	855,444
Minority [a]	13.4%	14.3%	17.3%

Source: U.S. Census Bureau 2017. Note: This information is available from the 2013–2017 American Community Survey 5-Year Estimates (Census data from Tables X02, X03, X11, and X17 in the national ACS2017 block group geodatabase).

a. "Minority" population includes all individuals who identify as being of a race other than "Non-Hispanic, White Alone" in addition to those of Hispanic origin.

Table 3-209. Missouri River Basin states poverty levels, 2013–2017 5-year estimates

Geography	State Population	Total Families	Percent of Families Below the Poverty Line
Montana	1,029,862	260,749	9.1%
North Dakota	745,475	187,057	6.8%
South Dakota	855,444	216,154	8.9%

Source: U.S. Census Bureau 2017.
Note: This information is available from the 2013–2017 American Community Survey 5-Year Estimates.

Ninety-two census block groups intersect the Missouri River floodplain from Fort Peck Lake to Lake Oahe, of which 29 contain potential populations of concern. Table 3-210 summarizes total populations and populations of concern at the block group level that intersect the floodplain for the states evaluated. The following section provides further detail regarding populations of concern and their locations within each of the states.

Table 3-210. Missouri River populations and populations of concern, 2013–2017 5-year estimates

State	Total Populations of All Block Groups that Intersect the Floodplain	Total Population of All Population of Concern Block Groups that Intersect the Floodplain [a]	Percent Populations of Concern
Montana	18,147	8,844	48.7%
North Dakota	101,145	21,479	21.2%
South Dakota	12,384	4,982	40.2%
Total	**131,676**	**35,305**	

Source: U.S. Census Bureau 2017.
a "Total Population of All Populations of Concern Block Groups that Intersect the Floodplain" includes the total block group population for block groups identified as minority, low income, or both.

Montana

Nine census block groups in the Montana portion of the study area demonstrate high concentrations of minority and/or low-income populations, with a majority located within the Fort Peck Reservation in Roosevelt and Valley counties. Four block groups have high concentrations of people that identify as both minority and low-income populations. The percentage of families living below the poverty line in these block groups ranges from 26 percent to 48 percent, and the percent minority population ranges from 80 percent to 99 percent of total population. Table 3-211 describes the populations of concern at the block group level that intersect the Missouri River floodplain in Montana.

Table 3-211. Potential populations of concern located in Missouri River floodplain in Montana, 2013–2017 5-year estimates

Type of Population	Number of Block Groups	Total Population of All Population of Concern Block Groups that Intersect the Floodplain [a]
Block Groups	18	18,147
Minority Block Groups	8	7,859
Poverty Block Groups	5	5,872
Both Minority and Poverty Block Groups	4	4,887
Block Groups with Environmental Justice Populations[b]	**9**	**8,844**

Source: U.S. Census Bureau 2017.

a “Total Population of All Population of Concern Block Groups that Intersect the Floodplain” includes the total block group population for block groups identified as minority, low income, or both.

b Overlap exists in the number of block groups with populations of concern. The totals represent those block groups that are identified block groups with either minority, poverty or both minority or poverty populations.

North Dakota

Fifteen census block groups that intersect the Missouri River floodplain in North Dakota comprise potential populations of concern. These block groups are concentrated on Standing Rock Reservation in Sioux and Corson counties and the Fort Berthold Reservation in Dunn, McKenzie, McLean, and Mountrail counties. They exhibit high concentrations of minority populations. These populations of concern are likely associated with the Standing Rock Sioux and Three Affiliated Tribal nations. Six block groups have high concentrations of people that identify as both minority and low-income populations. The percentage of families living below the poverty line in these block groups ranges from 33 percent to 38 percent, and the percent minority population ranges from 25 percent to 96 percent of total population. Table 3-212 describes the populations of concern at the block group level that intersect the Missouri River floodplain in North Dakota.

Table 3-212. Potential populations of concern located in Missouri River floodplain in North Dakota, 2013–2017 5-year estimates

Type of Population	**Number of Block Groups**	**Total Population of All Environmental Justice Block Groups that Intersect the Floodplain [a]**
Block Groups	62	101,145
Minority Block Groups	15	21,479
Poverty Block Groups	6	9,501
Both Minority and Poverty Block Groups	6	9,501
Block Groups with Environmental Justice Populations[b]	**15**	**21,479**

Type of Population	Number of Block Groups	Total Population of All Environmental Justice Block Groups that Intersect the Floodplain [a]

Source: U.S. Census Bureau 2017.

a “Total Population of All Environmental Justice Block Groups that Intersect the Floodplain” includes the total block group population for block groups identified as minority, low income, or both.

b Overlap exists in the number of block groups with environmental populations. The totals represent those block groups that are identified block groups with either minority, poverty or both minority or poverty populations.

South Dakota

Five block groups that intersect the Missouri River floodplain in South Dakota are identified as containing potential populations of concern. These block groups are concentrated near the on Standing Rock Reservation and Cheyenne River Reservation and exhibit high concentrations of minority populations. Two block groups have high concentrations of people that identify as both minority and low-income populations. The percentage of families living below the poverty line in these block groups ranges from 31 percent to 37 percent, and the percent minority population ranges from 85 percent to 90 percent of total population. Table 3-213 describes the populations of concern at the block group level that intersect the Missouri River floodplain in South Dakota.

Table 3-213. Potential populations of concern located in Missouri River floodplain in South Dakota, 2013–2017 5-year estimates

Type of Population	Number of Block Groups	Total Population of All Populations of Concern Block Groups that Intersect the Floodplain [a]
Block Groups	12	12,384
Poverty Block Groups	5	4,982
Minority Block Groups	2	1,838
Both Poverty and Minority Block Groups	2	1,838
Block Groups with Environmental Justice Populations[b]	**5**	**4,982**

Source: U.S. Census Bureau 2017.

a “Total Population of All populations of concern Block Groups that Intersect the Floodplain” includes the total block group population for block groups identified as minority, low income, or both.

b Overlap exists in the number of block groups with environmental populations. The totals represent those block groups that are identified block groups with either minority, poverty or both minority or poverty populations.

3.12.2 Environmental Consequences

Alternative means of achieving species objectives are evaluated for their effects on populations of concern. The alternatives evaluated include two test flows out of Fort Peck Dam.

The impact analysis focuses on determining if any of the test flows alternatives or their variations would have disproportionate impacts on populations of concern, and if so, what level of impact would be expected. This section presents the results of the assessment.

3.12.2.1 Impacts Assessment Methodology

An environmental justice assessment requires an analysis of whether minority and low-income populations (i.e., “populations of concern”) would be disproportionately affected[19] by a proposed federal action and, if so, understanding the severity of the adverse impacts from the action. The environmental justice assessment for this EIS first evaluated the nature and extent of impacts evaluated under the other resource areas addressed in the EIS (including flood risk management, water supply, thermal power, hydropower, irrigation, and recreation) and then qualitatively evaluated whether these impacts would fall disproportionately on potential environmental justice populations that live within the floodplain.

3.12.2.2 Summary of Environmental Consequences

Table 3-214 summarizes the environmental consequences relative to populations of concern.

Table 3-214. Environmental consequences to populations of concern

Alternative	Impacts to Populations of Concern
No Action	Not expected to have disproportionate adverse impacts on any potential populations of concern.
Alternative 1, Variation 1A and 1B	Not expected to have disproportionate adverse impacts on any potential populations of concern.
Alternative 2, Variation 2A and 2B	Not expected to have disproportionate adverse impacts on any potential populations of concern.

3.12.2.3 No Action

Under the No Action Alternative, operations at Fort Peck are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. The No Action Alternative is considered the baseline against which the other alternatives are measured. Under the No Action Alternative, there would generally be negligible impacts to populations of concern.

[19] The Council of Environmental Quality in *Environmental Justice, Guidance Under the National Environmental Policy Act*, defined disproportionate environmental impacts as “…environmental impacts are significant (as employed by NEPA) and are or may be having an adverse impact on minority population, low-income population, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group.” (CEQ 1997).

Under No Action, modeling results indicate the Missouri River floodplain would continue to experience flood damages when water surface elevations reach flood stages. The magnitude of these impacts would vary considerably from year to year as a result of the natural hydrologic cycles of precipitation and snowpack. Changes in flood risk have the potential to effect populations of concern and critical infrastructure. The largest flood events indicate that more than 9,400 people from Fort Peck Dam to Gavins Point Dam could be affected by flooding, with most of these people located between Garrison Dam and Oahe Dam.[20] Several reservations located in the Missouri River floodplain may be affected by flood damages, including the Fort Peck Reservation in Montana, Fort Berthold Reservation in North Dakota, Standing Rock Reservation in North and South Dakota, and Cheyenne River Reservation in South Dakota. While populations of concerns are likely to be impacted by flooding under the No Action Alternative, it is not expected that impacts would fall disproportionately on those populations.

Under the No Action Alternative, some water supply facilities may consider making capital investments to adapt their intake modifications to drier conditions. These capital investments have the potential to lead to higher retail water rates, although the magnitude of the rate increase is unknown. However, community well-being, economic vitality, and public health and safety are expected to be negligible under the No Action Alternative, and populations of concern are not expected to be disproportionately affected by management actions.

For thermal power generation, drought conditions could result in higher wholesale energy prices with the potential to have negligible to small impacts to retail electricity rates; the magnitude of electricity rate increases is unknown and it is unclear if the populations of concern will be disproportionately affected. The Missouri River power plants would also continue to have adverse impacts to air quality under the No Action Alternative populations of concern are not expected to be disproportionately affected by air quality impacts.

Under No Action, hydropower operations would be the same as current operations, with no change to how the dams are currently operated. Unlike thermal power generation, hydropower would continue to reduce greenhouse gases. In addition, preferred customer rates are not anticipated to change with negligible impacts to regional economic conditions. Relatively drier conditions would reduce these benefits; but, populations of concern are not expected to be disproportionally affected under the No Action Alternative.

Under the No Action Alternative, the Missouri River and reservoirs will remain a viable source of water for irrigation operations with the majority of irrigation occurring in the upper river.

[20] For detailed discussion on of flood impacts, see Section 3.5.2.3.

Although drought and high flow conditions could reduce net farm income, and result in additional operations and maintenance costs, no significant impacts are expected on irrigation operations under the No Action Alternative, and populations of concern are not expected to be disproportionally affected under this alternative.

Finally, no significant adverse impacts are expected on recreation because the Missouri River and its reservoirs would continue to provide a variety of recreational opportunities under the No Action Alternative.

3.12.2.4 Alternative 1

System operations under Alternative 1 are similar to the No Action Alternative except that there would be a flow release regime from Fort Peck Dam to benefit pallid sturgeon.

An Attraction Flow Regime would begin on April 16 and the peak flow would be twice as large as the spring release from Fort Peck Dam in a given year. The Spawning Cue Flow Regime under Alternative 1 begins on May 28 and would be 3.5 times the Fort Peck Dam spring flow release in the given release year. A further description of Alternative 1 is detailed in Chapter 2, Section 2.5, Alternatives Carried Forward for Further Evaluation. Relative to the No Action Alternative, impacts associated with resources under Alternative 1 are not expected to fall disproportionately on potential populations of concern.

Under Alternative 1, modeling results indicate the Missouri River floodplain would continue to experience flood damages when water surface elevations reach flood stages. The magnitude of these impacts would be larger than the No Action Alternative due to increases in agricultural losses in the Fort Peck Dam to Garrison Dam reach. However, impacts will still vary considerably from year to year as a result of the natural hydrologic cycles of precipitation and snow pack. Flood risk is expected to experience short-term, relatively small, adverse impacts under Alternative 1 with negligible other social effects. Populations of concern would be adversely affected in some years in ways similar to all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Alternative 1.

Under Alternative 1, a number of water supply facilities would see a small decrease in costs as a result of the test flow releases; these differences are small enough that impacts on rates and regional economic conditions are expected to be negligible with negligible other social effects, and impacts; therefore, there are not expected to be any adverse impacts on any populations of concern.

Under Alternative 1, thermal power generation, energy values, and variable costs would be negligible compared to No Action Alternative because of the very minor change in river flows and water surface elevations. There would be a negligible change in the impacts to consumer electricity rates and household costs compared to the No Action Alternative, with negligible changes in air emissions and the social cost to carbon. Therefore, there are not expected to be any adverse impacts on any populations of concern.

Under Alternative 1, hydropower generation and capacity value for the overall system would increase, but decrease for Fort Peck compared with the No Action Alternative. Changes implemented under Alternative 1 push the system to increase generation availability in the spring and decrease generation availability in the summer; this may result in needing to make power purchases in the summer which could be more costly. If the decreased generation was replaced by thermal power sources, there would be a small increase in annual greenhouse gas emissions. Any adverse impacts to populations of concern would be similar to impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Alternative 1.

Under Alternative 1, farmers could experience short-term, small adverse impacts to economic vitality and well-being compared to the No Action Alternative due to low river flow conditions. During certain years, these impacts would be small due to lower reservoir elevations and river stages; whereas, during worst difference years, reductions in net farm income would represent a large percentage of net farm income impacts in counties most effected. In particular, Roosevelt County—a county with high concentrations of minority and/or low-income populations—would experience a decrease in farm jobs and farm labor income relative to the No Action Alternative due to higher spring release during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation.

In years with high flows, farmers could experience short-term moderate adverse impacts to irrigation intakes in Montana, including intakes located on the mainstem and on side channels. Average annual net farmer income, employment, labor income, and sales would decrease and operations and maintenance costs would increase relative to the No Action Alternative in these years.

There are two agricultural irrigation intakes that supply water to a majority of the low-income and minority populations in Roosevelt County on Fort Peck Tribal Reservation lands. The smaller of the intakes has a relatively lower low flow threshold and the larger of the two intakes has a low flow threshold comparable to other irrigation intakes along the Missouri River in this reach. Therefore, the smaller of the two pumps is likely to be less impacted by low flows and the larger pump is likely to be experience impacts that are like other irrigation intakes in the area. Because this level of impacts would be equal to or lower than impacts to similar intakes in the area, impacts to minority or low-income individuals are not expected to be disproportionately high during these low flow years.

Impacts to minority and low-income populations are not expected to be disproportionately high during high flow years as only the smaller of the two irrigation intakes is impacted during a high flow event and impacts to this intake are relatively low compared to impacts to other intakes because it is not located on a side channel. Therefore, during high flow years, a majority of tribal irrigated agricultural lands would be unaffected by impacts to irrigation and lands that are affected would see a relatively similar or lower level of impact than lands irrigated by other irrigation intakes.

For recreational impacts, Alternative 1 is expected to result in adverse impacts to Fort Peck Lake and beneficial impacts at Lake Sakakawea compared to No Action. In addition, Alternative 1 is expected to result in decreased lake elevations during some of the years and years after the flow releases at Fort Peck Lake. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse impact to populations of concern. Any adverse impacts to populations of concern would be like impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Alternative 1.

3.12.2.5 Alternative 1 – 1A Variation

Variation 1A is a test flow variation of Alternative 1. The parameters for Variation 1A are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue Flow Regime is initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases. Similar to Alternative 1, impacts associated with resources under Variation 1A are not expected to fall disproportionately on potential populations of concern.

Under Variation 1A, modeling results indicate the Missouri River floodplain would continue to experience flood damages when water surface elevations reach flood stages. The magnitude of these impacts would be slightly larger than the No Action Alternative due to increases in agricultural losses in the Fort Peck Dam to Garrison Dam reach. However, impacts will still vary considerably from year to year because of the natural hydrologic cycles of precipitation and snowpack. Flood risk is expected to experience short-term, relatively small, adverse impacts under Variation 1A with negligible other social effects. Populations of concern would be adversely affected in some years in ways similar to all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 1A. Under Variation 1A, a number of water supply facilities would see a small decrease in costs as a result of the test flow releases; these differences are small enough that impacts on rates and regional economic conditions are expected to be negligible with negligible other social effects; therefore, there are not expected to be any adverse impacts on any populations of concern.

Under Variation 1A, thermal power generation, energy values, and variable costs compared to No Action would be negligible because of the very minor change in river flows and water surface elevations from No Action. There would be a negligible change in the impacts to consumer electricity rates and household costs compared to the No Action Alternative, with negligible changes in air emissions and the social cost to carbon. Therefore, there are not expected to be any adverse impacts on any populations of concern.

Under Variation 1A, hydropower generation and capacity value for the overall system and Fort Peck would decrease compared with the No Action Alternative. Similar to Alternative 1, changes implemented push the system to increase generation availability in the spring and decrease generation availability in the summer; this may result in needing to make power purchases in the summer which could be more costly. If the decreased generation was replaced by thermal power sources, there would be a small increase in annual greenhouse gas emissions. Any adverse impacts to populations of concern would be similar to impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 1A.

Under Variation 1A, farmers could experience short-term, small adverse impacts to economic vitality and well-being compared to the No Action Alternative due to low river flow conditions. During certain years, these impacts would be small due to lower reservoir elevations and river stages; whereas, during worst difference years, reductions in net farm income would represent a large percentage of net farm income impacts in counties most effected. In particular, Roosevelt County—a county with high concentrations of minority and/or low-income populations—would experience a decrease in farm jobs and farm labor income relative to the No Action Alternative due to higher spring release during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation. In years with high flows, farmers could experience short-term moderate adverse impacts to irrigation intakes in Montana, including intakes located on the mainstem and on side channels. Average annual net farmer income, employment, labor income, and sales would decrease and operations and maintenance costs would increase relative to the No Action Alternative in these years.

There are two agricultural irrigation intakes that supply water to a majority of the low-income and minority populations in Roosevelt County on Fort Peck Tribal Reservation lands. The smaller of the intakes has a relatively lower low flow threshold and the larger of the two intakes has a low flow threshold comparable to other irrigation intakes along the Missouri River in this reach. Therefore, the smaller of the two pumps is likely to be less impacted by low flows and the larger pump is likely to be experience impacts that are like other irrigation intakes in the area. Because this level of impacts would be equal to or lower than impacts to similar intakes in the area, impacts to minority or low-income individuals are not expected to be disproportionately high during these low flow years.

Impacts to minority and low-income populations are not expected to be disproportionately high during high flow years as only the smaller of the two irrigation intakes is impacted during a high flow event and impacts to this intake are relatively low compared to impacts to other intakes because it is not located on a side channel. Therefore, during high flow years, a majority of tribal irrigated agricultural lands would be unaffected by impacts to irrigation intakes and lands that are affected would see a relatively similar or lower level of impact than lands irrigated by other irrigation intakes.

For recreational impacts, Variation 1A is very similar to Alternative 1, with adverse impacts to Fort Peck Lake and beneficial impacts at Lake Sakakawea compared to No Action. In addition, Variation 1A is expected to result in decreased lake elevations during some of the years and years after the flow releases at Fort Peck Lake. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse impact to populations of concern. Any adverse impacts to populations of concern would be like impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 1A.

3.12.2.6 Alternative 1 – 1B Variation

Variation 1B is another test flow variation of Alternative 1. The parameters for Variation 1B are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 23 and the Spawning Cue Flow is initiated on June 4. The later initiation date is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date. Similar to Alternative 1 and Variation 1A, impacts associated with resources under Variation 1B are not expected to fall disproportionately on potential populations of concern.

Under Variation 1B, modeling results indicate the Missouri River floodplain would continue to experience flood damages when water surface elevations reach flood stages. The magnitude of these impacts would be larger than the No Action Alternative due to increases in property damages in the Garrison Dam to Oahe Dam reach. However, impacts will still vary considerably from year to year because of the natural hydrologic cycles of precipitation and snowpack. Flood risk is expected to experience short-term, relatively small, adverse impacts under Variation 1B with negligible other social effects. Populations of concern would be adversely affected in some years in ways similar to all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 1B.

Under Variation 1B, a number of water supply facilities would see a small decrease in costs as a result of the test flow releases; these differences are small enough that impacts on rates and regional economic conditions are expected to be negligible with negligible other social effects; therefore, there are not expected to be any adverse impacts on any populations of concern. Under Variation 1B, thermal power generation, energy values, and variable costs compared to No Action would be negligible because of the very minor change in river flows and water surface elevations from No Action. There would be a negligible change in the impacts to consumer electricity rates and household spending compared to the No Action Alternative, with negligible changes in air emissions and the social cost to carbon. Therefore, there are not expected to be any adverse impacts on any populations of concern.

Under Variation 1B, hydropower generation and capacity value for the overall system and Fort Peck would decrease compared with the No Action Alternative. Similar to Alternative 1 and Variation 1A, changes implemented push the system to increase generation availability in the spring and decrease generation availability in the summer; this may result in needing to make power purchases in the summer which could be more costly. If the decreased generation was replaced by thermal power sources, there would be a small increase in annual greenhouse gas emissions. Any adverse impacts to populations of concern would be similar to impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 1B.

Under Variation 1B, farmers could experience short-term, small adverse impacts to economic vitality and well-being compared to the No Action Alternative due to low river flow conditions. During certain years, these impacts would be small due to lower reservoir elevations and river stages; whereas, during worst difference years, reductions in net farm income would represent a large percentage of net farm income impacts in counties most effected. In particular, Roosevelt County—a county with high concentrations of minority and/or low-income populations—would experience a decrease in farm jobs and farm labor income relative to the No Action Alternative due to higher spring release during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation. In years with high flows, farmers could experience short-term moderate adverse impacts to irrigation intakes in Montana, including intakes located on the mainstem and on side channels. Average annual net farmer income, employment, labor income, and sales would decrease and operations and maintenance costs would increase relative to the No Action Alternative in these years.

There are two agricultural irrigation intakes that supply water to a majority of the low-income and minority populations in Roosevelt County on Fort Peck Tribal Reservation lands. The smaller of the intakes has a relatively lower low flow threshold and the larger of the two intakes has a low flow threshold comparable to other irrigation intakes along the Missouri River in this reach. Therefore, the smaller of the two pumps is likely to be less impacted by low flows and the larger pump is likely to be experience impacts that are like other irrigation intakes in the area. Because this level of impacts would be equal to or lower than impacts to similar intakes in the area, impacts to minority or low-income individuals are not expected to be disproportionately high during these low flow years.

Impacts to minority and low-income populations are not expected to be disproportionately high during high flow years as only the smaller of the two irrigation intakes is impacted during a high flow event and impacts to this intake are relatively low compared to impacts to other intakes because it is not located on a side channel. Therefore, during high flow years, a majority of tribal irrigated agricultural lands would be unaffected by impacts to irrigation intakes and lands that are affected would see a relatively similar or lower level of impact than lands irrigated by other irrigation intakes.

For recreational impacts, Variation 1B is very similar to Alternative 1, with adverse impacts to Fort Peck Lake and beneficial impacts at Lake Sakakawea compared to No Action. In addition, Variation 1B is expect to result in decreased lake elevations during some of the years and years after the flow releases at Fort Peck Lake. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse impact to populations of concern. Any adverse impacts to populations of concern would be similar to impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 1B.

3.12.2.7 Conclusion, Alternative 1 including Variants 1A and 1B

Impacts under Alternative 1, including Variations 1A and 1B, are expected to be small, short-term and adverse impacts among the resources evaluated; although in some years there may be somewhat higher adverse impacts. While these impacts would likely affect all populations in the study area, they are not expected to fall disproportionately on any potential populations of concern. Alternative 1, including Variations 1A and 1B, are not expected to have significant disproportionate impacts on potential populations of concern; therefore, environmental justice issues are unlikely.

3.12.2.8 Alternative 2

The parameters for Alternative 2 are the same as described for Alternative 1 except that the Attraction Flow Regime peak is 14,000 cfs (the maximum powerhouse capacity) rather than twice the average Fort Peck spring flow in the given year. The maximum amount of flow that can be run through the generators is 14,000 cfs. Any additional flow is run through the spillway and does not generate hydroelectricity. Additionally, releases as measured at the Wolf Point gage are held at 14,000 cfs until the Spawning Cue release is initiated. A further description of Alternative 2 is detailed in Chapter 2, Section 2.5, Alternatives Carried Forward for Further Evaluation.

Under Alternative 2, modeling results indicate the Missouri River floodplain would continue to experience flood damages when water surface elevations reach flood stages. The magnitude of these impacts would be larger than the No Action Alternative due to increases in agricultural losses in the Fort Peck Dam to Garrison Dam reach and property damages in the Garrison Dam to Oahe Dam reach. However, impacts will still vary considerably from year to year because of the natural hydrologic cycles of precipitation and snowpack. Flood risk is expected to experience short-term, relatively small, adverse impacts under Alternative 2 with negligible other social effects. Populations of concern would be adversely affected in some years in ways similar to all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Alternative 2.Under Alternative 2, a number of water supply facilities would see a small decrease in costs as a result of the test flow releases; these differences are small enough that impacts on rates and regional economic conditions are expected to be negligible with negligible other social effects; therefore, there are not expected to be any adverse impacts on any populations of concern.

Thermal power generation, energy values, and variable costs compared to the No Action Alternative would be slightly higher. There would be a negligible change in the impacts to consumer electricity rates and household costs compared to the No Action Alternative, with negligible changes in air emissions and the social cost to carbon. Therefore, there are not expected to be any adverse impacts on any populations of concern.

Under Alternative 2, hydropower generation and capacity value for the overall system and Fort Peck would decrease compared with the No Action Alternative. Similar to Alternative 1, changes implemented push the system to increase generation availability in the spring and decrease generation availability in the summer; this may result in needing to make power purchases in the summer which could be more costly. If the decreased generation was replaced by thermal power sources, there would be a small increase in annual greenhouse gas emissions. Any adverse impacts to populations of concern would be similar to impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Alternative 2.

Under Alternative 2, farmers could experience short-term, small adverse impacts to economic vitality and well-being compared to the No Action Alternative due to low river flow conditions. During certain years, these impacts would be small due to lower reservoir elevations and river stages; whereas, during worst difference years, reductions in net farm income would represent a large percentage of net farm income impacts in counties most effected. In particular, Roosevelt County—a county with high concentrations of minority and/or low-income populations—would experience a decrease in farm jobs and farm labor income relative to the No Action Alternative due to higher spring release during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation. In years with high flows, farmers could experience short-term moderate adverse impacts to irrigation intakes in Montana, including intakes located on the mainstem and on side channels. Average annual net farmer income, employment, labor income, and sales would decrease and operations and maintenance costs would increase relative to the No Action Alternative in these years.

There are two agricultural irrigation intakes that supply water to a majority of the low-income and minority populations in Roosevelt County on Fort Peck Tribal Reservation lands. The smaller of the intakes has a relatively lower low flow threshold and the larger of the two intakes has a low flow threshold comparable to other irrigation intakes along the Missouri River in this reach. Therefore, the smaller of the two pumps is likely to be less impacted by low flows and the larger pump is likely to be experience impacts that are like other irrigation intakes in the area. Because this level of impacts would be equal to or lower than impacts to similar intakes in the area, impacts to minority or low-income individuals are not expected to be disproportionately high during these low flow years.

Impacts to minority and low-income populations are not expected to be disproportionately high during high flow years as only the smaller of the two irrigation intakes is impacted during a high flow event and impacts to this intake are relatively low compared to impacts to other intakes because it is not located on a side channel. Therefore, during high flow years, a majority of tribal irrigated agricultural lands would be unaffected by impacts to irrigation intakes and lands that are affected would see a relatively similar or lower level of impact than lands irrigated by other irrigation intakes.

For recreational impacts, Alternative 2 is expected to result in adverse impacts to Fort Peck Lake and beneficial impacts at Lake Sakakawea compared to No Action. In addition, Alternative 2 is expected to result in decreased lake elevations during some of the years after the flow releases at Fort Peck Dam. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse impact to populations of concern. Any adverse impacts to populations of concern would be similar to impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Alternative 2.

3.12.2.9 Alternative 2 – 2A Variation

Variation 2A is a test flow variation of Alternative 2. The parameters for Variation 2A are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue flow would be initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

Under Variation 2A, modeling results indicate the Missouri River floodplain would continue to experience flood damages when water surface elevations reach flood stages. The magnitude of these impacts would be larger than the No Action Alternative due to increases in agricultural losses in the Fort Peck Dam to Garrison Dam reach. Fort Peck Dam to Garrison Dam reach. However, impacts will still vary considerably from year to year because of the natural hydrologic cycles of precipitation and snowpack. Flood risk is expected to experience short-term, relatively small, adverse impacts under Variation 2A with negligible other social effects. Populations of concern would be adversely affected in some years in ways similar to all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 2A.

Under Variation 2A, a number of water supply facilities would see a small decrease in costs as a result of the test flow releases; these differences are small enough that impacts on rates and regional economic conditions are expected to be negligible with negligible other social effects, and impacts; therefore, there are not expected to be any adverse impacts on any populations of concern. In addition, power generation and energy values compared to No Action would be slightly higher, while variable costs would be slightly lower. There would be a negligible change in the impacts to consumer electricity rates and household costs compared to the No Action Alternative, with negligible changes in air emissions and the social cost to carbon. Therefore, there are not expected to be any adverse impacts on any populations of concern.

Under Variation 2A, hydropower generation and capacity value for the overall system and Fort Peck would decrease compared with the No Action Alternative. Similar to Alternative 2, changes implemented push the system to increase generation availability in the spring and decrease generation availability in the summer; this may result in needing to make power purchases in the summer which could be more costly. If the decreased generation was replaced by thermal power sources, there would be a small increase in annual greenhouse gas emissions. Any adverse impacts to populations of concern would be similar to impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 2A. Under Variation 2A, farmers could experience short-term, small adverse impacts to economic vitality and well-being compared to the No Action Alternative due to low river flow conditions. During certain years, these impacts would be small due to lower reservoir elevations and river stages; whereas, during worst difference years, reductions in net farm income would represent a large percentage of net farm income impacts in counties most effected. In particular, Roosevelt County—a county with high concentrations of minority and/or low-income populations—would experience a decrease in farm jobs and farm labor income relative to the No Action Alternative. This is due to higher spring release during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation.

In years with high flows, farmers could experience short-term moderate adverse impacts to irrigation intakes in Montana, including intakes located on the mainstem and on side channels. Average annual net farmer income, employment, labor income, and sales would decrease, and operations and maintenance costs would increase relative to the No Action Alternative in these years. There are two agricultural irrigation intakes that supply water to a majority of the low-income and minority populations in Roosevelt County on Fort Peck Tribal Reservation lands. The smaller of the intakes has a relatively lower low flow threshold and the larger of the two intakes has a low flow threshold comparable to other irrigation intakes along the Missouri River in this area. Therefore, the smaller of the two pumps is likely to be less impacted by low flows and the larger pump is likely to be experience impacts that are like other irrigation intakes in the area. Because this level of impacts would be equal to or lower than impacts to similar intakes in the area, impacts to minority or low-income individuals are not expected to be disproportionately high during these low flow years.

Impacts to minority and low-income populations are not expected to be disproportionately high during high flow years as only the smaller of the two irrigation intakes is impacted during a high flow year and impacts to this intake are relatively low compared to impacts to other intakes because it is not located on a side channel. Therefore, during high flow years, a majority of tribal irrigated agricultural lands would be unaffected by impacts to irrigation intakes and lands that are affected would see a relatively similar or lower level of impact than lands irrigated by other irrigation intakes.

For recreational impacts, Variation 2A is expected to result in adverse impacts to Fort Peck Lake and beneficial impacts at Lake Sakakawea compared to No Action. In addition, Variation 2A is expected to result in decreased lake elevations during some of the years after the flow releases at Fort Peck Lake. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse impact to populations of concern. Any adverse impacts to populations of concern would be similar to impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 2A.

3.12.2.10 Alternative 2 – 2B Variation

Variation 2B is another variation of Alternative 2. The parameters for Variation 2B are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 23, rather than April 16, and the Spawning Cue flow is initiated on June 4, rather than May 21. The difference in timing is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

Under Variation 2B, modeling results indicate the Missouri River floodplain would continue to experience flood damages when water surface elevations reach flood stages. The magnitude of these impacts would be larger than the No Action Alternative and all other alternatives and variations due to increases in agricultural losses in the Fort Peck Dam to Garrison Dam reach and property damage in the Garrison Dam to Oahe Dam reach. However, impacts will still vary considerably from year to year because of the natural hydrologic cycles of precipitation and snowpack. Flood risk is expected to experience short-term, relatively small, adverse impacts under Variation 2B with negligible other social effects. Populations of concern would be adversely affected in some years in ways similar to all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 2B.

Under Variation 2B, a number of water supply facilities would see a small decrease in costs as a result of the test flow releases; these differences are small enough that impacts on rates and regional economic conditions are expected to be negligible with negligible other social effects, and impacts; therefore, there are not expected to be any adverse impacts on any populations of concern. In addition, power generation and energy values compared to No Action would be slightly higher, while variable costs would be slightly lower. There would be a negligible change in the impacts to consumer electricity rates and household costs compared to the No Action Alternative, with negligible changes in air emissions and the social cost to carbon. Therefore, there are not expected to be any adverse impacts on any populations of concern, Under Variation 2B, hydropower generation and capacity value for the overall system and Fort Peck would decrease compared with the No Action Alternative. Similar to Alternative 2 and Variation 2A, changes implemented push the system to increase generation availability in the spring and decrease generation availability in the summer; this may result in needing to make power purchases in the summer which could be more costly. If the decreased generation was replaced by thermal power sources, there would be a small increase in annual greenhouse gas emissions. Any adverse impacts to populations of concern would be similar to impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 2B.

Under Variation 2B, farmers could experience short-term, small adverse impacts to economic vitality and well-being compared to the No Action Alternative due to low river flow conditions. During certain years, these impacts would be small due to lower reservoir elevations and river stages; whereas, during worst difference years, reductions in net farm income would represent a large percentage of net farm income impacts in counties most effected. In particular, Roosevelt County—a county with high concentrations of minority and/or low-income populations—would experience a decrease in farm jobs and farm labor income relative to the No Action Alternative due to higher spring release during full release years that would require lower fall releases from Fort Peck Reservoir to balance system storage, causing decreased flows and decreased access to water for irrigation.

In years with high flows, farmers could experience short-term moderate adverse impacts to irrigation intakes in Montana, including intakes located on the mainstem and on side channels. Average annual net farmer income, employment, labor income, and sales would decrease and operations and maintenance costs would increase relative to the No Action Alternative in these years.

There are two agricultural irrigation intakes that supply water to a majority of the low-income and minority populations in Roosevelt County on Fort Peck Tribal Reservation lands. The smaller of the intakes has a relatively lower low flow threshold and the larger of the two intakes has a low flow threshold comparable to other irrigation intakes along the Missouri River in this area. Therefore, the smaller of the two pumps is likely to be less impacted by low flows and the larger pump is likely to be experience impacts that are like other irrigation intakes in the area. Because this level of impacts would be equal to or lower than impacts to similar intakes in the area, impacts to minority or low-income individuals are not expected to be disproportionately high during these low flow years.

Impacts to minority and low-income populations are not expected to be disproportionately high during high flow years as only the smaller of the two irrigation intakes is impacted during a high flow event and impacts to this intake are relatively low compared to impacts to other intakes because it is not located on a side channel. Therefore, during high flow years, a majority of tribal irrigated agricultural lands would be unaffected by impacts to irrigation intakes and lands that are affected would see a relatively similar or lower level of impact than lands irrigated by other irrigation intakes.

For recreational impacts, Variation 2B is expected to result in adverse impacts to Fort Peck Lake and beneficial impacts at Lake Sakakawea compared to No Action. In addition, Variation 2B is expected to result in decreased lake elevations during some of the years after the flow releases at Fort Peck Lake. These conditions would be temporary and are within the range of conditions under No Action. There would be a few years with notable differences in fishing success, but this is likely to have negligible to small adverse impact to populations of concern. Any adverse impacts to populations of concern would be similar to impacts all persons who would be impacted; therefore, these impacts are not expected to be disproportionately high and adverse for populations of concern under Variation 2B.

3.12.2.11 Conclusion Alternative 2 including Variants 2A and 2B

Impacts under Alternative 2, including Variations 2A and 2B, are expected to be small, short-term and adverse among the resources evaluated; although in some years there may be somewhat higher adverse impacts. While these impacts would likely affect all populations in the study area, these impacts are not expected to fall disproportionately on any potential populations of concern. Alternative 2, including Variations 2A and 2B, are not expected to have significant disproportionate impacts on potential populations of concern; therefore, environmental justice issues are unlikely.

3.12.2.12 Climate Change

Natural climatic conditions that result in flooding or droughts can have direct and indirect adverse impacts on environmental justice populations, especially when weather events are extreme. Substantial variability in hydrologic conditions occur within the basin including periods of drought (i.e., 1930s) and high runoff (i.e., 1997, 2011). This variation results in substantial variability in impacts to all populations, including populations of concern. These impacts would not represent a disproportional impact. For a detailed discussion of projected climate change see Section 3.2. The forecasted effects of climate change are not expected to change the effects to environmental justice populations described previously for the Alternatives and their variations and are not expected to lead to more disproportionate impacts on environmental justice populations.

3.12.2.13 Cumulative Impacts

Since none of the alternatives or their variations would result in environmental justice issues as described above, there would be no contribution to cumulative impacts from implementation of any of the alternatives.

3.13 Thermal Power

3.13.1 Affected Environment

There are 6 coal-fired thermal power plants located along the Upper Mainstem of the Missouri River and its reservoirs in North Dakota. One power plant is located on Lake Sakakawea and five are located on the river below Garrison Dam in North Dakota. In addition, there is an electricity conversion station operated by Minnesota Power that uses power from the Milton R. Young Station.

Coal combustion at these plants produces heat energy, which is used to boil water into steam. The steam turns the turbines, which spin the generators to produce electricity. The power plants operate generating units and one or more intakes for withdrawing water for once through cooling or for use in recirculating cooling systems. Of the 6 power plants, 4 have units with recirculating cooling systems or cooling ponds, while 2 plants withdraw water for once-through cooling.

These plants are mainly base load plants used to meet customers' continuous minimum demand for electricity. Base load plants typically run at all times of the year except during repairs or scheduled maintenance. Although coal-fired plants may be cycled over a 24-hour period to meet fluctuations in demand, it is most economical if they are operated at constant production levels. The power plants, notably the coal-fired plants, are increasingly being called on for "dispatchable" generation, providing flexible power generation in peak seasons to complement renewable energy sources.

Thermal power plants access water for once through cooling or recirculating through their cooling systems through intakes. River flows and the associated water surface elevations can affect the amount, timing, frequency, and duration of access to water through the intakes. Intake elevation data was initially collected from the Master Manual and survey data conducted by the Missouri River Basin Water Management Division in 2012; power plant representatives updated or confirmed the intake elevations during outreach with plants between 2015 and 2017 during the thermal power evaluation for the MRRMP-EIS.

All of the power plants discharge wastewater into the river and have NPDES permits that guide the effluent and temperature requirements based on state water quality standards. Low river flows and high river water temperatures can affect plant operational efficiency as well as the ability of the plants to meet their NPDES effluent and temperature requirements.

3.13.1.1 Gross Capacity of Power Plants along the Missouri River

The six coal-fired thermal plants along the UMR in North Dakota have a nameplate capacity of 4,207 (EIA 2018a). Nameplate capacity is the maximum rated output of a generator or power production equipment under specific conditions designated by the manufacturer (EIA 2016). Table 3-215 summarizes the location and gross megawatt capacity of the power plants.

Table 3-215. Gross Capacity of UMR Power Plants

Name	River Mile	County	State	Nameplate Capacity (MW)[a]
Basin Electric – Antelope Valley [b]	1415.5	Mercer	ND	954
Montana Dakota Utilities – Coyote [b]	1372.4	Mercer	ND	450
Basin Electric – Leland Olds Station	1371.6	Mercer	ND	656
Minnkota Power Coop – Missouri River Pump for Milton R. Young [b]	1364.4	Oliver	ND	734
Great River Energy – Coal Creek [b]	1362.4	McLean	ND	1,210
Montana Dakota Utilities – Heskett	1319.5	Morton	ND	203

Source: EIA 2018a, Report EIA-860.

a Plant nameplate capacity was obtained from the U.S. Energy Information Administration and reflects 2018 data.

b Indicates that the power plant has a recirculating cooling system or pond for at least one unit.

3.13.1.2 Energy Generation for Power Plants Along the UMR

Monthly energy generation is provided to the U.S. Energy Information Administration by the power plants. Table 3-216 summarizes the available average daily seasonal net generation for the UMR power plants in North Dakota based on monthly generation reported to the U.S. Energy Information Administration between 2015 and 2017. Power generation and market energy prices vary by season, with higher energy generation and market prices in the peak demand seasons of summer (July and August) and winter (January and February). For all of the units, average daily generation is highest during the summer and winter months, when peak demands for energy are highest.

Table 3-216. Average Daily Net Generatino for the UMR Thermal Power Plants by Season (MWh)

Thermal Power Plant	Winter (January and February)	Spring (March through June)	Summer (July and August)	Fall (September throu gh December)
Basin Electric – Antelope Valley[a]	19,296	14,437	19,085	18,054
Montana Coyote Utilities – Coyote[a]	7,038	6,000	7,542	6,944
Basin Electric – Leland Olds Unit 1	3,491	3,686	3,802	3,273
Basin Electric – Leland Olds Unit 2	7,411	5,850	7,868	7,141
Minnkota Power – Missouri River Pump Unit 2[a]	14,299	14,315	14,875	11,085
Great River Energy – Coal Creek[a]	25,371	18,023	26,196	24,395
Montana Dakota Utilities – Heskett	1,432	1,171	1,446	1,264

Source: EIA 2018b, Report EIA-923. Data is from 2015-2017

Note: Data from the U.S. Energy Information Administration between 2015 and 2017 were used unless otherwise noted. All relevant units are included in the energy generation estimates; energy generation from units that showed significantly decreased monthly power generation (e.g., taken offline from a scheduled maintenance) were not included in the average energy generation estimates.

a Indicates that the power plant has a recirculating cooling system or pond for at least one unit.

3.13.2 Environmental Consequences

Two action alternatives, each including two variations, were developed to meet the pallid sturgeon objectives. Each alternative and its variants are evaluated for their effects on access to water supply for thermal power. The alternatives evaluated include management actions with potential to affect river flows, reservoir elevations, and river stage. The thermal power evaluation focuses on how changes in river and reservoir conditions associated with each of the FPDTR-EIS alternatives could result in an impact to thermal power generation and operations. This section summarizes the thermal power methodology and presents the results of the assessment. A detailed description of the methods used for the thermal power evaluation, including data sources and assumptions, is provided in the “Thermal Power Environmental Consequences Analysis Technical Report.”.

3.13.2.1 Impact Assessment Methodology

This section describes the methodology for the NED, RED, and OSE analyses. The analysis focused on the costs (replacement costs of reduced power generation, capital costs for lost capacity, and variable costs) to power plants and utilities to adapt to changing river and reservoir conditions. As river flows and reservoir elevations fall below intake operational requirements or river temperatures increase above operational or regulatory thresholds, access to water, power plant operational efficiencies, and regulatory constraints could affect power generation and variable costs. Reductions in power generation can in turn drive costs to replace power generation and lost capacity. The following section provides a brief overview of the overall methodology for evaluating impacts to thermal power plants as well as the approach for each planning account evaluated.

The No Action Alternative is considered the baseline against which the other alternatives are measured and compared. Under the No Action Alternative, the Missouri River system would continue to be implemented as it is currently. As noted in Section 3.1.1, Impact Assessment Methodology, the No Action Alternative does not reflect actual past or future conditions but serve as a reasonable basis or “baseline” for comparing the impacts of the action alternatives on resources.

3.13.2.1.1 National Economic Development

The environmental consequences for the NED analysis evaluates the potential effects from changes in river stage, river flow, or temperatures at specified locations along the river near power plants. The hydrologic and hydraulic (H&H) data on river stages and flows were used to assess when and how often intake access to water was affected. As part of the Missouri River Recovery Management Plan-Environmental Impact Statement (MRRMP-EIS) thermal power evaluation, an extensive data collection effort was undertaken with power plants and utilities to obtain information on how river conditions affect power generation, operations, and variable costs. An important step in the process was to obtain the average daily power generation for the affected power plants for years when no adverse conditions occurred. Power generation was evaluated seasonally because replacement costs of power vary by season, with peak demand for electricity forcing replacement prices higher in the winter and summer months.

The changes in power generation relative to the No Action Alternative were used to estimate replacement power costs (changes in energy values). The analysis assumed that power generation from the market would be available to supply replacement power and that energy prices would remain constant for the analysis. Energy values for the Missouri River were estimated by the Hydropower Analysis Center using locational marginal pricing from the Western Area Power Administration hub of both the Midwest Independent System Operator (MISO) Regional Transmission Organization (RTO) and the Southwest Power Pool (SPP) RTO. Locational marginal pricing is a computational technique that determines a shadow price for an additional MWh of demand. Energy values or prices are specified for 4 seasons: winter (January and February), spring (March through June), summer (July and August), and fall (September through December).

The unit capacity value was based on a FERC spreadsheet model that estimates annual unit regional capacity values for different generating resources (Hydropower Analysis Center 2019). The unit capacity value was estimated to be $139.86 per KW-year for a combined cycle natural gas unit. The evaluation focused on changes in dependable generation when compared to the No Action Alternative. Based on the evaluation, there were no impacts to capacity and capacity values.

In addition, river conditions can also affect variable costs for power plants where power generation is not affected. Two power plant operators and a conversion station operator located in the Garrison reach specified increased variable costs (and loss of production tax credits) incurred during periods when river stages were below specified threshold conditions.

3.13.2.1.2 Regional Economic Development

The RED analysis used the estimated changes in power generation in the evaluation along with power generation information from the Regional Transmission Organizations (RTO) to assess the context of the changes in power generation on wholesale electricity prices and how changes to those prices could impact consumer electricity rates that are set by retail electricity providers (SPP 2015; SPP 2016; MISO 2014; MISO 2016). Any changes in retail electricity rates could impact household and business spending, with implications for jobs and income in regional economies. If consumers must spend more of their income on higher electricity rates, they would have less disposable income to spend on other goods and services, which could adversely impact jobs and income in affected industries.

3.13.2.1.3 Other Social Effects

The OSE account includes measures to evaluate air emissions associated with power generation under the alternatives. The power plants included in this evaluation include only coal-fired power plants. Changes in thermal power generation under the FPDTR-EIS alternatives would be replaced with power generation from the market. The changes in the fuel source mix is likely to affect air emissions. Because there is so little change in power generation under Alternatives 1 and 2 and the variations compared to the No Action Alternative, changes in air emissions were not quantified but are described qualitatively with data and information from the EPA (2016; 2018). When compared to other sources of power in the market, coal-fired power plants generate higher air emissions and greenhouse gas emissions than renewable, hydropower, natural gas, and nuclear sources of energy. Increases in air emissions would result in adverse environmental impacts, while decreases in air emissions would result in environmental benefits.

3.13.2.2 Summary of Environmental Consequences

The environmental consequences relative to thermal power are summarized in Table 3-217.

Table 3-217. The environmental consequences relative to Thermal Power

Alternative	NED Impacts	RED Impacts	OSE Impacts
No Action Alternative	Average Annual NED Value: $505,100,000. Range of Annual NED Values: $458,700,000 to $510,500,000. Power generation from the UMR power plants would continue to provide large and long-term thermal power NED benefits. Small and temporary adverse impacts in some years would occur from the variability in hydrology and change in hydrologic conditions over the POR.	Thermal power plants in the upper river would continue to provide low-cost electricity, supporting relatively lower rates, with benefits to household and business spending. There would be negligible to small adverse effects to RED associated with reduced power generation during drought and drier conditions.	The UMR power plants would continue to contribute to greenhouse gas and other air emissions associated with power generation, with long-term adverse OSE impacts.
Alternative 1	Change in Average Annual NED Value: +$221,000 or 0.04%. Negligible changes in thermal power NED values from slight changes in river flows	Negligible change in RED impacts.	Negligible change in OSE impacts.

	and stages associated with the Fort Peck Dam test flows.		
Variation 1A	Change in Average Annual NED Value: +$115,000 or 0.02%. Negligible changes in thermal power NED values from slight changes in river flows and stages associated with the Fort Peck Dam test flows.	Negligible change in RED impacts.	Negligible change in OSE impacts.
Variation 1B	Change in Average Annual NED Value: -$41,000 or -0.01%. Negligible changes in thermal power NED values from slight changes in river flows and stages associated with the Fort Peck Dam test flows.	Negligible change in RED impacts.	Negligible change in OSE impacts.
Alternative 2	Change in Average Annual NED Value: +$20,000 or 0.0%. Negligible changes in thermal power NED values from slight changes in river flows and stages associated with the Fort Peck Dam test flows.	Negligible change in RED impacts.	Negligible change in OSE impacts.
Variation 2A	Change in Average Annual NED Value: +$68,000 or 0.01%. Negligible changes in thermal power NED values from slight changes in river flows and stages associated with the Fort Peck Dam test flows.	Negligible change in RED impacts.	Negligible change in OSE impacts.
Variation 2B	Change in Average Annual NED Value: +$70,000 or 0.01%. Negligible changes in thermal power NED values from slight changes in river flows and stages associated with the Fort Peck Dam test flows.	Negligible change in RED impacts.	Negligible change in OSE impacts.

3.13.2.3 The No Action Alternative

Under the No Action Alternative, operations at Fort Peck are assumed to closely follow the Master Manual with no deviations for a pallid sturgeon test flow. As noted above, it is considered the baseline against which the other alternatives are measured. System operations under the No Action Alternative would be consistent with current operations. However, the impacts modeled do not account for the ability of water management to adapt to changing conditions on the System to serve authorized purposes, such as water supply for thermal power plants. It also does not account for what activities may be implemented in the future relative to bed degradation which may be influencing model results. This is because the 2012 river geometry used in HEC-RAS modeling reflects a level of bed degradation that was not present in prior years included in the POR analysis.

Consistent water supply for thermal power plants requires intakes to be submerged in the water at all times and at the same time to not be buried by sediment deposits. Thermal power intakes are thus affected from the variability in hydrology and change in hydrologic conditions over the POR as well as aggradation and degradation processes (see Section 3.2 “River Infrastructure and Hydrologic Processes”). The POR is characterized by substantial variability in hydrologic conditions which includes periods of drought (i.e., 1930s, mid-1990s, and 2000s) and high runoff. This variation results in variability in impacts to thermal power plants which can be adverse or beneficial depending on the conditions at the site of the intake.

Modeling results for the No Action indicate that thermal power intakes, if they were to remain at existing elevations, would experience adverse impacts under drought and relatively drier conditions with continuation of current System operations. These impacts would be due to instances when water surface elevations fall below critical shut down operating thresholds. Although two power plants experience no days below shut down intake elevations under the No Action Alternative, the remaining four power plants on average experience between 3 and 19 days per year when water surface elevations fall below critical shut down operating thresholds over the 82-year period of analysis.

3.13.2.3.1 National Economic Development

Management of the Missouri River system under the No Action Alternative would result in an annual average generation of 28.2 million MWH for the power plants in the upper river, equivalent to $505 million in energy values over the 82-year period of record. Power generation would vary over the period of record, with drier and drought periods (1930s, mid-1990s and

2000s) reducing water surface elevations below intake elevations, affecting power generation. Typical power generation is about 28.5 million MWH, which occurs in most of the years over the period of record. During the drought periods, power generation can reach approximately 26 million MWH, a reduction of up to 2.5 million MWH compared to typical power generation years.

Capacity values are defined as the amount of capacity that a power plant can reliably contribute to meeting peak season needs (USACE EM 1110-2-1701). The total value of dependable capacity in the summer would be $427 million (3,053 MW) and $415 million in the winter (2,970 MW) for all power plants in the upper river. Average annual variable costs would be small under the No Action Alternative, averaging $217,000 annually over the period of record. The NED analysis for the No Action Alternative is summarized in Table 3-218.

Table 3-218. Summary of Thermal Power NED Value For the No Action Alternative (2020 Dollars)

NED Value	Upper River [a]
Average Annual Missouri River Power Generation (MWh)	28,245,000
Average Annual Energy Value	$505,360,000
Range in Annual Energy Values	$458,800,000 -- $510,500,000
Average Annual Dependable Capacity – Summer (MW)[a]	3,053
Average Annual Dependable Capacity Value – Summer[a]	$426,993,000
Average Annual Dependable Capacity – Winter (MW) [a]	2,971
Average Annual Dependable Capacity Value – Winter[a]	$415,384,000
Average Annual Variable Costs [b]	-$217,000
Average Annual NED Value[c]	$505,143,000

Notes: The table reflects power generation, energy values, and variables costs associated with five power plants and one electricity conversion station. The Montana Dakota Utilities Coyote Plant would not be affected by changes in water surface elevations under the FPDTR-EIS alternatives and is not included in the evaluation.

a Capacity values are estimated by multiplying the 15th percentile of the available seasonal capacity during the summer and winter peak demand seasons from 1931-2012 by the unit capacity value. Capacity values represent an annualized capital cost to replace the estimated lost capacity; the unit capacity value was $139,860/MW-year (Hydropower Analysis Center 2019).

b Variable costs include operations and maintenance costs incurred under adverse conditions when power generation is not affected. Estimates of variable costs were provided by three power plants in the upper river; no variable cost data was provided by power plants in the lower river. In addition, the variable costs include losses in renewable energy credits for Minnesota Power when Minnkota Power Cooperative Missouri River intake is impacted during the summer.

c NED values for the No Action Alternative do not include capacity values because there are no capacity impacts under Alternatives 1 and 2, compared to the No Action Alternative. NED values include the energy values less the variable costs.

3.13.2.3.2 Regional Economic Development

Under the No Action Alternative, there would be varying impacts to power generation, with some of the lower power generation years occurring in the 1930s, early 1990s, and mid-2000s, when drought conditions would reduce river flows and water surface elevations. In the worst-case years (as modeled in 1937 and 1993), power generation from power plants along the UMR would be reduced by an estimated 2.5 million MWh, which is approximately 9% reduction from power generation with no adverse conditions (28.5 million MWh). This reduction in power generation represents less than a 0.4 percent decrease of SPP and MISO annual power generation (SPP 2015; SPP 2016; MISO 2014; MISO 2016).

In some years during drought conditions, it is possible that seasonal reductions in power generation could occur during one period of time during peak power demand seasons, when replacement power from MISO, SPP or other markets may be scarce, which may support rationale for retail electricity providers to increase consumer electricity rates compared to current rates because of the higher prices to purchase the wholesale electricity. The power reductions would be temporary and would likely represent negligible to small impacts on electricity rates, with negligible impacts to household and business spending.

3.13.2.3.3 Other Social Effects

In general, the coal-fired power plants emit more per unit carbon dioxide and nitrous oxide emissions than the average replacement power sources from the market. Plant-specific methane emission sources have both higher and lower emissions from the power plant when compared with the average replacement power sources from the market. Under the No Action Alternative, during drought and relatively drier conditions, replacement power from the MROWest would have fewer nitrous oxide and carbon dioxide air emissions than during power generation with no adverse conditions, while methane emissions would be both higher and lower when the power generation is replaced with the market fuel sources.

3.13.2.3.4 Conclusion

The average annual thermal power NED value under the No Action Alternative is estimated to be $505 million, with average annual power generation estimated to be 28.5 million MWh over the 82-year period of analysis. The annual value of dependable capacity is estimated to range from $415 million (winter) to $427 million (summer). Continued management of the System under the No Action Alternative would provide large energy and capacity benefits; adverse impacts to energy and capacity values and variable costs would occur during relatively drier and drought conditions.

During drought conditions, there could be relatively higher wholesale electricity prices with the potential to have negligible to small impacts to retail electricity rates. It is likely that replacement capacity would be available in the market during drought and relatively drier conditions, with minimal impacts to power supply and electricity reliability under the No Action Alternative (SPP pers. comm. 2018). There would be negligible to small adverse effects to RED associated with reduced power generation during drought and drier conditions. Under Alternative 1, there would be continued adverse impacts to air quality associated with coal-fired power generation from the UMR power plants.

the No Action Alternative provides the baseline conditions against which Alternatives 1 and 2 and the variations are compared.

3.13.2.4 Alternative 1

System operations under Alternative 1 are based on those described under the No Action Alternative except that it includes a flow release regime from Fort Peck Dam to benefit pallid sturgeon.

An Attraction Flow Regime would begin on April 16 and the peak flow would be twice as large as the spring release from Fort Peck Dam in a given year. The Spawning Cue Flow Regime under Alternative 1 begins on May 28 and would be 3.5 times the Fort Peck Dam spring flow release in the given release year. A further description of Alternative 1 is detailed in Chapter 2, Section 2.5 Alternatives Carried Forward for Detailed Evaluation.

3.13.2.4.1 National Economic Development

The NED analysis for Alternative 1 is summarized in Table 3-219. Table 3-220 includes a summary of all the years in the period of analysis. For all years over the period of record, Alternative 1 would result in an average annual increase of $221,000 (+0.04%) in thermal power NED value compared to the No Action Alternative over the period of record. The Missouri River power plants in the upper river would experience an increase in average annual power generation of 8,700 MWh and a negligible decrease in average annual variable costs of $62,000. There would not be changes in dependable capacity under Alternative 1 compared to the No Action Alternative. The variations in power generation, energy values, and variable costs compared to the No Action Alternative would be temporary, negligible, and beneficial because of the very minor change in river flows and water surface elevations from the No Action Alternative.

Table 3-219. Summary of Thermal Power NED Value for Alternative 1, 1931-2012 (2020 Dollars)

NED Value	NED Upper River[a]
Average Annual Missouri River Power Generation (MWh)	28,253,000
Change in Average Annual Generation from No Action (MWh)	+8,700
Average Annual Energy Values	$505,519,000

Change in Average Annual Energy Values from No Action	+$159,000
Percent Change in Average Energy Values from No Action	0.03%
Average Annual Dependable Capacity -- Summer (MW)	No Change from No Action
Average Annual Dependable Capacity – Winter (MW)	No Change from No Action
Average Annual Variable Costs[b]	-$155,000
Change in Average Annual Variable Costs from No Action	+$62,000
Average Annual NED Values	$505,364,000
Change in Average Annual NED Values from No Action[c]	+$221,000
Percent Change in Average Annual NED Values	+0.04%

Notes:

a The table reflects power generation, energy values, and variables costs associated with five power plants and one electricity conversion station. The Montana Dakota Utilities Coyote Plant would not be affected by changes in water surface elevations under the FPDTR-EIS alternatives and is not included in the evaluation.

b Variable costs include operations and maintenance costs incurred under adverse conditions when power generation is not affected. In addition, the variable costs include losses in renewable energy credits for Minnesota Power when Minnkota Power Cooperative Missouri River intake is impacted during the summer. Variable costs are shown as negative values to depict "costs" in the table; increases in costs are shown as a negative change from the No Action Alternative and decreases in costs are shown as a positive change from the No Action Alternative.

c Calculated by adding the change in average annual energy values with the change in average annual variable costs.

Additional results of flow actions are summarized in Table 3-220 for the POR from 1931 to 2012. These results show the difference in annual thermal power NED value during years when there would be a release action, the year after a full release and years with the greatest changes compared to the No Action Alternative. Beneficial changes from the No Action Alternative under Alternative 1 would occur during full and partial release years; there are only two years over the period of record with notable increases in thermal power NED value (up to 2% change from the No Action Alternative) under Alternative 1 (1983 and 1986). Releases from Fort Peck Lake would benefit reservoir elevations in Lake Sakakawea and river flows in the Garrison reach with fewer days below shut down intake elevations for three power plants compared to the No Action Alternative.

Table 3-220. Impacts from Flow Releases under Alternative 1 Compared to the No Action, 1931-2012 (2020 Dollars)

Release	NED Value Change	NED Upper River
Full Flow Release [a]	Lowest NED Value Change	−$2,700
	Highest NED Value Change	+$10,090,200
Partial Flow Release [b]	Lowest NED Value Change	−$2,700
	Highest NED Value Change	+7,480,000
Year after a Full Release	Lowest NED Value Change	$0
	Highest NED Value Change	+$440,000
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest NED Value Change	−$2,700
	Highest NED Value Change	+$10,090,200

Note: Impacts include changes in energy value and variable costs. Higher values represent higher NED value changes (beneficial impacts); negative values indicate reductions in the NED value or increased costs relative to the No Action Alternative.

a Flow action was fully implemented in 11 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was implemented.

b Flow action was partially implemented in 11 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was partially implemented.

3.13.2.4.2 Regional Economic Development

Impacts to power generation during peak seasons would be very similar to those described under the No Action Alternative, with drier and hotter periods potentially impacting consumer electricity rates associated with higher wholesale electricity prices. Alternative 1 would not contribute to these impacts. There would be a negligible change in the impacts to consumer electricity rates and household spending and associated regional economic conditions compared to the No Action Alternative.

3.13.2.4.3 Other Social Effects

Under Alternative 1, the changes in power generation compared to the No Action Alternative would be negligible, with negligible changes in air emissions and the social cost of carbon.

3.13.2.5 Alternative 1-1A Variation

Variation 1A is a test flow variation of Alternative 1. The parameters for 1A are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue Flow Regime is initiated on May 21, rather than May 28. Moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

3.13.2.5.1 National Economic Development

Variance 1A would result in an average annual increase in thermal power NED values compared to the No Action Alternative of $115,000 or 0.02 percent for the UMR power plants. On average, variable costs for power plants in the upper river under Variation 1A, would be slightly lower than the costs incurred under the No Action Alternative, and energy values would be slightly higher compared to the No Action Alternative (an increase in $104,000). There are no changes in capacity under Variation 1A compared to the No Action Alternative. Table 3-221 summarizes the thermal power NED values under Variation 1A.

Table 3-221. Summary of Thermal Power NED Value for Variation 1A, 1931-2012 (2020 Dollars)

NED Values	NED Upper River
Average Annual Missouri River Power Generation (MWh)	28,250,000
Change in Average Annual Generation from No Action (MWh)	+5,700
Average Annual Energy Values	$505,464,000
Change in Average Annual Energy Values from No Action	+$104,000
Percent Change in Average Energy Values from No Action	+0.02%
Average Annual Dependable Capacity -- Summer (MW)	No Change from No Action
Average Annual Dependable Capacity – Winter (MW)	No Change from No Action
Average Annual Variable Costs[b]	-$206,000
Change in Average Annual Variable Costs from No Action	+$11,000
Average Annual NED Values	$505,258,000
Change in Average Annual NED Values from No Action[c]	+$115,000
Percent Change in Average Annual NED Values	+0.02%

Notes:

a The table reflects power generation, energy values, and variables costs associated with five power plants and one electricity conversion station. The Montana Dakota Utilities Coyote Plant would not be affected by changes in water surface elevations under the FPDTR-EIS alternatives and is not included in the evaluation.

b Variable costs include operations and maintenance costs incurred under adverse conditions when power generation is not affected. In addition, the variable costs include losses in renewable energy credits for Minnesota Power when Minnkota Power Cooperative Missouri River intake is impacted during the summer. Variable costs are shown as negative values to depict “costs” in the table; increases in costs are shown as a negative change from the No Action Alternative and decreases in costs are shown as a positive change from the No Action Alternative.

c Calculated by adding the change in average annual energy values with the change in average annual variable costs.

Additional results of flow actions are summarized in Table 3-222 for the POR from 1931 to 2012. These results show the difference in annual thermal power NED value during years when there would be a release action, the year after a full release and years with the greatest changes compared to the No Action Alternative. Similar to Alternative 1, beneficial changes from the No Action Alternative under Variation 1A would occur during full release years; there are only two years over the period of record with notable increases in thermal power NED value (up to 1% change from the No Action Alternative) under Variation 1A (1983 and 1986). Releases from Fort Peck Lake would benefit reservoir elevations in Lake Sakakawea and river flows in the Garrison reach with fewer days below shut down intake elevations for three power plants compared to the No Action Alternative.

Table 3-222. Impacts from Flow Releases under Variation 1A Compared to the No Action Alternative, 1931-2012 (2020 Dollars)

Release	NED Value Change	Upper River
Full Flow Release [a]	Lowest NED Value Change	$0
	Highest NED Value Change	+$4,350,000
Partial Flow Release [b]	Lowest NED Value Change	$0
	Highest NED Value Change	+1,400
Year after a Full Release	Lowest NED Value Change	-$2,700
	Highest NED Value Change	+$551,000
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest NED Value Change	−$22,800
	Highest NED Value Change	+$4,350,000

Note: Impacts include changes in energy value and variable costs. Higher values represent higher NED value changes (beneficial impacts); negative values indicate reductions in the NED value or increased costs relative to the No Action Alternative.

a Flow action was fully implemented in 6 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was implemented.

b Flow action was partially implemented in 16 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was partially implemented.

3.13.2.5.2 Regional Economic Development

Impacts to power generation during peak seasons would be very similar to those described under the No Action Alternative, with drier and hotter periods potentially impacting consumer electricity rates associated with higher wholesale electricity prices. Variation 1A would not contribute to these impacts. There would be a negligible change in the impacts to consumer electricity rates and household spending and associated regional economic conditions compared to the No Action Alternative.

3.13.2.5.3 Other Social Effects

Under Variation 1A, the changes in power generation compared to the No Action Alternative would be negligible, with negligible changes in air emissions and the social cost of carbon compared to the No Action Alternative.

3.13.2.6 Alternative 1-1B Variation

Variation 1B is another test flow variation of Alternative 1. The parameters for 1B are the same as described for Alternative 1 except that the Attraction Flow is initiated on April 23 and the Spawning Cue Flow is initiated on June 4. Similar to the concept described in Variation 1A, the later initiation date is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

3.13.2.6.1 National Economic Development

Variation 1B would result in a slight decrease in average annual thermal power NED values of $41,000 compared to the No Action Alternative for the UMR power plants. On average, variable costs for power plants in the upper river under Variation 1B would be slightly lower ($2,800) than the costs incurred under the No Action Alternative, and energy values would be slightly lower (-$44,000) compared to the No Action Alternative. There are no changes in capacity under Variation 1B compared to the No Action Alternative. Table 3-223 summarizes the thermal power NED values.

Table 3-223. Summary of Thermal Power NED Value for Variation 1B, 1931-2012 (2020 Dollars)

NED Values	NED Upper River
Average Annual Missouri River Power Generation (MWh)	28,242,000
Change in Average Annual Generation from No Action (MWh)	-2,900
Average Annual Energy Values	$505,316,000
Change in Average Annual Energy Values from No Action	-$44,000
Percent Change in Average Energy Values from No Action	-0.01%
Average Annual Dependable Capacity -- Summer (MW)	No Change from No Action
Average Annual Dependable Capacity – Winter (MW)	No Change from No Action
Average Annual Variable Costs[b]	-$214,000
Change in Average Annual Variable Costs from No Action	+$2,800
Average Annual NED Values	$505,102,000
Change in Average Annual NED Values from No Action[c]	-$41,000
Percent Change in Average Annual NED Values	-0.01%

Notes:

a The table reflects power generation, energy values, and variables costs associated with five power plants and one electricity conversion station. The Montana Dakota Utilities Coyote Plant would not be affected by changes in water surface elevations under the FPDTR-EIS alternatives and is not included in the evaluation.

b Variable costs include operations and maintenance costs incurred under adverse conditions when power generation is not affected. In addition, the variable costs include losses in renewable energy credits for Minnesota Power when Minnkota Power Cooperative Missouri River intake is impacted during the summer. Variable costs are shown as negative values to depict “costs” in the table; increases in costs are shown as a negative change from the No Action Alternative and decreases in costs are shown as a positive change from the No Action Alternative.

c Calculated by adding the change in average annual energy values with the change in average annual variable costs.

Additional results of flow actions are summarized in Table 3-224 for the POR from 1931 to 2012. These results show the difference in annual thermal power NED value during years when there would be a release action, the year after a full release and years with the greatest changes compared to the No Action Alternative. Similar to Alternative 1 and Variation 1A, the simulated year 1983 would result in increased thermal power NED values compared to the No Action Alternative from higher river stages and flows. However, in 1986 as simulated, thermal power NED values would decrease by approximately $6.6 million or 1.3% compared to the No Action Alternative during a partial release year under Variation 1B. A partial release from Fort Peck Dam would decrease releases from Fort Peck Dam and Garrison Dam in July as the reservoir system rebalances following the partial release, which reduces river stages compared to the No Action Alternative, with adverse effects to power generation to one power plant and a conversion station.

Table 3-224. Impacts from Flow Releases under Variation 1B Compared to the No Action Alternative, 1931-2012 (2020 Dollars)

Release	NED Value Change	Upper River
Full Flow Release [a]	Lowest NED Value Change	$0
	Highest NED Value Change	+$0
Partial Flow Release [b]	Lowest NED Value Change	−$6,560,000
	Highest NED Value Change	$4,160,000
Year after a Full Release	Lowest NED Value Change	-$28,000
	Highest NED Value Change	+$440,000
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest NED Value Change	−$6,560,000
	Highest NED Value Change	+$4,160,000

Note: Impacts include changes in energy value and variable costs. Higher values represent higher NED value changes (beneficial impacts); negative values indicate reductions in the NED value or increased costs relative to the No Action Alternative.

a Flow action was fully implemented in 16 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was implemented.

b Flow action was partially implemented in 9 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was partially implemented.

3.13.2.6.2 Regional Economic Development

Impacts to power generation during peak seasons would be very similar to those described under the No Action Alternative, with drier and hotter periods potentially impacting consumer electricity rates associated with higher wholesale electricity prices. Variation 1B would not contribute to these impacts. There would be a negligible change in the impacts to consumer electricity rates and household spending and associated regional economic conditions compared to the No Action Alternative.

3.13.2.6.3 Other Social Effects

Under Variation 1B, the changes in power generation compared to the No Action Alternative would be negligible, with negligible changes in air emissions and the social cost of carbon.

3.13.2.6.4 Conclusion – Alternative 1 Including Variations

Under Alternative 1, including variations 1A and 1B, there would be negligible changes in average annual power generation, energy values, variable costs, and thermal power NED values compared to the No Action Alternative over the period of record. Changes in river flows and stages, including during full and partial release years, would result in increases (Alternative 1 and Variation 1A) and decreases (Variation 1B) in average annual NED values as the reservoir system rebalances (Table 3-207). The percentage change in average annual NED values would range from -0.01% to +0.11%. The last column of Table 3-204 provides a range of the values across the alternatives (i.e. the highest value minus to lowest value).The range for the average annual changes in NED value across the variations of Alternative 1 is $263,000 for all years over the period of record and $625,000 for the years with full or partial flow releases.

Variations 1 and 1A would result in very small increases in power generation and NED values compared to the No Action Alternative in two years from higher releases from Garrison Dam increasing flows and stages in the Garrison reach, with benefits to some power plants. In one year over the period of record under Variation 1B, a partial release from Fort Peck Dam would decrease releases from Garrison Dam, reducing river stages compared to the No Action Alternative, with adverse effects to power generation to one power plant and a conversion station. However, the decrease in NED value in this year would be small compared to the No Action Alternative (1.3%) and would be offset by years with higher NED values compared to the No Action Alternative. Table 3-225 provides a summary of the NED impacts for Alternative 1 including variations 1A and 1B in all years and in years when a partial or full flow release would be simulated to occur.

Table 3-225. Summary of NED Analysis for Alternative 1

NED Values	Alternative 1	Variation 1A	Variation 1B	Range across all Variations
All Years over the Period of Analysis				
Annual Average NED Value**	$505,364,000	$505,258,000	$505,102,000	$262,000
Difference in Annual Average NED Value from No Action	+$221,000	+$115,000	-$41,000	$263,000
Percentage Difference from No Action	+0.04%	+0.02%	-0.01%	+0.05%
Full or Partial Release Years over the Period of Analysis				
Annual Average NED Value**	$508,511,000	$508,165,000	$508,232,000	$346,000

Difference in Annual Average NED Value from No Action	+$565,000	+$301,000	-$60,000	$625,000
Percentage Difference from No Action	+0.11%	+0.06%	-0.01%	+0.12%

* Fiscal year 2020 prices.
** NED Value = Energy Value Less Variable Costs

3.18.2.1 Alternative 2

The parameters for Alternative 2 are the same as described for Alternative 1 except that the Attraction Flow Regime peak is 14,000 cfs (the maximum powerhouse capacity) rather than twice the average Fort Peck spring flow in the given year. The maximum amount of flow that can be run through the generators is 14,000 cfs. Any additional flow is run through the spillway and does not generate hydroelectricity. Additionally, releases as measured at Wolf Point gage are held at 14,000 cfs until the Spawning Cue release is initiated.

3.13.2.6.5 National Economic Development

Alternative 2 would result in an increase in thermal power NED values compared to the No Action Alternative of +$20,500 for the UMR power plants. On average, variable costs for power plants in the upper river under Alternative 2 would be slightly higher than the costs incurred under the No Action Alternative, and energy values would be slightly higher (+$22,000) compared to the No Action Alternative. There are no changes in capacity under Alternative 2 compared to the No Action Alternative. Table 3-226 summarizes the thermal power NED values.

Table 3-226. Summary of Thermal Power NED Value for Alternative 2, 1931-2012 (2020 Dollars)

NED Values	Upper River
Average Annual Missouri River Power Generation (MWh)	28,246,000
Change in Average Annual Generation from No Action (MWh)	+1,500
Average Annual Energy Values	$505,382,000
Change in Average Annual Energy Values from No Action	+$22,000
Percent Change in Average Energy Values from No Action	0.00%
Average Annual Dependable Capacity -- Summer (MW)	No Change from No Action
Average Annual Dependable Capacity – Winter (MW)	No Change from No Action
Average Annual Variable Costs[b]	-$218,000
Change in Average Annual Variable Costs from No Action	-$1,100
Average Annual NED Values	$505,163,000
Change in Average Annual NED Values from No Action[c]	+$20,500
Percent Change in Average Annual NED Values	0.00%

Notes:

a The table reflects power generation, energy values, and variables costs associated with five power plants and one electricity conversion station. The Montana Dakota Utilities Coyote Plant would not be affected by changes in water surface elevations under the FPDTR-EIS alternatives and is not included in the evaluation.

b Variable costs include operations and maintenance costs incurred under adverse conditions when power generation is not affected. In addition, the variable costs include losses in renewable energy credits for Minnesota Power when Minnkota Power Cooperative Missouri River intake is impacted during the summer. Variable costs are shown as negative values to depict "costs" in the table; increases in costs are shown as a negative change from the No Action Alternative and decreases in costs are shown as a positive change from the No Action Alternative.

c Calculated by adding the change in average annual energy values with the change in average annual variable costs.

Additional results of flow actions are summarized in Table 3-227 for the POR from 1931 to 2012. These results show the difference in annual thermal power NED value during years when there would be a release action, the year after a full release and years with the greatest changes compared to the No Action Alternative. Similar to Alternative 1, there are still beneficial changes from the No Action Alternative under Alternative 2 that would occur during partial release years; there is only one year over the period of record with notable increases in thermal power NED value (up to 1.5% change from the No Action Alternative) under Alternative 2 (1986). In 1986 as simulated, a full release from Fort Peck Dam would occur, which would result in higher releases from Garrison Dam in the summer and early fall; during July, August, and September, the releases from Garrison Dam would be higher under Alternative 2 compared to the No Action Alternative, which would increase river flows and stages in the Garrison reach.

In 2005, as simulated, there would be a notable decrease in thermal power NED value (-$6 million or -1.2%) from the No Action Alternative. This occurs when releases from Garrison Dam would be lower under Alternative 2 by about 1,000 cfs compared to the No Action Alternative after the system rebalances following a full release in 2000. The relatively lower river flows and stages would affect two power plants during this year, with more days below shut down compared to the No Action Alternative.

Table 3-227. Impacts from Flow Releases under Alternative 2 Compared to No Action, 1931-2012 (2020 Dollars)

Release	NED Value Change	Upper River
Full Flow Release [a]	Lowest NED Value Change	-$1,040,000
	Highest NED Value Change	+$966,000
Partial Flow Release[b c]	Lowest NED Value Change	−$1,400
	Highest NED Value Change	+7,500,000
Year after a Full Release	Lowest NED Value Change	$0
	Highest NED Value Change	+$22,800
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest NED Value Change	−$6,000,000
	Highest NED Value Change	+$7,500,000

Note: Impacts include changes in energy value and variable costs. Higher values represent higher NED value changes (beneficial impacts); negative values indicate reductions in the NED value or increased costs relative to the No Action Alternative.

a Flow action was fully implemented in 10 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was implemented.

b Flow action was partially implemented in 10 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was partially implemented.

3.13.2.6.6 Regional Economic Development

Impacts to power generation during peak seasons would be very similar to those described under the No Action Alternative, with drier and hotter periods potentially impacting consumer electricity rates associated with higher wholesale electricity prices. Alternative 2 would not contribute to these impacts. There would be a negligible change in the impacts to consumer electricity rates and household spending and associated regional economic conditions compared to the No Action Alternative.

3.13.2.6.7 Other Social Effects

Under Alternative 2, the changes in power generation compared to the No Action Alternative would be negligible, with negligible changes in air emissions and the social cost of carbon.

3.18.2.2 Alternative 2 – 2A Variation

Variation 2A is a test flow variation of Alternative 2. The parameters for Alternative 2A are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 9, rather than April 16, and the Spawning Cue flow would be initiated on May 21, rather than May 28. Again, moving the initiation date earlier in April is intended to analyze the differences in forecasted impacts that may result from altering the start of the test releases.

3.13.2.6.8 National Economic Development

Variation 2A would result in average annual increase in thermal power NED values of $68,000 compared to the No Action Alternative for the UMR power plants. On average, variable costs for power plants in the upper river under Variation 2A would be lower (+$30,000) than the costs incurred under the No Action Alternative, and energy values would be slightly higher (+$38,000) compared to the No Action Alternative. There are no changes in capacity under Variation 2A compared to the No Action Alternative. Table 3-228 summarizes the thermal power NED values.

Table 3-228. Summary of Thermal Power NED Value for Variation 2A, 1931-2012 (2020 Dollars)

NED Values	Upper River
Average Annual Missouri River Power Generation (MWh)	28,247,000
Change in Average Annual Generation from No Action (MWh)	+2,300
Average Annual Energy Values	$505,398,000
Change in Average Annual Energy Values from No Action	+$38,400
Percent Change in Average Energy Values from No Action	0.01%
Average Annual Dependable Capacity -- Summer (MW)	No Change from No Action
Average Annual Dependable Capacity – Winter (MW)	No Change from No Action
Average Annual Variable Costs[b]	-$187,000
Change in Average Annual Variable Costs from No Action	+$30,000
Average Annual NED Values	$505,211,000
Change in Average Annual NED Values from No Action[c]	+$68,000
Percent Change in Average Annual NED Values	+0.01%

Notes:

a The table reflects power generation, energy values, and variables costs associated with five power plants and one electricity conversion station. The Montana Dakota Utilities Coyote Plant would not be affected by changes in water surface elevations under the FPDTR-EIS alternatives and is not included in the evaluation.

b Variable costs include operations and maintenance costs incurred under adverse conditions when power generation is not affected. In addition, the variable costs include losses in renewable energy credits for Minnesota Power when Minnkota Power Cooperative Missouri River intake is impacted during the summer. Variable costs are shown as negative values to depict “costs” in the table; increases in costs are shown as a negative change from the No Action Alternative and decreases in costs are shown as a positive change from the No Action Alternative.

c Calculated by adding the change in average annual energy values with the change in average annual variable costs.

Additional results of flow actions are summarized in Table 3-229 for the POR from 1931 to 2012. These results show the difference in annual thermal power NED value during years when there would be a release action, the year after a full release and years with the greatest changes compared to the No Action Alternative. There are very similar effects under Variation 2A compared to Alternative 2 (1986 and 2005 effects are similar across all variations under Alternative 2). Under Variation 2A; there are two years over the period of record with notable increases in thermal power NED value (up to 1.6% change from the No Action Alternative) under Variation 2A (1983 and 1986). Similar to Alternative 2, during 2005 as simulated, there is a notable decrease in thermal power NED value (up to 1.2% change) from the No Action Alternative.

Table 3-229. Impacts from Flow Releases under Variation 2A Compared to No Action, 1931-2012 (2020 Dollars)

Release	NED Value Change	Upper River
Full Flow Release[a]	Lowest NED Value Change	−$1,050,000
	Highest NED Value Change	+$4,140,000
Partial Flow Release[b]	Lowest NED Value Change	$0

	Highest NED Value Change	+1,400
Year after a Full Release	Lowest NED Value Change	-$1,400
	Highest NED Value Change	+$0
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest NED Value Change	−$6,000,000
	Highest NED Value Change	+$8,500,000

Note: Impacts include changes in energy value and variable costs. Higher values represent higher NED value changes (beneficial impacts); negative values indicate reductions in the NED value or increased costs relative to the No Action Alternative.

a Flow action was fully implemented in 5 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was implemented.

b Flow action was partially implemented in 15 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was partially implemented.

3.13.2.6.9 Regional Economic Development

Impacts to power generation during peak seasons would be very similar to those described under the No Action Alternative, with drier and hotter periods potentially impacting consumer electricity rates associated with higher wholesale electricity prices. Variation 2A would not contribute to these impacts. There would be a negligible change in the impacts to consumer electricity rates and household spending and associated regional economic conditions compared to the No Action Alternative.

3.13.2.6.10 Other Social Effects

Under Variation 2A, the changes in power generation compared to the No Action Alternative would be negligible, with negligible changes in air emissions and the social cost of carbon.

3.13.2.7 Alternative 2-2B Variation

Variation 2B is a test flow is another variation of Alternative 2. The parameters for Alternative 2B are the same as described for Alternative 2 except that the Attraction Flow is initiated on April 23, rather than April 16, and the Spawning Cue flow is initiated on June 4, rather than May 21. Again, the difference in timing is intended to provide a contrast to explore any differences in forecasted impacts from a later flow initiation date.

3.13.2.7.1 National Economic Development

Variation 2B would result in average annual increase in thermal power NED values compared to the No Action Alternative of $70,000 for the UMR power plants. On average, variable costs for power plants in the upper river under Variation 2B would be slightly lower (+$35,000) than the costs incurred under the No Action Alternative, and energy values would be slightly higher (+$35,000) compared to the No Action Alternative. There are no changes in capacity under Variation 2B compared to the No Action Alternative. Table 3-230 summarizes the thermal power NED values.

Table 3-230. Impacts from Flow Releases under Variance 2B Compared to the No Action Alternative, 1931-2012 (2020 Dollars)

NED Values	Upper River
Average Annual Missouri River Power Generation (MWh)	28,247,000
Change in Average Annual Generation from No Action (MWh)	+2,000
Average Annual Energy Values	$505,395,000
Change in Average Annual Energy Values from No Action	+$35,000
Percent Change in Average Energy Values from No Action	0.01%
Average Annual Dependable Capacity -- Summer (MW)	No Change from No Action
Average Annual Dependable Capacity – Winter (MW)	No Change from No Action
Average Annual Variable Costs[b]	-$182,000
Change in Average Annual Variable Costs from No Action	+$35,000
Average Annual NED Values	$505,213,000
Change in Average Annual NED Values from No Action[c]	+$70,000
Percent Change in Average Annual NED Values	+0.01%

Notes:

a The table reflects power generation, energy values, and variables costs associated with five power plants and one electricity conversion station. The Montana Dakota Utilities Coyote Plant would not be affected by changes in water surface elevations under the FPDTR-EIS alternatives and is not included in the evaluation.

b Variable costs include operations and maintenance costs incurred under adverse conditions when power generation is not affected. In addition, the variable costs include losses in renewable energy credits for Minnesota Power when Minnkota Power Cooperative Missouri River intake is impacted during the summer. Variable costs are shown as negative values to depict "costs" in the table; increases in costs are shown as a negative change from the No Action Alternative and decreases in costs are shown as a positive change from the No Action Alternative.

c Calculated by adding the change in average annual energy values with the change in average annual variable costs.

Additional results of flow actions are summarized in Table 3-231 for the POR from 1931 to 2012. These results show the difference in annual thermal power NED value during years when there would be a release action, the year after a full release and years with the greatest changes compared to the No Action Alternative. There are very similar effects under Variation 2B compared to Alternative 2A, with higher thermal power NED values as simulated in 1983 (full release year) and 1986 (partial release year), and lower thermal power NED values in 2005 when compared to the No Action Alternative.

Table 3-231. Impacts from Flow Releases under Variation 2B Compared to No Action, 1931-2012 (2020 Dollars)

Release	NED Value Change	Upper River
Full Flow Release [a]	Lowest NED Value Change	−$1,400
	Highest NED Value Change	+$4,110,000
Partial Flow Release [b]	Lowest NED Value Change	-$22,000
	Highest NED Value Change	+$7,460,000
Year after a Full Release	Lowest NED Value Change	$0
	Highest NED Value Change	+$58,000
Years with Greatest Range in Impacts Regardless of Flow Actions	Lowest NED Value Change	−$6,000,000
	Highest NED Value Change	+$7,460,000

Note: Impacts include changes in energy value and variable costs. Higher values represent higher NED value changes (beneficial impacts); negative values indicate reductions in the NED value or increased costs relative to the No Action Alternative.

a Flow action was fully implemented in 16 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was implemented.

b Flow action was partially implemented in 9 years of the POR. Data represents the lowest and highest dollar impacts in the years the action was partially implemented.

3.13.2.7.2 Regional Economic Development

Impacts to power generation during peak seasons would be very similar to those described under the No Action Alternative, with drier and hotter periods potentially impacting consumer electricity rates associated with higher wholesale electricity prices. Variation 2B would not contribute to these impacts. There would be a negligible change in the impacts to consumer electricity rates and household spending and associated regional economic conditions compared to the No Action Alternative.

3.13.2.7.3 Other Social Effects

Under Variation 2B, the changes in power generation compared to the No Action Alternative would be negligible, with negligible changes in air emissions and the social cost of carbon.

3.13.2.8 Conclusion – Alternative 2 Including Variants

Under Alternative 2, including variations 2A and 2B, there would be negligible changes in average annual power generation, energy values, variable costs, and thermal power NED values compared to the No Action Alternative. Changes in river flows and stages, including during full and partial release years, would result in slight increases in average annual NED values. The percentage change in average annual NED values would range from no change to +0.08%. The last column of Table 3-214 provides a range of the values across the alternatives (i.e. the highest value to the lowest value). The range for the average annual changes in NED value across the variations of Alternative 1 is $50,000 for all years over the period of record and $150,000 for the years with full or partial flow releases.

Under Alternative 2, there would be one year with a notable increase in NED value compared to the No Action Alternative, while in Variation 2A and 2B, there would be two years with notable increases in thermal power NED values compared to the No Action Alternative. These relative increases in NED value would result from higher releases from Garrison Dam increasing flows and stages in the Garrison reach associated with full or partial releases in these years from Fort Peck Dam.

In one year over the period of record under Alternative 2 and variations 2A and 2B, a partial or full release from Fort Peck Dam would decrease releases from Garrison Dam in a subsequent year, reducing river flows and stages compared to the No Action Alternative, with adverse effects to power generation. However, the decreases in NED value in this year would be small compared to the No Action Alternative (1.2%) and would be offset by years with higher NED values compared to the No Action Alternative. Table 3-232 provides a summary of the NED impacts for Alternative 2 including variations 2A and 2B in all years and in years when a partial or full flow release would be simulated to occur.

Table 3-232. Summary of NED Analysis for Alternative 2

NED Values	Alternative 2	Variation 2A	Variation 2B	Range across all Variations
All Years over the Period of Analysis				
Annual Average NED Value**	$505,163,000	$505,211,000	$505,213,000	$50,000
Difference in Annual Average NED Value from No Action	+$20,000	+$68,000	+$70,000	$50,000
Percentage Difference from No Action	0.00%	+0.01%	+0.01%	0.01%
Full or Partial Release Years over the Period of Analysis				
Annual Average NED Value**	$508,992,000	$509,082,000	$508,606,000	$476,000
Difference in Annual Average NED Value from No Action	+$250,000	+$400,000	+$314,000	$150,000
Percentage Difference from No Action	+0.06%	+0.08%	+0.06%	+0.03%

* Fiscal year 2020 prices.

** NED Value = Energy Value Less Variable Costs

3.18.2.3 Tribal Resources

There are no power plants located on Tribal lands; all Tribal members would be affected by the RED and OSE effects as described in the previous sections.

3.18.2.4 Climate Change

A discussion on the influence of climate change on the alternatives is included in Section 3.2 River Infrastructure under Climate Change. The more extreme flood and drought periods would result in difficulties forecasting runoff and System storage. For drier periods under climate change, river stages would be reduced with the potential for a greater number of days below critical operating thresholds for thermal power plants. Impacts of climate change under Alternatives 1 and 2 would be similar to those described under the No Action Alternative.

3.18.2.5 Cumulative Impacts

Consumption of electricity has steadily increased, with sales of electricity increasing by 1.4 percent per year nationwide on average since 1990. Electricity sales in the Missouri River basin states have increased at a slightly higher rate of 2.0 percent on average over the same period. Continued increasing demand for electricity would benefit power generators, with market pressure to maintain generation with capital investments to maintain and increase capacity. However, the demand for cleaner electricity (i.e., natural gas and renewables) would result in increased environmental pressures and adverse effects for the coal-based power plants in the upper river.

In addition, fuel costs for power plants, including the price of coal and natural gas, would have both adverse and beneficial impacts on utilities and power plants, which would affect operating costs, RTO wholesale electricity prices, and potentially retail electricity rates. Costs to maintain operations and power generation and for replacement power would result in temporary and long-term adverse impacts to utilities, power plants, and potentially consumers of electricity.

EPA has proposed or implemented five recent rules that would affect Missouri River thermal power plants, including: the Clean Power Plan; Mercury and Air Toxics Standards (MATS); the Cross-State Air Pollution Rule (CSAPR); the Coal Ash Rule; and the Cooling Water Intake Structures Rule. However, more recently, the Clean Power Plan was recently repealed and the Mercury and Air Toxics Standards is under review. While there is current uncertainty for some of these rules and regulations, the trend toward policies that reduce the impacts of climate change and increase environmental protection would likely affect industry decisions.

The first three rules pertain to limiting air pollutants from coal-fired power plants including carbon dioxide, sulfur dioxide, nitrous oxide, mercury, hydrogen fluoride, and hydrogen chloride. Implementation of these rules could require additional pollution control equipment to reduce power plant emissions from coal-fired power plants. The Coal Ash Rule would require coal-fired power plants to close surface ash impoundments and dispose of ash in regulated landfills; EPA is currently considering amending the rule to allow states to determine how they would enforce it individually. The Cooling Water Intake Structures Rule would require plants with once through cooling technologies to use best technologies available for their cooling systems, which may force power plants to construct cooling towers or construct intake structures to limit potential impacts to fish and other aquatic organisms from entering cooling water intakes. Utilities may choose to retire power plants rather than comply with the rules because it may not be cost effective to undertake costly investments to comply with these rules or similar future ones.

Construction of the System and the associated dams allows operation with controlled flow releases from the upper river into the lower river to achieve multiple management objectives, including providing water supply access for various uses. Variability in natural hydrologic conditions (precipitation and snowmelt, which include periods of drought and high runoff) and the “rules” governing System operation would continue to dominate the flows in the Missouri River into the future. Natural flow variability and the requirement to operate for all authorized purposes under the Master Manual would continue to be the primary drivers of impact to access to water and river water temperatures on the Missouri River, thus impacting intake access and the ability to discharge water for thermal power plants. Other actions and programs, such as water depletions or withdrawals for agriculture, municipal, and industrial uses would continue to have adverse impacts to intake access to water, as they would affect the water surface elevations and flows of the river and reservoirs.

Future aggradation and degradation trends would have similar effects under all of the alternatives, although HEC-RAS modeling indicates that the action alternatives would not significantly contribute to aggradation or degradation. The change in stage in the riverine areas in the upper river over time relative to the No Action Alternative would be nearly the same for all alternatives. Actions that affect bed degradation could impact the riverbed and the stage of the river over time as well as the stability of the intake and outfall infrastructure of the power plant and reduce the ability of the plant to access water for cooling. Actions that affect aggradation, such as floodplain development and habitat construction, could impact sediment and/or silting in intakes or outfalls. These types of actions would result in long-term, adverse impacts to power plants and may require power plants to incur operating and maintenance costs or undertake capital investments to modify intakes and/or dredge sediment. It could also impact the ability of power plants to generate power with reduced access to water.

Continued management of the System would provide large energy and capacity benefits under the No Action Alternative and Alternatives 1 and 2 and their variations. The Fort Peck Dam test releases would have some adverse effects on upper river thermal power generation and NED values in some years, but the decreases would be offset by years with increases in power generation and thermal power NED values, with negligible changes on average from the No Action Alternative. There would be negligible changes in thermal power RED and OSE benefits compared to the No Action Alternative.

When combined with other past, present, and reasonably foreseeable future actions, the cumulative impacts associated with the No Action Alternative would be both beneficial and adverse in the short term although in the long-term would likely be primarily adverse. Although power plants would continue to provide essential electricity to the MISO and SPP RTOs, they would be adversely impacted by climate, air quality, water quality, and other environmental regulations, natural cycles of drought, higher fuel costs, and actions that affect bed degradation and aggradation. Natural wet hydrologic periods along with actions such as bank stabilization activities would provide some benefits to power plants but these activities are small in comparison with the potentially large adverse impacts of pending and current environmental regulations, fuel costs, and natural drought periods. The continued implementation of the No Action Alternative and Alternatives 1, 2, and the variations would provide a negligible contribution to these cumulative impacts.

3.14 Unavoidable Adverse Impacts

Unavoidable adverse impacts are those impacts that cannot be avoided or fully mitigated should a test flow be implemented. Table 3-233 describes those types of impacts which may not be fully avoided, as required by CEQ regulations (40 CFR 1502.16). Location and intensity of unavoidable impacts would be similar between the alternatives. Full descriptions of impacts are provided under each resource topic previously in this chapter. Most unavoidable adverse impacts would be short-term in nature restricted to years in which a test-flow release occurs. Some impacts would be longer-term and would last several years or more after test releases are implemented. The alternatives are designed to avoid or minimize adverse impacts by restricting the conditions under which a test flow release is implemented, but certain disturbances would still occur (e.g., increased erosion, temporary adverse impacts to flood risk management, hydropower, and irrigation).

Table 3-233. Unavoidable adverse impacts to resources

Resource	Unavoidable Adverse Impacts
River Infrastructure and Hydrologic Processes	• Overall, small, temporary impacts on the river system from releases, including changes in reservoir elevations and shoreline erosion in the upper three reservoirs, and degradation and aggradation rates (and associated future water levels) in the inter-reservoir reaches from Fort Peck Dam to Lake Sakakawea and from Garrison Dam to Lake Oahe. •
Fish and Wildlife Habitat	• There would be temporary small adverse impacts to reservoir terrestrial habitats and fisheries during test flow years depending on location and species. Fort Peck Lake levels would be lower during test flow years and Lake Sakakawea levels would be higher.
Water Quality	• Negligible to small temporary increases in sediment and turbidity could occur during test flow years below Fort Peck Dam from increased erosion due to higher flows. • Small temporary increases in water temperature and decreases in dissolved oxygen would occur in April and then again in mid-May to July below the Fort Peck Dam Spillway which discharges approximately 9 miles downstream of the Dam. This would be a benefit to native warmwater species and an adverse impact to non-native coldwater species.
Cultural Resources	• Cultural resources located along reservoirs and river banks would be at risk of adverse impacts due to erosion, vandalism, or looting, depending on water levels under Alternatives 1 and 2.
Flood Risk Management and Interior Drainage	• Alternatives 1 and 2 would both have a small adverse impact on flood risk management in the Fort Peck Dam to Lake Sakakawea reach compared to the No Action Alternative.
Hydropower	• Under Alternatives 1 and 2, the Missouri River hydropower system would experience a small average annual benefit on average. However, Ft. Peck hydropower specifically would experience small adverse impacts on average, which can be large in full flow and partial flow years.
Irrigation	• Test flows under Alternatives 1 and 2 would have an overall small adverse impact due to changes in river stages and reservoir elevations associated with test flow releases. Some local impacts could be large.
Recreation	• Alternatives 1 and 2 would cause visitation to Fort Peck Lake to decrease in some of the years when a release would occur or the year following a release, when reservoir elevations are lower than under No Action. Adverse impacts would be temporary and would range from small to large depending on the year. USACE would coordinate with recreation community prior to implementing a release, but is likely that not all impacts due to lower reservoir levels could be avoided.

3.15 Relationship between Short-Term Uses and Long-Term Productivity

To facilitate comparison of the alternatives, NEPA requires that an EIS consider the proposed short-term uses of the environment and the maintenance and enhancement of long-term productivity (40 CFR Section 1502.16). This section discusses whether the short-term uses of water resources proposed by the alternatives would impact, either adversely or beneficially, the long-term productivity of the environment.

Short-term uses necessary to carry out the action alternatives would include water used for test flow releases. Impacts of these short-term uses of water include disturbance or alteration of aquatic and terrestrial habitats, water quality impacts associated with increased turbidity, temporary impacts to hydropower, irrigation, and flood risk management, and temporary loss of recreational opportunities, and all associated economic impacts. The maintenance and enhancement of long-term environmental productivity is not anticipated to be affected by the test flow alternatives given they are test flows that would occur only 3-5 times over a relative short time frame.

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3.16 Irreversible and Irretrievable Commitment of Resources

NEPA requires that an EIS include a discussion of any irreversible and irretrievable commitments of resources that would be involved in the Proposed Action should it be implemented (40 CFR 1502.16). An irreversible or irretrievable commitment of resources refers to impacts on or losses to resources that cannot be recovered or reversed. The use of water resources associated with flow actions under the alternatives would not represent an irreversible or irretrievable commitment of resources because it is assumed that water resources would be restored during the winter months as part of the annual precipitation cycle. In the event of drought conditions, it may take several years for water resources to be restored. .
The primary irreversible and irretrievable commitment of resources associated with the proposed test flows would be the use of funding and labor expended to design, analyze, implement, and monitor the test flows that otherwise could be directed to another management action or program. The Fort Peck test flow management action has been prioritized to fulfill the Corps' commitment in the 2018 Biological Opinion (BiOp) to examine test flows from Fort Peck Dam.

4.0 Preferred Alternative Implementation

4.1 Introduction

This chapter summarizes how the U.S. Army Corps of Engineers (USACE) would implement the preferred alternative under the Ft Peck AM Framework included as Appendix H of this EIS. The AM Framework is a companion document to this EIS and is the implementation plan for the preferred alternative. The AM Framework identifies the process and criteria to implement the initial actions, assess hypotheses, and introduce new actions should they become necessary. The AM Framework will ultimately be incorporated into the MRRMP-EIS SAMP and can be changed as new information is learned from monitoring of actual performance and processed through a governance structure. The SAMP describes the governance approach and decision-making processes which would be used to assess, plan and design, implement, evaluate, and finally make adjustments based on new information. Any future actions identified through the AM process would need to comply with all applicable laws, including NEPA and will require a separate public involvement process.

4.2 The Preferred Alternative

As identified in Chapter 2, Alternative 1 (Alt 1), including its variations, has been identified as the preferred alternative. A full description of the alternative can be found in Section 2.5 and 2.7.

The Alt 1 test flow may be implemented in any given year in which conditions meet the implementation criteria discussed below, with consideration given to the current state of the science, condition of the Upper Basin pallid sturgeon population, and applicable law and policy. Because the test flow is considered to be experimental, it is anticipated that the test flow would only run 3-5 times. There could be periods of time where a test flow is not able to be implemented because of drought, high flow conditions, or other reasons. It is possible that implementing the test flow 3-5 times under either of the action alternatives would occur over an extended period of time given that full flows would be predicted to run only 11-16 times over the 82 year period of record modeling. Appropriate conditions to run the flow would be assessed on a year to year basis. A permanent change in operations to implement the flow change may require additional analyses and will require a separate public involvement process. Several criteria must be met in order to run the test flow (or continue to run the test flow once it has begun):

- The forecasted Fort Peck Lake pool elevation must remain above 2227.0 feet for the duration of the test flow
- The May – June monthly runoff forecast in the Fort Peck to Garrison reach of the river cannot exceed that of an upper quartile year
- The forecasted flow at Wolf Point, MT or Culbertson, MT cannot exceed 35.0 kcfs
- The forecasted stages at Williston, ND cannot reach flood stage (22.0 feet)
- The forecasted water surface elevation cannot exceed 1853.5 feet at the downstream portion of the Williston Levee.
- The forecasted Lake Sakakawea pool elevation must remain below 1850.0 feet for the duration of the test flow
- It is acknowledged that no forecasts are perfect and the criteria above can be exceeded when observed precipitation exceeds forecasted precipitation. The best available forecasting tools will be used to minimize the risk of exceeding the criteria.

Section 5.3.2 of the SAMP and Chapter V of the USACE Master Manual include discussions of routine monitoring that occurs as part of operation of the system that will help understand any impacts that occur to HCs from the preferred alternative once implemented. In addition, specific monitoring of the Fort Peck spillway will occur as discussed in 3.2.2.11 to identify any impacts from use of the spillway for the purpose of a test flow.

Effective monitoring of implementation of the action would include measuring physical conditions in the river, tracking of adult movement and spawning, as well as monitoring early life stages (e.g., free embryo and larvae). The UMR below Fort Peck Dam is part of an integrated system which includes the Yellowstone River. Hence, monitoring would need to occur across this entire system and, as such, include coordination and engagement across multiple state and federal agencies. At this time, monitoring of a potential test flow is expected to include activities described in Table 4-1, which are aligned with monitoring activities described in Appendix E of the SAMP. These metrics would inform an evidentiary framework for determining if Fort Peck flows are benefiting pallid sturgeon. This framework is described in Section 3.7 of the Fort Peck AM Framework (Appendix H). By necessity, these activities would also be aligned and integrated with other past, on-going, and/or planned studies (e.g., Pallid Sturgeon Population Assessment Program [PSPAP], Habitat Assessment and Monitoring Project [HAMP], genetic studies, free embryo release experiments).

Table 4-1. Summary of monitoring activities and performance metrics to evaluate effectiveness of potential Fort Peck Level 2 actions

Monitoring Activity	Performance Metrics
Fixed in-river monitoring to characterize discharge, stage, and temperature conditions. If possible, turbidity or conductivity should also be monitored for their potential roles as covariates.	• Water temperature • Discharge • Turbidity or conductivity
Free embryo sampling (and genetic analysis) using rectangular plankton nets deployed by boat to collect free embryos downstream from identified spawning sites. These samples will be subject to genetic analysis to identify species, and in the case of identified pallid sturgeon, parentage.	• Number of free embryos • Genetic ID
Age-0 sampling (and genetic analysis) using benthic beam or otter trawling methods to collect age-0 fish. This activity is to target potential progeny that have survived to later in the season, further downstream.	• Number of age-0 individuals • Genetic ID
Tagging (and genetic analysis) of reproductive and non-reproductive adults by deploying drifted trammel nets to catch, tag (with acoustic tags), and collect baseline biological information.	• Fish ID • Fish condition (length, weight, Kn, health metrics) • Sex • Reproductive stage
Passive telemetry network as represented by automated and fixed telemetry logging stations to document location, movement, and potential spawning of tagged individuals across segments and reaches within the Upper Missouri and Yellowstone Rivers.	• Fish ID • River mile location • Movement of tagged adults passing points along network
Manual tracking of tagged adults by boat (or aerial flights if more appropriate) to provide a finer scale resolution of information on the location and movement of tagged individuals at the reach, bend, and macro-habitat scale (equipped with acoustic receivers).	• Fish ID • location, movement • Aggregation and spawning behavior
Detailed monitoring of spawners at a spawning site using 2D / 3D acoustic telemetry arrays and boat-mounted DIDSON acoustic imagery to precisely document fish location and behavior at a spawning site at the time of suspected spawning.	• Fish ID • 2D / 3D location • Movement, aggregation and spawning behavior • Substrate conditions
Adult recapture and reproductive assessment using drifted trammel nets to catch tagged adults after spawning has occurred and confirm spawning outcome (using surgical evaluation, endoscopy, ultrasound, weight, and/or blood samples).	• Fish ID • Spawning outcome

Physical monitoring of the affected environment will be performed during the flow test for the purposes of evaluating potential impacts to bank erosion, flood extent, water intakes, Fort Peck Dam spillway, and similar concerns. General goals and methods of the monitoring plan are as follows:

- Bank Erosion. Ten to twenty representative locations will be selected for bank erosion monitoring. Repetitive channel and bank surveys will be used to evaluate conditions before, during, and after the flow test.

- Water Intakes. Twenty to thirty representative municipal and irrigation water intakes will be monitored to evaluate sandbar migration, turbidity, and similar geomorphic processes to evaluate potential impact on function. Other areas identified as critical features will be monitored on an as-needed basis.
- Water Surface Elevation Profiles. A water surface profile before, during, and after the flow test will be collected to evaluate hydraulic model accuracy, flood inundation extent, and to identify changes in water surface elevations in the reach.
- Aerial Photography. A before, during, and after test set of aerial photos will be collected for use in identifying bank erosion.
- Fort Peck Dam Spillway. Installation of equipment to monitor flow within the discharge channel sub-drain system to help estimate uplift pressures due to the test flow.
- Surveys of the new RCC structure walls to determine if they move as a result of the test flow.
- Surveys of the downstream unlined channel to determine the amount of channel scour and bank erosion due to the test flow.
- Flow measurement and velocity information will be collected with the spillway exit channel and the Missouri River to assess velocity distribution and magnitude. This information will be used to evaluate risk during sustained releases and drawdown.

4.3 Implementation Authorities and Process

The authority to implement the preferred alternative is inherent in the USACE discretion and authority to operate the System for all of its purposed under the Flood Control Act of 1944.

Implementation of the test flow outlined in the preferred alternative would occur through a Master Manual deviation request that would be coordinated through Missouri River Basin Water Management biannual public meetings. This ensures the test flow is incorporated in the Annual Operating Plan and the public is informed. This EIS serves as the NEPA compliance process for this potential deviation.

In addition to discussion at the biannual public meetings, any updates regarding the test release would be posted at https://www.nwd.usace.army.mil/MRWM/MRWM-News/ and notifications would be posted on social media and provided in the NWD Water Management (WM) monthly press release. Individuals wishing to be on the contact list for the press release should contact cenwd-pa@usace.army.mil and ask to be on the emailing lists for information specific to the Fort Peck Project or Missouri River Water Management Operations.

5.0 Tribal, Stakeholder and Public Involvement

This chapter describes Tribal, stakeholder and public involvement as well as the coordination and public engagement activities that have been conducted as part of the Fort Peck Dam Test Release –Environmental Impact Statement.

5.1 Missouri River Recovery Implementation Committee

The Missouri River Recovery Implementation Committee (MRRIC) is an interdisciplinary group charged by Congress with making recommendations and providing guidance on a long-term study of the Missouri River and its tributaries and on the existing Missouri River recovery and mitigation plan. MRRIC recommendations and USACE responses related to the FPDTR-EIS process can be found in Appendix J. The committee was established by the Secretary of the Army in 2008, as authorized by Section 5018 of the 2007 Water Resources Development Act (WRDA). The committee is intended to help guide the prioritization, implementation, monitoring, evaluation, and adaptation of recovery actions, while providing representation for a broad array of interests. MRRIC is comprised of nearly 70 members representing Tribal, local, state, and federal interests throughout the Missouri River Basin. The MRRIC is the primary venue for interacting with MRRP stakeholders, agencies, and Tribes. A list of MRRIC members can be found at https://www.nwo.usace.army.mil/mrrp/mrric/.

USACE has coordinated with MRRIC throughout the development of the FPDTR-EIS in addition to receiving consensus recommendations (Section 5.1.2). Coordination has included in-person plenary meetings, webinars, in-person and virtual meetings with MRRIC work groups, and collaboration on the preparation and review of the Fort Peck AM Framework document. Collaboration has also included specific meetings with Tribal, irrigation, and hydropower stakeholders to discuss specific issues in depth. In addition to regularly scheduled engagements with MRRIC's Fish Work Group, Tribal Interests Work Group and Human Considerations Work Group, MRRIC members were invited to participate in the following activities:

- Joint Fish Work Group and Human Considerations Work Group Meeting, Sioux Falls, South Dakota, May 21, 2018
- Update during Fall Science Meeting webinars, October 2018
- Update during MRRIC Plenary Meeting, Kansas City, Missouri, November 2018

- Joint Fish Work Group and Human Considerations Work Group webinar, February 1, 2019
- Adaptive Management Workshop, Nebraska City, Nebraska, February 25-27, 2019
- Hydropower analysis discussion with a subset of the Human Considerations Work Group, webmeeting March 7, 2019
- Scoping Results Webinar, April 22, 2019
- Update during MRRIC Plenary Meeting, Sioux Falls, South Dakota, May 21-23, 2019
- Fort Peck Initial Modeling results webinar October 8th, 2019
- Update during MRRIC Plenary Meeting, Omaha, Nebraska, November 19-21, 2019
- Fort Peck updated on modeling results webinar February 2, 2020
- Fort Peck fish model results presented on webinar February 27, 2020.
- Fort Peck EIS Update presented on webinar December 15, 2020.
- Fort Peck EIS update presented in March, 2021
- Fort Peck EIS Tribal Working Group Presentation, July 2021
- Fort Peck EIS IEPR Presentation to MRRIC, July 2021

In addition to these engagements, the MRRIC Independent Science Advisory Panel (ISAP) provided a review of the Fort Peck Adaptive Management Framework Document (Appendix H). The ISAP also provided a review of the FPTR-EIS.

5.1.1 MRRIC Recommendations

MRRIC has made several substantive recommendations related to the FPDTR-EIS process in a July 3, 2019 letter transmitting MRRIC consensus recommendations to the USACE and USFWS. The full MRRIC recommendations and USACE responses are provided in Appendix J.

5.2 Tribal Coordination and Consultation

The United States Government has a unique legal relationship with Tribal Nations. The relationship is defined by treaties, statutes, Executive Orders, court decisions, and the U.S. Constitution. Within this legal framework, USACE interacts with tribes on a government-to-government level. In undertaking any action which may impact tribal rights or interests, USACE is guided by the following six principles:

TRIBAL SOVEREIGNTY – USACE recognizes that Tribal governments are sovereign entities, with rights to set their own priorities, develop and manage Tribal and trust resources, and be involved in

Federal decisions or activities which have the potential to affect these rights. Tribes retain inherent powers of self-government.

TRUST RESPONSIBILITY – USACE will work to meet trust obligations, protect trust resources, and obtain Tribal views of trust and treaty responsibilities or actions related to the Corps, in accordance with provisions of treaties, laws and Executive Orders as well as principles lodged in the Constitution of the United States.

GOVERNMENT-TO-GOVERNMENT RELATIONS – USACE will ensure that Tribal Chairs/Leaders meet with Corps Commanders/Leaders and recognize that, as governments, Tribes have the right to be treated with appropriate respect and dignity, in accordance with principles of self-determination.

PRE-DECISIONAL AND HONEST CONSULTATION – USACE will reach out, through designated points of contact, to involve Tribes in collaborative processes designed to ensure information exchange, consideration of disparate viewpoints before and during decision making, and utilize fair and impartial dispute resolution mechanisms.

SELF RELIANCE, CAPACITY BUILDING, AND GROWTH – USACE will search for ways to involve Tribes in programs, projects and other activities that build economic capacity and foster abilities to manage Tribal resources while preserving cultural identities.

NATURAL AND CULTURAL RESOURCES – USACE will act to fulfill obligations to preserve and protect trust resources, comply with the Native American Graves Protection and Repatriation Act, and ensure reasonable access to sacred sites in accordance with published and easily accessible guidance.

In addition to working with Tribes through the MRRIC process, the USACE sent letters to all basin Tribes on February 6, 2019 advising of the purpose of this EIS and inviting them to attend the scoping meetings. (An example of this letter can be found in Appendix B.) At the request of the Fort Peck Tribe, an additional scoping meeting was held in the Tribal Chambers, on February 20, 2019. Letters were sent to the Tribes again in July of 2019 offering Government to Government consultation on the EIS process. Another letter was sent to basin Tribes on August 9, 2019 offering consultation under Section 106 of the National Historic Preservation Act. The USACE visited with Fort Peck Tribe representatives on two occasions to tour the Tribe's two irrigation intake sites. These two intakes were included in ground surveys completed in the summer of 2020 and were analyzed in the irrigation impact analysis. The USACE has also been working with the Fort Peck Tribe to identify specific sites (e.g. TCPs) along the Missouri River in the vicinity of the Fort Peck Reservation that are important to the Tribe for cultural reasons.. The USACE has provided the Tribe maps of potential inundation at different flow volumes to help determine how these sites might be affected by the test flow alternatives. The USACE sent letters to all basin Tribes announcing the release of the Draft EIS for comment in March of 2021. A formal consultation on the Fort Peck Test Release EIS was held with the Fort Peck Tribes and the USACE on August 13, 2021.

5.3 Public Involvement

5.3.1 Public and Agency Scoping

To solicit public input in the FPTR-EIS process, the USACE conducted public scoping meetings at the Fort Peck Interpretive Center in Fort Peck, Montana on February 19, 2019 and the Williams County Administration Building in Williston, North Dakota on February 20, 2019. The dates, times, and locations of the public scoping meetings were announced in the Notice of Intent, published in the Federal Register on February 8, 2019; via a press release from the Omaha District Public Affairs Office on February 5, 2019.

Members of the public were invited to submit questions and comments in-person at the scoping meetings, by mail, or email. The comment period was open from February 8, 2019 through March 26, 2019, during which approximately 50 correspondences were received. The content of comments received and responses are summarized in the Scoping Summary Report (Appendix G).

Public meetings were also held during the Draft EIS comment period, and comments and responses are included in Appendix G of the Final EIS. Approximately 70 correspondences were received during the public comment period on the Draft EIS which was open from March 26, 2021 to May 25, 2021.

6.0 Compliance with Other Environmental Laws

This section addresses federal statutes, implementing regulations, and executive orders potentially applicable to the Fort Peck Dam Test Releases – Environmental Impact Statement. Applicable requirements are summarized below.

6.1 Threatened and Endangered Species

6.1.1 Endangered Species Act

The Endangered Species Act (ESA) (16 USC 1531 et seq.) established a program to promote the conservation and facilitate recovery of imperiled species and the habitats in which they are found. As such, ESA prohibits "take" of any species listed as threatened or endangered by the U.S. Fish and Wildlife Service (USFWS), where "take" is defined as to, "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect," any species listed under ESA. Section 7 of the ESA requires federal agencies to ensure that any actions authorized, funded, or carried out by the agency do not jeopardize the continued existence of a federally listed threatened or endangered species, or result in the destruction or adverse modification of the designated critical habitat of a federally listed species.

The Fort Peck Dam test release flow study is being undertaken in accordance with the 2018 BiOp because the USACE reinitiated consultation with the USFWS under the ESA in 2015 as part of the MRRMP-EIS process. The selected alternative from the MRRMP-EIS included developing test flow releases from Fort Peck Dam to benefit pallid sturgeon. The 2018 BiOp relied on development of test flow releases from Fort Peck Dam to support its determination that the implementation of the USACE Proposed Action as amended is not likely to jeopardize the pallid sturgeon, interior least tern, or piping plover. The consultation history for the pallid sturgeon is further summarized in Chapter 1, Section 1.7 of this EIS. Discussions between the USACE and the USFWS are ongoing, both agencies are committed and actively involved in the Science and Adaptive Management Plan process, and the USFWS provides significant input to the Fort Peck AM Framework (see Appendix H) that was specifically designed to guide the development and implementation of Fort Peck Dam test release flow.

The BiOp referenced above is provided as accompanying documents to the MRRMP-EIS and available at https://www.nwo.usace.army.mil/MRRP/.

6.1.2 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 USC §§ 668a–668d) prohibits the take, possession, or sale of bald and golden eagles, with limited exceptions for the scientific or exhibition purposes, for religious purposes of Indian Tribes, or for the protection of wildlife and agriculture or for preservation of the species. In 2009, USFWS created a permit program for non-purposeful take of eagles and their nests. The test release flow alternatives would more closely reflect a naturalized hydrograph than the No Action alternative, which would strengthen the riparian area habitats where eagles would nest, and strengthen the food web to provide improved feeding opportunities for eagles. The Fort Peck Dam Test Release Environmental Impact Statement has considered the potential impacts of the proposed alternatives and has determined that the alternatives are not likely to result in the take of bald or golden eagles.

6.2 Fish and Wildlife Conservation

6.2.1 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) (16 USC 661 et seq.) requires federal agencies to coordinate with USFWS or the National Marine Fisheries Service and appropriate state wildlife agencies to avoid or minimize adverse impacts of federal actions that propose to modify any stream or water body. Modification of a stream or water body includes impoundment, diversion, and deepening of channels. USACE has coordinated with USFWS and Montana Department of Fish, Wildlife and Parks biologists throughout the development of this EIS and has received and incorporated the resource agencies' input into the development of the EIS. The resource agencies support the naturalization of the hydrograph in the Missouri River downstream of Fort Peck Dam as beneficial for pallid sturgeon, and for improving natural variability of the system to improve robustness of the ecosystem and species populations. The resource agencies are also supportive of the adaptive management framework and process and expressed their desire to continue their involvement as the adaptive management process matures. Copies of the correspondence referenced above are available in Appendix A.

6.2.2 Migratory Bird Treaty Act

The Migratory Bird Treaty Act, originally implemented in 1918, prohibits the take, possession, or sale of migratory birds (16 USC § 703(a)). No construction, clearing of vegetation, or destruction of migratory bird habitat is planned or included in the suite of alternatives considered in this EIS. The test release flow alternatives would more closely reflect a naturalized hydrograph than the No Action alternative, which would strengthen riparian area migratory habitats. No significant impacts to migratory birds are anticipated under any of the Fort Peck Dam test release alternatives. Migratory birds are further addressed in Section 3.10 Fish and Wildlife and Appendix I.

6.3 Water Resources and Wetlands Conservation

6.3.1 Clean Water Act

The objective of the Clean Water Act (CWA) (33 USC 1251 et seq.), as amended, is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. USACE regulates discharges of dredge or fill material into waters of the United States pursuant to Section 404 of the CWA. This permitting authority applies to all waters of the United States including water deemed jurisdictional by virtue of possession of a significant nexus with traditionally navigable waters. The selection of disposal sites for dredged or fill material is done in accordance with the Section 404(b)(1) guidelines, which were developed by the U.S. Environmental Protection Agency (USEPA) (40 CFR Part 230). Section 401 of the CWA allows states to grant or deny water quality certification for any activity that results in a discharge into waters of the United States and requires a federal permit or license. Certification requires a finding by the affected states that the activities permitted would comply with all water quality standards individually or cumulatively over the term of the permit. Section 401 water quality certifications would be obtained for site-specific management actions, as required, prior to construction. The CWA also established the National Pollutant Discharge Elimination System (NPDES) for permitting point-source discharges to waters of the United States.

No construction, dredge, fill, or discharge of dredge or fill material related activities are planned or included in the suite of alternatives considered in this EIS. It is possible for water temperature to be increased above the No Action alternative with Alternative 1 during April. Although the Corps believes reservoir surface water released over the spillway during a short term spike release in April (i.e., Alternative 1) would not impact water quality nor constitute an increase in water temperature outside the normal range of temperatures experienced downstream of Fort Peck Dam during April, it is unknown how much water temperature would increase.

6.3.2 Executive Order 11988 Flood Plain Management

Executive Order 11988 requires federal agencies to evaluate the potential effects of their actions on floodplains and to consider alternatives to avoid or minimize impacts. This requirement applies to the following actions: (1) acquiring, managing, and disposing of federal lands and facilities; (2) providing federally undertaken, financed, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities. Implementation of the preferred alternative will avoid, to the extent possible, long- and short-term adverse impacts the floodplain. It will also avoid direct and indirect support of development or growth (construction of structure/or facilities, habitable or otherwise) in the base floodplain. Potential impacts to the Missouri River floodplain are described in Section 3.2 Hydrologic Processes and River Infrastructure.

6.4 Cultural Resources and Heritage

6.4.1 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) (16 USC 470) requires federal agencies to evaluate the effects of federal undertakings on historical, archeological, and cultural resources. To do this, USACE must identify any district, site, building, structure, or object that is located in or near the project area, and is included in or eligible for inclusion in the National Register of Historic Places. In addition to ongoing coordination, the USACE Omaha District has developed a programmatic agreement (PA) in consultation with Tribes, Tribal Historic Preservation Officers (THPOs), State Historic Preservation Officers (SHPOs), agencies, and interested parties to address cultural and historic resource impacts involved with the ongoing operation and maintenance of the Missouri River System. More information regarding cultural resources identification and potential impacts to cultural resources are described in Section 3.11 Cultural Resources and Appendix B. The Programmatic Agreement for the Operation and Management of the Missouri River Main Stem System for compliance with the National Historic Preservation Act, as amended (PA) is available at:
https://www.nwo.usace.army.mil/Missions/Civil-Works/Cultural-Resources/Programmatic-Agreement/

6.4.2 Archaeological Resources Protection Act

The Archeological Resources Protection Act (16 USC 470aa-470mm) provides for the protection of archeological sites located on public and Tribal lands; establishes permit requirements for the excavation or removal of cultural properties from public or Tribal lands; and establishes civil and criminal penalties for the unauthorized appropriation, alteration, exchange, or other handling of cultural properties. Potential impacts to archaeological resources are described in Section 3.11 Cultural Resources.

6.4.3 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001 et seq.) addresses the discovery, identification, treatment, and repatriation of Native American human remains and cultural items. This Act also establishes penalties for the sale, use, and transport thereof. In recognition of the sensitivity and cultural importance of human remains, funerary objects, sacred objects, or objects of cultural patrimony, each USACE District has developed a standard operating procedure to provide guidance to assure respectful and responsive treatment of human skeletal remains inadvertently discovered on federal lands managed by the district. USACE does not have NAGPRA jurisdiction over human remains or other NAGPRA related collections recovered from private and non-Tribal lands. This is also true if remains are recovered during a federal undertaking on private lands. Under those circumstances, specific state unmarked burial laws would take precedence. Management actions described in this EIS would make the appropriate efforts to avoid adverse impacts to Tribal sites as described in Section 3.11 Cultural Resources. Tribal coordination and consultation is addressed in Chapter 5, Section 5.2, of this EIS.

6.4.4 American Indian Religious Freedom Act

The American Indian Religious Freedom Act (AIRFA) of 1978 (42 USC 1996) provides for the protection and preservation of American Indian rights of freedom of belief, expression, and exercise of traditional religions. Courts have interpreted AIRFA to mean that federal agencies must consider American Indian interests before undertaking actions that might cause unnecessary interference with those traditional practices. USACE recognizes its responsibilities with respect to AIRFA and will coordinate with Tribes in carrying out the requirements of the AIRFA for any actions described in the Fort Peck Dam test release Environmental Impact Statement. Tribal coordination and consultation is addressed in Chapter 5, Section 5.2, of this EIS.

6.4.5 Executive Order 13007 Indian Sacred Sites

Executive Order 13007 requires federal agencies to accommodate access to, and ceremonial use of, American Indian sacred sites by Tribal religious practitioners. The order requires federal agencies to avoid adverse impacts to Tribal sacred sites and maintain the confidentiality of information pertaining to Tribal sacred sites. The USACE recognizes its responsibility to avoid adverse impacts to Tribal sacred sites and honors the confidentiality pertaining to Tribal sacred sites pursuant to Executive Order 13007. Tribal coordination and consultation is addressed in Chapter 5, Section 5.2, of this EIS.

6.5 Water Rights

Modifying the operation of the System for purposes other than endangered species compliance is outside the scope of this analysis. The alternatives in the FPDTR-EIS that do analyze such changes do not establish, regulate, determine, quantify, or impact consumptive water rights for any State, Tribe, or individual.

USACE operates the Mainstem System in accordance with federal legislation that Congress has enacted. In accordance with Congressional intent, USACE endeavors to operate its projects for their authorized purposes in a manner that does not interfere with lawful purposes pursuant to State and Tribal water right authorities. USACE develops water control plans and manuals through a public process, affording all interested parties the opportunity to present information regarding uses that may be affected by USACE operations for authorized purposes of its projects. USACE would consider modifications to System operation, in accordance with pertinent legal requirements, as State or Tribal water rights are exercised in accordance with applicable law. The Winters Doctrine, developed by the Supreme Court in *Winters v. United States*, 207 U.S. 564 (1908), maintains that sufficient water was reserved by implication to fulfill the purposes of the Tribal Reservation at the time the Reservation was established. Case law supports the premise that American Indian reserved water rights cannot be lost, whether or not those rights are exercised.

6.6 Environmental Justice

Executive Order 12898 Federal Actions to Address Environmental Justice in Minority and Low Income Populations

Executive Order 12898, passed in 1994, requires federal agencies to make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States. Executive Order 12898 calls for federal agencies to provide opportunities for stakeholders to obtain information and provide comment on federal actions. One additional way USACE is complying with this executive order by engaging with MRRIC and providing regular and accessible means for stakeholders in the Missouri River Basin to obtain information and provide comments to USACE related this EIS and its potential effects to their resource or use of concern. A more detailed description of the level of engagement USACE has had with MRRIC is included in Section 5.1, Missouri River Recovery Implementation Committee. Impacts to environmental justice populations are addressed in Section 3.12 Environmental Justice. USACE would take all appropriate measures to ensure that management actions described in the FPDTR-EIS would not disproportionately adversely impact minority or low-income communities.

6.7 Farmland Protection

Farmland Protection Policy Act

The Farmland Protection Policy Act (7 USC 4201, et seq.) requires federal agencies to coordinate with the USDA to develop criteria for identifying the effects of federal programs on the conversion of farmland to non-agricultural uses. USACE does not anticipate the frequency of test flows, or the duration of any test flow, would fall outside the normal range of flow patterns that would have the potential to convert farmland to non-agricultural use. Air Quality

Clean Air Act

The Clean Air Act (42 USC 7401 et seq.), amended in 1977 and 1990, was established "to protect and enhance the quality of the Nation's air resources so as to promote public health and welfare and the productive capacity of its population." The Clean Air Act authorizes USEPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. The Clean Air Act establishes emission standards for stationary sources, volatile organic compound emissions, hazardous air pollutants, and vehicles and other mobile sources. USACE does not anticipate impacts to air quality to fall outside of compliance with NAAQS from naturalization of flows implemented during test flow releases from Fort Peck Dam.

6.8 Navigation

Rivers and Harbors Act

The Rivers and Harbors Appropriation Act of 1899 (33 USC 1344) prohibits obstruction or alteration of any navigable water of the United States. The purpose of the act was to preserve the public right of navigation and prevent interference with interstate and foreign commerce unless authorized by Congress and approved by the Chief of Engineers and Secretary of the Army. The Missouri River is designated a navigable water under the Rivers and Harbor Act. Potential impacts to navigation are addressed in Chapter 3, Section 3.2 Hydrologic Processes and River Infrastructure.

6.9 Recreation

Federal Water Project Recreation Act

The Federal Water Project Recreation Act (16 USC 4612 et seq.) requires federal agencies to give full consideration to outdoor recreation and fish and wildlife enhancement in the investigating and planning of any federal navigation, flood control, reclamation, hydroelectric, or multipurpose water resource project, whenever any such project can reasonably serve either or both purposes consistently. Projects must be constructed, maintained, and operated to provide recreational opportunities, consistent with the purposes of the project. Potential impacts to recreation are addressed in Chapter 3, Section 3.9 Recreation. Chapter 5, Section 5.3 Public Involvement, and Appendix G summaries the scoping and public comment process the USACE utilized to demonstrate its commitment to fulfilling the intent of the Federal Water Project Recreation Act, and incorporate consideration of outdoor recreation and fish and wildlife enhancement to this EIS.

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8.0 Glossary

Accounts – Human Considerations objectives and performance criteria are organized into four accounts that were established to facilitate evaluation and display the effects of alternative plans in accordance with U.S. Army Corps of Engineers Planning Guidelines. The four accounts are:

- Environmental Quality (EQ)
- National Economic Development (NED)
- Regional Economic Development (RED)
- Other Social Effects (OSE)

Active adaptive management – The active form of adaptive management employs management actions in an experimental design aimed primarily at learning to reduce uncertainty; near-term benefits to the resource are secondary.

Adaptive Management (AM) – Adaptive management is a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process.

Aggradation (or alluviation) – Increase in land elevation within a river system due to the deposition of sediments; aggradation occurs within river reaches where the supply of sediment is greater than the amount of material the system is able to transport.

Annual Work Plan (AWP) – This document includes real estate actions, habitat creation actions, monitoring of physical and biological responses to actions, and research activities for a particular year within the five-year Strategic Work Plan. It is used by product delivery teams to budget and implement management actions annually.

Baseload power plant – An energy plant devoted to the production of baseload supply.

Benthic – The zone on the bottom under a river or reservoir and the organisms that live there.

Biological Assessment (BA) – A document prepared for the Section 7 process to determine whether a proposed major construction activity under the authority of a Federal action agency is likely to adversely affect listed species, proposed species, or designated critical habitat.

Biological Opinion (BiOp) – Document stating the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) opinion as to whether a Federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat. Specifically in the MRRP, the USFWS 2000 Biological Opinion (BiOp) found that the operation of the Missouri River Mainstem Reservoir System and the operation and maintenance of the BSNP, as proposed by the USACE, would likely jeopardize the continued existence of three federally listed species: the piping plover, least tern, and pallid sturgeon. The BiOp was amended in 2003 to note that, with additional actions proposed by the USACE, operation of the System and the operation and maintenance of the BSNP would not likely jeopardize terns and plovers, but would jeopardize pallid sturgeon.

Capacity value – Represents the capital, fixed operating and maintenance cost of the displaced thermal resource. Measured in units of dollars per kilowatt-year.

Capacity – The maximum amount of power that a generating unity or power plant can deliver under a specified set of conditions.

Carbon monoxide (CO) – A colorless, odorless, tasteless, and poisonous gas that is formed when carbon in fuel is not completely burned. It is a component of motor vehicle exhaust, which contributes approximately 56 percent of all CO emissions nationwide.

Carbon sink – Ecosystems that absorb and store more carbon dioxide from the atmosphere than they release, which offsets greenhouse gas emissions; e.g., forests and oceans.

Carbon sequestration – The practice of capture and long-term storage of atmospheric carbon dioxide or other forms of carbon.

Channel – The top width of the river at the ordinary high water level.

Conceptual Ecological Models (CEMs) – CEMs are graphical depictions of an ecosystem that are used to communicate the important components of the system and their relationships. They are a representation of the current scientific understanding of how the system works.

Critical uncertainties – Uncertainties that impede the identification of a preferred alternative management action.

Dependable capacity – A measure of the amount of capacity that a project can reliably contribute towards meeting system peak demand.

Decision criteria – Broadly refers to the set of pre-determined criteria used to make AM decisions. Performance metrics, targets, and decision triggers are considered to be different types of decision criteria. They can be qualitative or quantitative based on the nature of the performance metric and the level of information necessary to make a decision.

Decision trigger – Decision triggers are pre-defined commitments (population or habitat metric for a specific objective) that trigger a change in a management action. Decision triggers are addressed in the Evaluate step (Step 4 of the AM process) specifying the metrics and actions that will be taken if monitoring indicates performance metrics are or are not reaching target values. In some cases a decision trigger may be learning a new piece of information that triggers the Continue/Adjust/Complete step (Step 5 of the AM process).

Degradation – A lowering of a fluvial surface, such as a stream bed or floodplain, through erosional processes.

Dissolved oxygen – Dissolved oxygen concentrations that are too high **or** too low are harmful to aquatic animal life. Water temperature affects dissolved oxygen concentrations with colder water holding more oxygen. Low oxygen levels can result from decomposition of large amounts organic matter following eutrophication and high levels can result from enhanced photosynthesis activity during the over-production of algae.

Effects Analysis (EA) – The purpose of this effort is to conceptually and quantifiably make explicit the effects of operations and actions on the listed species by specifically evaluating the effects of hydrologic and fluvial processes on the Missouri River, as well as ongoing Mitigation and Biological Opinion management actions to the status and trends of the listed species (piping plover, interior least tern, and pallid sturgeon) and their habitats.

Effluent – Liquid waste or sewage discharged into a receiving water body such as the Missouri River.

Emergent plants – A plant which grows in water but which pierces the surface so that it is partially in air; collectively, such plants are called emergent vegetation.

Emergent Sandbar Habitat – Habitat for nesting, brood rearing, and foraging for least terns and the Northern Great Plains piping plover that is a complex of side channels and sandbars with the proper mix of habitat characteristics required by the birds.

Energy value – Represents the fuel cost or variable cost of an alternative thermal generation resource that replaces the lost hydropower generation (cost per megawatt-hour).

Energy – The capability of doing work expressed in terms of kilowatt-hours (kWh).

Ephemeral pool – A seasonal body of standing water that typically forms in the spring from melting snow and/or other runoff that dries out completely in the summer; provides an important breeding habitat for many terrestrial and semiaquatic species.

Erosion – The wearing away of rock and soil found along a river bed and banks; involves the breaking down of rock particles being carried downstream by the river.

Eutrophication – Process whereby water bodies, such as lakes, reservoirs, or slow-moving rivers and streams, receive high nutrient concentrations that stimulate excessive plant growth (e.g., algae and nuisance plants weeds).

Formal consultation – The consultation process conducted when a Federal agency determines its action may affect a listed species or its critical habitat, and is used to determine whether the Proposed Action may jeopardize the continued existence of listed species or adversely modify critical habitat. This determination is stated in the Service's biological opinion.

Firm power – Capacity and energy that is guaranteed to be available at all times. If insufficient generation is available power must be purchased from alternative resources to meet contractual agreements.

Fledge Ratio – The ratio of adult pairs of birds to the number of fledged chicks; applies in the MRRMP-EIS to least terns and piping plovers.

Floodplain – An area of low-lying ground adjacent to a river formed mainly of river sediments and subject to flooding.

Floodplain connectivity – Maintaining a connection (which may be seasonal) between the Missouri River and its associated floodplain habitats.

Fundamental objectives – Fundamental objectives are used to formalize the desired outcome of the program in terms of biological response. They are derived to achieve avoidance of jeopardizing the three species from USACE actions on the Missouri River and articulate the ends the program is trying to achieve.

Greenhouse gas (GHG) – Gases that trap heat within the earth's atmosphere by absorbing energy and slowing the rate at which the energy escapes. GHGs differ in their radiative efficiency (ability to absorb energy) and lifetime (how long they stay in the atmosphere).

Genotype – The genetic constitution of an individual organism.

Hydrograph – A graph showing the rate of flow (discharge) versus time past a specific point in a river (e.g., Missouri River); typically expressed in cubic feet per second.

Human Considerations (HCs) – A set of objectives with associated metrics and proxy metrics that are related to the wide array of uses and stakeholder interests on the Missouri River. They form the basis for some of the monitoring and decision criteria in the AM Plan.

Hydropower – The converting of energy from running water to produce electricity; a renewable energy source.

Hypolimnion – The lower layer of water in a stratified lake or reservoir, typically cooler than the water above and relatively stagnant.

Implement – Implementation of the selected alternative.

Integrated Science Program (ISP) – The component of the MRRP that is responsible for conducting scientific monitoring and investigations. The ISP monitors federally listed species under the Endangered Species Act (ESA), the habitats upon which they depend, and researches and monitors critical uncertainties.

Invasive species – A plant or animal species that is not native to a specific location (an introduced species) and which has a tendency to spread to a degree believed to cause damage to the environment, human economy or human health.

Implementation level (or Level) – Refers to one of four classifications of action that could be implemented to assist pallid sturgeon as part of the MRRP (see also *Pallid Sturgeon Framework*). The levels include:

- **Level 1: Research** – Studies without changes to the system (Laboratory studies or field studies under ambient conditions).
- **Level 2: In-river testing** – Implementation of actions at a level sufficient to expect a measurable biological, behavioral, or physiological response in pallid sturgeon, surrogate species, or related habitat response.
- **Level 3: Scaled implementation** – A range of actions not expected to achieve full success, but which yields sufficient results in terms of reproduction, numbers, or distribution to provide a meaningful population response and indicate the level of effort needed for full implementation.
- **Level 4: Ultimate required scale of implementation** – Implementation to the ultimate level required to remove an issue.

Investigations – Research activities that are intended to generate information that will fill the key gaps in understanding and reduce uncertainty associated with implementation of management actions.

Jeopardy – As defined by the Endangered Species Act (ESA), jeopardy occurs when there is an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.

Lower Missouri River – The reach of the river downstream of Gavins Point Dam (RM 810) as it pertains to management for pallid sturgeon.

Management actions – Proposed or potential actions to be taken by the USACE to address species needs on the Missouri River. Original management actions were prescribed by the Biological Opinion as Reasonable or Prudent Alternatives or actions outside the BiOp if necessary to achieve species objectives.

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Master Manual – The Missouri River Mainstem Reservoir System Master Water Control Manual (Master Manual) is the guide used by the U.S. Army Corps of Engineers to operate the system of six dams on the Missouri River Mainstem Reservoir System (System) – Fort Peck, Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point.

Mixing zone – A mixing zone is defined generically as a limited area or volume of a receiving water body where the initial dilution of a permitted or authorized discharge occurs. Defined mixing zones are intended to dilute or reduce pollutant concentrations below applicable water quality standards (USEPA 1991). It is important to note that mixing zones are designed to ensure that water quality standards are met in the receiving water body a high percentage of the time. For example, flows in a given river will be higher than a 7Q10 low-flow over 99 percent of the time. Thus, if flows were to drop below the established low-flow criterion, water quality standards are waived.

Monitoring – In the context of the MRRMP-EIS, monitoring is the process of measuring attributes of the ecological, social or economic system. Monitoring has multiple purposes, including: to provide a better understanding of spatial and temporal variability, to confirm the status of a system component, to assess trends in a system component, to improve models, to confirm that an action was implemented as planned, to provide the data used to test a hypothesis or evaluate the effects of a management action, and to provide an understanding of a system attribute which could potentially confound the evaluation of action effectiveness.

National Environmental Policy Act (NEPA) – Requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their actions and reasonable alternatives to those actions. To meet NEPA requirements federal agencies may be required to prepare a detailed statement known as an Environmental Impact Statement (EIS).

Naturalization of the flow regime – Naturalization of the flow regime involves incremental changes which move the flow regime towards the hydrological attributes which would exist in the absence of dams and reservoirs, while recognizing social and economic constraints. It does not mean matching the unaltered, historical flow regime. More generally, naturalization refers to the process of using characteristics of the natural ecosystem to guide elements of river restoration, but constrained by social and economic values.

Navigation channel – The navigation channel is congressionally authorized as a 9-feet-deep by 300-feet-wide channel and generally refers to that portion of the Missouri River between Sioux City and the mouth at St. Louis as defined by normal water levels during the navigation support flow season.

Navigation season – The period usually between April and December that the USACE supports navigation on the river from Sioux City, Iowa, to St. Louis, Missouri.

Nitrogen and phosphorus – The inorganic nutrients nitrogen and phosphorus support primary productivity (i.e., the production of energy by plants through photosynthesis) in the river.

Excessive nutrients present in the water column foster the growth of plants and algae potentially resulting a state of eutrophication and algae blooms and, then following decomposition, depleted dissolved oxygen. Disturbance to bed sediment has the potential to resuspend nutrients into the Missouri River.

Nitrogen dioxide – Nitrogen dioxide has a strong, harsh odor and is a liquid at room temperature, becoming a reddish-brown gas above 70°F. It is released to the air from the exhaust of motor vehicles, the burning of coal, oil, or natural gas, and during processes such as arc welding, electroplating, engraving, and dynamite blasting.

Non-routine repair, replacement, and rehabilitation (R, R, & R) costs – Costs covered include (1) support for two river field offices including any funds necessary for rescues, funds for repairs of equipment, funds for staff, and funds for other expenses; (2) repair, replacement, and rehabilitation of thousands river structures; (3) emergency dredging that is required for extreme river conditions.

Objectives – Objectives define an endpoint of concern and the direction of change that is preferred. Objectives are concise statements of the interests that could be affected by a decision — the “things that matter” to people. In PrOACT, objectives typically take a simple form such as: Minimize costs, Increase population number, increase habitat availability.

Other pollutants – Other pollutants of concern within the Missouri River system are metals, hydrocarbons, organic toxins, pesticides, and treated wastewater. Pollutants and toxic chemicals may adhere to suspended matter that settles to the bottom of the river or remain in suspension, where they can pose a hazard to native species or affect socioeconomic resources such as water supply, irrigation, wastewater treatment, and recreational uses.

Ozone (O_3) – A gas composed of three oxygen atoms. It is not usually emitted directly into the air, but at ground-level is created by a chemical reaction between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight.

Ozone precursor – Oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) which chemically react in the atmosphere producing ground-level ozone (O_3).

Particulate matter – A complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

Passive adaptive management – In passive AM, management actions are intended to achieve resource objectives but and are improved using knowledge gained from monitoring and assessment.

Peak and off-peak power – The daily and seasonal variation of energy cost following system demand.

Peaking power plants – Power plants that are generally run only when there is high demand.

Period of Record – A period of record between 1931 and 2012 used to develop predictive models and assess changes in physical river and reservoir conditions.

Performance metric – A specific metric or quantitative indicator that is monitored and can be used to estimate and report consequences of management alternatives with respect to a particular objective.

Plant factor – The ratio of the actual monthly generation to the maximum possible monthly generation.

Population Augmentation – Stocking to supplement year class structure to the pallid sturgeon population due to lack of natural recruitment in the Missouri River.

Power marketing administrations – A U.S. federal agency within the Department of Energy with the responsibility for marketing hydropower. Western Area Power Administration (WAPA) represents the Mainstem of the Missouri River hydropower plants.

Preferred alternative – The preferred alternative is the alternative which the USACE believes would best fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors.

Recovery – An improvement in the status of a listed species to the point at which listing is no longer appropriate under the Endangered Species Act.

Riparian – The natural zone located along the bank of a watercourse (e.g., Missouri River), tributary, or reservoir.

River Segment – A term used to designate an area of study or action. The area begins at the base of a dam and proceeds downstream including the area of the separate area of the river channel and the separate area the lake waters with the segment ending at the top of the next downstream dam.

Run-of-River – Flows that are basically uncontrolled, as was experienced before the construction of the Missouri River dams.

Run-of-river hydroelectric plants – A type of hydroelectric generation whereby the natural flow and elevation drop of the river are used to generate electricity.

Section 7 – The section of the Endangered Species Act that requires all Federal agencies, in "consultation" with the Service, to insure that their actions are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat.

Selected alternative – The alternative identified in the ROD that the USACE intends to implement.

Sediment and turbidity – Turbidity is a measure of the loss of water clarity due to the presence of suspended particles such as eroded sediment and organic matter in the water column. Although sediment and turbidity maintain natural ecological conditions, turbidity also affects the water temperature, can accumulate in reservoirs, and sediment transport can impact water intake pipes and destabilizing intake structures.

Sediment load – The solid material that is transported by a river within the water column.

Service level – The daily minimum discharge required for the level of navigation service determined from available system storage.

Snowpack – A seasonal accumulation of slow melting packed snow; runoff to the Missouri River system.

Snow water equivalent (SWE) – A measurement for the amount of water contained within a snowpack. Specifically, it is the depth of water that would theoretically result if you melted the entire snowpack instantaneously.

Spawning habitat – Functional spawning habitat produces a successful hatch of embryos. For successful hatch to take place, hydraulics and substrate must be conducive first to attraction and aggregation of reproductive adults, followed by egg and milt release, fertilization, and deposition of eggs in a in a protected environment.

Spawning cue – Either a natural or man-made condition that may prompt fish to spawn.

Stage – The water level above some arbitrary point in the river, often with the zero height being near the river bed.

Structured Decision Making (SDM) – Organized approach to identifying and evaluating creative options and making choices in complex decision situations. It is used to inform difficult choices, and to make them more transparent and efficient. PrOACT is a specific application of SDM to collaborative problem solving.

Success criteria – A qualitative or (preferably) quantitative description of the conditions for which the parties agree that the objectives have been sufficiently met. Usually expressed in terms of the performance metrics.

Target – Targets are a specific value or range of performance metric that define success. Targets can be quantitative values or overall trends (directional or trajectory)

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