Missouri River Recovery Management Plan and Environmental Impact Statement

Cultural Resources Environmental Consequences Analysis

Technical Report

August 2018

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Acronyms and Abbreviations

BiOp	2003 Amended Biological Opinion
EIS	environmental impact statement
EQ	environmental quality
ER	Engineering Regulation
ESH	emergent sandbar habitat
ESA	Endangered Species Act
H&H	hydrologic and hydraulic (model)
HC	human considerations
HEC	Hydrologic Engineering Center - River Analysis System
HEC	Hydrologic Engineering Center - Reservoir System Simulation
MRRMP-EIS	Missouri River Recovery Management Plan and Environmental Impact Statement
MRRP	Missouri River Recovery Program
NED	national economic development
NRHP	National Register of Historic Places
OSE	other social effects
P&G	1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PDT	project delivery team
POR	period of record
RED	regional economic development
RPA	reasonable and prudent alternative
SHPO	State Historic Preservation Office
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

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1.0 Introduction

The Kansas City and Omaha Districts of the U.S. Army Corps of Engineers (USACE), in cooperation with the U.S. Fish and Wildlife Service (USFWS), have developed the Missouri River Recovery Management Plan and Environmental Impact Statement (MRRMP-EIS). The purpose of the MRRMP-EIS is to develop a suite of actions that meets Endangered Species Act (ESA) responsibilities for the piping plover, the interior least tern, and the pallid sturgeon.

The purpose of this Cultural Resources Environmental Consequences Analysis Technical Report is to provide supplemental information on the cultural resources analysis and results in addition to the information presented in the MRRMP-EIS. Additional details on the Environmental Quality (EQ) methodology and results are provided in this technical report. The Other Social Effects (OSE) impacts are presented in the MRRMP-EIS, Chapter 3, Cultural Resources, Environmental Consequences section. No National Economic Development (NED) or Regional Economic Development (RED) analyses were undertaken for cultural resources.

1.1 Summary of Alternatives

The MRRMP-EIS evaluates the following alternatives. A detailed description of the alternatives is provided in Chapter 2 of the MRRMP-EIS.

- **Alternative 1 – No Action.** This is the No Action alternative, in which the Missouri River Recovery Program (MRRP) would continue to be implemented as it is currently, including a number of management actions associated with the MRRP and 2003 Amended Biological Opinion (BiOp) compliance. Management actions under Alternative 1 include creation of early life stage habitat for the pallid sturgeon and emergent sandbar habitat (ESH), as well as a spring pulse for pallid sturgeon. The construction of habitat would be focused in the Garrison and Gavins reaches for ESH (an average rate of 164 acres per year) and between Ponca to the mouth near St. Louis for pallid sturgeon early life stage habitat (3,999 additional acres constructed).
- **Alternative 2 – USFWS 2003 Biological Opinion Projected Actions.** This alternative represents the USFWS interpretation of the management actions that would be implemented as part of the 2003 Amended BiOp Reasonable and Prudent Alternative (RPA) (USFWS 2003). Whereas Alternative 1 only includes the continuation of management actions USACE has implemented to date for BiOp compliance, Alternative 2 includes additional iterative actions and expected actions that the USFWS anticipates would ultimately be implemented through adaptive management and as impediments to implementation were removed. Considerably more early life stage habitat (10,758 additional acres constructed) and ESH (an average rate of 1,331 acres per year) would be constructed under Alternative 2 than under Alternative 1. In addition, a spring pallid sturgeon flow release would be implemented every year if specific conditions were met. Alternative 2 would also modify System operations to allow for summer flows that are sufficiently low to provide for early life stage habitat as rearing, refugia, and foraging areas for larval, juvenile, and adult pallid sturgeon.
- **Alternative 3 – Mechanical Construction.** The USACE would only create ESH through mechanical means at an average rate of 332 acres per year distributed between the Garrison, Fort Randall, and Gavins Point Reaches. This amount represents the acreage necessary to meet the bird habitat targets after accounting for available ESH resulting from System operations. The average annual construction amount includes replacing

ESH lost to erosion and vegetative growth, as well as constructing new ESH. An estimated 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under Alternative 3. There would not be any reoccurring flow releases or pulses implemented under this alternative; however, a one-time spawning cue test release from Gavins Point could be implemented if Level 1 studies during the first 9 years do not provide a clear answer on whether a spawning cue is important. At the present time, it is assumed the test release would be similar to the timing, magnitude, duration, and pattern of the spawning cue included as a recurring release under Alternative 6.

- **Alternative 4 – Spring ESH Creating Release.** The USACE would mechanically construct ESH annually at an average rate of 195 acres per year distributed between the Garrison, Fort Randall, and Gavins Point Reaches. This amount represents the acreage necessary to meet the bird habitat targets after accounting for available ESH resulting from implementation of an ESH-creating reservoir release in the spring. Alternative 4 would be similar to Alternative 1 (the No Action alternative), with the addition of a spring release designed to create ESH for the least tern and piping plover. An estimated 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under Alternative 4.
- **Alternative 5 – Fall ESH Creating Release.** The USACE would mechanically construct ESH annually at an average rate of 253 acres per year distributed between the Garrison, Fort Randall, and Gavins Point Reaches. This alternative is based on Alternative 1 (the No Action alternative), with the addition of a release in the fall designed to create sandbar habitat for the least tern and piping plover. An estimated 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under Alternative 5.
- **Alternative 6 – Pallid Sturgeon Spawning Cue.** The USACE would mechanically construct ESH annually at an average rate of 245 acres per year distributed between the Garrison, Fort Randall, and Gavins Point Reaches. In addition, the USACE would attempt a spawning cue pulse every three years in March and May. These spawning cue pulses would not be started and/or would be terminated whenever flood targets are exceeded. An estimated 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under Alternative 6.

1.2 USACE Planning Accounts

Alternate means of achieving species objectives were evaluated including consideration for the effects of each action or alternative on a wide range of human considerations (HC). Human considerations to be evaluated in the MRRMP-EIS alternatives are rooted in the economic, social, and cultural values associated with the natural resources of the Missouri River. The HC effects evaluated in the MRRMP-EIS are required under the National Environmental Policy Act and its implementing regulations (40 CFR Parts 1500–1508). The 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (U.S. Water Resources Council 1983) also served as the central guiding regulation for the economic and environmental analysis included within the MRRMP-EIS. Further guidance that is specific to USACE is described in Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, which provides the overall direction by which USACE Civil Works projects are formulated, evaluated, and selected for implementation (USACE 2000). These guidance documents describe four accounts that were established to facilitate evaluation and display the effects of alternative plans:

- The NED account displays changes in the economic value of the national output of goods and services expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.
- The RED account registers changes in the distribution of regional economic activity (i.e., jobs and income).
- The EQ account displays non-monetary effect of significant natural and cultural resources.
- The OSE account registers plan effects from perspective that are relevant to the planning process, but are not reflected in the other three accounts. In a general sense, OSE refers to how the constituents of life that influence personal and group definitions of satisfaction, well-being, and happiness are affected by some condition or proposed intervention.

The accounts framework enables consideration of a range of both monetary and non-monetary values and interests that are expressed as important to stakeholders, while ensuring impacts are not double counted. Because impacts to cultural resources are not expressible in monetary terms impacts to cultural resources are evaluated only under the EQ and OSE accounts.

1.3 Approach for Evaluating Environmental Consequences of MRRMP-EIS

The USACE Planning Guidance Notebook (ER 1105-2-100) defines cultural resources in terms of "historic properties" as follows:

> An 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.

Evaluation of the environmental consequences of the MRRMP-EIS to cultural resources requires an understanding of how the physical conditions of the river would change under each of the MRRMP-EIS alternatives. Cultural resource sites are primarily affected by river flows, reservoir levels, channel movement, and river-floodplain connectivity. River flows and geomorphologic changes could influence erosion, deposition of sediment, and river-floodplain connectivity. Changes in river flows and reservoir elevations could impact cultural resource sites through burial, inundation, exposure, erosion, and flooding all of which could affect exposure to vandalism or degradation of the resources. Some risk of cultural resource loss will continue under any future scenario. The purpose of this analysis is to measure how these risks to cultural resources might differ across alternative plans when compared to Alternative 1 (the No Action alternative).

The conceptual flow chart shown in Figure 1 demonstrates, in a stepwise manner, how changes to the physical conditions of the Missouri River and its floodplain can lead to changes to the fundamental objectives associated with cultural resources. Figure 2 shows the intermediate factors and criteria that were applied in assessing consequences to cultural resources.

The analysis of changes in river stages (relative to cultural resource site elevations) and river flows uses USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) data for the period of record (POR) between 1931 and 2012 to assess when and how often fluctuating water levels affect cultural resources. The following sections in this report provide further details on the methodology.

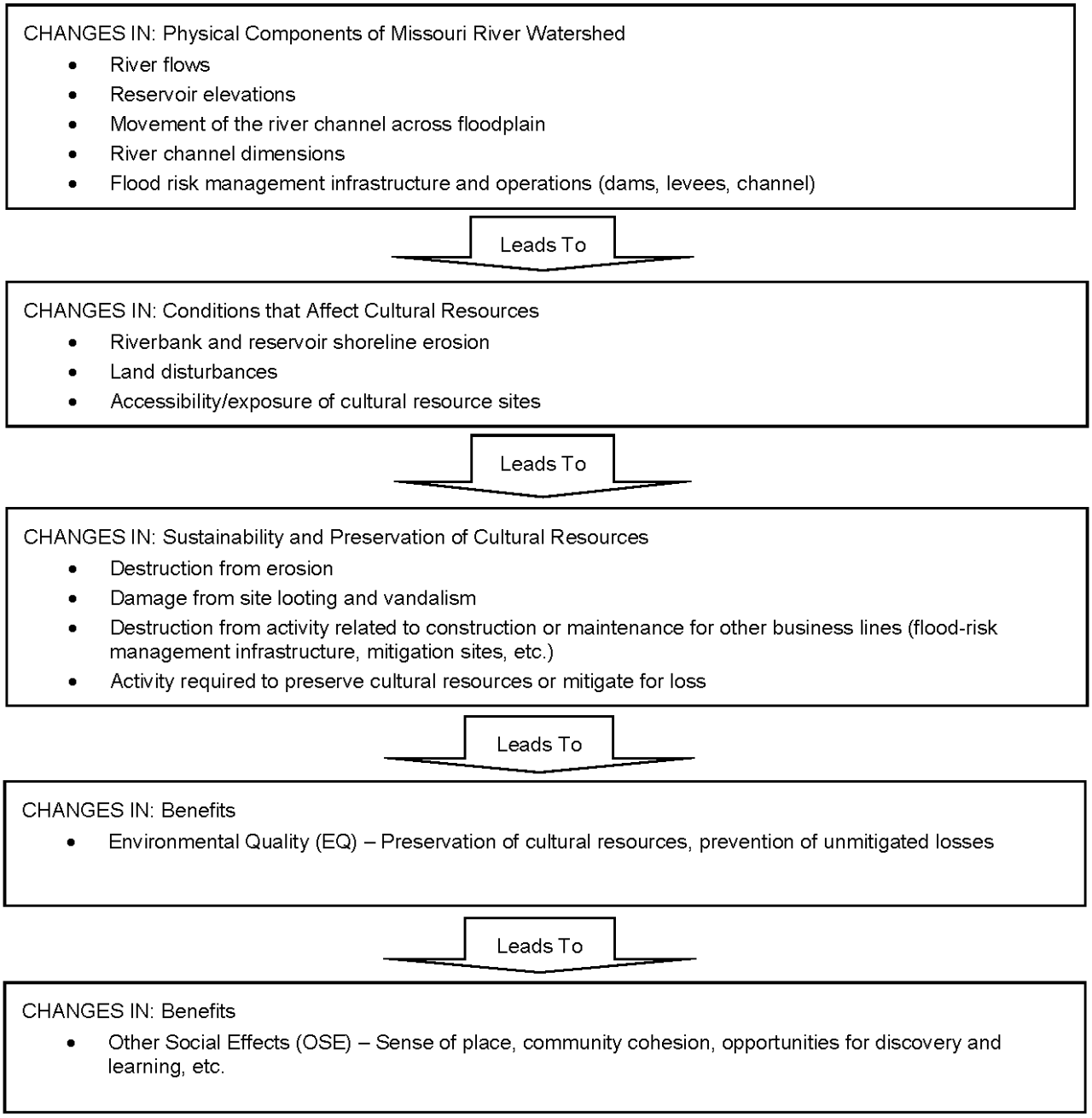


Figure 1. Flow Chart of Inputs Considered in Cultural Resource Impact Evaluation

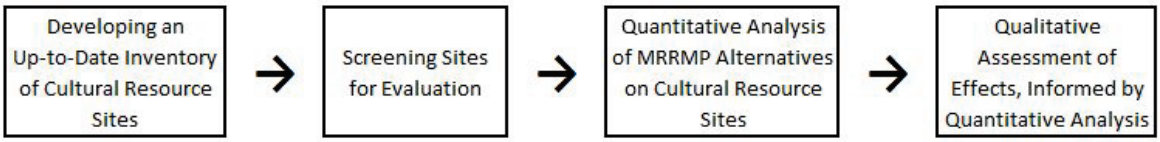


Figure 2. Environmental Consequences Approach for Cultural Resources

2.0 Methodology and Assumptions

The methodology includes a summary of assumptions and risk and uncertainty considerations. The initial step in the process, evaluating the relationship between river conditions and cultural resource sites, is then described, as well as the subsequent steps to assess the EQ and OSE impacts.

2.1 Assumptions

The primary impacts to cultural resource sites from the MRRMP-EIS alternatives would be related to modifications of flow and changes in reservoir pool elevations that could change the magnitude and frequency of risk of erosion or vandalism and looting. The analysis was based on an assumption that cultural resource sites that are typically submerged (or partially submerged) face a greater risk of exposure to vandalism and looting as well as erosion when river/pool elevations decrease within proximity of the site. Modeled impacts to cultural resource sites that are typically above (or partially above) the normal river/reservoir surface level elevation are subject to greater risk of erosion when river/pool elevations increase to within proximity of the site. More simply, the integrity of cultural resource sites (whether located on reservoirs or riverine reaches) are sensitive to changes in water surface elevations.

The following assumptions were used in the evaluation:

1. Cultural resource sites are equally susceptible to damage/vandalism/looting. In reality, some sites would be more/less resistant to damage from waves and erosion, and some sites will be more/less accessible and desirable targets for looters/vandals (Lenihan 1981; Dunn 1996).
2. Cultural resource sites are equally damageable at all times of the year. Submerged sites on the Mainstem reservoirs may, in fact, be at greater risk during the recreation season. Or maybe more at risk during winter seasons, due to physical erosion from ice cracking, snow runoff, etc.
3. Cultural resource sites of each type (e.g., sites above normal pool levels and sites below normal pool levels) are considered equally in the estimation of the overall risk. In reality, the cultural value placed on the protection of all sites might not be equal. For example, many people would identify the protection of sites with human remains to be more important than the protection of other sites.
4. In general, any potential beneficial effects for protection of cultural resource sites due to temporary inundation of the floodplain in riverine reaches (i.e., ‘continued productivity of natural riparian vegetation or wetlands’) are overwhelmed by the negative effects of that inundation (i.e., increasing risk of erosion). Additionally, different 'types' of sites do not

vary significantly in terms of their damageability/susceptibility to erosion or vandalism (Lenihan 1981; Dunn 1996).

5. All calculations are based on known cultural resources site information. It is understood that there are many unknown cultural resource sites existing on the landscape, as well as important cultural resources that do not necessarily meet the definition of a cultural resource site used in this study. The inventory of known cultural resource sites used in the analysis is intended to serve as a representative sample, indicating which MRRMP-EIS alternatives have greater or lesser impacts to cultural resources in general.
6. The modeling efforts focused on changes in hydrologic and hydraulic (H&H) modeling outputs: river flows, river stages, and reservoir elevations. The model is unable to evaluate changes in other physical aspects of the river that could impact cultural resources (e.g., sedimentation, geomorphology).
7. The analysis uses data from the HEC-RAS modeling of the river and Reservoir System Simulation (HEC-ResSim) modeling of the reservoir System. The analysis assumes that the HEC-RAS and HEC-ResSim models reasonably estimate river flows and reservoir levels over the 82-year POR under each of the action alternatives as well as under Alternative 1 (No Action).

While imperfect, the use of these assumptions allowed for an analysis that shows (broadly) how MRRMP-EIS alternatives would impact the risk to cultural resources.

2.2 Risk and Uncertainty

Risk and uncertainty are inherent with any model that is developed and used for water resource planning. Much of the risk and uncertainty with the overall MRRMP-EIS is associated with the operation of the Missouri River System and the extent to which flows and reservoir levels will mimic conditions that have occurred over the 82-year POR. Unforeseen events such as climate change and weather patterns may cause river and reservoir conditions to change in the future and would not be captured by the H&H models or carried through to the cultural resources model described in this document. The Project Delivery Team has attempted to address risk and uncertainty in the MRRMP-EIS by defining and evaluating a reasonable range of plan alternatives that include an array of management actions within an adaptive management framework for the Missouri River. All of the alternatives were modeled to estimate impacts to cultural resources.

Another source of uncertainty associated with the cultural resources analysis is predicting how long-term changes in river and reservoir conditions would affect cultural resources. To address this uncertainty, project team archeologists have made assumptions on impacts based on past professional experience and observations on similar long-term adverse effects to cultural resources. Some of these conditions have not occurred in the recent past and therefore represent the anticipated impacts to cultural resources under a hypothetical situation.

2.3 Methodology

The purpose of the cultural resources analysis is to link H&H modeling efforts, which simulate river operations of the Missouri River under each of the MRRMP-EIS alternatives, with the analysis necessary to estimate the environmental consequences to cultural resource sites along the reservoirs and riverine sections of the Missouri River. This analysis used Microsoft Excel® to evaluate potential effects of changes in reservoir elevations and river stages on cultural

resource sites. For cultural resources impacts, the analysis evaluated the number of days and number of sites where cultural resources are at greater-than-normal risk to either erosion or vandalism as a result of changes in reservoir elevations or river stage. “Greater-than-normal risk” is defined as a site experiencing a greater risk for erosion or vandalism than it would when reservoir conditions are between the minimum and maximum normal pool elevations or when riverine levels exceed more than a few feet from the bottom of the site. The results are presented by reservoir or riverine reaches within specific geographic areas.

Three measures were used to estimate greater-than-normal risk to cultural sites:

1. **Site-Days** [*The Primary Measure*]: This is the total number of days in each year over the 82-year POR that cultural resource sites were at greater-than-normal risk along a riverine reach or reservoir of the Missouri River. If more than one site was at greater-than-normal risk on a given day, the total number of sites at risk for that day was reflected in this statistic. For example, if 4 out of 11 submerged sites were at greater-than-normal risk in Lake Sakakawea from December 2 to December 3, for the modeled 1951 year, then there were a total of eight site-days under greater-than-normal risk on Lake Sakakawea over those two days as four sites were impacted for two days each. This measure is also presented on an average annual basis as “Average Annual Site-Days.”
2. **Average Days**: This is the average number of days each year that a site was under greater-than-normal risk. This statistic was obtained by taking the total site-days in a given time-period and reach or reservoir and dividing that number by the maximum number of sites impacted under any alternative in that reach or reservoir. Each alternative’s denominator is the same value, which is the maximum number of sites impacted under any alternative, in that reach or reservoir. For consistency, this same denominator value was used for all alternatives, because there are some sites in the inventory that are not affected by one or more alternative. These average-days statistics are calculated for each type of site (e.g., sites above normal pool, sites below normal pool, etc.) for each reservoir and the riverine reaches of each state along the Missouri River Mainstem.
3. **Sites**: This is the total number of sites of each type impacted in any year in a reach or reservoir regardless of the amount of time that each site was impacted. For example, if there are two submerged cultural resource sites that are impacted on Lake Sakakawea in the modeled 2010 year and one is impacted for 2 days at greater-than-normal risk and the other is impacted for 75 days at greater-than-normal risk then the total number of submerged sites impacted in Lake Sakakawea in the modeled 2010 year would be two sites. This measure can also be presented as the “maximum number of impacted sites” which is the maximum number of impacted sites in any year under the period of record for an alternative.

2.3.1 Geographic Scope and Screening

Data for this cultural resources analysis were obtained from USACE records and from State Historic Preservation Offices (SHPOs) 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. Some of the federal lands in the Mainstem Reservoir System have been surveyed for historic properties. Future undertakings will be evaluated for their potential to affect cultural resource sites in consultation with the appropriate state historic preservation officer and American Indian tribe.

The cultural resources information used to conduct this analysis was obtained from existing inventories. Within the Mainstem Reservoir System USACE Omaha District maintains an inventory of sites that has been developed based upon archaeological surveys of much of these federal lands in compliance with Sections 110 and 106 of the National Historic Preservation Act. USACE obtained location data for sites on non-federally owned lands in riverine settings from the various SHPOs in the basin. Inventories of sites on non-federally owned lands are less common, and consequently the inventories from the SHPOs are typically less complete. As discussed above, it is expected that although the total number of sites is likely much larger, these "unrecorded" cultural resource sites would be impacted by MRRMP-EIS alternatives in a similar manner to sites included in this analysis. Additionally, if a riverine or reservoir cultural resources site lacked specific locational data, including elevation data, they would not be included in this analysis.

After the collection of archaeological sites inventory data, sites that had previously been formally determined to be ineligible for the National Register of Historic Places (NRHP) were removed from further analysis, unless the ineligible site had associated human remains. Further, sites at elevations that were higher or lower than any foreseeable changes to the minimum and maximum operational water levels under any of the MRRMP-EIS alternatives were also screened from further modeling analysis.

The study area used in the analysis was the Mainstem of the Missouri River from Fort Peck Reservoir in Montana to the mouth of the Missouri River in St. Louis, Missouri. Figure 3 below provides a map overview the entire study area, and describes the Missouri River, the floodplain, and each of the Mainstem reservoirs all of which are key geographic regions in this study. For the purpose of this study, all recorded archeological sites located within the bluffs of the Missouri River floodplain were identified. The analysis was categorized between sites located on the federally managed lakes (reservoir sites), and sites located within the riverine environment of the Missouri River flood plain (riverine sites). The analysis for each of the Mainstem reservoirs included all of the historic properties and archaeological sites located on federal land within the individual reservoir project. This data was obtained from the USACE Omaha District, which maintains a database of all cultural resources located on the Mainstem reservoirs managed by the USACE. The riverine sites were subdivided by state because each SHPO maintains its own individual database of cultural resource sites. For riverine reaches the geographic extent were as follows:

Montana: The relevant riverine setting on the Missouri River flows from Fort Peck Dam to the border of Montana and North Dakota. This section includes all cultural resources within the Missouri River Flood plain contained within the expanse, excluding sites counted in one of the reservoirs, until approximate river mile 1586 at which point the river enters North Dakota.

North Dakota: All sites in the State of North Dakota are accounted for at Lake Sakakawea or Lake Oahe.

South Dakota: All sites in this section are accounted for in the analysis of Lake Oahe, Lake Sharpe, Lake Francis Case, and Lewis and Clark Lake.

Nebraska: The Missouri River makes up a portion of the Northern and Eastern Border of Nebraska. This section includes cultural resource sites located along the right descending bank from approximately 5 miles south of the Fort Randall Dam, river mile 875, continuing to the borders of Iowa, Nebraska, and South Dakota, river mile 734, and then downstream to the border of Kansas and Nebraska, river mile 490.

Iowa: The Iowa section of the Missouri River includes cultural resource sites located along the left descending bank from the borders of Iowa, Nebraska, and South Dakota in Sioux City, river mile 734, to the border of Iowa and Missouri, river mile 555.

Kansas: The Kansas section of the Missouri River includes cultural resource sites located on the right descending bank from the border of Kansas and Nebraska, river mile 490, to the confluence with the Kansas River at Kansas City, river mile 366.

Missouri: The Missouri section of the Missouri River includes cultural resource sites located on the left descending bank from the Iowa and Missouri border, river mile 555, to Kansas City, river mile 366, and both banks from Kansas City to the rivers confluence with the Mississippi River in St. Louis, Missouri.

Table 1 shows the total number of recorded cultural resource sites located within the meander belt of the Missouri River before sites were screened as potentially affected during model analysis. The cultural resource sites are categorized by state for sites in riverine settings, and by reservoir for sites in the six Mainstem reservoirs. Preliminary analysis indicated that many of these sites would not be impacted by any alternative. Tables 5 and 6 (later in the report) show the total number of sites that are affected under each of the alternatives by geographic region. Due to the sensitive nature cultural resource site location information, all results of this analysis are reported in aggregate, as averages for each of the six reservoirs and as averages across riverine reaches of each state.

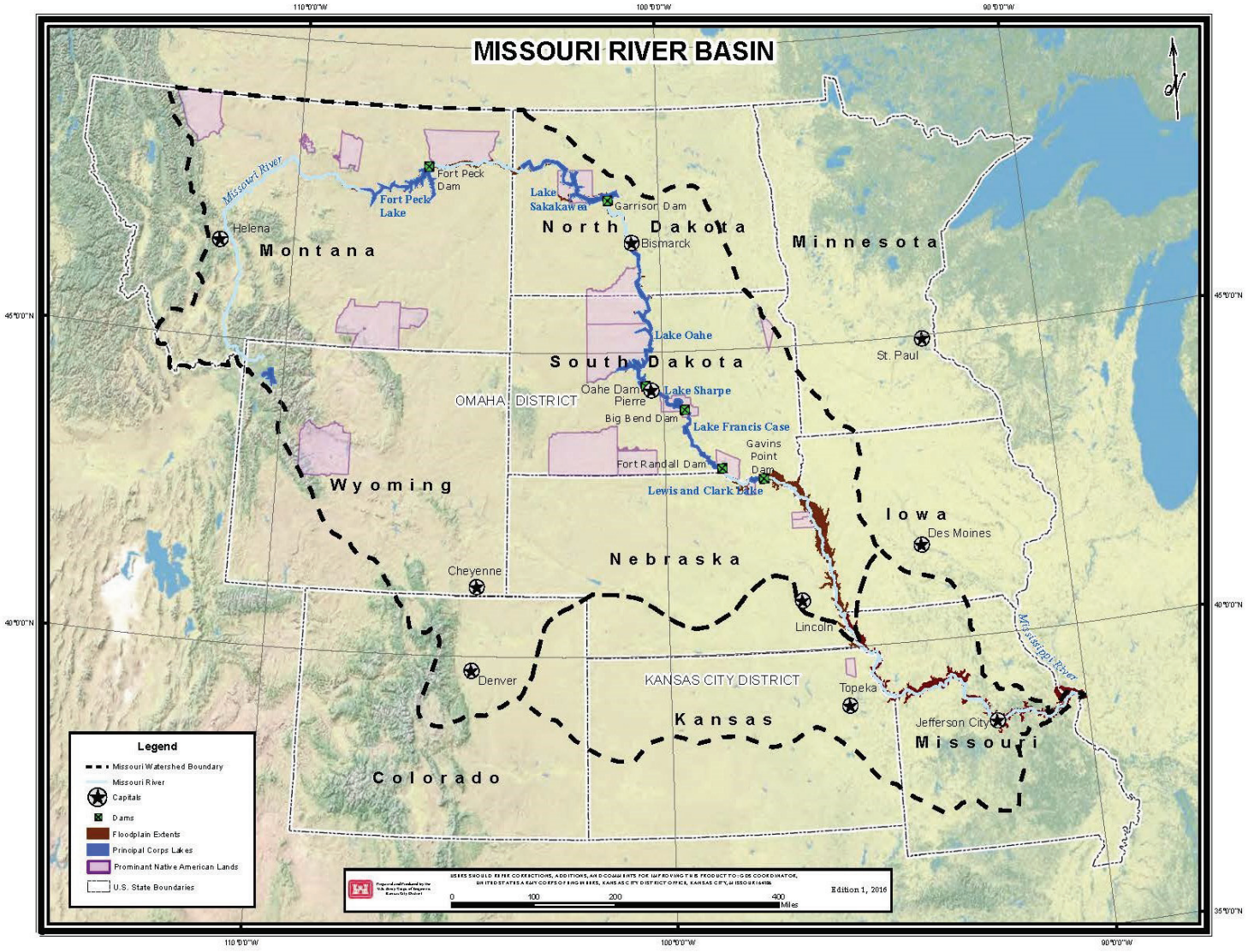


Figure 3. Missouri River Watershed

Table 1. Total Number of Cultural Resource Sites Considered by Geographic Region

Geographic Area	Number of Sites
Fort Peck Lake	53
Lake Francis Case	359
Lewis and Clarke Lake	57
Lake Sakakawea	838
Lake Sharpe	333
Lake Oahe	1,047
Montana Riverine Sections	136
South Dakota Riverine Sections	13
North Dakota Riverine Sections	444
Nebraska Riverine Sections	661
Missouri Riverine Sections	1,800
Kansas Riverine Sections	72
Iowa Riverine Sections	336

2.3.2 Measures for the Analysis of Cultural Resources

Impacts to cultural resources in proximity to the Missouri River in reservoir settings were estimated by modeling the elevation of the site relative to the operational elevation levels under the proposed alternatives. Sites above the maximum-normal and below the minimum-normal operating elevations of the reservoirs were the focus of the evaluation (Table 2). The minimum-normal pool elevation is the elevation of the top of each reservoir's "Carryover Multiple Use Zone" while the maximum-normal pool elevation as the elevation of the top of each reservoir's "Annual Flood Control and Multiple Use Zone." Table 2 provides the elevations of these "normal" pool levels.

Table 2. 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
Lake Sharpe	1,420.0	1,422.0
Lake Francis Case	1,350.0	1,365.0
Lewis and Clark Lake	1,204.5	1,208.0

Note: FAMSL is Feet Above Mean Sea Level

Site-specific critical thresholds were established for sites located above and below these normal operating elevation levels. For sites above normal pool elevation the critical threshold is three feet below the bottom elevation of site. Sites more than three feet above normal operating level

are at risk of erosion or damage from waves. For sites that are typically submerged below the minimum-normal pool elevation, the critical threshold is a pool elevation of one foot above the top of the site (or lower). These sites are considered to be at greater-than-normal risk of exposure to wave action, looting, or other damage when the pool elevation falls below this critical threshold. Table 3 details the specific measures used in this analysis.

Table 3. Reservoir Analysis Measures for Sites at Greater-than-Normal Risk

Reservoir Conditions	Measure	Description
1 – Number of days reservoir elevations are one foot above the site or lower for sites that are below normal reservoir pool elevations (summed across all applicable sites)	Number of site-days	This measure is an estimate of the number of days in a year that reservoir elevations are one foot above the cultural resource site or lower for sites that are below minimum-normal reservoir pool elevations. Once water elevations are at least one foot or lower than the top of a cultural resource site for sites that are below the minimum-normal pool elevation for the reservoir, the site is considered to be at "very high risk" for vandalism. The focus of this measure is on greater-than-normal risk to cultural resource sites.
2 – Number of days reservoir elevations are three feet or less from the bottom of sites that are above normal pool elevations (summed across all applicable sites)	Number of site-days	This measure is an estimate of the number of days in a year that reservoir elevations are within 3 feet from the bottom of a cultural resource site for sites that are above normal pool elevations for the reservoir. Once water elevations are within 3 feet from the bottom of a cultural resource site for sites that are above the normal pool elevation for the reservoir, the site is considered to be at "high risk" for erosion. Once the water level touches the bottom of these sites the site is considered to be at "very high risk" of erosion. The focus of this measure is on greater-than-normal risk to cultural resource sites and impacted sites.
3 – Number of days reservoir elevations are above or below the normal operating elevations of the reservoir for sites that span the normal operating elevation range of the reservoir (summed across all applicable sites)	Number of site-days	This measure is an estimate of the number of days in a year that reservoir elevations are either above or below the normal operating range of pool elevation for a reservoir. Once reservoir elevations are outside of the normal range, sites that have elevations spanning this range can be subject to greater-than-normal risk of vandalism or erosion. The focus of this measure is on greater-than-normal risk to cultural resource sites.

Sites are considered to be "Very High" risk of exposure to looting/vandalism on days when the pool elevation falls (below minimum-normal pool elevation) to within one foot of the top of the site or lower (Figure 4) and for sites below the normal range of pool elevations (Figure 5). For the purposes of simplifying terms in this analysis, the term "site-days" is used to reflect the number of site-days that a site has the potential to experience "high" or "very high" risk of erosion or vandalism due to changing water elevations either inundating or exposing a site.

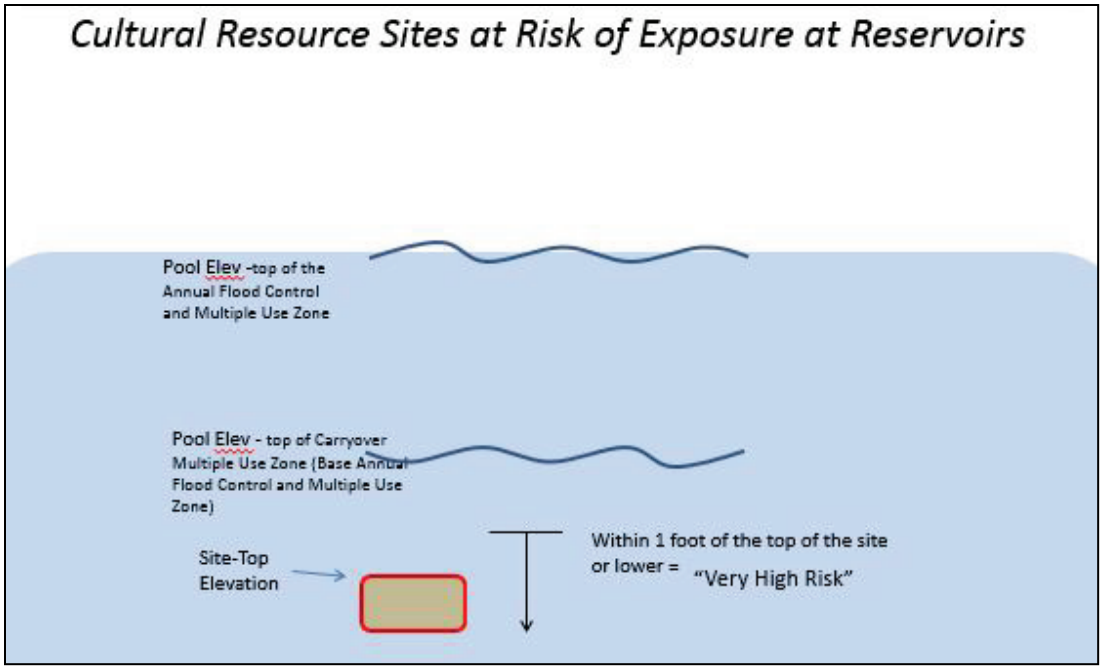


Figure 4. Reservoir Measure: Sites Below Normal Range of Pool Elevations at Reservoirs

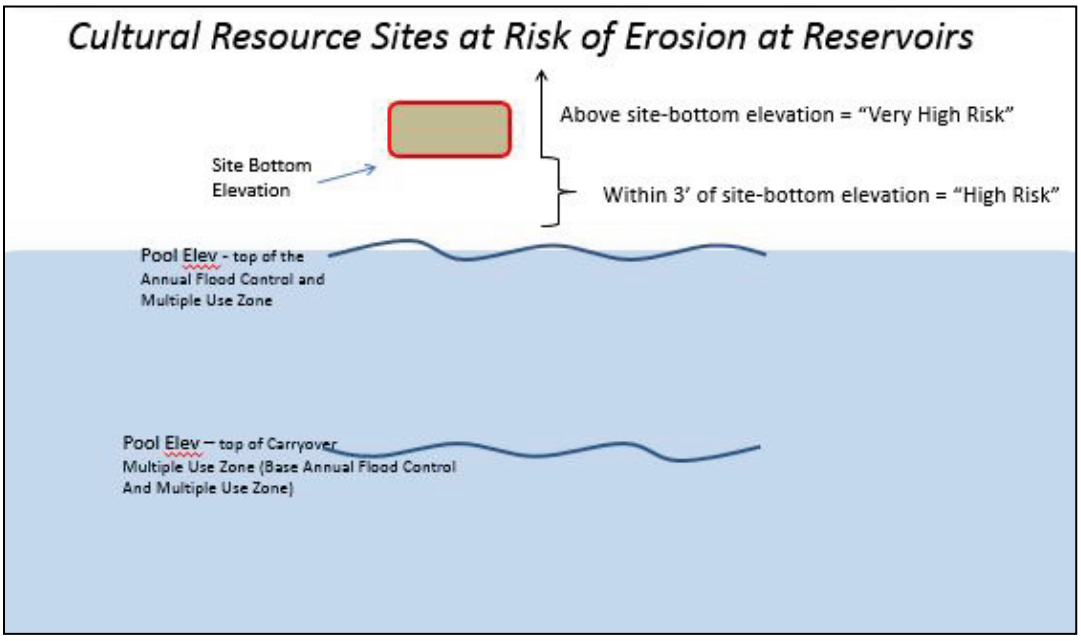


Figure 5. Reservoir Measure: Sites Above the Normal Range of Pool Elevations at Reservoirs

A site that is typically above normal pool elevations is at "High Risk" of erosion on days when the pool elevation rises to within three feet of the bottom of the site (Figure 6). If the pool elevation rises further, to the point where the pool elevation is as high as (or higher than) the elevation of the bottom of the site, the site would be at "Very High Risk." When the pool elevation is more than three feet lower than the bottom of a site of this type, the site is at relatively low risk. For simplicity, the combined site-days of "High Risk" and "Very High Risk" are

reflective of “greater-than-normal risk” and are described as “site-days” for sites above the normal range of pool elevations.

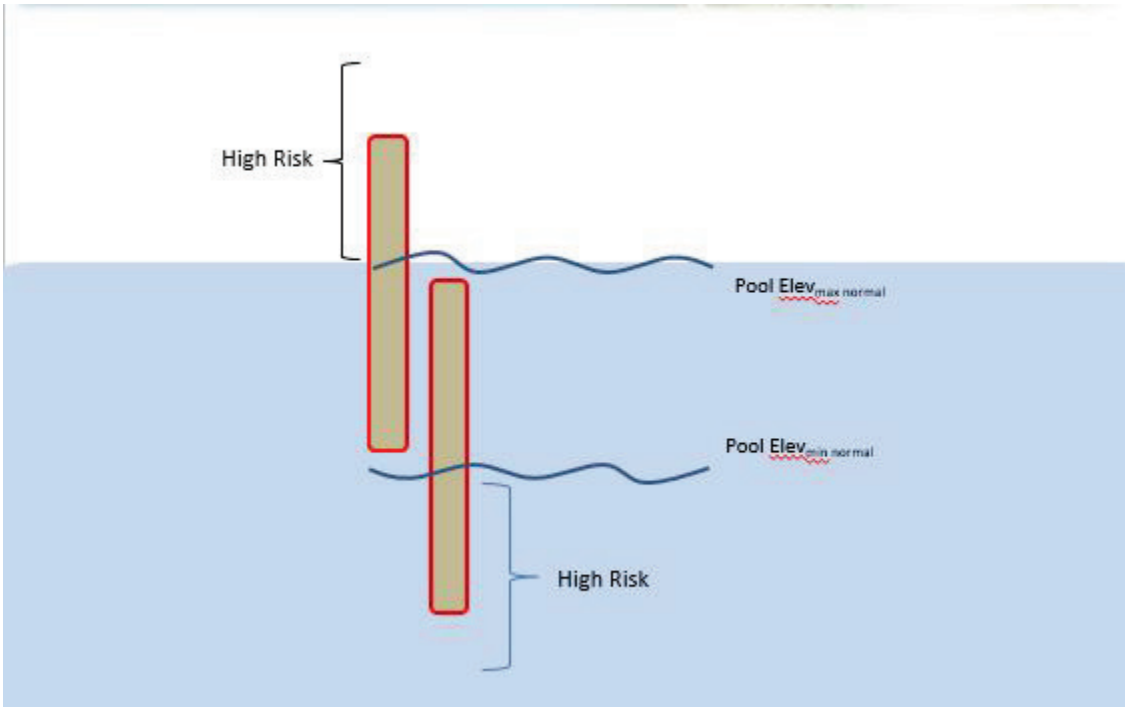


Figure 6. Reservoir Measure: Sites which Span the Normal Range of Pool Elevations at Reservoirs

A site that spans (or partially spans) the normal range of pool elevations is at relatively greater risk on days when pool elevations fall below the normal range of pool elevations (exposing part of the site that is typically submerged) or when pool elevations rise above the normal range of pool elevations (subjecting the higher part of the site to increased erosion risk). When the pool elevations are within their normal range, the site is considered to be at relatively low risk, because at least part of the site is relatively safe from exposure and/or erosion. Therefore only sites that are *entirely* above or *entirely* below the normal range of pool elevations are included in the assessment of cultural resources in this evaluation.

The risks to cultural resources of the Missouri River in riverine settings are evaluated by the frequency that water surface elevations rise above critical thresholds in proximity to the sites. For example, cultural resource sites that are typically above the river’s surface face an increased risk of erosion when river stages reach the bottom of the cultural resource sites. Table 4 details the specific measure used in this analysis.

Table 4. Riverine Analysis Measure

River Conditions	Measure	Description
Number of days riverine stages are at or above the bottom of sites (summed across all applicable sites)	Number of site-days	Once water elevations are above the bottom of a cultural resource site (or above the top of a levee), then the site is considered to be at greater-than-normal for erosion. The focus of this measure is on greater-than-normal risk to cultural resource sites.

A site in a riverine reach that is not behind a levee will be at relatively "high risk" of erosion on days when river stage rises higher than the bottom of the site (i.e., floodwater reaching the site) (Figure 7). A site in a riverine reach that is behind a levee will only be at relatively "high risk" of erosion when river stage rises higher than the top of the levee, overtopping the levee with higher risks to cultural resource sites located in the floodplain behind the levee. Cultural resource sites located behind levees were grouped in similar locations and were associated with the closest gage location along the Missouri River to assess the elevation at which the levee would be overtopped and the sites would be at risk of impact due to flood waters. These sites are otherwise at relatively low risk when river stage is lower than these critical thresholds. For simplicity, the Environmental Consequences chapter of the EIS referred to site-days of "High Risk" as "site-days of greater-than-normal risk" for sites in riverine reaches.

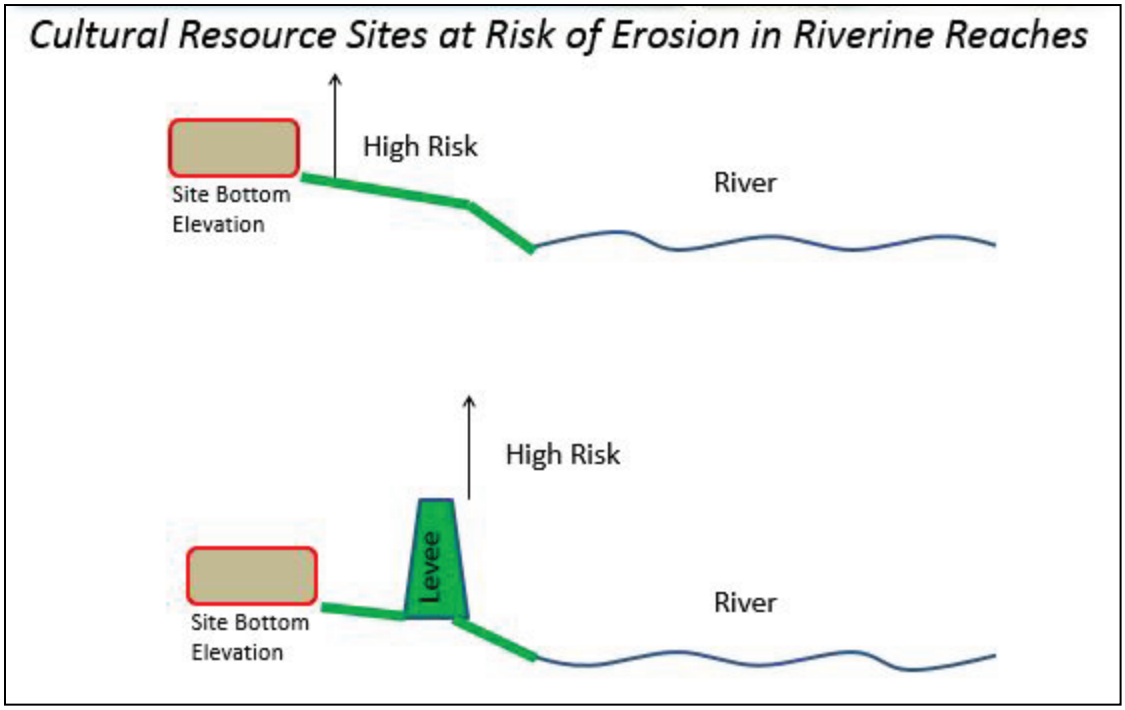


Figure 7. Riverine Measures: Sites located in Riverine Reaches

3.0 Environmental Quality Results

3.1 Summary of Impacts

Most alternatives would impact the same number of individual sites although the frequency of site-days varied among the alternatives. Tables 4 and 5 provide a summary of individual cultural resource sites impacted by each alternative. These modeled impacts are related to fluctuations in water levels which would result in greater-than-normal risk either from erosion or access that correlates to increased likelihood of looting. In general, the more water levels fluctuate, the greater the degree and magnitude of impacts to cultural resource sites.

The primary differences among the MRRMP-EIS alternatives were changes in total days when sites were subject to greater risk, rather than large differences in the number of sites affected. That is to say that most of the same sites are subject to greater risk of erosion or looting at least

one day over the 82-year POR under each alternative, with the difference between alternatives primarily occurring in the number of days that sites were subject to greater risk relative to Alternative 1. Further identification of specific sites may need to be undertaken to better understand impacts to specific cultural resource sites should management actions under the Adaptive Management Plan require modifications to water storage and releases within the System. A description of increases and decreases to risk in each geographic area for all alternatives is presented in this section based on comparison with Alternative 1. On average, there are minimal differences in the annual number of site-days when sites were exposed to risk compared to Alternative 1 across all alternatives in all geographic locations (Table 7).

Table 5 summarizes the total maximum number of sites in reservoir settings subject to modeled impacts over the 82-year POR for each alternative. Most of the reservoirs have the same number of maximum number of affected cultural resource sites. Lake Oahe and Lake Sakakawea have the largest number of affected sites. Lake Sakakawea is the only lake that experiences changes in the individual recorded sites impacted across the MRRMP-EIS alternatives. On Lake Sakakawea, there are fewer maximum number of sites affected under Alternative 2 and slightly higher number of sites affected under Alternatives 4 and 6.

Table 5. Maximum Number of Affected Reservoir Sites Over All Years (Outside Normal Pool Elevations)

Location	Location Relative to Normal Pool Elevation	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Fort Peck Lake	Above	22	22	22	22	22	22
	Below	6	6	6	6	6	6
Lake Sakakawea	Above	405	382	405	405	405	405
	Below	58	59	58	59	58	59
Lake Oahe	Above	215	215	215	215	215	215
	Below	191	191	191	191	191	191
Lake Sharpe	Above	46	46	46	46	46	46
	Below	16	16	16	16	16	16
Lake Francis Case	Above	122	122	122	122	122	122
	Below	30	30	30	30	30	30
Lewis and Clark Lake	Above	26	26	26	26	26	26
	Below	1	1	1	1	1	1

Table 6 summarizes the total number of sites in riverine settings that would be subject to modeled impacts over the 82-year POR for each alternative. With the exception of Iowa and Missouri, all alternatives would have the same maximum number of sites with modeled impacts over POR. In Missouri one less site is impacted under Alternatives 2 and 6, and in Iowa, seven less sites are impacted under Alternative 2.

Table 6. Maximum Number of Affected Riverine Floodplain Sites Over All Years

Location	Montana	Nebraska		Iowa		Kansas		Missouri	
Levee status	No Levee	Behind Levee	No Levee	Behind Levee	No Levee	Behind Levee	No Levee	Behind Levee	No Levee
Alternatives 1, 3–5	5	24	134	121	61	4	21	196	917
Alternative 2	5	24	134	121	54	4	21	196	916
Alternative 6	5	24	134	121	61	4	21	196	916

Note: Neither North Dakota nor South Dakota had inventoried cultural resource sites in riverine settings of the study area that may be impacted as all sites in these states were attributed to reservoirs.

Table 7 summarizes the difference in average annual site-days of increased risk, the primary measure, across the MRRMP-EIS alternatives. Alternative 3 would result in reductions in the average annual site-days of risk for sites at the reservoirs compared to Alternative 1. Alternatives, 2, 4, 5, and 6 would increase the average annual site-days at risk at the reservoirs; Alternative 6 would result in the largest adverse impacts, with an increase in 2,464 (4.4%) average annual site-day affected compared to Alternative 1. Alternative 2 and Alternative 5 have decreased site-days of risk for riverine sites compared to Alternative 1.

Table 7. Average Annual Site-Days of Impact

Geography	Sum of Average Annual Site-Days No Action	Difference Relative to No Action				
		Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Reservoir Sites	55,937	1,614	-237	1,707	879	2,464
Percent Change from Alternative 1	NA	2.9%	-0.4%	3.1%	1.6%	4.4%
Riverine Sites	16,430	-50	-16	38	-68	53
Percent Change from Alternative 1	NA	-0.3%	-0.1%	0.2%	-0.4%	0.3%

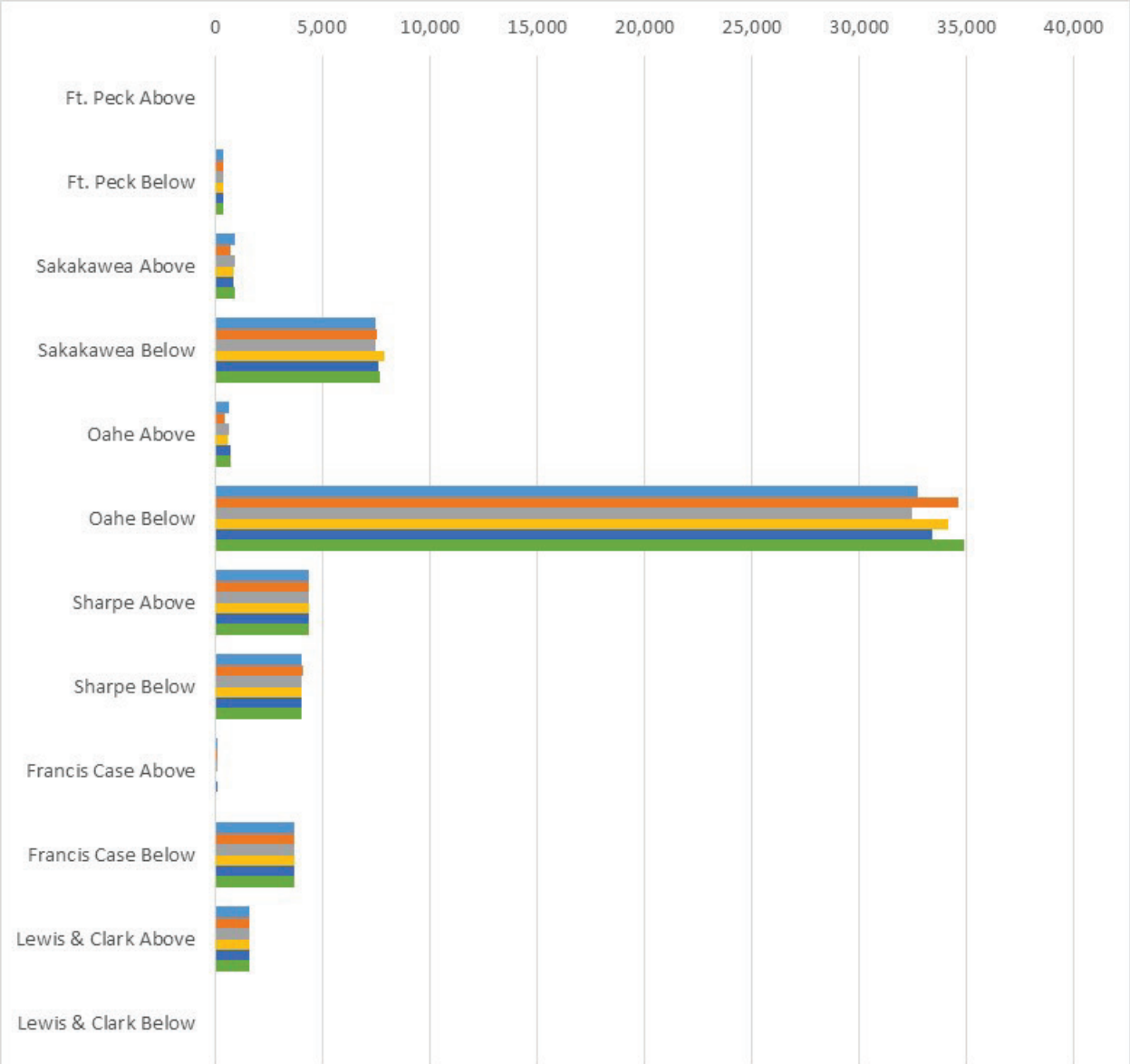
3.2 Impacts to Cultural Resources in Reservoir Settings

As stated above, cultural resource sites are subject to small changes in risks in reservoir settings across all alternatives relative to Alternative 1. The model results indicated that the greatest differences among the alternatives (in terms of average risk) would be at Lake Sakakawea and Lake Oahe, partially due to these lakes having the largest number of known cultural resource sites that could be affected by changes in flow releases and reservoir elevations. There would be minimal differences in risk compared to Alternative 1 for sites at Fort Peck Lake, Lake Sharpe, Lake Francis Case, and Lewis and Clark Lake. The lower three reservoirs, Lake Sharpe, Lake Francis Case, and Lewis and Clarke, maintain reservoir elevations that are fairly stable, even during flow releases; as a result, there are very few variations in impacts across the alternatives for these lakes. Figures 8 and 9 present a summary of the average annual site-days of greater-than-normal risk for cultural resource sites at all reservoirs for both sites above and sites below normal pool elevations.

Alternatives 2, 4, 5, and 6 would result in adverse impacts to cultural resource sites that are located below the normal pool levels at the upper three reservoirs, Fort Peck Lake, Lake Sakakawea, and Lake Oahe. The release events under these alternatives would reduce

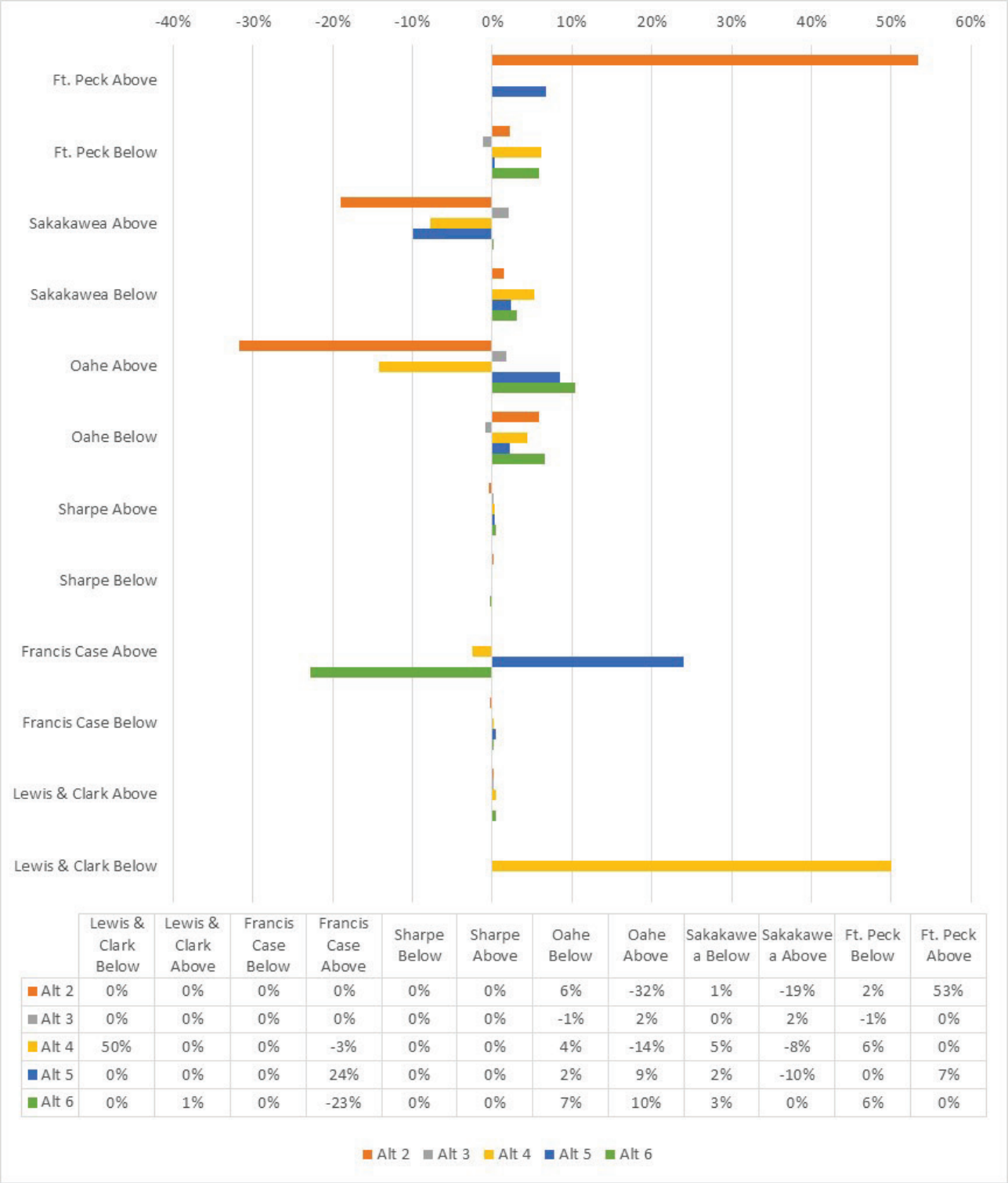
reservoir elevations in the year of and years following the releases, resulting in an increase in site-days, between 1 and 7 percent higher than Alternative 1. The cultural resources sites at Lake Oahe would be most affected for the sites below the normal pool elevations.

There would be some changes in risks for cultural resources sites located above the normal pool elevations. Alternatives 2 and 4 would result in a reduction in risks to these sites at Lake Sakakawea and Lake Oahe, in general from the pulses reducing reservoir elevations on average in these reservoirs. Alternatives 5 and 6 would result in mixed impacts to risks to the cultural resources on average for sites located above the normal pool level. Alternative 3 would result in very small changes in risks to cultural resources, with small reductions in risks to cultural resource sites at Fort Peck Lake and Lake Oahe for site below the normal pool level and increases in risks to sites located above the normal pool level at Lake Sakakawea and Lake Oahe.



	Lewis & Clark Below	Lewis & Clark Above	Francis Case Below	Francis Case Above	Sharpe Below	Sharpe Above	Oahe Below	Oahe Above	Sakakawea Below	Sakakawea Above	Ft. Peck Below	Ft. Peck Above
Alt 1	2	1,582	3,704	79	4,054	4,367	32,723	669	7,462	921	360	15
Alt 2	2	1,583	3,696	79	4,062	4,349	34,617	457	7,569	746	368	23
Alt 3	2	1,584	3,704	79	4,053	4,368	32,461	681	7,456	940	356	15
Alt 4	3	1,588	3,708	77	4,046	4,383	34,164	574	7,854	850	382	15
Alt 5	2	1,582	3,719	98	4,047	4,381	33,419	726	7,635	830	361	16
Alt 6	2	1,590	3,708	61	4,045	4,384	34,860	738	7,693	922	381	15

Figure 8. Average Annual Site-Days of Greater-than-Normal Risk in Reservoir Settings over the 82-Year POR



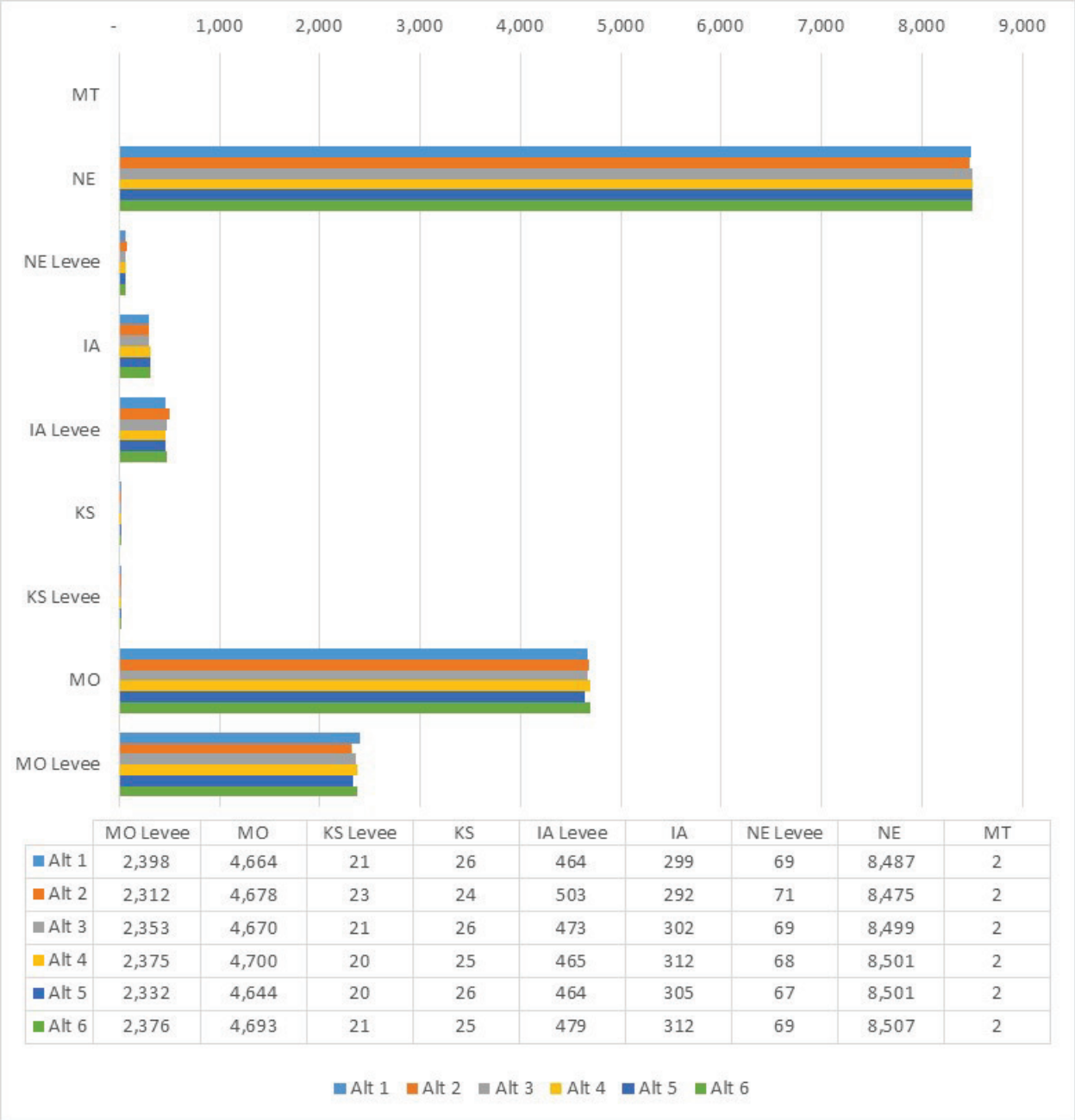
	Lewis & Clark Below	Lewis & Clark Above	Francis Case Below	Francis Case Above	Sharpe Below	Sharpe Above	Oahe Below	Oahe Above	Sakakawea Below	Sakakawea Above	Ft. Peck Below	Ft. Peck Above
Alt 2	0%	0%	0%	0%	0%	0%	6%	-32%	1%	-19%	2%	53%
Alt 3	0%	0%	0%	0%	0%	0%	-1%	2%	0%	2%	-1%	0%
Alt 4	50%	0%	0%	-3%	0%	0%	4%	-14%	5%	-8%	6%	0%
Alt 5	0%	0%	0%	24%	0%	0%	2%	9%	2%	-10%	0%	7%
Alt 6	0%	1%	0%	-23%	0%	0%	7%	10%	3%	0%	6%	0%

Figure 9. Summary of Percentage Difference of Site-Days of Greater-than-Normal Risk in Reservoir Settings Compared to Alternative 1

3.3 Impacts to Cultural Resources in Riverine Settings

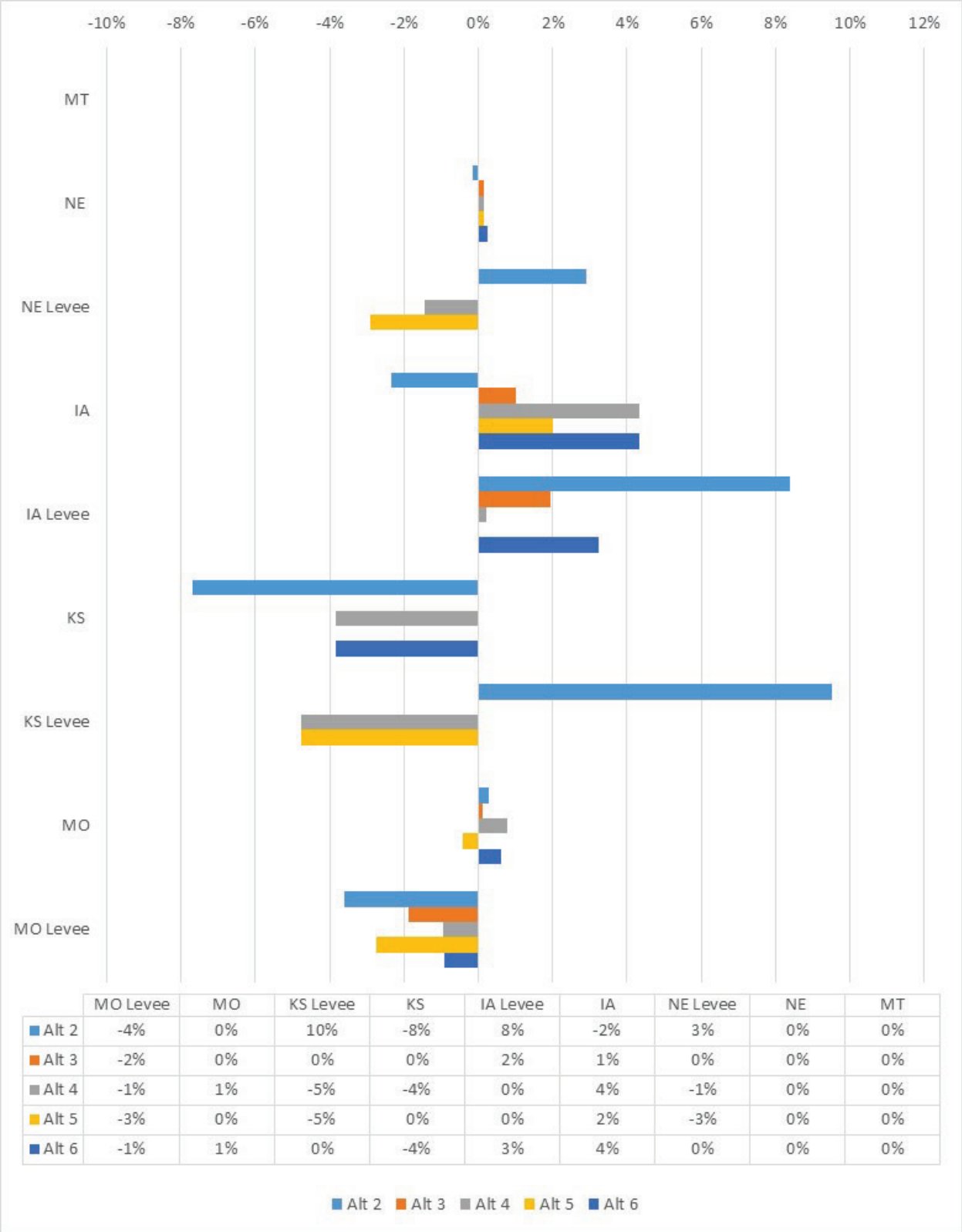
Similar to cultural resource sites located above normal pool elevation at a reservoir, cultural resource sites located along river banks or in riverine floodplains are also subject to increased risk of erosion when river stages rise during periods of high water. Unlike reservoir sites, which are located on federal fee owned land, most of the sites in riverine settings are located on land that is not federally owned. Cultural resource sites located close to river banks (and not behind levees) can be affected by erosion on a daily basis or during relatively minor high-water events. Erosion affects these sites by destroying cultural materials and degrading intact cultural deposits. The exposure of these sites along shorelines can also lead to both intentional and unintentional damage. Exposed cultural resources can lead to greater risk of vandalism and looting.

Overall cultural resource sites in the riverine reaches would be subject to relatively small changes in risk based on the MRRMP-EIS alternatives. The total number of sites at risk, number of years that risks to sites could occur, and the average annual number of site-days of greater-than-normal risk to cultural resource sites in riverine reaches varied little among alternatives. Modeled results indicated small changes in site-days for Alternatives 2 through 6 compared to Alternative 1. Alternative 2 had the greatest change in both increased and decreased average annual site-days of greater-than-normal risk compared to other alternatives. Cultural resource sites in Iowa located behind levees would experience an increase in risk of 39 average number of site-days per year (8%), while sites in Missouri located behind levees would experience a decrease in risk of 86 average number of site-days per year (4%). The change in average annual site-days for sites in Missouri would be partly due to a partial release in March that would occur under Alternative 2 as opposed to a full release in March that would occur in one year under Alternative 1, causing a slight reduction in water levels relative to Alternative 1 and resulting in a reduction in risk of impacts to cultural resource sites in Missouri. Risk of impacts to cultural resource sites in Iowa would increase as a result of a partial release occurring in March in one year instead of an eliminated release that would occur under Alternative 1, slightly increasing the risk of impacts to sites behind levees. The results are further summarized in Figures 10 and 11.



	MO Levee	MO	KS Levee	KS	IA Levee	IA	NE Levee	NE	MT
Alt 1	2,398	4,664	21	26	464	299	69	8,487	2
Alt 2	2,312	4,678	23	24	503	292	71	8,475	2
Alt 3	2,353	4,670	21	26	473	302	69	8,499	2
Alt 4	2,375	4,700	20	25	465	312	68	8,501	2
Alt 5	2,332	4,644	20	26	464	305	67	8,501	2
Alt 6	2,376	4,693	21	25	479	312	69	8,507	2

Figure 10. Average Annual Site-Days of Greater-than-Normal Risk in Riverine Settings over the 82-Year POR



	MO Levee	MO	KS Levee	KS	IA Levee	IA	NE Levee	NE	MT
Alt 2	-4%	0%	10%	-8%	8%	-2%	3%	0%	0%
Alt 3	-2%	0%	0%	0%	2%	1%	0%	0%	0%
Alt 4	-1%	1%	-5%	-4%	0%	4%	-1%	0%	0%
Alt 5	-3%	0%	-5%	0%	0%	2%	-3%	0%	0%
Alt 6	-1%	1%	0%	-4%	3%	4%	0%	0%	0%

Figure 11. Summary of Percentage Difference of Site-Days of Greater-than-Normal Risk in Riverine Settings

4.0 Literature Cited

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U.S. Water Resources Council (1983): “Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.” Informally known as the P&G.

USACE (2000): ER (Engineering Regulation) 1105-2-100, “Planning Guidance Notebook” (22 April 2000 and later appendices). This regulation implements the above-referenced P&G; the main flood risk guidance is found in Section 3-3 and Appendix E, Section III.