CHAPTER 6

Potential Mitigation Measures

NEPA and its implementing regulations require that an EIS identify potential mitigation measures for the adverse impacts potentially resulting from a proposed action. Mitigation measures are actions that could be taken to avoid, offset, reduce, or compensate for adverse effects to the environment (40 CFR 1580. 20). The technical analyses presented in the previous chapters discuss the potential for some adverse environmental impacts to result from the Proposed Action and the alternatives. Most of the impacts are associated with the indirect effects of commercial dredging of sand and gravel in the LOMR on channel geomorphology (i.e., river bed elevations, water surface elevations, and sediment dynamics). The resources most affected by changes in river channel conditions are aquatic habitats, the federally listed pallid sturgeon, infrastructure, and cultural resources. Impacts related to air quality also may require mitigation.

Potential measures that would mitigate identified impacts are discussed below. The CEQ regulations provide for mitigation (1) in the form of alternatives (fully discussed in Chapter 2); (2) as an integral part of the design of the Proposed Action or the alternatives; (3) as additional measures that further reduce or offset impacts; and (4) as monitoring to ensure that mitigation is being performed and is achieving the expected results (Sutley 2010) or monitoring for adaptive management. All of these measures have been considered in the EIS.

The USACE determination under the CWA Section 404(b)(1) Guidelines will be based on and coordinated with this EIS. Under these guidelines, the USACE has a formal process, requirements, and restrictions that must be met (see Section 1.4), including identification of the least environmentally damaging practicable alternative and practicable and necessary mitigation measures. The Section 404(b)(1) analysis and ROD will consider the potential mitigation measures presented below in determining which measures are practicable and necessary.

In the following sections, mitigation measures are discussed according to four general categories:

- Existing mitigation measures integrated into the Proposed Action and alternatives – measures included in recent dredging permits that are designed to avoid, minimize, or mitigate dredging impacts;

- Potential dredging restrictions and operational conditions – measures that could further reduce dredging impacts on river bed degradation by restricting the location or operation of dredging activities;
- Potential monitoring and permit cycle reevaluation – measures that could be included to verify the implementation and effectiveness of mitigation on environmental conditions, monitor actual impacts to improve understanding in areas of uncertainty, trigger other mitigation measures, or provide a basis for adaptive changes to levels of commercial dredging of sand and gravel; and
- Other potential mitigation measures – measures to reduce impacts to environmental resources or address other human environment resources.

6.1 EXISTING MITIGATION MEASURES INTEGRATED INTO THE PROPOSED ACTION AND ALTERNATIVES

Commercial dredging of sand and gravel is an ongoing activity on the LOMR under permits issued by the USACE. The USACE issued a permit decision document in August 2007 that included specific dredging restrictions, operating procedures, and monitoring requirements intended to allow dredging to continue through December 31, 2009, with less-than-significant impacts while this EIS was being prepared (USACE 2007). In March 2008, the USACE issued a supplemental permit decision document with some minor modifications to the initially proffered permit in response to issues of appeal made by the applicants (USACE 2008a). When it was apparent that this EIS would not be completed by December 31, 2009, the USACE extended the permits for an additional year to allow additional time to complete this EIS.

Because responding to public comments regarding the published Draft EIS took longer than anticipated, this Final EIS was not published and the permit decision was not complete by December 31, 2011; therefore, the permits were once again extended through March 31, 2011. Throughout this period, the USACE Kansas City District, the USFWS, and the Dredgers have informally consulted under Section 7 of the ESA on each permit and permit extension. The existing mitigation measures described in this section include the measures outlined in the original 2007 permit decision document, measures in the 2008 supplemental permit decision document, and measures in the 2009 permit extension—all resulting from informal consultation between the USACE, the USFWS, and the Dredgers.

Existing mitigation measures are listed in Section 2.4.3 and include (1) restrictions to dredging locations; (2) restrictions to dredging operations; and (3) monitoring requirements. As part of the

restrictions to dredging locations, dredging is excluded from the areas listed in Table 2.2-6 as habitat areas for pallid sturgeon. These existing mitigation measures were included as part of the project description for the Proposed Action and Alternatives A, B, and C when the Environmental Consequences analysis was undertaken.

The existing mitigation measures generally include:

- Concentration restrictions – Under the currently authorized dredging permits, no more than 1,200,000 tons of material may be extracted within 1 year from any 10-mile reach of the Missouri River between RM 49.8 and RM 490.0. When monthly reports from all the dredge plant monitoring systems indicate that the total extraction of all dredgers in a 10-mile reach has reached 1,200,000 tons, all Dredgers authorized to operate within that reach will be notified that the reach is closed to further dredging for the remainder of the calendar year. This restriction reduces the contribution of dredging to river bed degradation and the adverse effects of dredging on navigation, flood control, water intake structures, and endangered species and their habitat.
- Exclusion zones – In 2007, Dredgers were authorized to dredge within specific reaches of the river delimited by river mile. They were further restricted from dredging within set distances of (1) the shoreline; (2) infrastructure facilities (levees, pipeline crossings, dikes, and bridges); (3) water intake structures; and (4) pallid sturgeon habitat areas. By establishing these exclusion zones, the effects of dredging on shorelines and shoreline-based facilities and habitat are reduced. These restrictions reduce the effects of dredging on existing permeable aquifer material, reduce adverse impacts to the quality and quantity of water sources, reduce adverse impacts to municipal drinking water intake structures, and provide a mixing zone sufficient to reestablish water quality to background conditions on the Missouri River. Avoidance of dredging near certain pallid sturgeon habitats reduces potential effects to the pallid sturgeon and its habitat. The USFWS determination that recent levels of dredging activities are not likely to adversely affect endangered species was conditional and based, in part, on this restriction. The dredge operator is responsible for determining that the dredge does not operate within these exclusion areas. The dredge location is documented with GPS, and compliance with permit exclusion locations is documented in reports submitted to the USACE.
- Discharge and disposal requirements – To protect water quality, both in the river and as a supply source for municipal and industrial use, Dredgers are restricted from discharge of contaminated material back into the river during dredging operations. Activities related to the handling of fuel, lubricants, and other similar materials are regulated; and the Dredgers must

prepare and implement appropriate pollution prevention plans. Dredgers must issue appropriate notification to operators of water intake structures when changes in water quality may occur.

- Navigation requirements – Dredgers must comply with all USCG, State of Missouri, State of Kansas (RM 367 to RM 490), and USACE regulations concerning the prevention of navigation obstructions in navigable waters of the United States. This requirement reduces adverse impacts to navigation from dredging-related activities.
- Monitoring and reporting requirements – Dredgers must prepare and implement monitoring plans to report the locations and volume of dredge materials removed, and must conduct annual bathometric surveys to monitor changes in river bed elevations. This information assists the USACE in monitoring the compliance of Dredgers with permit conditions and the effectiveness of certain mitigation measures.

6.2 POTENTIAL DREDGING RESTRICTIONS AND OPERATIONAL CONDITIONS

The following section discusses measures that the USACE could consider to further avoid, minimize, or mitigate adverse impacts. These measures may be appropriate only if the USACE determines that it will authorize an alternative other than the Environmentally Preferred Alternative. Measures described in this section could be implemented through USACE permit conditions. These measures are directed primarily at reducing river bed degradation. These measures have not been included as part of the Proposed Action or Alternatives A, B, or C; nor were they included in the impact analyses.

6.2.1 Restrict Concentrated Dredging

The greatest potential for localized dredging-related impacts occurs when considerable dredging is concentrated in one portion of a river segment. Under existing dredging permits, the amount of material that may be dredged from any 10-mile reach is limited to 1,200,000 tons. Given the extent of river bed degradation that has occurred in areas of concentrated dredging to date, a more conservative approach may be warranted.

To estimate potential dredging intensity effects on river bed degradation, historical dredging data were used to determine where dredging occurred (dredging reach) and at what intensity (annual average dredging amount in tons/mile/year). This information was then compared with observed patterns of local bed degradation by analyzing changes in local bed elevations in relation to dredging intensities using linear regression. The regression results suggest that dredging up to

approximately 60,000 tons/mile/year is a level of local dredging intensity that is reasonably unlikely to result in local bed degradation. See Section 3.4.6.3, "Commercial Dredging," and Appendix A for more details on the linear regression analysis.

Reducing the amount of dredge materials removed from a concentrated area would reduce local dredging-related impacts on river bed elevations and water surface elevation changes. This mitigation may require Dredgers to travel longer distances to dredge locations and require longer tow hauls to ship sand and gravel to land-based plants, increasing production costs.

6.2.2 Prohibit the Use of Cutter-Head Dredges

Cutter-head dredges were originally developed to loosen densely packed deposits and cut through soft rock; they can excavate a wide range of materials, including clay, silt, sand, and gravel (Kleinfelder et al. 2002). Because they are equipped with a rotating cutter apparatus surrounding the intake end of the suction pipe, a cutter-head dredge can efficiently dig and pump all types of alluvial materials and compacted deposits such as clay and hardpan (USACE 1983, Kleinfelder et al. 2002).

The use of cutter-head dredges in the LOMR allows dredging of consolidated layers of sediment that are below the looser, regularly mobilized sediment layer on the river bottom. It appears that, when using cutter-head dredges, the Dredgers may sometimes mine consolidated deposits of coarser sand well below the active river bed to get a mix of sand that meets specifications. The use of cutter-head dredges may exacerbate river bed degradation by cutting into these denser underlying deposits, destabilizing the river bed, and/or stimulating development of headcuts. Prohibiting the use of cutter-head dredges may reduce the disturbance of consolidated sediments not typically mobilized by higher flows and may lessen river bed degradation in heavily dredged areas. Prohibitions on the use of cutter-head dredges have been used elsewhere to reduce potential impacts on the river bed and certain aquatic habitats (Frerker pers. comm.)—as have restrictions on the depth of dredging, which can fulfill the same purpose and leave sand and gravel above the bottom or rock layers to protect the integrity of the channel and certain habitats (USACE 2007).

Prohibiting the use of cutter-head dredges will cost the Dredgers the expense of removing the cutter heads from their dredges or replacing the dredges. The amount of material available for dredging that meets specifications may be reduced in some areas because it cannot be dredged (i.e., consolidated sediment) or does not have a suitable range of size fractions, and the effort needed to obtain amounts of suitable materials may increase. A larger volume of material may need to be

dredged in order to obtain the same amount of sand that meets the required material specifications. Another potential result of prohibiting the use of cutter-head dredges is that the Dredgers may not be able to extract as much sand as they have in recent years solely by dredging in historically dredged areas. These circumstances may result in some dredging in areas not currently dredged.

6.2.3 Limit the Dredging Season

Potential impacts to pallid sturgeon include mortality of eggs and larvae that may be entrained and pass through the dredge. It is reasonable to assume that ceasing or restricting dredging during the time of highest larval pallid sturgeon drift, from May 15 to July 15, may prevent entrainment of some larvae, which may benefit the species as a whole. However, the rate of larval entrainment into dredges and entrainment mortality on pallid sturgeon are poorly understood and appear to be very low, as are the possible population-level effects of entrainment. Larval pallid sturgeon have not been documented in the action area. The USACE completed a Draft Biological Assessment which found that the potential for entrainment of pallid sturgeon due to dredging and towboat propellers and related mortality would be extremely low and thus was judged to be minor and discountable. The Biological Assessment concluded that the Proposed Action may affect, but is not likely to adversely affect the species (USACE 2010).

6.2.4 Use a Mine-and-Relax Strategy to Limit Dredging Intensity

During the 2007 and 2009 permit extension processes and again during the EIS scoping process, certain Dredgers proposed a mine-and-relax strategy to reduce the localized impacts of dredging activities on river bed degradation. The strategy would limit the period during which an area is dredged and would require sufficient time for its “recovery” before that area is dredged again. Conceptually, the strategy could include expanding the reaches to be mined, limiting dredging in a 1-mile reach to 1 week, and then resting that 1-mile reach for at least 4 weeks before dredging again. However, the proposed mine-and-relax strategy included no cap on the total amount dredged in a reach, and it would not limit the amount dredged by segment or by Dredger. In addition, the effectiveness of the mine-and-relax may depend on how long it takes for a reach to recover, and the length of time for this to occur is currently not known because data are limited. Further work on determining the recovery time for a specific dredging location or reach is needed before such a strategy could be effectively employed.

Although the mine (dredge)-and-relax strategy has the potential to reduce localized dredging impacts, the effects on general degradation of a reach would depend on the total amount dredged in the reach. This is based on the need for dredging to balance with the bed load of the river at that

location. For the strategy to be effective, it must include a cap on the total amount dredged in a reach, and there must be better information on localized recovery time. The Restrict Concentrated Dredging measure discussed above is in some ways similar in approach.

6.3 MONITORING AND ADAPTIVE MANAGEMENT FRAMEWORK

In concert with permit criteria that specify overall dredging amounts and limitations on dredging density, a monitoring and adaptive management framework could monitor ongoing trends in bed profile; measure aggradation or degradation in relation to past dredging activity; and, if warranted, adjust permit criteria (dredging levels) in future permit actions.

The analysis of bed degradation incorporated into the EIS is based on the best information available to form an understanding of the dynamics of the river, including the effects of changes in sediment inputs, construction of the upstream dams and the BSNP, major flow events, and commercial dredging. While a significant amount of data has been collected, it is not sufficient to completely describe the dynamics of the LOMR. Estimates of bed material loads and bed degradation use models and estimates based on calculations that are subject to uncertainty. In addition, a river system—even one with an extensive control system like the LOMR—is inherently variable due to changing flows, sediment loads, tributary inputs, and channel characteristics. The uncertainty associated with the analysis used to predict future river bed degradation levels and the inherent variability in the river's natural cycle lead to implementation of a monitoring and adaptive management framework.

A proposed adaptive management framework is shown in Figure 6.3-1. It consists of six elements, including problem assessment, design, implementation, monitoring, evaluation, and adjustment. It allows for the adjustment of management approaches based on systematic collection and evaluation of new information.

The elements of the monitoring and adaptive management framework that apply to monitoring and management of commercial dredging and recovery of those portions of the LOMR with long-term bed degradation are described below.

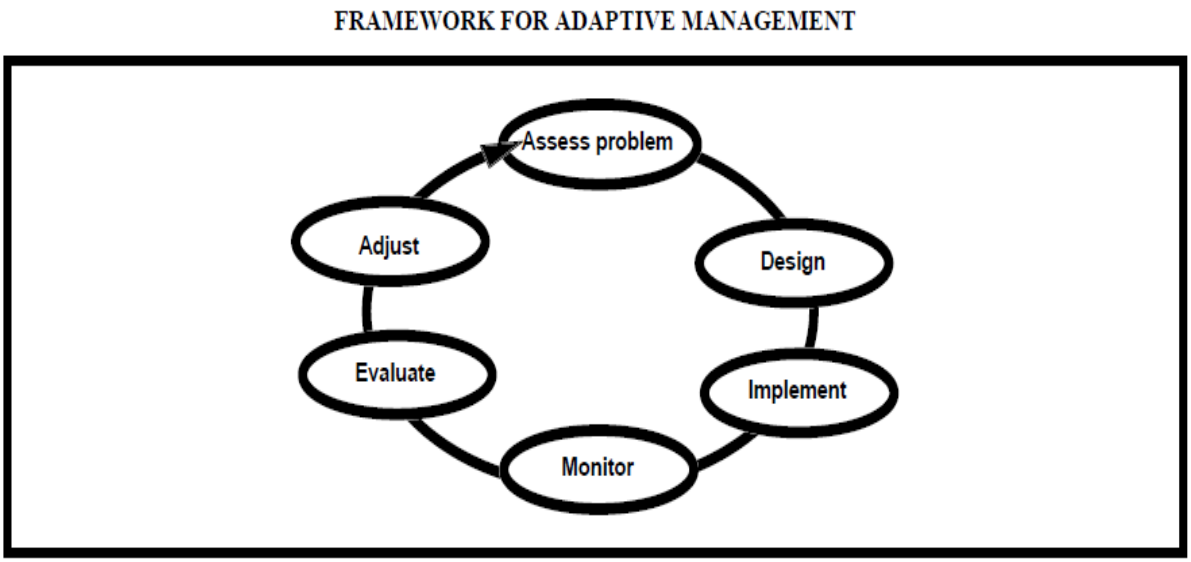

Figure 6.3-1 A Framework for Adaptive Management

Source: Nyberg 1999.

6.3.1.1 Problem Assessment

The first step in the adaptive management framework is to assess the problem. An initial problem assessment has been completed for the LOMR in this FEIS. Chapter 3 describes the affected environment of the LOMR as it currently exists and the historical conditions that led to these current conditions. When additional research such as the Degradation Feasibility Study is completed, finer scale information will be available for some portions of the river that will more clearly define river dynamics and the causes of river changes.

This EIS describes the current condition of the affected environment, how various parameters have changed in the past, and potential effects of the alternatives. Objectives for management of commercial dredging in the larger context of the LOMR's congressionally mandated purposes of preserving and protecting the environmental resources of the LOMR need to be defined as key elements of assessment. For example, in some portions of the LOMR such as the Kansas City segment, aggradation to raise the bed elevation and protect infrastructure while maintaining appropriate navigation depths may be a reasonable objective; in other portions of the LOMR, where risk to infrastructure or shallow-water habitat is low, some bed degradation may be acceptable.

Finally, a baseline from which to measure change must be selected. Of the baselines available, selecting 2009 as the baseline for the purpose of setting adaptive management goals has the following advantages:

- It is the most current and comprehensive description of LOMR conditions and was used in this EIS as the basis for the geomorphic analysis.
- It can be compared to any past benchmark—for example 1990, 1998, or 2005—to describe change relative to previous conditions as defined by those years.
- One of the primary goals of the MRRP is to restore shallow-water habitat. No period in the recent past better represents the conditions that the MRRP is trying to achieve than 2009.
- As described in Section 3.4, the river has been changing continuously in response to natural variability and human modification, and the MRRP will further modify the LOMR over the next decade. Substantial data for the year 2009 are available to describe the river's condition at that time.

6.3.1.2 Design

The analyses contained in this EIS found that a relationship exists between commercial dredging and river bed degradation both on a spatial scale and a temporal scale. Although other factors may be contributing to bed degradation, commercial dredging is the proposed activity to be permitted and regulated; therefore, the design of the adaptive management program should focus on managing and monitoring commercial dredging in the context of natural processes.

The Proposed Action and each of the alternatives limit commercial dredging on a broad scale by setting annual dredging limits for each river segment and at the local scale through permit restrictions (including no-dredge buffers around sensitive areas). Chapter 4 describes the environmental consequences associated with levels of dredging incorporated into the Proposed Action and each of the alternatives if dredging were to continue at the locations where dredging has historically occurred. In the past, dredging has generally been concentrated near the sand plants operated by the Dredgers; these tend to be located near urban areas. The EIS analysis found that dredging impacts would likely be mitigated by limiting the intensity of dredging in any one local area, as described in Section 6.2.1 (see Sections 2.7.4 and 3.4.6.3 and Appendix A for more details).

One adaptive management approach would be to permit a more liberal level of dredging within each segment with similar permit restrictions to those currently in place, and to set degradation thresholds for action within a 5-year permit cycle based on monitored changes to water surface

elevations or bed elevations in the river. For example, after setting an initial annual dredging limit (tons/year/segment), dredging could be curtailed or reduced even before the permits expired if monitoring showed that degradation exceeded a set limit in a specific portion of the river. It should be noted that under such an approach, to the extent that bed degradation occurs from any cause, or combination of causes, future dredging restrictions would be implemented. Factors to be considered in this approach include determining how or what to monitor, the length of time to monitor, the length of river that can be accurately measured, the baseline from which to measure degradation, and the extent of degradation that triggers an action. An advantage to this approach is flexibility for Dredgers to select the locations and the degree of intensity they wish to dredge until restrictions are triggered. One problem with this approach is the uncertainty for Dredgers concerning how much and for how long dredging could occur in a reach. It also allows for a certain amount of degradation before triggering a restriction on dredging, which may have impacts. This approach does not directly manage dredging intensity but rather manages the impacts from intense dredging. Another problem is the increased level of human resources required of the USACE to monitor degradation and to adjust dredging restrictions within a permit cycle.

A second approach uses the relationship between dredging intensity and degradation (see discussion in Section 3.4.6.3) to set more restrictive limits on dredging intensity that would be expected to limit degradation to the level that is acceptable for a specific segment. Bed and water surface elevations would be monitored as discussed above. Based on data collected over the previous permit cycle, permit conditions such as the total dredging limit for the segment or the dredging intensity could be adjusted for the next permit period. This approach has the following advantages:

- It reduces the likelihood that degradation would occur by limiting the intensity of dredging;
- It incorporates a basis for setting a target dredging intensity;
- It provides flexibility in the location of dredging as long as dredging does not exceed the target intensity; and
- It provides Dredgers with the maximum possible predictability and minimizes the human resource demand on the USACE by limiting permit modification to the normal permit reevaluation period at the end of each 5-year permit cycle.

Disadvantages of this approach include requiring Dredgers to dredge less in some areas and to dredge in areas farther from their facilities. Dredging intensities could vary from one permit cycle to the next.

6.3.1.3 Implementation

Implementation would be through permit issuance upon completion of this EIS and the accompanying Section 404(b)(1) analysis and ROD, and periodic modification of permits or reissuance of permits. Changes in permits to reflect revised conditions may include changes to dredging amounts, changes to dredging locations, and specific restrictions on dredging activities. Permit conditions considered as part of the Proposed Action and alternatives are summarized in Section 2.4.3, and will be finalized at the time the permits are issued. Adherence to the permit conditions, along with the monitoring described below, constitutes implementation of the monitoring and adaptive management framework.

6.3.1.4 Monitoring

To provide the basis for adaptive management decisions, a monitoring and adaptive management framework must include appropriate monitoring. This section briefly describes how existing data can be used in developing a detailed monitoring plan, the criteria for an effective monitoring plan, how two existing monitoring programs meet the criteria, and suggestions for additional monitoring.

Measurements of low-flow water surface elevations and river bed elevations have been completed in recent years for a variety of purposes. Although these data were not collected specifically to monitor degradation or potential effects from commercial dredging, they are instructive for determining spatial and inter-annual variability—important considerations in developing a monitoring plan that is capable of detecting river bed elevation changes at a scale required for adaptive management and regulatory compliance decisions. In particular, the 2-year USGS study of channel morphodynamics (USGS 2009) describes variability and changes in a 4.1-mile section of the LOMR channel near Waverly.

Although extensive data have been collected on the LOMR for a variety of purposes, a systematic program of data collection for the purpose of monitoring the effects of commercial dredging does not currently exist. Development of a monitoring plan to meet the needs of an effective monitoring and adaptive management framework would need to address the following:

1. Parameters measured – data collected must be appropriate to answer management questions.
2. Period of record – data must be collected over a period of time that is sufficient to establish an appropriate baseline and show significant change from that baseline.

3. Density and frequency – data must be collected with sufficient density and frequency to address the variability of the parameters measured on the LOMR and support management decisions on a 5-year permit cycle.

4. Project-wide coverage – data need to be collected from the whole Project area since dredging occurs throughout the LOMR.

5. Cost effectiveness and practicality – costs and access cannot be prohibitive to collect data at the level necessary to address management questions.

6. Commitment – parties responsible for data collection need to commit resources to the monitoring program over the long term.

Section 3.4.6.1 describes the data that were used for the geomorphic analysis of existing conditions on the LOMR and describes how the data were collected and used in the analysis. Data such as bed profiles at USGS gaging stations, sediment size distributions, sediment loads, discharge, dredging pit-refill studies, LiDAR, and time-series of aerial photos provide additional information but do not answer the key management and compliance issues of water surface elevations and bed elevation changes in a way that meet the criteria described above. These data should continue to be collected, however, because they provide valuable information for other monitoring purposes. Two existing sources of data that do meet some of the elements described above are low-flow water surface elevation data and hydroacoustic river bed elevation data.

Low-Flow Water Surface Elevation Surveys

Low-flow water surface elevation survey data are available for 25 of the last 38 years including 1974, 1988, 1990, 1994, 1998, 2000, 2002, 2005, 2006, 2007, 2008, and 2009 (USACE 2010). These surveys provide a long-term database of low-flow water surface elevations and changes for the entire Project area, which meets several of the monitoring criteria described above.

The procedure for collecting and analyzing low-flow water surface elevation data is summarized here. Water surface elevation profiles are created by measuring low-flow water surface elevations throughout the LOMR in a short period of time so that changes in flows are minimal. Surveys are usually conducted in August or September when discharge is close to the CRP flow, which is a 75-percent exceedance flow during navigation season. The elevation of the edge of water is recorded at locations near USACE temporary benchmarks located on the banks of the river that are surveyed to provide an accurate geospatial reference. The current monitoring program utilizes approximately 200 benchmarked locations, averaging less than one per every 2–3 miles of river in the Project area.

Because surveys cannot be conducted during the target flow every year and at every location, the data are compared to flow data from USGS gages at the time of the survey and normalized to a common discharge (typically the 2005 CRP discharge). The elevations are then adjusted based on the normalized flow data, which allows elevation data from different years and flows to be compared.

The low-flow water surface elevation data meet criteria 1, 2, 4, and 5 from the list above, but does not have enough resolution for monitoring 1-mile increments of the river because benchmarks are located 2–3 miles apart. Water surface elevations could be interpolated between survey points, but would represent a simplistic model rather than actual water surfaces. The low-flow water surface elevation data are useful on a segment scale rather than a mile-by-mile scale due to unknown variability in water surface elevations and only one sample collected at each station.

The additional step in normalizing the flows and adjusting elevations based on nearby USGS gages adds another potential source of error. The model introduces additional uncertainty as water surface elevations and flows are interpolated between USGS gage locations, which can be miles away. USGS stage and flow estimates are accurate to about +/- 5 percent based on the technology used to measure flows on the LOMR (Oberg, Morlock, and Caldwell 2005).

The low-flow water surface elevation data have also been used to estimate changes in river bed elevations. While changes in bed elevations can affect low-flow water surface elevations, the reverse is not necessarily true. Water surface elevations do not exactly parallel river bed elevations because water surface elevations result from a combination of factors, including discharge, slope, velocity, channel geometry, channel roughness, and to some degree, water temperature. The water surface tends to be much smoother than the highly variable river bed. An initial review by the USACE determined that changes in low-flow water surface elevation profiles under-predicted bed degradation by a factor of 1.5 at the Kansas City USGS gage location (USACE 2010).

The advantages of low-flow water surface elevation data are the period of record that is available, the ability to collect data on the water surface and use it to estimate gross changes in bed elevation, the consistency of the data collected over a short period of time, and the low cost and effort for data collection.

Potential modifications to the low-flow water surface elevation protocol, to tailor the information to adaptive management and compliance monitoring include:

- Increasing the number of measurement locations to give results that could be used to monitor changes at a 1-mile scale;
- Comparing water surface elevations relative to higher density bed elevation and water surface elevation data from the HBED protocol;
- Statistical analysis to identify the number of measurements (and therefore reach length) that can show statistically significant changes in the water surface profile; and
- Collecting low-flow water surface elevation data annually to compensate for the low level of accuracy and precision of data from a single year and to show trends over the permit cycle.

Hydroacoustic Bed Elevation Data

As described in Section 3.4.6.1, HBED was collected in 1998–1999, and in 2007, 2008, and 2009. The 1998–1999 data were collected following a serpentine pattern on the river; the 2007–2009 data were collected along established transects every 250 feet along most of the river and every 87 feet at habitat monitoring locations (USACE 2008b). HBED directly measures the bed elevation of the main portion of the river and thus provides data on changes in bed elevation spatially and over time. The resolution is high, with bed elevation points collected every 2 feet along each transect.

Data are collected by using a boat with a sonic depth sounder to measure the depth of the water at each sampling point and a GPS unit to determine location. Water surface elevation is measured by utilizing the same temporary benchmarks described above for the low-flow water surface elevation protocol, with additional temporary points used to establish shore elevations between temporary benchmarks. Accuracy requirements for the data are 5 feet for horizontal measurements, 0.1 foot for vertical water surface elevation measurements, and 0.5 foot for vertical bed elevation measurements.

The HBED likely meets Criteria 1, 3, and 4. Without a rigorous statistical analysis, it has not yet been determined whether the spatial density of sampling points and the length of record are sufficient to estimate the spatial and temporal variability of bed elevations on the LOMR. With over 20 cross sections per mile, a fairly detailed topography of the river bed can be constructed. The number of closely spaced bed elevation measurements, when averaged, can help reduce measurement error.

The advantages of using HBED for monitoring purposes are that it measures bed elevations directly rather than using estimates from water surface elevations or models, surface water elevations are

collected simultaneously, data exist for the whole Project area, and high-resolution data exist for 1998 (using a different protocol), 2007, 2008 (partial), and 2009.

Disadvantages of using HBED for monitoring purposes include the high collection and data processing costs, the need to normalize water surface elevation data collected during HBED surveys to a standard flow, and the fact that the surface of the river bed varies with flow. The variation of river bed elevations with flows is minimized by conducting the surveys within a range of similar low flows.

Potential actions or modifications to the HBED protocol in order to tailor the information to adaptive management and compliance monitoring include:

- A rigorous statistical analysis to determine the number of sampling points and river cross sections needed to show significant changes in bed elevations for a river reach;
- Adjusting the density of sampling points based on an analysis of bed variability;
- Conducting surveys during low flows and/or using multiple crews to better control for flow and bed elevation variation;
- Sampling only near the thalweg to focus on changes to the main part of the channel;
- Using improved geodetic survey equipment and methods (e.g., total station) to enhance vertical and horizontal accuracy of the measurements (e.g., see USGS 2009); and
- Making it more affordable to the Dredgers by requiring HBED surveys on the established cross sections less frequently than every year.

6.3.1.5 Additional Monitoring

In addition to monitoring data collected on water surface and bed elevations, data on dredging amounts and locations would continue to be collected under the current program, as described in Section 2.4.3. Records are currently being kept on the time, location (GPS log), and amount dredged by each commercial dredge operating on the LOMR. Additional parameters to monitor for adaptive management include the following:

- Infrastructure affected by changes in bed elevations or low-flow water surface elevations;
- Effect of mainstem LOMR changes on tributaries;
- Flow and sediment loads on large tributaries;

- Headcutting on smaller tributaries;
- Investigation of the hardpan layer;
- Monitoring depth of dredging;
- Analyzing core samples at various locations to determine the boundary between the active transport sediment layer and glacial deposits;
- Monitoring dredge operation waste material to better determine the ratio of waste to retained material; and
- Additional data collection to refine estimates of bed loads and bed material loads.

6.3.1.6 Evaluate and Adjust

Monitoring data could be processed and evaluated in reference to the selected baseline either within or between permit cycles. Data and effects of other management and monitoring programs, such as the MRRP and the Degradation Feasibility Study, should be evaluated in conjunction with data collected as part of this monitoring plan. Other research to review includes the ERDC dune migration study, climate change projections, and progress in the sediment management program.

Once the available data have been reviewed, adjustments to the segment-level dredging limits could be considered. Dredging intensity targets or implementation of the threshold criteria could be modified based on monitoring data. Factors that could influence the amount of sediment available for dredging include changes in average annual flows and sediment loads, full implementation of the MRRP, engineering changes to river training structures (particularly in the Kansas City segment), and the trend and rate of change of river bed elevations. Analysis of HBED and low-flow water surface elevation data would indicate areas of aggradation or degradation on the river, which would be assessed with respect to the factors described above.

6.4 OTHER MITIGATION MEASURES

The following section discusses measures that the USACE could consider to further avoid, minimize, or mitigate adverse impacts. These measures may be appropriate only if the USACE determines that it will authorize an alternative other than the Environmentally Preferred Alternative. Measures described in this section could be implemented through USACE permit conditions. These measures are directed primarily at reducing river bed degradation. These measures have not been included as part of the Proposed Action or Alternatives A, B, or C; nor were they included in the impact analyses.

6.4.1 Repair or Stabilize Affected Infrastructure

- Water intake structures – Dredging activities could erode the channel or bank to a level that compromises the stability of water intake facilities or reduces water levels outside of the design elevations. Funding for the design and implementation of erosion countermeasures, rehabilitative construction, or other measures might possibly be required before dredging could continue in that area to maintain the stability and continued operation of water intake facilities.
- Levee foundations – Dredging activities could erode the channel or bank to a level that compromises the stability of levee foundations. Channel cross sections could be monitored at levee locations where the levee slope projects directly into the channel section. If the channel or bank was eroded or degraded to a level that compromises the stability of the levee foundation (e.g., the projected slope), funding the design and implementation of erosion countermeasures might possibly be required before dredging could continue in that area to maintain the stability and continued operation of the levee as it relates to the foundation.
- Pipeline crossings – Dredging activities could erode the river bed and cause exposure of buried pipelines. Annual bathymetric cross-section surveys at the limits of restricted dredging areas might possibly be required to document local bed trends and adjustments to exclusion zones. If river bed degradation trends indicate that pipelines are at risk for exposure (i.e., the minimum cover has been eroded), funding for the design and implementation of erosion countermeasures to protect the pipeline crossing might possibly be required before dredging could continue in that area.
- Boat ramps – Boat ramps are susceptible to local scour and deposition due to river bed degradation limiting or impeding access to the river. Boat ramps might possibly be monitored periodically during low-flow seasons and repairs made to ensure access.

6.4.2 Develop a Programmatic Agreement for Cultural Resources

Although no direct effects to historic properties would be associated with dredging activities, indirect effects may result from headcutting, erosion, scour, and fluctuations in high and low water surface elevations if more than a slight amount of degradation occurs in the future. To address these potential adverse impacts if the permit action is anticipated to result in more than slight degradation, a PA could be developed. The PA would outline (1) procedures for coordinating further cultural resource surveys and inventories related to identification of historic properties; and (2) development of measures to address indirect effects to these historic properties.

Within the PA, a Historic Properties Management Plan (HPMP) would be developed to address the long-term management and treatment of cultural resources in the APE. The HPMP would be a living document that would inform USACE planning and management practices along the LOMR, and would be developed in coordination with the Section 106 consulting parties. More specifically, the HPMP would address the following:

- Identification of specific areas in the APE that are indirectly affected by dredging (examples of indirect effects include river bed degradation, tributary headcutting, and erosion caused by extremes in water surface levels).
- A program to conduct cultural resource surveys within indirectly affected areas to identify and evaluate cultural resources; determine effects to historic properties; and develop avoidance, minimization, or treatment measures as appropriate. These measures would include:
    1. A Monitoring Plan for historic properties indirectly affected by dredging;
    2. An Avoidance Plan to protect the character-defining features of NRHP-eligible sites;
    3. An Inadvertent Discoveries Plan that outlines the processes of notification, evaluation, and actions to be taken should unanticipated cultural resources be found during dredging or during monitoring activities; and
    4. A Treatment Plan for historic properties that are adversely affected by dredging in the LOMR.

6.4.3 Dredge in Dike Fields/Bank Line to Create Shallow-Water Habitat

The USACE has considered excavating sediments from the dike fields/bank line under the MRRP, or allowing Dredgers to do so, to create shallow-water habitat for nursery and refugia for young pallid sturgeon and other native fish. Under the MRRP, shallow-water habitat typically is constructed by widening the top width of the river channel and restoring chutes and side channels. This is accomplished by excavating pilot channels, notching structures, and letting the natural river/chute meandering process widen the river. It may be possible to allow or encourage commercial dredging in certain suitable areas, including dike fields, to create or enhance shallow-water habitats.

6.4.4 Remove or Reposition Submerged Objects

Continuing river bed degradation could result in hazards to navigation by exposing previously submerged structures (e.g., sunken vessels, old bridge piers, pipelines, and rock/clay outcroppings) on the river bed (USACE 2009). The submerged object could be removed or sunken further. By dredging under and around the object, it would settle and be re-buried beneath the surface of the river bed. The Dredgers could be required to contribute to or assist in these efforts.

6.4.5 Monitor Fish Entrainment and Mortality in Dredges

The analysis of potential entrainment impacts for fish and the endangered pallid sturgeon identified that limited studies and data are available to estimate entrainment rates or entrainment mortality for fishes in the LOMR. This may be particularly important for pallid sturgeon, for which information also is limited about the early life history stages. An entrainment monitoring plan could be developed to provide better information for management decisions about the impact of entrainment and the need for additional management measures to avoid, reduce, or mitigate those impacts. However, based on the results of the Draft Biological Assessment (USACE 2010), it appears that entrainment is not likely to adversely affect the pallid sturgeon.

6.4.6 Implement Measures to Reduce NO_X Emissions

The permit applicants could be required to implement emissions control technology on all equipment, vehicles, and vessels, and to reduce fuel consumption in order to reduce NO_X and GHG emissions. Such measures may include, but are not limited to, the following.

For dredges:

- Pursue a program to retrofit engines to the latest USEPA Tier 3 standard or replace Tier 0 engines with engines that are USEPA Tier 3 certified.
- Pursue a program to retrofit engines with diesel oxidation catalysts, if economically feasible.
- Replace dredge engines with hybrid electric engines.
- Reduce engine idling time.
- Reduce equipment use, to the maximum extent practical, on days with orange or red Air Quality Indices (AQI).

For towboats, materials-handling equipment, and haul trucks:

- Reduce engine idling time.

- Pursue a program to retrofit engines with diesel oxidation catalysts, if economically feasible.
- Reduce equipment use, to the maximum extent practical, on days with orange or red AQI.

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6.5.2 Personal Communication

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