CHAPTER 2

Proposed Action and Alternatives

2.1 INTRODUCTION

This chapter describes and compares the Proposed Action and the alternatives being considered by the USACE that meet the defined purpose and need – to provide the sand and gravel aggregate materials needed to support the region's construction and manufacturing needs. NEPA requires that, in addition to the Proposed Action, federal agencies must evaluate a reasonable range of alternatives and the alternative of taking no action. Five alternatives were selected and carried forward for detailed evaluation in this EIS. The Proposed Action (or proposed Project) is defined as the action proposed in the Dredgers permit applications, including the proposed amounts, locations, and methods of commercial dredging. The USACE is neither an opponent nor a proponent of the applicants' proposals. The No Action Alternative is one that results in no activity requiring a USACE permit. It may be reached by the applicants electing to modify their proposals to eliminate work under the jurisdiction of the USACE or by USACE denial of the permits.

Three additional alternatives were defined by a range of annual authorized amounts of commercial dredging from the LOMR. For some alternatives, the authorized dredging amounts from the LOMR would not completely meet the regional demand for sand and gravel. For these alternatives and the No Action Alternative, it was assumed that other sources would meet the balance of the regional demand for sand and gravel. A detailed description of the Proposed Action, the No Action Alternative, and each of the other three alternatives is provided in the following Sections 2.2 and 2.3. Section 2.4 discusses development of the alternative actions, the rationale for setting alternative dredging amounts, and replacement of Missouri River sand and gravel from alternate sources.

Comments on the Proposed Action, including the identification of natural and human environmental issues and alternatives to be considered in the EIS, were received during the public and agency scoping process. A number of other alternatives and actions were considered but not carried through detailed analyses. The reasons for their elimination from further consideration are presented in Section 2.5.

Identifying and quantifying the relative benefits, impacts, and trade-offs between the alternatives were essential to the evaluation summarized in this EIS. In Section 2.6, the benefits achieved under each alternative and the associated consequences to the natural and human environment are summarized and compared. Chapter 4 includes detailed analyses of the environmental consequences associated with each alternative. In Section 2.7, the Environmentally Preferred Alternative is identified and discussed.

2.2 PROPOSED ACTION

The USACE has received 11 permit applications from eight companies to dredge sand and gravel from selected locations between RM 0.0 and RM 447.7 on the LOMR for commercial uses. The Proposed Action includes approval of the 11 Department of the Army (DA) Permits (DA permits) for dredging of specified quantities of sand and gravel from designated reaches of the LOMR, generally with the existing permit conditions (e.g., exclusion zones and operating protocols). Table 2.2-1 contains the names of each of the applicants, the annual tonnage amount requested, and the locations by river segment and general reaches for proposed dredging activities. This information was obtained from Application for Department of the Army Permit (ENG FORM 4345 NOD, July 1997) applications filed with the Kansas City and St. Louis Districts of the USACE. The requested reaches are identified by river mile as measured starting at the confluence of the Missouri and Mississippi Rivers (RM 0.0) and increasing upstream.

The Proposed Action considered in this EIS includes authorization of all 11 applications considered together. The applicants include companies who would:

- Own and operate dredging equipment, tug boats, and barges and who would dredge sand and gravel from within their requested dredging reaches and deliver it to their own onshore sand plants;
- Own onshore sand plants and contract with other companies to dredge sand and gravel from within their requested dredging reaches and deliver it to onshore sand plants; and
- Own dredging equipment and contract to deliver sand and gravel dredged from their requested dredging reaches to onshore plants owned by other companies.

All but two of the applicants – The Master's Dredging Company, Inc. and Edward N. Rau Contractor Company – are existing dredging operators or contractors on the LOMR.

Table 2.2-2 lists the specific reaches by river segment that are included in the Dredgers permit applications.

Table 2.2-1 Summary of Permit Applications for Commercial Dredging in the Lower Missouri River

Permit Applicant	Amount Requested (tons/yr)	Segment of Operation [a]	General Reaches Requested [b] (river mile)	Activity [c]
J.T.R., Inc. (three permits for three operations)	1,550,000	St. Charles	0–35	Dredging / distribution
Limited Leasing Company	1,200,000	St. Charles	0–47	Dredging
Capital Sand Company, Inc. (St. Louis District permit)	500,000	St. Charles	40–50	Dredging/ distribution
Edward N. Rau Contractor Company	100,000	St. Charles	62–75	Distribution
Capital Sand Company, Inc. (Kansas City District permit)	2,255,000	St. Charles, Jefferson City, and Waverly.	62–354	Dredging / distribution
Hermann Sand & Gravel, Inc.	1,000,000	St. Charles, Jefferson City	56–164	Dredging / distribution
Con-Agg of MO, L.L.C.	250,000	Jefferson City	177–202	Distribution
Holliday Sand & Gravel Company, L.L.C.	3,760,000	Waverly, Kansas City, and St. Joseph	320–448	Dredging / distribution
The Master's Dredging Company, Inc.	1,000,000	Waverly	383–390	Dredging / distribution
Total	11,615,000		0–390	

[a] For analysis, the lower Missouri River has been divided into five segments: St. Charles (river mile [RM] 0 – RM 130; Mississippi River to Osage River); Jefferson City (RM 130 – RM 250; Osage River to Grand River); Waverly (RM 250 – RM 357; Grand River to Blue River); Kansas City (RM 357 – RM 391; Blue River to Platte River); and St. Joseph (RM 391 – RM 498; Platte River to Rulo, Nebraska). See Section 3.3 for further discussion.

[b] Indicates total range of the river within which individual reaches have been requested. See Table 2.2-2 for a list of specific reaches included in the permit applications.

[c] Distribution indicates operation of an onshore sand plant for offloading, processing, storage, and distribution of sand and gravel.

2.2.1 Overview of Sand and Gravel Dredging

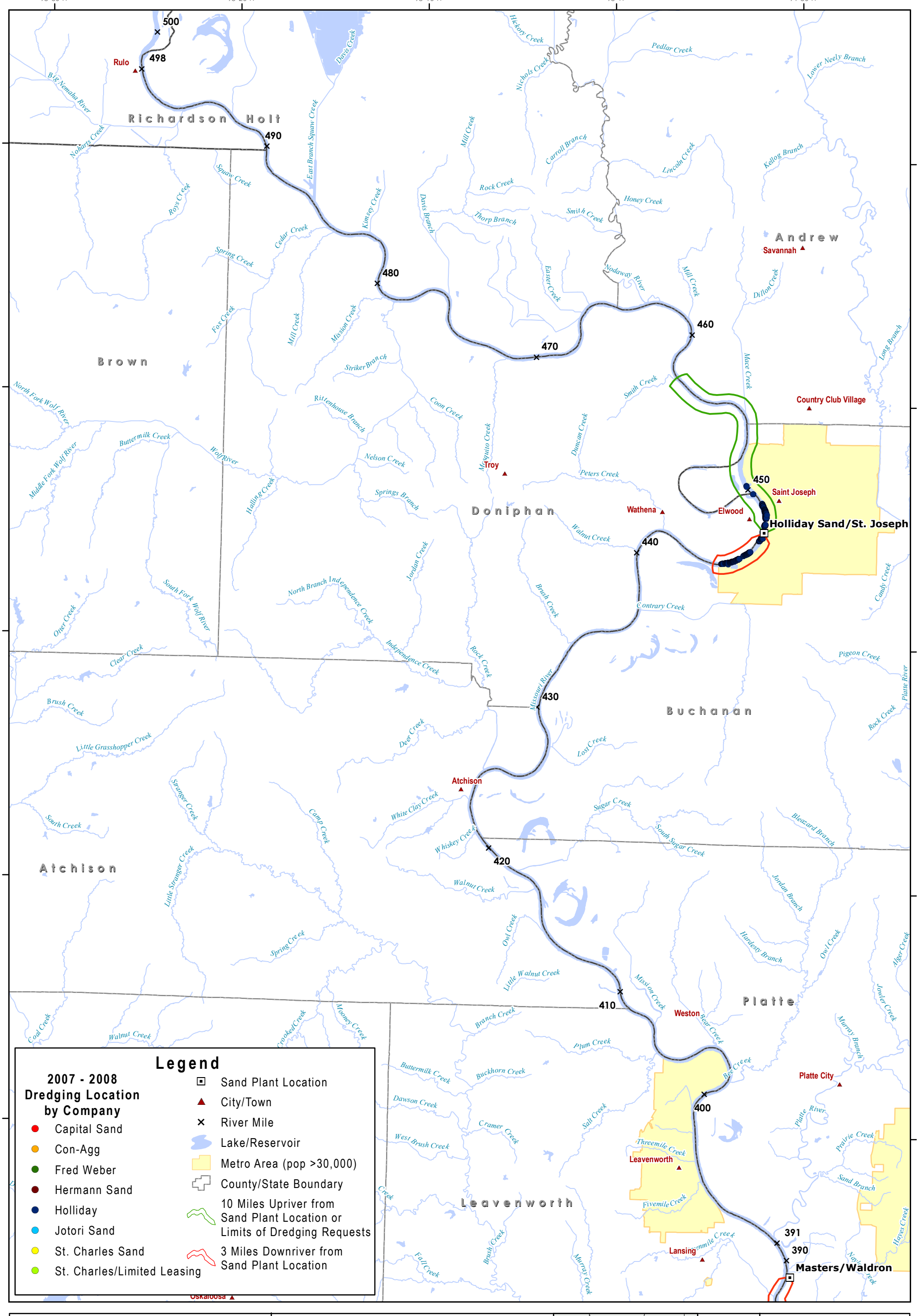
Dredging for sand and gravel on the LOMR is generally conducted by using hydraulic suction-head or cutter-head dredges mounted on movable barges (except for The Master's Dredging Company, Inc., which is described at the end of Section 2.2.2). The dredged material is passed though screens and settling-sorting equipment to achieve a desired grain size distribution that meets material specifications for various commercial uses. The sand and gravel retained are loaded onto a barge and transported

from the dredge site to an onshore sand plant; following offloading at the sand plant, empty barges are returned to the dredge site for reloading. At the sand plant, the sand and gravel are further processed and stacked according to material type. Additional processing at the plant may include removal of lignite (coal) or further sorting by grain size. The sand and gravel product is then loaded into trucks and transported for use. Semi-trailer trucks are the primary mode of transporting sand and gravel to the location of end use.

Table 2.2-2 River Reaches Requested for Permitting by the Applicants by River Segment

Permit Applicant	Reaches by River Miles	Segments To Be Dredged (river miles)
J.T.R., Inc.	0–4, 6–12, 14–24, 30–35	St. Charles (RM 0–130)
Limited Leasing Company	0–12, 20–35, 40–47	St. Charles (RM 0–130)
Edward N. Rau Contractor Company	62–65, 70–75	St. Charles (RM 0–130)
Capital Sand Company, Inc. (St. Louis District permit)	40–50	St. Charles (RM 0–130)
Capital Sand Company, Inc. (Kansas City District permit)	62–75, 109–127.5, 130–164, 172–210, 220–230, 245–265, 283–303, 314–328, 340–354	St. Charles (RM 0–130), Jefferson City (RM 130–250), Waverly (RM 250–357), Kansas City (RM 357–391)
Hermann Sand & Gravel, Inc.	56–66, 70–89.75, 93.55–101.7, 109–118.4, 146–164	St. Charles (RM 0–130), Jefferson City (RM 130–250)
Con-Agg of MO, L.L.C.	177.85–201.95	Jefferson City (RM 13–250)
Holliday Sand & Gravel Company, L.L.C.	320–336, 338–339.15, 350–386	Waverly (RM 250–357), Kansas City (RM 357–391), St. Joseph (RM 391–498)
The Master's Dredging Company, Inc.	383–390	Kansas City (RM 357–391)

The applicants prefer to dredge at locations upstream of the sand plant. This allows loaded barges to travel downstream with the current and empty barges to travel back upstream. River currents in the LOMR are swift, and pushing loaded barges upstream is more costly in terms of fuel consumption. Dredging typically occurs no more than 7–10 miles upstream of a company's sand plant and typically no more than 3–9 miles downstream. This range is dictated by the travel times to move loaded barges to the plant, offload, and return to the dredging site, and by the associated fuel costs. Extending the range of dredging upstream from a sand plant would require using additional barges and tugs to maintain full-time operation of the dredge. Some companies contract for dredging and delivery of dredged sand and gravel, causing some dredging equipment to be relocated to different reaches or segments of the LOMR. Figure 2.2-1 shows recent dredging activity and the location of existing sand plants operated by the permit applicants, along with the name and company owner of each sand plant.



Legend

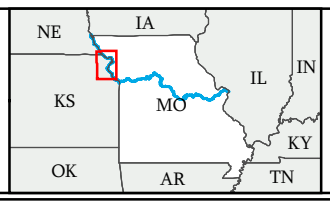
2007 - 2008 Dredging Location by Company

- Capital Sand
- Con-Agg
- Fred Weber
- Hermann Sand
- Holliday
- Jotori Sand
- St. Charles Sand
- St. Charles/Limited Leasing

- Sand Plant Location
- City/Town
- River Mile
- Lake/Reservoir
- Metro Area (pop >30,000)
- County/State Boundary
- 10 Miles Upriver from Sand Plant Location or Limits of Dredging Requests
- 3 Miles Downriver from Sand Plant Location

0 5 Miles
0 5 Kilometers

Figure 2.2-1
Dredging Sand Plant Locations
Sheet 1 - St. Joseph Segment
Missouri River Commercial Dredging EIS



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Map Projection: NAD83 UTM Zone15 North

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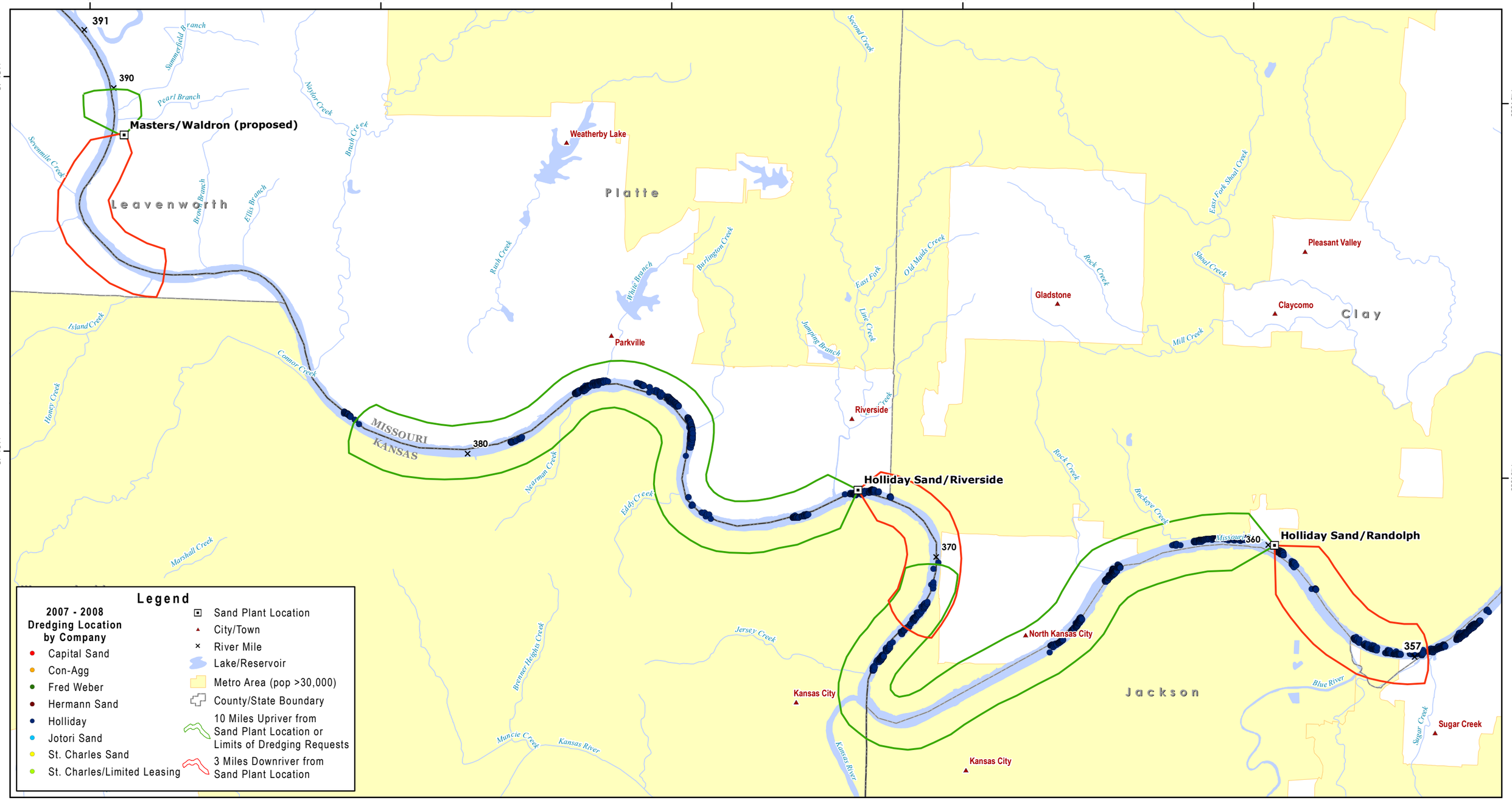

0 2.5 5 Miles

0 2.5 5 Kilometers

Figure 2.2-1
Dredging Sand Plant Locations
Sheet 2 - Kansas City Segment

Missouri River Commercial Dredging EIS

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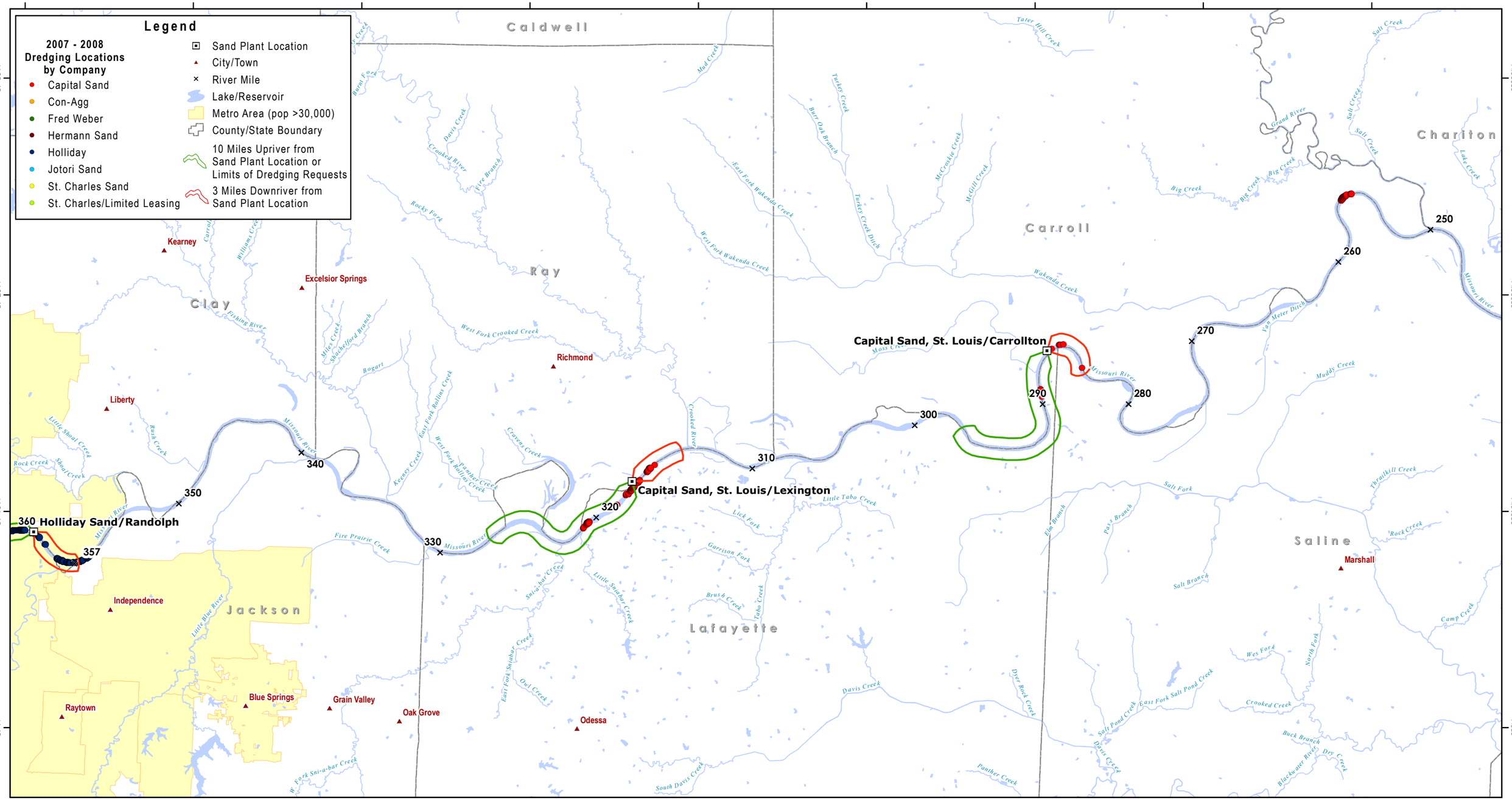

Figure 2.2-1
Dredging Sand Plant Locations
Sheet 3 - Waverly Segment

Missouri River Commercial Dredging EIS

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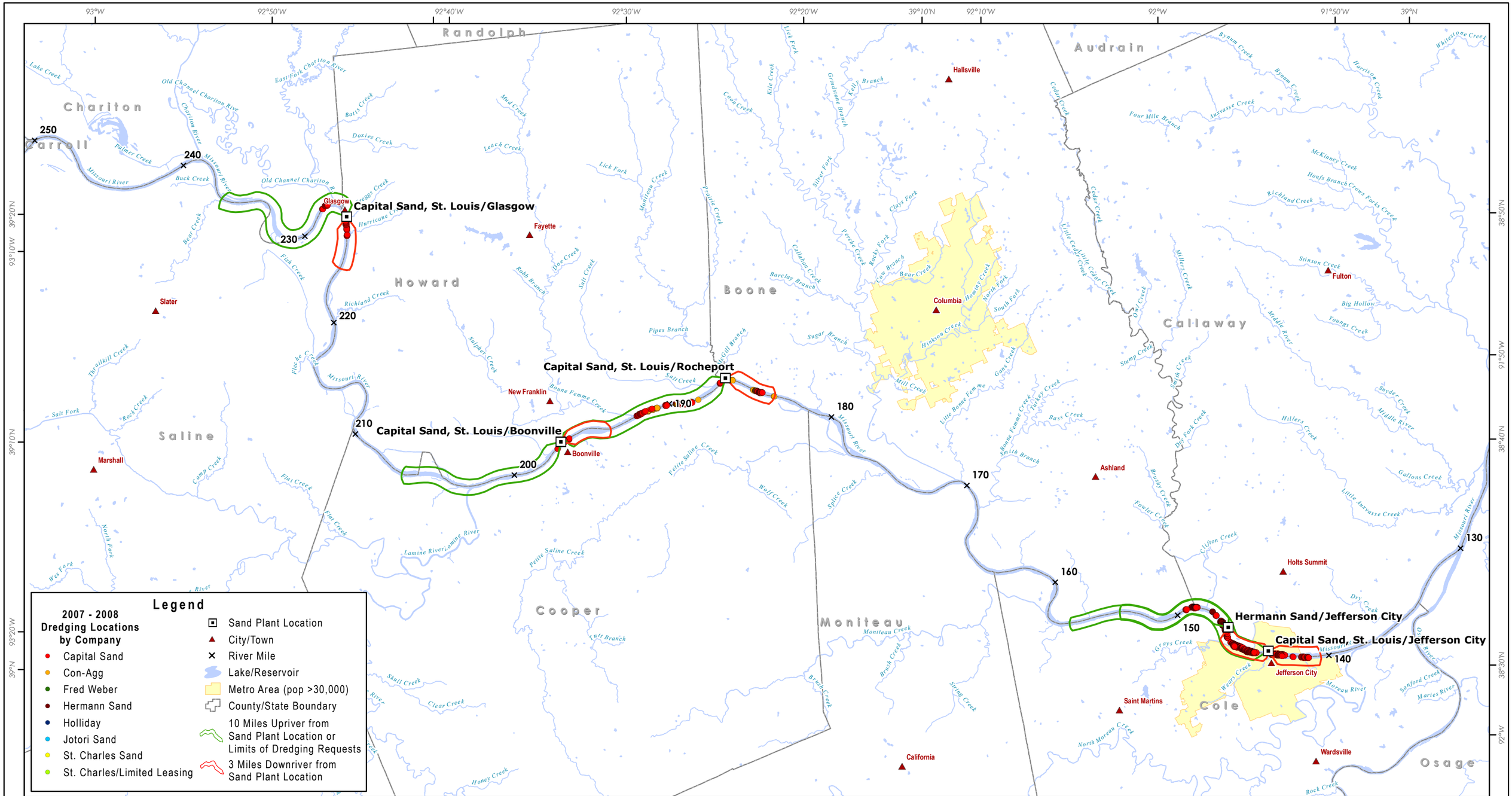

Figure 2.2-1
Dredging Sand Plant Locations
Sheet 4 - Jefferson City Segment

Missouri River Commercial Dredging EIS

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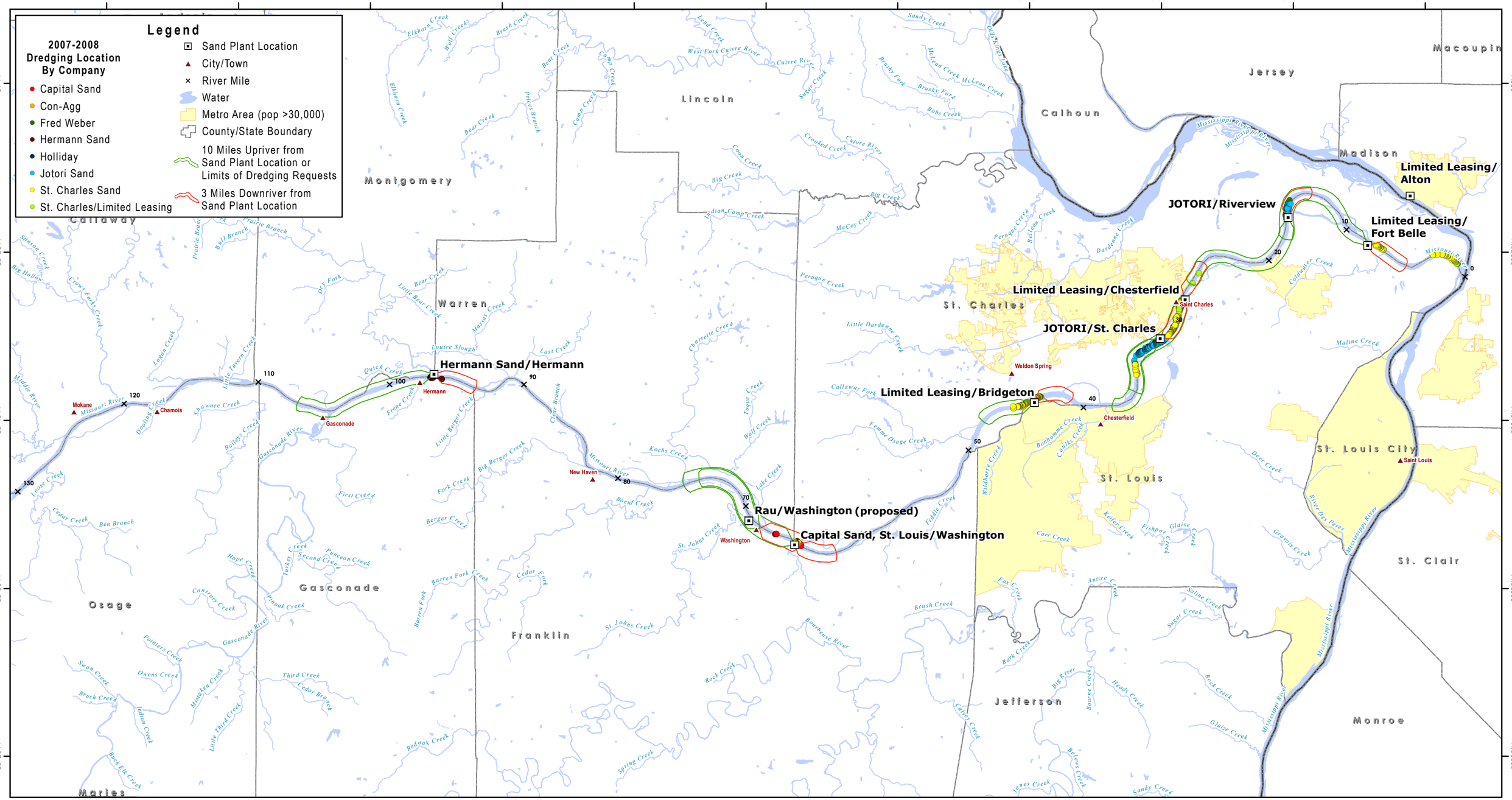

0 5 10 15 20 25 30 Miles

0 5 10 15 20 25 30 Kilometers

Figure 2.2-1
Dredging Sand Plant Locations
Sheet 5 - St. Charles Segment

Missouri River Commercial Dredging EIS

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Dredging locations shown in this figure are for the years 2007 and 2008, two recent years for which precise dredging location data are available.

2.2.2 Dredge Barge and Related Facilities

The dredge consists of mechanical equipment mounted on a barge that can be moved into position and anchored during dredging operations. The dredge barge is held in a fixed position during dredging by deploying large, fortress-style anchors from the forward corners of the barge on the end of 1,000- to 2,000-foot-long cables. By selectively manipulating the length of each anchor cable, the dredge can be moved forward, backward, and from side to side during the dredging operation. From a single anchoring position, a dredge can operate in an area approximately 1,000–2,000 feet in length and approximately 400–500 feet in width before moving the anchors. Some dredges include piles (called spuds) that can be raised and lowered to the river bottom, to assist with maintaining the dredge position.

Barges for transporting excavated material to terminal locations are tied up alongside the dredge barge during dredging operations. Transport barges and the dredge barge are positioned or moved using tugboats.

All permit applicants use hydraulic dredges with a diesel internal combustion-engine driven, centrifugal pump attached to a suction line mounted on a boom (called a ladder) that can be lowered to the river bed. Dredged material is discharged from the pump system as a slurry to sorting or processing equipment also mounted on the dredge. Following sorting or processing, marketable material is loaded onto a barge and transported to an onshore storage and distribution facility (the sand plant). Material that has been dredged but removed during the sorting/processing step, along with the slurry water, is returned to the river at the dredging site.

Two general types of dredges are currently used in dredging operations on the LOMR. In the upper and middle segments, dredges with cutter heads and onboard processing equipment are used by Holliday Sand & Gravel Company, L.L.C. and Capital Sand Company, Inc. Figure 2.2-2 shows the dredge *Riverside* operated by Holliday Sand & Gravel Company, L.L.C.

The working end of the dredge includes a crane for raising and lowering the suction line, which is mounted on the ladder (see Figure 2.2-3). At the end of the ladder is the dredging pipe intake. The cutter head, in this case a chain-type cutter, is attached to the end of the ladder (see Figure 2.2-4) and is used to loosen material on the river bottom for suction into the dredge pipe. Dredges operated in the

middle segments of the LOMR use an alternative rotary basket design that operates with the dredge ladder swinging from side to side in an arc.

Figure 2.2-2 Cutter-Head Dredge with Onboard Processing Equipment (view of the stern of the dredge with a loaded barge on the left and an empty barge on the right)

The characteristics of bottom sediments in the LOMR vary with location. Dredging in the LOMR produces material of highly variable grain size, including small stones, coarse and fine gravels, sands of various sizes, fine material, and some lignite particles. This material is sorted, and material ranging from 0.1 to 4.0 millimeters (mm) (see Figure 3.4-14) is typically retained. The unwanted material is discharged into the river. Sand and gravel suitable for commercial use in building materials must meet material specifications defined by grain size distribution and proportion of each grain size that may be included in the product.

In the upper segments of the LOMR, typically 30–40 percent of the bottom sediments excavated by dredging meets the materials specifications. The remaining oversized and undersized material, water, and lignite are removed by mechanical screening and the use of settling tanks, and are discharged back to the river at the dredging site. The dredge *Riverside* includes onboard material processing equipment, and the sand and gravel loaded onto the barge from the dredge is frequently sampled to ensure that it meets material specifications.

In the middle and lower segments of the LOMR, Capital Sand Company, Inc. uses a cutter-head dredge while plain suction-head dredges are used by Hermann Sand & Gravel Company, Limited

Leasing Company, and J.T.R., Inc. Figure 2.2-5 shows a plain suction-head dredge on the dredge *St. Charles* operated by Limited Leasing Company in the St. Charles segment.

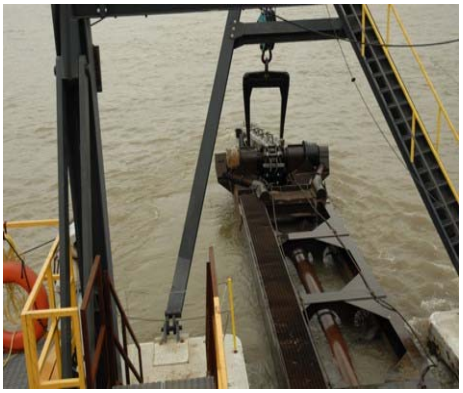


Figure 2.2-3 Dredge Boom

Figure 2.2-4 Cutter Head

Figure 2.2-5 Suction-Head Dredge Showing Boom with Suction Head

A much higher proportion of the bed material that is excavated in the middle and lower segments of the LOMR meets the typical material specifications when compared to bed material excavated from the upper LOMR segments. For this reason, Dredgers operating in the middle and lower LOMR do not require such extensive on-board processing equipment and rely instead on screens to separate usable

and unusable material. The screens comprise the floor of the loading chutes shown in Figures 2.2-6 and 2.2-7. The chutes are seen as arms that overhang the barges. In Figure 2.2-6, the chute extending from the right side of the dredge is passing primarily water as it begins operation. Figure 2.2-7 shows barge loading in operation. Material meeting the specifications is dropping through the screen into the barge; oversized material is discharged from the end of the chute back into the river.

Figure 2.2-6 Suction-Head Dredge with Barges

Figure 2.2-7 Screening and Sorting Dredged Materials

The ladder and suction head used for excavation of sand and gravel from the river bed are shown in Figure 2.2-5. During dredging, the suction head is lowered to the river bottom with the dredge ladder. Sediment is removed from the river bottom until the suction head comes into contact with hard materials (such as bedrock, large rock substrates, or consolidated sediment layers) at which time the suction head does not advance further into the river bottom, and the amount of bottom sediments sucked into the suction head is greatly reduced. The dredge boom is then raised, the dredge relocated and excavation recommences.

Both types of dredges are maintained in position during dredging by 1,000- to 2,000-foot-long anchor cables, as discussed above. The dredge anchors are placed and the dredge is suspended downstream by the anchor cables. As material is excavated at a specific location, the dredge operator can take in or let out the anchor cables to move the dredge forward, backward, or side to side. The cutter-head dredge used by Holliday Sand & Gravel Company, L.L.C. faces upstream toward the anchors during dredging; the suction head dredges used in the middle and lower segments typically face downstream.

In most instances, the dredges load usable material onto barges tied alongside the dredge. The barges typically range from 120 to 200 feet long and from 30 to 45 feet wide. A typical barge with tug is shown in Figure 2.2-8.

Figure 2.2-8 Empty Transport Barge

Figure 2.2-9 Unloading a Barge

Once loaded, barges are moved downstream to a sand plant where they are tied next to an unloading barge with conveyor transfer equipment (Figure 2.2-9). A front-end loader or a clamshell crane is used to transfer the sand and gravel to a conveyor system that moves it ashore. Offloaded material may be resorted into various classifications, washed, and stored for sale and transport. The terminal where the unloading barge is located (the sand plant) typically includes a system of overhead conveyors, stackers, and earth-moving equipment for moving and stacking bulk materials, truck loading facilities, scales, and equipment maintenance facilities. A typical example of conveyors and stacking equipment is shown in Figure 2.2-10.

Table 2.2-3 identifies the dredging equipment, barges, and tugs proposed for operation by the applicants.

Sand plant facilities typically have direct access to local, state, and interstate highway systems for product transport. The onshore terminal may also include moorage for dredge barges, transport barges, and tugs. To the extent practicable, vessel maintenance is performed at the onshore facility. While described here for completeness, construction of company sand plant facilities has previously been permitted, if necessary, by the USACE; however, their operations are not regulated by the USACE and are not part of the activities proposed to be authorized by the USACE.

Figure 2.2-10 Rotary Stacker at a Sand Plant

Table 2.2-3 Production Equipment Proposed by the Applicants

Permit Applicant	Dredge Barges	Tugs	Barges
J.T.R., Inc.	3	3	7
Limited Leasing Company	3	3	29
Capital Sand Company, Inc.	3	3	12
Edward N. Rau Contractor Company	0	0	0
Hermann Sand & Gravel, Inc.	1	3	4
Con-Agg of MO, L.L.C.	0	0	0
Holliday Sand & Gravel Company, L.L.C.	3	5	13
The Master's Dredging Company, Inc.	2	0	0

One applicant, The Master's Dredging Company, Inc., proposes to convey the dredged material in a pipeline as slurry to an onshore plant where the water is removed for the slurry and sand and gravel is recovered. In this instance, a pipeline connects the dredge barge to the processing location, which must include a settling pond or other means for separating the slurry water from the product sand and gravel. Because a pipeline is required in this type of dredging activity, the onshore processing facilities usually are located reasonably close to the river. The reach of the dredge can be extended by adding pipeline segments and in-line booster pumps. This type of dredge process is used by dredgers on the Kansas River and was used for extracting material from the LOMR for construction of the Riverside Levee (L-385), but is not currently practiced by any dredgers on the LOMR.

Table 2.2-4 shows the location, approximate size and storage capacity, length of water frontage, and adjacent land use of each facility currently operated or proposed by the Dredgers. Two of the applicants, The Master's Dredging Company, Inc. and Edward N. Rau Contractor Company, do not currently own and operate sand plants. If permits are authorized for these applicants, they propose to develop sand plants on property they own or control to support the authorized dredging operations. A description of these proposed sites is found in Appendix B. While these facilities are not part of the proposed dredging activity, they are a related action as a means of offloading, storing, and distributing commercial sand and gravel produced by the dredging operation. Sites have been secured and some preliminary steps have been taken to initiate development of these facilities. The locations of the proposed facilities are shown in Figure 2.2-1.

Table 2.2-4 Existing and Proposed Sand Plants in the Lower Missouri River

Company	Plant Name	Location (river mile)	Size (acres)	Storage Capacity	Adjacent Land Use
Holliday Sand & Gravel Company, L.L.C.	St. Joseph	447.7	11	100,000	Industrial
	Riverside	371.8	28	200,000	Industrial
	Randolph	359.9	17	100,000	Industrial
Total			56	400,000	
The Master's Dredging Company, Inc.	Waldron	389.0	20 – 60	500,000 – 1,000,000	Agriculture
Capital Sand Company, Inc.	Lexington	317.2	30	135,000	Agricultural
	Carrollton	287.0	12	10,000	Agricultural
	Glasgow	226.2	3.5	38,000	Industrial
	Boonville	196.6	4	50,000	Agricultural
	Rocheport	186.3	10	68,000	Agricultural
	Washington	65.4	21	150,000	Agricultural
	Jefferson City	143.5	9	202,000	Agricultural/ Industrial
Total			89.5	653,000	
Edward N. Rau Contractor Company	Washington	69.0	25.6	100,000	Recreation/ Residential
Hermann Sand & Gravel, Inc.	Jefferson City	146.6	12 [a]	150,000	Agricultural
	Hermann	96.9	17 [a]	150,000	Agricultural/ Industrial
Total			29[a]	400,000	

Table 2.2-4 Existing and Proposed Sand Plants in the Lower Missouri River

Company	Plant Name	Location (river mile)	Size (acres)	Storage Capacity	Adjacent Land Use
J.T.R., Inc.	St. Charles	16.7	2[a]	60,000	Industrial
	Riverview	31.2	2	40,000	Industrial
Total			4	100,000	
Limited Leasing	Bridgeton[b]	44.0	30	90,000	Industrial
	Chesterfield[b]	28.0	86	190,000	Industrial
	F. Belle[c]	8.2	10	50,000	Industrial
	Alton[d]	203.9	3	N/A	Industrial/ Commercial
Total			N/A	230,000	

Note: N/A = Not applicable.

[a] Numbers are approximate.

[b] Owned by LaFarge.

[c] Owned by Central Stone.

[d] The Alton facility is located on the Mississippi River and is served by LOMR RM 0 – 12 in the St. Charles segment.

For three applicants, the sum of proposed limits by segment exceeds the applicant's total permit request because they want the flexibility to dredge more or less from a river segment in response to annual flow variations and other operational factors. The annual dredging that could occur by river segment is shown in Table 2.2-5. Table 2.2-5 shows that the sum of all dredging by river segment is 13,350,000 tons per year, an amount that is higher than the 11,615,000 tons per year requested through the permit applications (first column in Table 2.2-5). It was assumed that each Dredger would be limited by the maximum dredging amount requested in the respective permit application, not the sum of the tonnage the Dredger anticipates might be dredged in each river segment. Therefore, the maximum total tonnage that could be dredged by all Dredgers combined would be no more than 11,615,000 tons/ year if the Proposed Action is authorized.

2.2.3 Dredging Operations

The applicants dredge to obtain sand and gravel to meet specific material specifications. The most common specifications and materials produced are:

- Concrete sand – designed to meet MoDOT and KDOT specifications;
- Asphalt sand – designed to meet MoDOT and KDOT specifications; and
- Masonry sand – designed for use in the preparation of masonry mortar.

Other materials produced in much smaller quantities include dry sand (high-grade sand used in making glass), gravel for landscaping, and non-structural concrete sand.

Table 2.2-5 Potential Annual Dredging Amounts by River Segment (tons/year)

Applicant	Total Application Request	Segment: St. Joseph RM 391 – RM 489	Kansas City RM 357 – RM 391	Waverly RM 250 – RM 357	Jefferson City RM 130 – RM 250	St. Charles RM 0 – RM 130	Total for All Segments
J.T.R., Inc.	1,550,000					1,550,000	1,550,000
Limited Leasing Company	1,200,000					1,200,000	1,200,000
Capital Sand Company, Inc. (St. Louis District permit)	500,000					500,000	500,000
Edward N. Rau Contractor Company	100,000					100,000	100,000
Capital Sand Company, Inc. (Kansas City District permit)	2,255,000			665,600	2,000,000	534,400	3,200,000
Hermann Sand & Gravel, Inc.	1,000,000				500,000	500,000	1,000,000
Con-Agg of MO, L.L.C.	250,000				250,000		250,000
Holliday Sand & Gravel Company, L.L.C.	3,760,000	1,150,000	3,060,000	340,000			4,550,000
The Master's Dredging Company, Inc.	1,000,000		1,000,000				1,000,000
Total	11,615,000	1,150,000	4,060,000	1,005,000	2,750,000	4,384,400	13,350,000

Note: RM = River mile.

Seasonal flows, the configuration of river training structures and bends, and sediment transport in the river generate a pattern of sediment deposition that dredge operators can reasonably predict in some locations. Based on previous experience, dredge operators frequently return to known locations of sediment deposits that meet sand and gravel market criteria. Being able to return to specific locations minimizes the time for dredge movement, produces more consistent dredge material, maximizes yield for a given period of dredging, and reduces the cost of operation. Experience gained over time helps the dredge operators identify these prime locations. Moving to a new reach requires the dredger to search for new or other prime locations, increasing costs and reducing certainty of supply.

Dredging typically occurs from March through December or January. During the coldest periods when ice formation may hinder operations and demand for aggregate and sand is lowest, dredgers typically perform annual maintenance on their equipment. Dredging operations are typically only performed during daylight hours but are capable of operating around the clock.

The operation of screens, sorting equipment, and other materials handling equipment and internal combustion engines constitute a source of noise and air emissions during dredging operations. Noise emissions may be audible for some distance from an operating dredge, including along shoreline areas, depending on meteorological conditions and the dredge location.

Since 2008, each permitted dredge operator has been required to continuously report its dredge location using GPS coordinates and its operating status. This reporting is required to monitor compliance with permit conditions and better understand where dredging is occurring.

No specific testing of overboard discharge of dredge slurry water or undesirable size fractions of sediment is conducted as the discharged material is not exposed to any processing other than sorting.

2.2.4 Dredging Locations and Exclusion Areas[1]

Currently operating dredgers were authorized in 2007 by the USACE to dredge within specific reaches of the river delimited by river mile. The currently authorized dredging permits prohibit dredging within the following exclusion areas:

- Confluence of tributaries to the Missouri River – dredging is prohibited within 1,000 feet upstream and 4,000 feet downstream of the tributary.
- Levees, pipeline crossings, dikes, and bridges – dredging is prohibited within 500 feet of any levee centerline, pipeline, or submerged utility crossing, bridge pier, or abutment; within 200 feet of any dike, revetment, or other structure built or authorized by the U.S. Government; and within 100 feet of any normal bank line or island, unless specifically authorized.
- Water intake structures – dredging is prohibited within a zone extending 4,000 feet upstream and 500 feet downstream from any municipal drinking water intake structure located along either bank of the river; within a zone extending 1,000 feet upstream and 1,000 feet downstream from any municipal drinking water horizontal collector well located along either bank of the river; and within a zone extending 500 feet upstream and 500 feet downstream from any other water intake structure,

[1] Exclusion zone distances are measured from the end of the cutter head rather than from a general point on the dredge.

other than those used for municipal drinking water. This condition may be exempted by the USACE if requested by the Dredger and approved by the company owning and operating the water intake.

- Pallid sturgeon habitat – dredging is prohibited within the reaches identified in Table 2.2-6, which contain pallid sturgeon habitat features.
- Rectified channel lines (RCL) – dredging must be confined between the RCL to preserve the structural integrity of the landmass landward of the RCL.

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 location exclusions is documented in reports submitted to the USACE. The applicants acknowledged that these exclusion areas were needed in future permits to protect the pallid sturgeon but could be reevaluated if necessary.

Table 2.2-6 Pallid Sturgeon Habitat Areas Excluded from Dredging on the Lower Missouri River

Missouri River Miles (including 0.25-mile buffer)		
Downstream Limit	Upstream Limit	Habitat Feature
49.15	50.05	RDB Centaur Chute
56.85	59.05	LDB Chute/Island
58.55	61.25	RDB Chute/Island
89.75	91.10	RDB Island
89.90	91.45	LDB Loutre Slough
91.20	93.55	LDB Lunch Island
103.00	104.95	Both Gasconade Confluence and Dike Field
105.20	106.25	RDB Dike Field
115.20	115.95	RDB Island -Revised -114.75 to 115.20 deleted
118.40	119.15	RDB Dike Field
119.35	119.85	RDB St. Albert Chute
124.35	124.95	RDB St. Albert Chute
126.05	126.90	LDB Dike Field
127.50	130.20	Both Osage River Confluence and Dike Field
157.00	158.45	LDB Island
176.40	177.85	LDB Island
184.75	185.65	RDB Chute

Table 2.2-6 Pallid Sturgeon Habitat Areas Excluded from Dredging on the Lower Missouri River

Missouri River Miles (including 0.25-mile buffer)		
Downstream Limit	Upstream Limit	Habitat Feature
186.90	188.20	RDB Chute and Dike Field
193.40	195.75	RDB Dike Field/Island
202.10	202.75	RDB Lamine River Confluence
212.95	214.05	RDB Dike Field
214.25	215.00	LDB Chute
217.75	218.55	LDB Chute
218.40	219.65	RDB Island
226.95	227.55	LDB Little Chariton Confluence
238.40	239.10	LDB Chariton River Confluence
249.65	250.30	LDB Grand River Confluence
269.85	271.35	RDB Shallow/Island
280.40	282.05	RDB Island
297.90	299.05	RDB Island
300.00	301.05	LDB Island
367.00	367.75	RDB Kansas River Confluence
390.85	391.45	LDB Platte River Confluence
462.65	463.25	LDB Nodaway River Confluence
478.55	479.15	RDB Wolf Creek Confluence
494.55	495.20	RDB Big Nemaha River Confluence

Notes:

LDB = Left descending bank.
RDB = Right descending bank.

2.3 NO ACTION ALTERNATIVE

2.3.1 Definition of No Action Alternative

NEPA requires that one of the alternatives evaluated in detail in an EIS is the No Action Alternative. The No Action Alternative for this EIS is defined by the following:

- The pending permit applications for commercial sand and gravel dredging on the LOMR would not be approved.

- Current commercial dredging permits would expire on December 31, 2010; commercial sand and gravel dredging on the LOMR would cease.
- Currently available alternate local sources of commercial sand and gravel, or commercial sand and gravel imported from outside the local market would supply sand and gravel needs in the market and region currently served by existing commercial dredging permits.

The No Action Alternative would result in the cessation of commercial dredging in the LOMR following denial of permit requests and expiration of existing extended permits held by the applicants. Denial of permit requests would result in the disruption of business operations dependent on sand and gravel operations in the LOMR or within certain market areas along the LOMR. After stockpiles of sand and gravel were exhausted, the applicants would be unable to satisfy (using sand and gravel from the LOMR) the needs and contracts of customers who have routinely purchased sand and gravel materials from the applicants. This may allow certain applicants with concrete or asphalt production capabilities to produce products from their own supply of sand and gravel, possibly at lower levels of production or higher costs.

The No Action Alternative also would result in short-term and long-term, and direct and indirect effects associated with obtaining sand and gravel from land-based operations within the region, importing sand and gravel from other locations, and recycling materials. Implicit in this alternative are the practicality of relying on sources other than commercial dredging in the LOMR and the assumption that other sources can satisfy the demand for sand and gravel. It should be noted that Alternatives A and B (described in Section 2.4) would partially rely on alternate sources of sand and gravel to meet regional demand. The same alternate sources described for the No Action Alternative would be relied on under Alternatives A and B.

2.3.2 Alternate Sources of Sand and Gravel

Under the No Action Alternative, reductions in the quantity of construction sand and gravel dredged from the LOMR would need to be replaced by alternate sources. Some of the applicants who own sand and gravel mines, or other companies with alternate sand and gravel supplies or who operate in broader geographic markets, may be able to supply their own internal needs for commercial sand and gravel. Reductions in authorized dredging of sand and gravel under Alternatives A and B (described in Section 2.4) also would require replacement of sand and gravel from alternate sources, but to a lesser degree than under the No Action Alternative. Although supplies dredged from the LOMR represent the majority of sand and gravel used in the primary market area in proximity to the river, other existing

mining operations may be available to provide immediate replacement supplies. In the long term, new sources likely would be developed in proximity to existing processing facilities and urban centers, which represent the largest sources of demand for construction sand and gravel.

New mining operations could be located in the floodplain adjacent to the Missouri River, if suitable sand deposits can be located on available land and the required permits can be obtained from local communities, counties, and levee/drainage districts. If allowed by the USACE and local communities, the dredging equipment that is currently used in river dredging could be used to dredge bays in the floodplain that are connected to and accessible from the river. However, the dredging equipment that is currently used in river dredging cannot be easily transported overland to create isolated dredge pits in the floodplain. Because of these constraints, as well as the extended start-up period required for new mines, existing sources likely would need to provide replacement supplies in the short term. This section describes the alternate sources of sand and gravel and assesses the available capacity of these sources.

As shown in Table 2.4-1 (in Section 2.4), dredging from the LOMR supplied approximately 6.9 million tons of sand and gravel annually for regional construction activities from 2004 to 2008. The table also shows that permitted dredging quantities in the LOMR would be reduced under Alternatives A and B, and that dredging in the LOMR would be eliminated entirely under the No Action Alternative. To meet regional demand for commercial sand and gravel under Alternatives A and B and under the No Action Alternative, alternate sources were assumed to supply the difference between the approximately 6.9 million tons currently supplied annually from the LOMR and the reduced amount of dredging defined for the alternative.

2.3.2.1 Description of Alternate Sources

Four general types of sand and gravel mining operations represent an alternate source to material dredged from the LOMR. The most comparable alternate source of sand and gravel is material dredged from the Kansas and Mississippi Rivers, which potentially could serve demand centers in the western and eastern sides of Missouri, respectively. Sand produced from these sources is generally considered to be Class A (natural) sand and meets material specifications for road and other construction projects. Other alternate sources include floodplain open-pit mines and quarries, instream mining, and manufactured sand. However, the suitability, availability, and cost of production of these sources vary widely.

Dredging from Other Rivers

River sources include existing dredging operations within the Mississippi River in proximity to St. Louis/ St. Charles and within the Kansas River in proximity to Kansas City. Small commercial sand and gravel dredging operations exist on several major tributaries to the LOMR, including the Osage and Gasconade Rivers; and floodplain operations are located near these and other major tributaries. River sources typically use hydraulic dredging for extraction of sand and gravel, and they use similar equipment and onshore facilities similar to those operating on the LOMR.

In the Mississippi and Kansas Rivers, commercial dredging of sand and gravel is authorized by permits issued by the USACE. Currently, six mining operations are permitted to dredge sand and gravel in the Mississippi River in proximity to the market areas served by the Missouri River. Reaches of the Mississippi River that are authorized for dredging extend from approximately RM 48 to RM 282. Along the Kansas River, five mining operators have dredging permits in three designated reaches of the river: Kansas City (RM 0 – RM 22), Lawrence (RM 42 – RM 52), and Topeka (RM 77 – RM 92). In recent years, permitted quantities in the Kansas River have been reduced due to concerns of river bed degradation in the Kansas City area. Because the quality and material specifications of sand and gravel extracted from the Mississippi and Kansas Rivers are comparable to sand and gravel extracted from the Missouri River, these sources represent a clear option to offset changes in Missouri River supplies, particularly in the urban areas located in the eastern (Kansas City) and western (St. Louis) regions of Missouri.

Section 2.2 describes the dredging equipment, barge transports, and onshore facilities required for river dredging of commercial sand and gravel. Similar technology, operating procedures, and general environmental effects are associated with dredging on the Mississippi and Kansas Rivers (the two nearest river alternate dredging sources of supply to the LOMR). The locations of sand plants on the Mississippi and Kansas Rivers closest to the sand and gravel markets served by dredging in the LOMR (principally the Kansas City and St. Charles/St. Louis metropolitan markets) are shown in Figure 2.3-1.

Floodplain Open-Pit Mines and Quarries

Floodplain open-pit mines and quarries include sand and gravel operations that are located outside the ordinary high water mark of a river or stream. Existing open-pit mine operations in proximity to the region currently served by dredging in the LOMR are shown in Figure 2.3-1 and include mining operations in Missouri, Kansas, and Illinois.

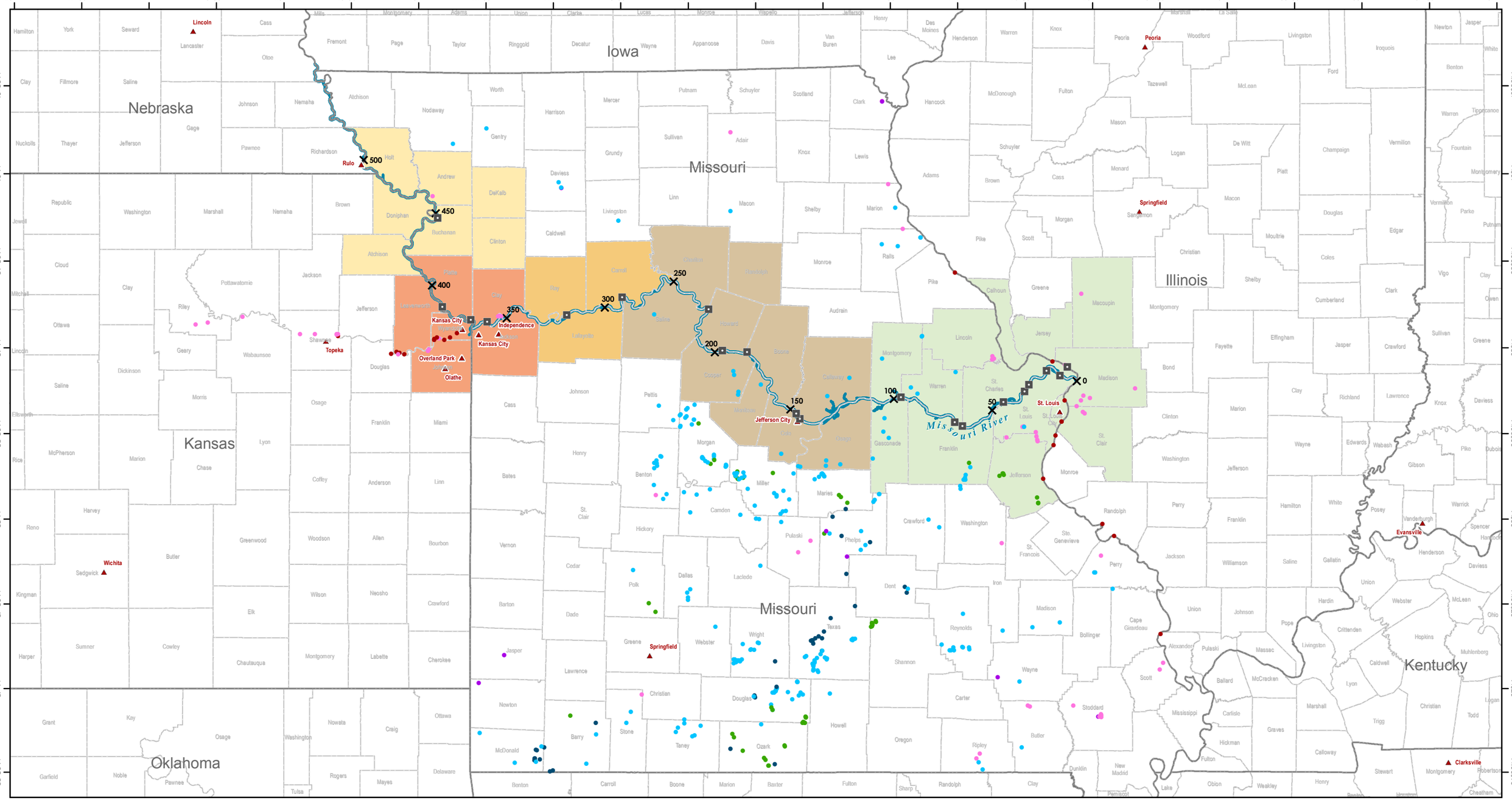
Open-pit mining operations are permitted by the MDNR, Kansas State Conservation Commission, and Illinois Department of Natural Resources in their respective states. In Missouri, there are a total of 35 active permits for open-pit mines with no production limit, eight permits for open-pit mines with a maximum production of approximately 5,000 tons annually, and 57 combined open-pit and instream mining permits (MDNR 2009a). Further, a floodplain open-pit mining operation along the Meramec River in Missouri is permitted by the USACE; this operation produces high-quality sand that meets MoDOT specifications. Floodplain open-pit mining expanded considerably in Kansas, in response to reductions in commercial dredging on the Kansas River. Twelve permitted floodplain open-pit mining operations in the eastern reaches of Kansas have been identified as alternate sources of sand and gravel (KSCC 2010).

Although numerous open-pit mines and quarries produce construction sand and gravel within the dry channel of the Arkansas River in Kansas, these operations were deemed to be too distant from the market areas along the Missouri River to represent a viable alternate supply source. In Illinois, nine open-pit sand and gravel mines are operating in the market area served by commercial dredging in the LOMR (IDNR 2010).

Open-pit mining for sand and gravel involves four sequential operations: (1) site clearing to expose mineable deposits (removal of trees and vegetation, soil cover, and other overburden; soil is stockpiled and reused later); (2) mining to extract commercial deposits of sand and gravel; (3) processing (crushing, screening, washing, blending, and stockpiling the mined material to meet market product requirements); and (4) reclamation of the mined area. Open-pit mines in Missouri permitted by the MDNR range from 2 to 389 acres, and the average mine size is 61.2 acres (MDNR 2009a).

Hydraulically Excavated Open-Pit Mines

Open-pit mines located in regions with shallow groundwater may use a hydraulic dredge for extraction of sand and gravel. After removing any overburden, a small self-contained lagoon is formed to hold the dredge and provide water for operation of the dredge. The dredge pumps the sand and gravel as a slurry to mechanical sorting equipment, where the material is sorted by particle size and dewatered. Separated slurry water is returned to the dredge excavation site. Sorted material is stacked and stored by product type using conveyors and stackers. Material is typically loaded into trucks for transportation to the point of use. Surplus fine-grained and oversized material from the sorting process (spoils) may be stored for later use in site reclamation.



1:3,000,000

0 20 40 60 80 100 Miles

0 20 40 60 80 100 120 Kilometers

Sand/Gravel Mine Type

- Sand Plants (Missouri River)
- Other River Dredging
- Instream < 5000 Tons
- Instream > 5000 Tons
- Open Pit > 5000 Tons
- Open Pit < 5000 Tons
- Open Pit & In-Stream

Legend

- River Mile
- City/Town
- County Boundary
- State Boundary

Counties by Segment

- St. Joseph
- Kansas City
- Waverly
- Jefferson City
- St Charles

Figure 2.3-1
Existing Regional Open-Pit Sand and Gravel Mines and Sand Plants

Missouri River Commercial Dredging EIS

February 2011

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Map Projection: Mercator, WGS84

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Facilities and equipment typically used in hydraulically excavated open-pit mine operations include the dredge, wheeled and tracked earth-moving equipment, screens and shaker tables, portable and fixed conveyor systems, load-out bins, truck scales, equipment maintenance and fueling faculties, and offices. Roads within the mine area are typically unpaved. Dredges used in open-pit mines are generally smaller than those used for river dredging operations.

As the dredge extracts material from the pit deposit, the lagoon footprint moves within the overall mine boundary until the usable deposit has been exhausted. The site is reclaimed by infilling the excavated pit with available spoils and stored overburden, typically leaving a recontoured site with a water body. A dredged open-pit mining operation typically does not create significant topographic relief and may be suitable for development as a water-related mixed use or recreation resource following mine closure.

A typical hydraulically excavated open-pit mine is shown in Figure 2.3-2. The mined lagoon occupies the center of the site, with processing and material stockpile areas adjacent to the lagoon. The active mining area of this facility is approximately 132 acres that is surrounded by undeveloped land adjacent to a river. A nearby highway provides transportation access.

Operation of hydraulically excavated open-pit mines generates air emissions and noise from equipment operations. Operation of vehicles and movable equipment on graded haul roads and operation of conveyors and processing equipment also generate particulate emissions (dust). To the extent that they are visible from neighboring land uses or local/regional scenic viewing points, hydraulically excavated open-pit mines may alter the visual landscape.

Conventional Open-Pit Mines

Open-pit mines located in areas without sufficient available groundwater or that are otherwise unsuitable for dredging typically use front-end loaders and draglines to excavate suitable sand and gravel deposits. After removal of overburden, material is excavated in layers or benches, deepening the pit one layer at a time. This technique creates a large open pit with high walls that may rise to 50 feet.

Material is excavated by scrapers, front-end loaders, or drag lines and moved to mechanical sorting equipment including screens, shaker tables, and conveyors. Sorted material is moved to segregated storage piles with fixed and portable conveyors. From the storage piles, material for transport and delivery is moved via a conveyor or front-end loader to a loading point.

Figure 2.3-2 Hydraulically Excavated Sand and Gravel Open-Pit Mine (Simpson Construction Materials, Eureka, Missouri)

Source: GoogleEarth.

A typical conventional open-pit mine is shown in Figure 2.3-3. Sorting and grading equipment and conveyors for moving and stacking material can be seen in the left portion of the active mine site. The pit excavation is to the right, with shadow lines at the high wall evident in the portion of the excavation furthest to the right in the figure. The active mine site is approximately 55 acres and is adjacent to agriculture and rural residential land uses.

Reclamation of an open-pit mine that has been mined with conventional earth-moving equipment and has a high wall typically involves replacement of any overburden material that has been stockpiled and re-contouring the mine pit to the extent possible. Reclaimed conventional open-pit mines may be suitable for use as solid waste disposal facilities.

Figure 2.3-3 Conventional Open-Pit Sand and Gravel Mine (Williams Materials Company, Popular Bluff, Missouri)

Source: GoogleEarth.

Operation of conventional open-pit mines generate air emissions and noise from equipment operations. Operation of vehicles and movable equipment on graded haul roads and operation of conveyors and processing equipment also generate particulate emissions (dust). To the extent that they are visible from neighboring land uses or local/regional scenic viewing points, conventional open-pit mines may alter the visual landscape.

Development of a conventional open-pit mine for sand and gravel production in the State of Missouri requires a permit from the MDNR Land Reclamation Program (LRP). The LRP permit requires both a mining and reclamation plan. Open-pit mines that intersect jurisdictional wetlands or other environmentally sensitive areas may require permits from the USACE under Section 404 of the CWA. Air and water quality permits also may be required depending on the circumstances of an individual mining operation.

Instream Mining

Instream sand and gravel mines occur within the ordinary high water mark of rivers and streams on exposed sand or gravel bars. Sand and gravel is removed with earth-moving equipment during low water conditions from typically small areas that can be accessed from the adjacent riverbank. Wheeled front-end loaders are the most commonly used equipment for excavation, although a dragline may be used if conditions warrant. Excavated material may be mechanically processed and classified at an adjacent facility or transported to a central facility for processing.

Operation of an instream sand and gravel mine generates air emissions from equipment operations. Operation of vehicles and movable equipment on graded haul roads and operation of conveyors and processing equipment also generate some particulate emissions (dust). To the extent that they are visible from neighboring land uses or local/regional scenic viewing points, instream sand and gravel mines may alter the visual landscape.

A typical instream sand and gravel mining operation is shown in Figure 2.3-4.

In the State of Missouri, instream mining activity also requires a permit from the LRP, including a Sand and Gravel Excavation Plan with site restoration requirements. The MDNR regulations that govern instream mining operations include measures to protect water quality and stream habitat. The regulations include provisions to:

- Limit excavation to unconsolidated deposits that contain no woody debris, are small sized, and above the water line at the time of removal;
- Require undisturbed buffer zones between the excavation zone and the water edge, and along the riparian zone;
- Prohibit alteration of the stream channel;
- Require restoration of the excavated area within 30 days of completion, including revegetation as required;
- Limit the construction and maintenance of access points; and
- Require that all processing of excavated material and stockpiling of tailings take place outside the high bank.

Figure 2.3-4 Typical Instream Sand and Gravel Mining Operation

Source: MDNR 2009b.

Instream sand and gravel permits issued by MDNR are distinguished by the level of production. Permits are issued for operations producing less than 5,000 tons and for operations producing greater than 5,000 tons annually. A total of 227 active permits represent instream sand and gravel operations that produce less than 5,000 tons annually. These operations are typically small, ranging from 0.1 to 136 acres, and with an average size of 5.0 acres. In addition, 35 permitted sites produce greater than 5,000 tons per year, with an average size of 6.5 acres (MDNR 2009a). Regulations governing operation of these facilities limit their operation to certain areas and to certain times of the year, typically during low water periods when sand and gravel bars are exposed and accessible. The combined limited area and limited time of operation restrict the overall production of sand and gravel available from this type of resource.

Manufactured Sand

Manufactured sand is a result of rock crushing and is typically produced at open-pit mines where native limestone rock is quarried and crushed to form course aggregate. It is also produced at some open-pit sand and gravel mines where the resource is poorly graded and a significant amount of oversized material is produced. After grading, oversized material may be stockpiled and then passed to one of several types of crushers to reduce its size. After crushing, it is again screened and may be washed to remove fine material. The wet sand of selected size is conveyed to a stockpile and stored for commercial use.

Manufactured sand operations are not typically developed and operated independently; rather, they are part of a rock quarrying or sand and gravel operation. Their operations generate additional air emissions (primarily particulate matter from material handling), waste water, and noise (from crushing). As an integral part of the open-pit mining operation, the environmental effects are typically incremental to the overall mining operation.

The use of manufactured sand in the construction industry in Missouri has been relatively limited based on the abundance of other sand sources, including natural river sand. Manufactured sand tends to be more angular than natural sand, which is not conducive to finishing applications. Further, there are concerns associated with the use of manufactured limestone sands in concrete mixes due to deleterious chemical reactions. Recently, the use of manufactured sand has been tried on an experimental basis by MoDOT in its road construction projects.

2.3.2.2 Available Capacity of Existing Alternate Sources

As described above, the short-term responses to reductions in sand and gravel dredging from the LOMR would be increased production from the alternate sources identified above. Short-term replacement supplies from existing sources likely would be needed over the next several years until new mines were permitted and constructed in response to market pressures. The primary factors affecting which alternate sources of supply would be utilized are the distances to markets, quality of sand and gravel resources, and ability of existing sources to increase production beyond what is required to meet their existing demands. The available (or unused) capacity of alternate sources of construction sand and gravel is difficult to estimate because production data and operating parameters of individual mining operations are not known and often are considered proprietary information. Therefore, estimates of available capacity have been developed using the best available data and a set of analytical assumptions that are presented here.

As indicated above, the quality of alternative sources of sand and gravel has a direct bearing on their ability to offset reductions in supplies from the LOMR. For this EIS, it was assumed that sand and gravel from all alternate sources would meet specifications for general construction, such as residential and commercial building. Currently, most of the sand and gravel from the LOMR is used for general construction purposes based on its availability and proximity to markets. However, the quality of sand and gravel from the LOMR also meets specifications for Class A fine aggregate, which is required for road construction projects undertaken by the MoDOT and KDOT. Only those alternate sources that meet state specifications can be used as replacement supplies for sand and gravel from the LOMR.

Dredging from Other Rivers

The available capacity of dredging operations in other rivers was based on the difference between the maximum permitted amounts and current production (demand). For the six dredging operations in the Mississippi River, the total amount of sand and gravel authorized to be mined is approximately 2.2 million tons per year, while current production is approximately 1.1 million tons per year (USACE 2010). Taking into account deviations among permitted and actual production volumes in specific reaches of the river, it is estimated that an approximate 1.2 million tons of additional sand and gravel can be extracted from the Mississippi River annually and used to serve the primary market area currently served by the LOMR.

Similarly, additional production capacity exists in the Kansas River. Up to approximately 2.2 million tons can be extracted annually from the Kansas River based on existing permits. When compared to existing and historical production figures (approximately 1.4 million tons per year), the available capacity in the Kansas River is estimated at approximately 757,000 tons annually.

Use of the Kansas River and the Mississippi River as alternate sources was considered as a short-term response to reductions in the overall supply of sand and gravel. It was assumed that other alternate sources would be developed over time. Increased production from the Kansas and Mississippi Rivers is available and implementable in the short term based on existing permitted capacities but may not be sustainable in the long term. The Kansas River has set tonnage and river bed degradation limits, Increasing the rate of dredging to the currently authorized tonnage limit may cause the river bed degradation limits to be reached sooner, possibly resulting in curtailment of dredging. In the long term, increasing commercial dredging in the Mississippi River beyond currently authorized tonnage would encounter significant challenges associated with additional permit review, NEPA compliance, and potential effects on endangered species.

Floodplain Open-Pit Mines and Quarries

Open-pit mines may be found in Missouri, Kansas, and Illinois. According to the USGS, total construction sand and gravel production in the state of Missouri in 2007 was approximately 15.4 million tons (U.S.), which includes commercial dredging from the LOMR (USGS 2009a). Because state-level production data beyond 2007 are unavailable, production through 2009 was extrapolated based on national trends. In the United States, sand and gravel production fell by 15.4 percent in 2008 and by 23.1 percent in 2009 compared to previous levels (USGS 2009b). Applying these rates of change to production in Missouri, it is estimated that approximately 10.0 million tons of sand and gravel were produced in the state in 2009. Using a similar approach, it is estimated that approximately 4.2 million tons of sand and gravel were extracted by commercial dredging operators in the LOMR in 2009, and another approximately 285,000 tons were produced by floodplain open-pit operations on the Meramec River permitted by the USACE. The 2009 reports submitted by the Missouri River Dredgers to the USACE, as required in their existing dredging permits, show that they extracted 4,639,887 tons. Based on these figures, it is estimated that the remaining approximately 5.5 million tons of construction sand and gravel production came from all mines permitted by the MDNR, including open-pit mines. In lieu of mine-specific information, and accounting for mining operations with permit limits on production, the remaining volume was allocated to existing mining operations in Missouri based on their relative size.

Using this approach, an estimated 4.5 million tons of sand and gravel were produced from 2,483 acres of existing open-pit mines permitted by MDNR (without limits on production). An additional 18,000 tons were estimated to be produced by open-pit mines with production limits (less than 5,000 tons per year). Historical production data were used to estimate the available capacity of MDNR-permitted operations. Specifically, an expansion factor was calculated using 2009 production levels (approximately 5.5 million tons) relative to 2006 levels, when production peaked at approximately 10.8 million tons annually. The assumption is that existing operations can produce at least as much sand and gravel as was produced in 2006. The capacity expansion factor is calculated to be 1.94. This factor was applied to open-pit mines permitted by MDNR, except those limited to 5,000 tons per year. A comparable expansion factor was calculated for Meramec River operations. For mines with permit caps, available capacity was based on the different between estimated production and permitted levels. Based on these assumptions, an estimated 4.4 million tons of available capacity are present in open-pit mines throughout Missouri.

In Illinois, existing production levels were estimated based on total sand and gravel production in the state and the number of mining operations. It is estimated that approximately 22.8 million tons of sand

and gravel were produced in Illinois in 2009 by a total of 336 mining operations, resulting in an average production estimate of 67,854 tons per mine. Accounting for the nine mining operations considered in this analysis, an estimated 611,000 tons of sand and gravel were produced by alternate mining sources in Illinois in 2009. The expansion factor for Illinois mines is 1.87, resulting in an estimated 532,000 tons of available capacity[2].

Of the three states, only Kansas has publicly available information on existing production levels for sand and gravel mines. According to data provided by the Kansas State Conservation Commission (2010), approximately 2.2 million tons of construction sand and gravel were produced by floodplain operators along the Kansas River in 2008. However, one of these operations is scheduled to close in 2010 due to depleted reserves, resulting in a loss of approximately 512,000 tons per year in production. Applying an expansion factor of 1.32 for Kansas to the adjusted 2008 total, and accounting for the need to replace lost supplies from the floodplain open-pit closure, yields an estimated available capacity of only 38,000 tons per year.

Instream Mining

The available capacity of instream mining operations in Missouri was estimated using assumptions similar to those outlined for MDNR-permitted open-pit mines. In total, existing production from instream mining was approximately 579,000 tons annually for operations limited to less than 5,000 tons per year and approximately 412,000 tons annually for operations with no permit limit. The available capacity of these operations is estimated at approximately 546,000 tons and approximately 389,000 tons per year, respectively.

2.3.2.3 Capacity of Sources to Meet Road Construction Material Specifications

As indicated above, the MoDOT and the KDOT require Class A natural sand for their road construction projects. Historically, these demands were met in part from sand and gravel from the LOMR. Between 2004 and 2008, it is estimated that MoDOT used approximately 497,000 tons of sand per year from the LOMR based on demands in MoDOT Districts 1, 2, 4, 5, 7, 8, and 9 (MDNR 2009c). In addition, the KDOT has used an average of 56,000 tons of sand annually from the LOMR, primarily in the Kansas City area (KDOT 2009). Based on these figures, Class A sand requirements account for approximately 8.0 percent of total demand from the LOMR.

[2] The estimated amount of 22.8 million tons of sand and gravel was projected based on USGS 2009c; the number of mines is based on IDNR 2010.

Alternate supplies capable of meeting Class A specifications could include the Mississippi and Kansas River sources, Meramec River floodplain operations, and other approved mining operations designated by the MoDOT (MoDOT 2010). Accounting for these sources exclusively, approximately 3.7 million tons were estimated as the available capacity to meet these specific demands.

2.3.2.4 Summary of Available Capacity

Table 2.3-1 presents the available capacity of alternate sand and gravel sources considered in this EIS. As shown, the estimated production of existing sand and gravel operations is approximately 11.0 million tons annually.

Table 2.3-1 Estimated Production and Available Capacities of Alternate Sand and Gravel Sources (tons/year)

Alternate Source	Estimated Production	Available Capacity
Other River Sources		
Mississippi River	1,124,902	1,224,308
Kansas River	1,154,529	756,765
Subtotal	*2,279,431*	*1,981,073*
Open-Pit Mines and Quarries		
Open pit mines (Missouri)[a]	4,899,964	4,424,881
Open pit mines < 5,000 tons (Missouri)	18,005	16,995
Floodplain open-pit mines (Kansas)	2,244,253	38,091
Open-pit mines (Illinois)	610,682	531,970
Subtotal	*7,772,904*	*5,011,937*
Instream Mining		
< 5,000 tons (Missouri)	578,732	546,268
> 5,000 tons (Missouri)	411,840	388,738
Subtotal	*990,572*	*935,006*
Total	11,042,907	7,928,016

Note: N/A = Not applicable.

[a] Includes open-pit mines with no production limit and combined open-pit and instream mining operations.

In order to offset displaced supplies from the LOMR, existing production levels at alternate sources would need to increase by approximately 63 percent under the No Action Alternative, 43 percent under Alternative A, and 17 percent under Alternative B (Table 2.4-1 [in Section 2.4.2]). Under the Proposed Action and Alternative C, permitted dredging from the LOMR would meet current and recent levels of

demand for commercial sand and gravel; therefore, no increase in the use of alternate supplies likely would be needed. With an available capacity of approximately 7.9 million tons, the alternate sources would be able to produce the required amount of replacement sand and gravel supplies under all of the alternatives, including the No Action Alternative (where dredging of the LOMR would cease entirely).

The location of demand within the primary market area dictates where the alternate supply sources will come from. Based on shipping and production costs, it is likely that alternate suppliers closest to each demand center would be utilized first, all else equal. A transportation-cost model was developed to estimate the pattern of commodity movement from alternate supply sources to demand centers and the resulting effect on the delivered price of construction sand and gravel in the region. For more information on the transport cost analysis, refer to Section 3.13.

It is acknowledged that an increase in production by these alternate mining operations would affect the overall rate of resource utilization at these sources. Because most alternate sources are bound by a finite set of sand and gravel reserves, it is plausible that these alternate sources would deplete their reserves at a faster rate if required to offset the displaced demand for sand and gravel from the LOMR. Accordingly, this likely would result in the need for new mining operations to restore long-term equilibrium in the sand and gravel market in Missouri.

2.3.2.5 Development of New Alternate Sources

Development of new alternate sources of sand and gravel in the region will depend on the initiative of business owners to acquire property with available resources and to permit and develop new projects.

As moderate to large-scale extractive industrial activities, these types of projects must resolve a number of issues, including:

- Acquisition of land with reserves of suitable grades of sand and gravel that are accessible for extraction;
- Acquisition of permits and approvals from federal, state, and local government agencies;
- Local landowner resistance to project development during the permitting process; and
- Feasible site reclamation following closure.

Several open-pit mine projects have been developed or proposed in the region. Anecdotal evidence indicates that a period of up to 5 years, or more, is typically required for project permitting and development. Table 2.3-2 lists the federal and state permit, approval, and consultation processes that

may be required for development of a new source of sand and gravel, depending on its location and configuration. Various local permits also may be required such as zoning and grading permits that are not specified in the table. Because new alternate sources would be developed by private initiative at currently unidentified sites, the table shows a range of requirements possible for development of a new source.

Table 2.3-2 Permits, Approvals, and Consultations Potentially Required for Development of Alternate Sources of Sand and Gravel

Agency	Permit/Approval/ Consultation	Applicability and Requirements	Alternate Source
FEDERAL			
U.S. Army Corps of Engineers	Clean Water Act (CWA) Section 404 permit	Required prior to discharging dredged or fill material into waters of the United States.	Floodplain open-pit mines, instream mining, dredging of other rivers
	Rivers and Harbors Act of 1899 Section 10 permit	Required prior to any work in or over navigable waters of the United States.	Dredging of other rivers
Advisory Council on Historic Preservation	Consultations under Section 106 of the National Historic Preservation Act (NHPA)	Has the opportunity to comment on any federally authorized, funded, or proposed action.	Floodplain open-pit mines, instream mining, dredging of other rivers
U.S. Environmental Protection Agency	Compliance with Sections 401, 402, and 404 of the CWA	Consider issuance of water use and crossing, National Pollutant Discharge Elimination System (NPDES) discharge, stormwater, and wetland dredge-and-fill permits. Permitting authority delegated to the states.	Floodplain open-pit mines, instream mining, dredging of other rivers
U.S. Fish and Wildlife Service	Consultations under Section 7 of the Endangered Species Act (ESA)	Required to ensure that a federally authorized, funded, or proposed action is not likely to jeopardize the continued existence of a listed species or result in destruction or adverse modification of designated critical habitat.	Floodplain open-pit mines, instream mining, dredging of other rivers
STATE			
Missouri			
Department of Natural Resources (MDNR) – Land Reclamation Program	Instream mining permit	Required for any commercial instream (other than the Missouri or Mississippi River) mining activity. Requires a description of measures to minimize stream impacts, reclamation plan, and operation plan. MDNR consults with appropriate federal and state agencies to avoid jeopardizing any state- or federally listed threatened or endangered species.	Instream mining

Table 2.3-2 Permits, Approvals, and Consultations Potentially Required for Development of Alternate Sources of Sand and Gravel

Agency	Permit/Approval/ Consultation	Applicability and Requirements	Alternate Source
STATE (continued)			
Missouri (continued)			
MDNR – Land Reclamation Program (continued)	Industrial mineral open-pit mining permit	Required for any surface mine for industrial minerals, including sand and gravel. Requires an operation and reclamation plan.	Open-pit mining
MDNR – Water Protection Program	NPDES permit	Required for stormwater and other specified water discharge from a mining or sand and gravel washing facility. Other agencies, including state cultural and protected species agencies, notified via Notice of Intent.	Open-pit mining, instream mining
	CWA 401 certification	Required when placing material, or fill, into the jurisdictional waters of the United States.	Open-pit mining, instream mining
MDNR – Air Pollution Control Program	Air Pollution Control Permits (Air Pollution Construction Permit; State Air Operating Permits)	Required for construction and operation facilities with potential emissions that would exceed *de minimis* levels.	Open-pit mining, instream mining, manufactured sand
Kansas			
State Conservation Commission	Mining license	Required for all new and existing mines. Site registration and reclamation plan required.	Open-pit mining
Department of Health and Environment (KDHE) – Bureau of Water	NPDES permit	Required for runoff associated with construction and storm water runoff from industrial activity. Other agencies, including state cultural and protected species agencies, notified via Notice of Intent.	Open-pit mining, manufactured sand
KDHE – Bureau of Air and Radiation	Class II (Synthetic Minor) Operating permit	Required for crushed and broken stone facilities to limit potential-to-emit of covered sources to below major source thresholds for particular matter less than 10 microns (PM_{10}).	Manufactured sand
	Tree and Brush Open Burn authorization	Authorization to burn vegetative clearing debris.	Open-pit mining
Kansas Department of Agriculture – Division of Water Resources	Notice of Intent to Open or Expand a Sand and Gravel Operation	Required for operation of sand and gravel pits. Requires a reclamation plan and groundwater protection measures.	Open-pit mining

Table 2.3-2 Permits, Approvals, and Consultations Potentially Required for Development of Alternate Sources of Sand and Gravel

Agency	Permit/Approval/ Consultation	Applicability and Requirements	Alternate Source
STATE (continued)			
Illinois			
Department of Natural Resources (IDNR) – Office of Mines and Minerals, Mine Safety and Training Division	Surface mining permit	Required for any operation that affects more than 10 acres of land or 10 feet of overburden per year. Reclamation plan is required, and IDNR consults with appropriate state agencies to avoid jeopardizing any state-listed threatened or endangered species.	Open-pit mining
IDNR – Division of Water Resources Management	Floodplain construction permit	Required for construction within a floodplain. Requires consultation with State Historic Preservation Office and avoidance of jeopardizing any state-listed threatened or endangered species.	Open-pit mining
County and City			
Local county and city agencies responsible for land development	Zoning/land use approval, grading and construction permits	May be required for construction and operations of sand pits and materials-handling facilities.	Open-pit mining, manufactured sand
Levee districts	Construction plan review	Depending on proximity to an existing levee, review of construction plans by levee district with consultation from the USACE may be required.	Open-pit mining

2.4 DEVELOPMENT OF ALTERNATIVE ACTIONS

In accordance with 33 CFR 325, Appendix B and 40 CFR 1500–1508, this EIS evaluates a range of practicable alternatives to meet the basic and overall purpose of the Proposed Action. Alternatives to the Proposed Action were identified through review of the record of previous dredging authorizations; analysis of bed material load of the LOMR and recent and historical degradation; discussions with USACE staff from the Regulatory, Engineering, and other divisions; and an understanding of the broader aggregate market. Based on this review and analysis, a list of alternatives to the Proposed Action were identified and evaluated. Three alternative actions, in addition to the Proposed Action and the No Action Alternative, were selected for detailed evaluation. These alternative actions are:

- Alternative A – Allowable commercial dredging tonnages would be set at levels at the lower end of the range that are reasonably expected to reduce the contribution of sand and gravel dredging to

continued river bed degradation in the LOMR (2,190,000 tons per year).

- Alternative B – Allowable commercial dredging tonnages would be set at levels at the upper end of the range that are reasonably expected to reduce the contribution of sand and gravel dredging to river bed degradation (5,050,000 tons per year).

Alternative C – Allowable commercial dredging tonnages would be set at levels that approximate recent dredging amounts (6,900,000 tons per year).

2.4.1 Rationale for Setting Alternative Dredging Amounts

Available evidence suggests that commercial dredging has exacerbated river bed degradation on the Missouri River (West Consultants 1999, Stark et al. 2000, USACE 2009b) (also see Section 3.4). As described in Section 3.4.6.3 and reported in the Reconnaissance Study (USACE 2009b), analyses to date show a strong correlation between the locations, time frames, and quantities of dredging in the LOMR and degradation of the river bed. Dredging contributes to degradation by removing considerable amounts of sediment from the river bed relative to the available annual bed material load. While dredging may not be the only cause of bed degradation, data collected over the last 15 years suggest that increased dredging, combined with the BSNP and changes in flow regime, are likely the dominant causes of degradation (USACE 2009b).

During early EIS scoping and discussions, development of alternative actions focused on evaluating different levels of dredging that would allow continued commercial dredging without unacceptable levels of further bed degradation or that would reduce or stop the contribution of commercial dredging to bed degradation. As described in Section 3.4, the annual amount of sediment (bed material load) moved by the Missouri River annually was estimated for three locations along the LOMR (St. Joseph, Kansas City, and Hermann). These bed material load estimates were reviewed and compared to estimates in the published literature and other relevant data, and were determined to be the best available estimate of sediment loads of the same size as the material removed by commercial dredging. Estimates of bed material load were found to be greater during periods of higher river flow and lower during periods of lower river flows. Because the estimates of bed material load were found to vary with the flow conditions in the LOMR, estimates were made for two time periods, 2000–2009 (representing below-average flow conditions) and 1994–2009 (representing average flow conditions). See Appendix A and Sections 4.3 and 4.4.5.5 for details on estimation of bed material loads and below-average and average flow conditions.

The Missouri River bed material load estimates for each segment were compared to the average annual amount of material dredged during the 2000–2009 time period for average and below-average flows. In the river segments where river bed degradation is acute in areas of concentrated dredging, Kansas City and St. Charles, dredging removed approximately 46–53 percent of the estimated bed material load. In segments that are stable or only slightly degraded, St. Joseph and Waverly, dredging removed approximately 10 percent of the bed material load. These results are shown in Table 3.4-19 in Section 3.4.

Using this information as guidance, dredging levels for Alternatives A and B were developed. Alternative A would allow 10 percent of the estimated bed material load under below-average flow conditions (represented by the period from 2000–2009, Table 3.4-19) to be extracted. Alternative B would allow for a somewhat higher level, 15 percent of the estimated bed material load under average flow conditions (represented by the period from 1994–2009, Table 3.4-19). Alternative C dredging limits would be based on average annual dredging levels by river segment from 2004 to 2008. Together with the Proposed Action and the No Action Alternative, these three alternatives bound the range of practicable alternatives. The values are shown in Table 2.4-1, which also shows the sum of the applicants' requested dredging tonnages by river segment for the Proposed Action. These three action alternatives are described in Section 2.4.3.

2.4.2 Replacement of Missouri River Sand and Gravel from Alternate Sources

If future dredging amounts are constrained below recent historical dredging amounts, supplies of sand and gravel from alternate sources would be relied on to make up the difference to meet the regional demand for sand and gravel.

Historical dredging amounts have ranged from approximately 2 to 3 million tons per year in the 1960s and 1970s to a peak of over 8 million tons in the late 1990s. The average annual dredging tonnages for the five river segments were calculated for the recent 5-year period. This value is shown in Table 2.4-1. The average annual dredging total during this period of 6,891,930 tons was not dominated by the effects of the current recessionary economic conditions.

Using the recent 5-year annual average of 6,891,930 tons per year to represent that portion of regional sand and gravel demand supplied by the LOMR, the increase in supply that would be needed from alternate sources is calculated by subtracting the permitted dredging tonnages specified in the alternatives. These values are shown in Table 2.4-1; they range from 0 tons per year for Alternative C to 6,891,930 tons per year for the No Action Alternative.

Table 2.4-1 Dredging Amounts for the Proposed Action and Alternatives by River Segment (tons/year)

Segment	Annual Average (2004–2008)	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
St. Joseph (RM 391 – RM 498)	326,928	1,150,000	0	350,000	860,000	330,000
Kansas City (RM 357 – RM 391)	2,658,831	4,060,000	0	540,000	1,230,000	2,660,000
Waverly (RM 250 – RM 357)	677,987	1,005,600	0	500,000	1,140,000	680,000
Jefferson City (RM 130 – RM 250)	1,578,858	2,750,000	0	430,000	980,000	1,580,000
St. Charles (RM 0 – RM 130)	1,649,326	4,384,400	0	370,000	840,000	1,650,000
Total dredging[a]	6,891,930	13,350,000	0	2,190,000	5,050,000	6,900,000
Alternate sources[b]		*N/A*	*6,900,000*	*4,710,000*	*1,850,000*	*0*

Note: N/A = Not applicable.

[a] Sum of Dredgers request by segment – the total amount authorized would be limited to approximately 11.6 million tons per year.

[b] Calculation of alternate sources was based on 2004–2008 average annual total dredging.

2.4.3 Summary of Proposed Action and Alternatives

As a basis for assessing environmental consequences, the Proposed Action and each alternative was defined in terms of:

- Annual tonnage – the total annual tonnage of dredging to be permitted and the tonnages to be permitted by river segment. These amounts are described in Sections 2.4.3.1 through 2.4.3.5.
- Dredging location – the general location of permitted dredging activities by river segment, defined by river miles. These locations are presented in Sections 2.4.3.1 through 2.4.3.5.
- Restrictions to dredging operations – conditions that further define the permissible specific areas for dredging as well as areas where dredging is not allowed. These conditions include:
    1. Exclusion zone distances will apply to and be measured from the end of the dredge head rather than from a general point on the dredge.

2. Dredging will be confined between the rectified channel lines (RCL) to preserve the structural integrity of the landmass landward of the RCL. (Note: The current RCL is 200 feet from the high water mark.)
3. Dredging will not occur within 1,000 feet upstream and 4,000 feet downstream of the tributary.
4. Dredging will not occur within 500 feet of any levee centerline, pipeline or submerged utility crossing, bridge pier, or abutment; nor within 200 feet of any dike, revetment, or other structure built or authorized by the U.S. Government; nor within 100 feet of any normal bank line or island, without special authorization.
5. Dredging will not occur in a zone extending 4,000 feet upstream and 500 feet downstream from any municipal drinking water intake structure located along either bank of the river.
6. Dredging will not occur in a zone extending 1,000 feet upstream and 1,000 feet downstream from any municipal drinking water horizontal collector well located along either bank of the river.
7. Dredging will not occur in a zone extending 500 feet upstream and 500 feet downstream from any water intake structure other than those used for municipal drinking water.
8. Dredging will not occur in the within the reaches identified in pallid sturgeon habitat areas, as defined in Table 2.2-6.

- Discharge and disposal requirements – requirements governing the operation of dredging equipment and the discharge of dredged material back to the river. These requirements include:
  1. Dredgers will discharge only suitable material that is free from toxic pollutants in other than trace quantities.
  2. Dredgers will investigate for water supply intakes or other activities that may be affected by increases in suspended solids and turbidity caused by work in the watercourse and give sufficient notice to the owners of affected activities to allow preparation for any changes in water quality.
  3. Dredgers will implement measures to prevent dredged materials stored or disposed of onshore from running off or eroding into wetlands or tributaries to the Missouri River.
  4. Dredgers will implement measures to prevent or control spilled fuels or lubricants from entering the waters of the United States.
  5. Dredgers will store all construction materials, equipment, and petroleum products that are part of the onshore operation, when not in use, above anticipated high water levels.

6. Dredgers may return unwanted dredged material and river water extracted from the Missouri River back to the Missouri River. Dredgers will not dispose of waste materials, water, or garbage below the ordinary high water mark of any other water body, in a wetland area, or at any location where the materials could be introduced into the water body or an adjacent wetland as a result of runoff, flooding, wind, or other natural forces.
7. Dredgers will 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.
8. Dredgers will conduct operations in the Missouri River such that there will be no unreasonable interference with navigation.
9. Dredgers operating within the USACE's St. Louis District (RM 0 – to RM 49) will be limited to the use of suction head dredges and will not remove material below the consolidated surface of the river bed (hardpan layer).

- Monitoring requirements – requirements for monitoring and reporting the location and extent of dredging operations and dredging site conditions. These requirements include:

1. Within 30 days of execution of the permit, the Dredgers will provide a Dredge Monitoring Plan (DMP) for each individual dredge plant to the Regulatory Branch of the USACE, Kansas City or St. Louis District for approval.
2. Dredgers will survey each dredged reach every fifth year, beginning in 2014, in accordance with the USACE's Standard Operating Procedures for Hydrographic Surveying and Dredge Monitoring.
3. Dredgers will equip each dredge with a Global Positioning System (GPS) and record GPS coordinates, tons of material removed, and the presence of any hard substrates or unusual concentration of gravel daily.

2.4.3.1 Proposed Action

The Proposed Action would include the following:

- Annual tonnage – Amounts dredged under the Proposed Action are assumed to be the amounts shown in Table 2.4-2 for each segment, with the limitation that total dredging in all segments combined will not exceed 11,615,000 tons per year.

- Dredging locations – Dredging locations would be limited to those river reaches shown for each applicant in Table 2.2-2.
- Dredging operations and monitoring requirements – Dredging operations, restrictions to dredging operations, and monitoring requirements would be the same for the Proposed Action and the action alternatives, as described in Section 2.4.3.

Table 2.4-2 Annual Tonnage for the Proposed Action

Segment	River Miles	Annual Amount (tons/year)
St. Joseph	391–498	1,150,000
Kansas City	357–391	4,060,000
Waverly	250–357	1,005,000
Jefferson City	130–250	2,750,000
St. Charles	0–130	4,384,000
Total not to exceed		11,615,000

2.4.3.2 No Action Alternative

No dredging would be authorized to any commercial sand and gravel dredger under the No Action Alternative.

2.4.3.3 Alternative A

Alternative A would include the following:

- Annual tonnage – Amounts dredged are assumed to be the amounts shown in Table 2.4-3 for each segment, with the limitation that total dredging in all segments combined will not exceed 2,190,000 tons per year.
- Dredging locations – Dredging locations would be limited to those river reaches shown for each applicant in Table 2.2-2.
- Dredging operations and monitoring requirements – Dredging operations, restrictions to dredging operations and monitoring requirements would be the same for the Proposed Action and the action alternatives, as described in Section 2.4.3.

Table 2.4-3 Annual Tonnage for Alternative A

Segment	River Miles	Annual Amount (tons/year)
St. Joseph	391–498	350,000
Kansas City	357–391	540,000
Waverly	250–357	500,000
Jefferson City	130–250	430,000
St. Charles	0–130	370,000
Total not to exceed		2,190,000

2.4.3.4 Alternative B

Alternative B would include the following:

- Annual tonnage – Amounts dredged are assumed to be the amounts shown in Table 2.4-4 for each segment, with the limitation that total dredging in all segments combined will not exceed 5,050,000 tons per year.
- Dredging locations – Dredging locations would be limited to those river reaches shown for each applicant in Table 2.2-2.
- Dredging operations and monitoring requirements – Dredging operations, restrictions to dredging operations and monitoring requirements would be the same for the Proposed Action and the action alternatives, as described in Section 2.4.3.

Table 2.4-4 Annual Tonnage for Alternative B

Segment	River Miles	Annual Amount (tons/year)
St. Joseph	391–498	860,000
Kansas City	357–391	1,230,000
Waverly	250–357	1,140,000
Jefferson City	130–250	980,000
St. Charles	0–130	840,000
Total not to exceed		5,050,000

2.4.3.5 Alternative C

Alternative C would include the following:

- Annual tonnage – Amounts dredged are assumed to be the amounts shown in Table 2.4-5 for each segment, with the limitation that total dredging in all segments combined will not exceed 6,900,000 tons per year.
- Dredging locations – Dredging locations would be limited to those river reaches shown for each applicant in Table 2.2-2.
- Dredging operations and monitoring requirements – Dredging operations, restrictions to dredging operations, and monitoring requirements would be the same for the Proposed Action and the action alternatives, as described in Section 2.4.3.

Table 2.4-5 Annual Tonnage for Alternative C

Segment	River Miles	Annual Amount (tons/year)
St. Joseph	391–498	330,000
Kansas City	357–391	2,660,000
Waverly	250–357	680,000
Jefferson City	130–250	1,580,000
St. Charles	0–130	1,650,000
Total not to exceed		6,900,000

2.5 ALTERNATIVES CONSIDERED BUT NOT INCLUDED IN DETAILED ANALYSIS

During the scoping process and preparation of the EIS, the applicants, public, agencies, and organizations were provided the opportunity to submit formal and informal ideas and suggestions about alternative means for achieving the Project purpose. A number of comments and ideas about alternatives and alternative methods and strategies were received and considered. Each alternative was considered with regard to the Project purpose and need, current laws and regulations, practicability, and other criteria. This section describes the reasons why some alternatives were not carried forward for further analysis in the EIS. These reasons include, but are not limited to, an alternative not meeting the scope of the Project purpose and need; being sufficiently similar to, or included in, other alternatives so that individual consideration was not required; not being technically feasible; or resulting in unacceptable environmental impacts.

2.5.1 No Cap Mine-and-Relax Strategy

The Dredgers proposed an alternative they call the No Cap Mine-and-Relax Strategy. The strategy consists of the following elements: (1) no limit on the amount dredged by segment or by Dredger; (2) expanding the permitted areas available for dredging; (3) limiting dredging activity in any given mile to 1 week; and (4) restricting dredging in the same mile for 4 weeks to allow the reach to "recover."

This alternative was not analyzed separately for several reasons. First, with no cap on the amount of material that could be dredged, some assumption would be needed concerning how much dredging would actually occur under this strategy. The No Cap Mine-and-Relax Strategy could result in higher or lower yields than the Proposed Action or any of the other alternatives. Limiting the total dredging amount to levels similar to any of the five alternatives already considered in this EIS would not differentiate it sufficiently from the other alternatives and would not meet the first element of the proposed strategy.

Second, the proposed strategy would spread the potential effects of dredging from localized reaches to 5-mile reaches. A dredge operation could operate year-round on one 5-mile reach by dredging each mile for a week and then moving on to the next mile and allowing the remaining 4 miles to recover. While this would limit dredge operations from dredging the same mile indefinitely, it would provide little if any difference in the overall amount dredged from the 5-mile reach. Given the degree and lateral extent of degradation in heavily dredged reaches of the LOMR, spreading dredging operations out over a 5-mile reach would not make a sufficient a difference to warrant analysis under an additional alternative.

Third, allowing a dredged reach to "recover" does not mean that river bed degradation would not occur in that reach or adjoining ones. There is evidence that the river bed in recently dredged areas fills in over a period from several days to over a week (USACE 2007). However, the sediment that fills in that dredged reach does not get moved downriver or the increased transport capacity of the river below the dredged area results in degradation below the dredged reach. With time, river bed degradation from dredging a particular reach spreads out above the dredge location by head-cutting and below the dredge location by sediment-poor water picking up sediment from the bed. The response of the river to localized dredging is eventually to spread out the degradation from local areas to broader segments of the river.

Finally, the river transports only a certain amount of sediment each year, and a 4-week recovery period does not change the total amount dredged relative to the total amount of sediment transported by the

river. River bed degradation in a reach occurs when more sediment leaves the reach than enters the reach; dredging represents a long-term cumulative loss to the reach even when it is being dredged only 1 of every 5 weeks.

2.5.2 Sand Supplied from Distant Sources

Several commenters suggested that sand not available from dredging of the LOMR that was needed to meet the demand for sand and gravel could be replaced from sources outside the existing sand and gravel market areas. Specifically, suggestions included providing sand and gravel by railroad, trucking sand from the Wichita, Kansas area, and bringing sand from the East on empty coal train return trips.

Relying on sand and gravel supplied from distant sources is included in the No Action Alternative, and in Alternatives A and B. In each of these alternatives, some portion of the demand for sand and gravel would not be met from dredging of the LOMR. Together, these alternatives fully evaluate the benefits and environmental impacts of using alternate sources to the LOMR in order to meet regional needs for sand and gravel.

2.5.3 Sand from Locally Available Alternate Sources

Several commenters suggested that sand not available from dredging of the LOMR that was needed to meet the demand for sand and gravel could be replaced from various local sources within the existing sand and gravel market areas. Specific suggested sources included manufactured sand from quarry operations (limestone, quartz, and flint), sand from recycling or concrete and highway demolition, floodplain mining with or without direct water connection to the river, and concrete using alternate materials for strength (such as fiberglass fibers).

Relying on locally available sources of sand and gravel is included in the No Action Alternative, and in Alternatives A and B. In each of these alternatives, some portion of the sand and gravel demand would not be met from dredging of the LOMR. Together, these alternatives fully evaluate the benefits and environmental impacts of using alternate sources to the LOMR in order to meet regional needs for sand and gravel.

2.5.4 Increasing Sediment Supply in the Lower Missouri River

Several commenters suggested various means for increasing the sediment supply in the LOMR. Specific suggestions included reconstructing channel chutes to reintroduce trapped sediments, and

piping sand and gravel from upstream mainstem Missouri River dams via sediment slurry pipelines to move sediment accumulated in the reservoir back into the LOMR channel.

This alternative does not meet the Project purpose and need because it does not supply the sand and gravel to support the regional construction and manufacturing needs. This alternative could be part of a long-term river management strategy that may ultimately increase the bed load of the river or reduce river bed degradation, and thus potentially allow greater levels of dredging. However, it could not be practicably implemented in sufficient time to meet the current need, and whether these actions would result in the desired or predicted effect is not certain.

This alternative is evaluated indirectly in Chapter 5, "Cumulative Impacts."

2.6 SUMMARY OF ENVIRONMENTAL CONSEQUENCES – PROPOSED ACTION AND ALTERNATIVES

The current condition of environmental resources potentially affected by dredging in the LOMR and the associated environmental consequences of dredging activities are described in Chapters 3 and 4, respectively. The results of the impact analyses for the Proposed Action and alternatives are summarized in the following sections.

2.6.1 Overview and Comparison of Impacts of the Proposed Action and Alternatives

2.6.1.1 Overview

Most of the direct and indirect environmental effects associated with the Proposed Action and alternatives, except the No Action Alternative, are closely related to: (1) the volume, location, and direct localized effects of dredging activity; and (2) indirect effects related to changes in the river bed and water surface elevations, and the risk of associated impacts. Most impacts on environmental resources were found to be indirect impacts generated by the direct impacts of dredging and its effects on water surface elevations, river bed elevations, and sediment dynamics.

Two exceptions are economic/employment impacts and air quality impacts. The analysis of economics and demographics effects included impacts related to replacement sources of sand and gravel. For those alternatives that rely heavily on alternate sources of sand and gravel (the No Action Alternative and Alternatives A and B), losses in output, labor income, and employment would occur in the primary market area of the dredging industry along the LOMR. Offsetting increases in output, income, and employment from shifts to sand and gravel production from alternate sources and increased trucking

would result in a net increase in statewide output, income, and employment under the No Action Alternative and Alternative A.

For air quality, the background air quality conditions in the St. Charles segment that are degraded for ozone may disproportionately affect air quality compliance with federal regulations related to the Project.

2.6.1.2 Comparison of Impacts of the Proposed Action and Alternatives

The Proposed Action, which includes commercial dredging for sand and gravel at approximately twice the 2004–2008 annual average level, could result in the greatest impacts to environmental resources[3]. These effects include increased river bed degradation in those portions of the LOMR where river bed degradation already has occurred. The Proposed Action was projected to cause little change to regional or state output, income, or employment.

The No Action Alternative, under which no future dredging would be authorized, is likely to result in the least adverse effect to the environmental resources affected by dredging in the LOMR and would lessen related river bed degradation and changes in water surface elevations. However, the No Action Alternative would lead to increased production of sand and gravel at existing alternate supply sources in the short term, and could result in development of new floodplain open-pit mines or additional instream mining sites in the long term to offset the reduction in sand and gravel supplies from dredging in the LOMR. Additional production at existing alternate supply sources and development of new supply sources could result in increased air and noise emissions, disturbance of habitat, and dedication of land for industrial use. These impacts likely would occur in the vicinity of existing or new alternate sources.

Although the No Action Alternative is projected to result in the greatest negative economic effects (changes in output, labor income, and employment) in the primary market area of the LOMR (see Section 3.12.3), it would result in the greatest net economic gain statewide because of geographic and industry shifts in employment.

Adverse environmental consequences under Alternatives A and B are expected to be substantially less than those under the Proposed Action. Alternative A, which includes dredging at approximately one-

[3] The analysis of regional economic benefits assumes as a worst-case scenario that dredging amounts would be market-driven (i.e., potentially less than authorized levels) rather than equal to the authorized levels. Analysis of other environmental resources assumes that dredging amounts would occur at authorized levels, also as a worst-case scenario for those resources.

third the 2004–2008 annual average level, would result in the least impact to environmental resources affected by dredging. Alternative B, which includes dredging at approximately three-quarters of the 2004–2008 annual average level, is expected to result in less impact than the Proposed Action but greater impact than Alternative A.

Similar to the No Action Alternative, Alternatives A and B would rely to some extent on increased production from alternate sources of sand and gravel in the region to offset the reduction in sand and gravel produced from the LOMR. Increased production from existing alternate sources of supply in the short term and potential development of new alternate sources in the long term under Alternatives A and B are expected to result in increased environmental effects from reliance on alternate sources, but less than those under the No Action Alternative.

Loss of output, income, and employment in the primary market area of the LOMR is likely to occur under Alternative A. However, geographic and industry shifts in employment would balance job losses, resulting in net statewide increases in output, income, and employment. Under Alternative B, a net loss in statewide output, income, and employment is projected to occur.

Under Alternative C, dredging would continue at 2004–2008 annual average levels and would continue to generate impacts to environmental resources at current or cumulatively increasing levels. In particular, river bed degradation, which has previously occurred in the areas with the most concentrated dredging, would be expected to continue where dredging is most concentrated. The continuing trend of river bed degradation would further lower the river bed elevation and further affect water surface elevations.

Alternative C is not expected to increase reliance on alternate sources of sand and gravel; therefore, minimal change in the existing level of utilization of these resources is expected to occur under Alternative C. Alternative C likely would have a neutral effect on regional and statewide output, income, and employment.

Table 2.6-1 provides a summary of the environmental consequences associated with the Proposed Action and alternatives. The resources are listed in the order of their presentation in Chapters 3 and 4.

2.6.2 Summary of Impacts for the Proposed Action and Alternatives

A detailed summary of the impacts for the Proposed Action and each alternative is given in the following sections.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Geology and Geomorphology					
Sediment load availability and composition	• Local short-term decrease in sediment availability; increase in fine sediment in the water column.	• No change.	• Local short-term decrease in sediment availability; increase in fine sediment in the water column.	• Local short-term decrease in sediment availability; increase in fine sediment in the water column.	• Local short-term decrease in sediment availability; increase in fine sediment in the water column.
River bed composition	• Increase in localized coarse gravel and cobbles.	• No change.	• Increase in localized coarse gravel and cobbles.	• Increase in localized coarse gravel and cobbles.	• Increase in localized coarse gravel and cobbles.
River bed elevation	• Moderate to substantial degradation possible in the St. Joseph segment; substantial degradation in the Kansas City, Jefferson City, and St. Charles segments; slight degradation in the Waverly segment.	• Slight to moderate aggradation in the St. Joseph segment; slight aggradation/degradation in the Waverly, Jefferson City, and St. Charles segments; moderate to substantial aggradation possible in the Kansas City segment.	• Slight degradation possible in the St. Joseph and Jefferson City segments; slight aggradation/degradation in the Waverly and St. Charles segments; slight aggradation in the Kansas City segment.	• Slight degradation possible in the Waverly segment; slight to moderate degradation possible in the St. Joseph, Jefferson City, and St. Charles segments; moderate degradation in the Kansas City segment.	• Slight degradation in the St. Joseph segment; moderate to substantial degradation in the Jefferson City and St. Charles segments; slight aggradation/ degradation in the Waverly segment; substantial degradation in the Kansas City segment.
Channel geometry and water surface elevations – low-flow elevations	Slight decrease in the Waverly segment; moderate decrease in the Jefferson City segment; moderate to substantial decrease in the St. Joseph and St. Charles segments; substantial decrease in the Kansas City segment.	Slight increase in the St. Joseph, Jefferson City, and St. Charles segments; moderate to substantial increase in the Kansas City segment; no change in the Waverly segment.	Slight decrease in the St. Joseph and Jefferson City segments; slight increase in the Kansas City segment; no change in the Waverly segment; slight increase/decrease in the St. Charles segment.	Slight decrease in the Waverly and Jefferson City segments; slight to moderate decrease in the St. Joseph, Kansas City, and St. Charles segments.	Slight decrease in the St. Joseph segment; slight to moderate decrease in the St. Charles segment; moderate to substantial decrease possible in the Kansas City and Jefferson City segments; no change in the Waverly segment.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Geology and Geomorphology (continued)					
Channel geometry and water surface elevations – high-flow elevations	• Increase in the St. Joseph, Kansas City, Jefferson City, and St. Charles segments; no change in the Waverly segment.	• Increase in all segments except Waverly; no change in the Waverly segment.	• Increase or decrease in the St. Joseph segment; increase in the Kansas City and Jefferson City segments; no change in the Waverly or St. Charles segments.	• Increase possible in all segments except Waverly; no change in the Waverly segment.	• Increase or decrease in the St. Joseph and Jefferson City segments; increase in the Kansas City and St. Charles segments; no change in the Waverly segment.
Tributary degradation	• Increased tributary degradation in areas of concentrated dredging in all segments except Waverly; no change in the Waverly segment.	• No impacts.	• No impacts.	• Increased tributary degradation in areas of concentrated dredging in all segments except Waverly; no change in the Waverly segment.	• Increased tributary degradation in areas of concentrated dredging in the Kansas City, Jefferson City, and St. Charles segments; no change in other segments.
Infrastructure					
Water intake facilities and water supply wells	• Increased maintenance and utility rate costs and increased risk of long-term shutdown of intake structures in all segments except Waverly. • Potential decreases in flow rate capacity and filtration effectiveness in the St. Joseph and Kansas City segments.	• No impacts.	• Little to no adverse impact on existing water intake facilities. • No noticeable adverse effect on water supply wells.	• Increased maintenance and utility rate costs and increased risk of long-term shutdown of intake structures in all segments except Waverly. • Potential decreases in flow rate capacity and filtration effectiveness in the St. Joseph and Kansas City segments.	• Increased maintenance and utility rate costs and increased risk of long-term shutdown of intake structures in Kansas City, Jefferson City, and St. Charles segments. • Potential decreases in flow rate capacity and filtration effectiveness in the St. Joseph and Kansas City segments.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Infrastructure (continued)					
Levees and Bank Stabilization and Navigation Project (BSNP) structures	• Increased risk of levee and BSNP structure failure in all segments except Waverly.	• Decreased risk of levee and BSNP structure failure.	• Decreased risk of levee and BSNP structure failure except in the Jefferson City segment, where risk would be unchanged.	• Increased risk of levee and BSNP structure failure in all segments except Waverly.	• Increased risk of levee and BSNP structure failure in the Kansas City, Jefferson City, and St. Charles segments.
Bridge, pipeline, and cable crossings; boat ramps	• Increased risk of structural damage to bridge, pipeline, and cable crossings in the Kansas City segment. • Increased risk of damage to four boat ramps.	• Decreased risk of structural damage to bridge, pipeline, and cable crossings.	• Decreased risk of structural damage to bridge, pipeline, and cable crossings. • No effect or decreased risk to boat ramps.	• No effect on bridge, pipeline, and cable crossings. • Potential increased risk of damage to two boat ramps; no effect in the Waverly segment.	• No effect on bridge, pipeline, or cable crossings. • Potential increased risk of damage to two boat ramps.
Navigation and Transportation					
Changes in number of tugs/barges and navigation risk	• Increase in dredging vessels and navigation traffic in all segments. • Increased potential for previously submerged objects to become exposed and to become a navigation hazard in all segments.	• Elimination of dredging vessels and associated navigation traffic and any obstacle they pose to other navigation (all segments).	• Slight increase in dredging vessels and navigation traffic in the St. Joseph segment; decrease in traffic in all other segments.	• Increase in dredging vessels and navigation traffic in the St. Joseph and Waverly segments; decrease in traffic in all other segments.	• No change in dredging vessels or navigation traffic in all segments. • Increased potential for previously submerged objects to become exposed and to become a navigation hazard in most segments.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Navigation and Transportation (continued)					
Changes in number of tugs/barges and navigation risk (continued)		• Decreased potential for previously submerged objects to become exposed and become a navigation hazard in the St. Joseph and Kansas City segments; no change or negligible change in hazard potential in the Waverly, Jefferson City, and St. Charles segments.	• Slight degradation in the long term in the St. Joseph, Waverly, Jefferson City, and St. Charles segments, resulting in exposure of previously submerged objects or clay/rock outcroppings; no increase in the potential for previously submerged objects to become exposed and become a navigation hazard in the Kansas City segment.	• Moderate increased potential for previously submerged objects to become exposed and to become a navigation hazard in the long term in the St. Joseph, Kansas City, Jefferson City, and St. Charles segments; negligible increased potential for hazards in the Waverly segment.	
Changes in highway truck traffic	• Substantial increase in haul truck traffic; most pronounced in the St. Joseph and St. Charles segments, potentially resulting in congestion and traffic delays.	• Elimination of haul truck traffic associated with dredging in all segments; minimal increased truck traffic due to alternate sources.	• Decrease in haul truck traffic in all segments except near new sand plants in the Kansas City and St. Charles segments; minimal increased truck traffic near alternate sources.	• Decrease in haul truck traffic in all segments except the St. Joseph and Waverly segments; increase in trucks near new sand plants (Kansas City and St. Charles segments); minimal increased truck traffic near alternate sources.	• No change in haul truck traffic in any segment, other than increase in trucks near new sand plants (Kansas City and St. Charles segments).

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Water Resources					
Surface water suspended sediment and contaminants	• Substantial increase in localized, short-term suspended sediment plumes and increased suspended sediment delivered to the LOMR via tributaries; temporarily increased erosion from sand plant construction. • Increase in contaminated sediment disturbance; increased risk of vessel collision or inadvertent contaminant release.	• Reduction in localized, short-term suspended sediment plumes; reduced suspended sediment delivered to the LOMR via tributaries.	• Reduction in localized, short-term suspended sediment plumes and reduced suspended sediment delivered to the LOMR via tributaries; temporarily increased erosion from sand plant construction. • Considerable reduction in contaminated sediment disturbance; decreased risk of vessel collision or inadvertent contaminant release.	• Reduction in localized, short-term suspended sediment plumes and reduced suspended sediment delivered to the LOMR via tributaries; temporarily increased erosion from sand plant construction. • Considerable reduction in contaminated sediment disturbance; decreased risk of vessel collision or inadvertent contaminant releases.	• No additional direct impacts in localized, short-term suspended sediment plumes; continued levels of suspended sediment delivered to the LOMR via tributaries. • No change in contaminated sediment disturbance; no change in risk of vessel collision or inadvertent contaminant release.
Groundwater alluvial aquifer levels and interactions	• Substantial increase in localized, short-term changes in river bed hydraulic conductivity; decrease in alluvial groundwater levels where river bed degradation lowers LOMR stage over prolonged periods.	• No short-term changes in river bed hydraulic conductivity; increase in or stabilization of groundwater levels during low-flow periods. • Potential impacts from construction of new alternate sources.	• Reduction in localized, short-term changes in river bed hydraulic conductivity; increase in or stabilization of groundwater levels during low-flow periods. • Potential impacts from construction of new alternate sources.	• Reduction in localized, short-term changes in river bed hydraulic conductivity; increase in or stabilization of groundwater levels during low-flow periods. • Potential impacts from construction of new alternate sources.	• Continuation of direct impacts of localized, short-term changes in river bed hydraulic conductivity; decrease in alluvial groundwater levels where river bed degradation lowers LOMR stage over prolonged periods.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Aquatic Resources					
Aquatic habitat connectivity and availability	• Potential alteration of shallow-water habitat and connectivity in those segments most affected by river bed degradation, removal of sediment load, and decreased low-flow surface water elevation.	• Increase in or stabilization of shallow-water habitat in the mainstem. • Potential degradation of aquatic habitat from contaminated runoff and stream geomorphology changes from the use of open-pit and instream mining.	• Increase in or stabilization of shallow-water habitat in the mainstem in most areas. • Potential degradation of aquatic habitat from contaminated runoff and stream geomorphology changes from the use of open-pit and instream mining.	• Potential alteration of shallow-water habitat and connectivity in those segments most affected by river bed degradation, removal of sediment load, and decreased low-flow surface water elevation. • Potential degradation of aquatic habitat from contaminated runoff and stream geomorphology changes from the use of open-pit and instream mining.	• Potential alteration of shallow-water habitat and connectivity in those segments most affected by river bed degradation, removal of sediment load, and decreased low-flow surface water elevations.
Impacts to individuals (entrainment, elevated noise, and elevated turbidity)	• Substantial increase, compared to recent levels of dredging, in the rate of entrainment, noise disturbance, and elevated suspended sediment.	• No entrainment, noise disturbance, or elevated suspended sediment caused by dredging. • Potential reduction in reproductive success, behavioral changes, or mortality through the introduction of contaminants and aquatic habitat alterations from alternate sources.	• Substantial decrease, compared to recent levels of dredging, in entrainment, noise disturbance, and elevated suspended sediment caused by dredging. • Potential reduction in reproductive success, behavioral changes, or mortality through the introduction of contaminants and aquatic habitat alterations from alternate sources.	• Decrease, compared to recent levels of dredging, in entrainment, noise disturbance, and elevated suspended sediment caused by dredging. • Potential reduction in reproductive success, behavioral changes, or mortality through the introduction of contaminants and aquatic habitat alterations from alternate sources.	• Entrainment, noise disturbance, and elevated suspended sediment rates similar to recent levels of dredging.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Wetlands, Floodplains, and Terrestrial Ecology					
Groundwater-dependent wetlands and wildlife in floodplain	• Short-term and long-term loss of wetland acreage, altered composition of vegetation, and altered wetland habitat functions during periods of low flow in those segments most affected by river bed degradation.	• Increase in or stabilization of LOMR wetland habitats during low-flow periods in all segments. • Potential decrease in groundwater input to wetlands due to potential river bed degradation in Kansas and Mississippi Rivers.	• Increase in or stabilization of LOMR wetland habitats during low-flow periods in most segments. • Potential decrease in groundwater input to wetlands due to potential river bed degradation in Kansas and Mississippi Rivers.	• Short-term and long-term loss of wetland acreage, altered composition of vegetation, and altered wetland habitat functions during periods of low flow in those segments most affected by river bed degradation. • Potential decrease in groundwater input to wetlands due to potential river bed degradation in Kansas and Mississippi Rivers.	• Short-term and long-term loss of wetland acreage, altered composition of vegetation, and altered wetland habitat functions during periods of low flow in those segments most affected by river bed degradation.
Fill or conversion of terrestrial habitat	• Displacement of mobile species and loss of non-mobile wildlife and vegetation species from clearing.	• Conversion of wildlife habitat and vegetative land cover to industrial land covers at alternate sources.	• Displacement of mobile species and loss of non-mobile wildlife and vegetation species from clearing. • Conversion of wildlife habitat and vegetative land cover to industrial land covers at alternate sources.	• Displacement of mobile species and loss of non-mobile wildlife and vegetation species from clearing • Conversion of wildlife habitat and vegetative land cover to industrial land covers at alternate sources.	• Displacement of mobile species and loss of non-mobile wildlife and vegetation species from clearing.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Federally Listed Species					
Pallid sturgeon	• Localized increase in cover habitat; potential entrainment; potential alteration of shallow-water habitat and connectivity in segments most affected by river bed degradation, removal of sediment load, and decreased low-flow surface water elevation.	• No additional cover habitat from suspended sediment; no potential for entrainment; increase in or stabilization of shallow-water habitat in the mainstem. • Potential entrainment and habitat alteration in Kansas and Mississippi Rivers.	• Localized minor cover habitat from suspended sediment; potential entrainment; increase in or stabilization of shallow-water habitat in the mainstem in most areas. • Potential entrainment and habitat alteration in Kansas and Mississippi Rivers.	• Localized minor cover habitat from suspended sediment; potential entrainment, if pallid sturgeon are present in the dredge suction field; potential alteration of shallow-water habitat and connectivity in those segments most affected by river bed degradation, removal of sediment load, and decreased low-flow surface water elevation. • Potential entrainment and habitat alteration in Kansas and Mississippi Rivers.	• Localized minor cover habitat from suspended sediment; potential entrainment, if pallid sturgeon are present in the dredge suction field; potential alteration of shallow-water habitat and connectivity in those segments most affected by river bed degradation, removal of sediment load, and decreased low-flow surface water elevations.
Piping plover and interior least tern	• No impact.	• Loss of sand bar habitat where associated with floodplains of alternate sources; increase in low-quality nesting habitat at floodplain open-pit mines.	• Increased loss of sand bar habitat in floodplains of alternate sources; minor increase in low-quality nesting habitat at floodplain open-pit mines.	• Increased loss of sand bar habitat in floodplains of alternate sources; minor increase in low-quality nesting habitat at floodplain open-pit mines.	• No impact.
Indiana bat	• Potential roosting habitat cleared for sand plant construction.	• Increased loss of riparian habitat in floodplains of alternate sources.	• Potential roosting habitat cleared for sand plant construction; increased loss of riparian habitat in floodplains of alternate sources.	• Potential roosting habitat cleared for sand plant construction; increased loss of riparian habitat in floodplains of alternate sources.	• Potential roosting habitat cleared for sand plant construction.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Federally Listed Species (continued)					
Decurrent false aster	• Potential clearing of habitat and individuals for sand plant construction.	• Potential loss of riparian and wetland habitat in floodplains of alternate sources.	• Potential clearing of habitat and individuals for sand plant construction; increased potential for loss of riparian and wetland habitat in floodplains of alternate sources.	• Potential clearing of habitat and individuals for sand plant construction; increased potential for loss of riparian and wetland habitat in floodplains of alternate sources.	• Potential clearing of habitat and individuals for sand plant construction.
Land Use and Recreation					
Existing or planned land uses	• Zoning conflict and reduction in prime farmland in the Kansas City segment.	• Reduction in prime farmland and potential zoning conflicts at alternate sources.	• Zoning conflict and reduction in prime farmland in the Kansas City segment. • Reduction in prime farmland and potential zoning conflicts at alternate sources.	• Zoning conflict and reduction in prime farmland in the Kansas City segment. • Reduction in prime farmland and potential zoning conflicts at alternate sources.	• Zoning conflict and reduction in prime farmland in the Kansas City segment.
Recreational boating/access to boat ramps and land-based trails/fishing	• Increased boat/tug/ barge interference; decreased access to boat ramps in the St. Joseph, Kansas City, Jefferson City, and St. Charles segments; decreased trail access during flood events; decrease in fishing opportunities.	• Benefit related to fewer tugs/barges and increased boat ramp access; most pronounced in the Kansas City segment.	• Increased boat/tug/ barge interference in the St. Joseph segment; no change in access to boat ramps.	• Increased boat/tug/ barge interference in the St. Joseph and Waverly segments; decreased boat ramp access in the St. Joseph, Kansas City, Jefferson City, and St. Charles segments.	• No change in boat/tug/ barge interference; disruptions to boat ramp access in the Kansas City, Jefferson City, and St. Charles segments.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Land Use and Recreation (continued)					
Recreational boating/access to boat ramps and land-based trails/fishing (continued)		• Decreased trail access during flood events in the Jefferson City and St. Charles segments; no change or slight increase in fishing opportunities. • Potential decreased access, boat interference, and decreased fishing at alternate sources.	• Decreased trail access during flood events in the Jefferson City and St. Charles segments; decrease in fishing opportunities. • Potential decreased access, boat interference, and decreased fishing at alternate sources.	• Decreased trail access during flood events in the Jefferson City and St. Charles segments; decrease in fishing opportunities. • Potential decreased access, boat interference, and decreased fishing at alternate sources.	• Decreased trail access during flood events in the Jefferson City and St. Charles segments; decrease in fishing opportunities due only to sand plant construction.
Wetlands-related recreational opportunities	• Decrease in all segments except the Waverly segment.	• Decrease at alternate sources, including potential open-pit mine developments in the river floodplain.	• Decrease at alternate sources, including potential open-pit mine developments in the river floodplain.	• Decrease in the St. Joseph, Kansas City, and St. Charles segments. • Decrease at alternate sources, including potential open-pit mine developments in the river floodplain.	• Decrease in the Kansas City, Jefferson City, and St. Charles segments.
Economics and Demographics					
Regional economic effects (change in annual value of sand/gravel production, transportation/ consumer costs)	• Decrease of approximately $2 million (-2%).	• Decrease of approximately $110 million (-133%).	• Decrease of approximately $51 million (-62%).	• Decrease of approximately $14 million (-17%).	• Increase of approximately $1 million (1%).
Regional change in sector annual employment (jobs)	• -8 (-1%).	• -921 (-166%).	• -414 (-74%).	• -98 (-18%).	• +10 (+2%).

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Economics and Demographics (continued)					
Statewide economic effects (change in annual value of sand/gravel production, transportation/ consumer costs)	• Decrease of approximately $1 million (-1%).	• Increase of approximately $42 million (50%).	• Increase of approximately $10 million (12%).	• Decrease of approximately $9 million (-11%).	• Increase of approximately $1 million (1%).
Statewide change in sector annual employment (jobs)	• -4 (1%).	• +395 (+70%).	• +112 (+20%).	• -55 (-10%).	• +11 (+2%).
Economic effects of river bed degradation on infrastructure	• Potential for continued costs related to river bed degradation and changes in water surface elevations; higher risk of levee failure and related costs in all segments.	• Potential decrease in costs related to river bed degradation and changes in water surface elevations; substantial decrease in the likelihood of levee failure.	• Potential decrease in costs related to river bed degradation and changes in water surface elevations; higher risk of levee failure and related costs in the St. Joseph segment.	• Potential decrease in costs related to river bed degradation and changes in water surface elevations; higher risk of levee failure and related costs in the St. Joseph and Waverly segments.	• Potential for continued costs related to river bed degradation and changes in water surface elevations; no change to risk of levee failure.
Noise					
Noise related to construction of new facilities	• Short-term exposure of noise-sensitive land uses to noise from construction of the Edward N. Rau Contractor facility.	• Potential exposure of noise-sensitive land uses to noise from construction of new alternate source facilities in the long term.	• Short-term exposure of noise-sensitive land uses to noise from construction of the Edward N. Rau Contractor facility; potential exposure of noise-sensitive land uses to noise from construction of new alternate source facilities in the long term.	• Short-term exposure of noise-sensitive land uses to noise from construction of the Edward N. Rau Contractor facility; potential exposure of noise-sensitive land uses to noise from construction of new alternate source facilities in the long term.	• Short-term exposure of noise-sensitive land uses to noise from construction of the Edward N. Rau Contractor facility.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Noise (continued)					
Noise from dredging and processing	• Long-term exposure of noise-sensitive land uses to noise from increased dredging (all segments) and processing (St. Joseph, Jefferson City, and St. Charles segments).	• Decreased noise levels near segments • Potential exposure of noise-sensitive land uses to noise from expanded or new dredging or processing at alternate sources.	• Long-term exposure of noise-sensitive land uses to noise from slightly increased dredging (St. Joseph segment) and increased processing (Jefferson City and St. Charles segments) • Potential exposure of noise-sensitive land uses to noise from expanded or new dredging or processing at alternate sources.	• Long-term exposure of noise-sensitive land uses to noise from increased dredging (St. Joseph and Waverly segments) and increased processing (St. Joseph, Jefferson City, and St. Charles segments) • Potential exposure of noise-sensitive land uses to noise from expanded or new dredging or processing at alternate sources.	• Continued long-term exposure of noise-sensitive land uses to dredging noise; long-term exposure of noise-sensitive land uses to noise from processing (Jefferson City and St. Charles segments).
Visual and Aesthetic Resources					
Visual impacts and changes to scenic vistas and routes, visual character, or visual quality	• Change in views from construction activity (short term), presence of new facilities in the Kansas City and St. Charles segments (long term), and increase in barges/tugs (most pronounced in the St. Joseph and St. Charles segments).	• Improvement of views from less industrial activity and fewer tugs/barges; possible introduction into viewshed of vacant sites and abandoned equipment.	• Change in views from construction activity (short term), presence of new facilities in the Kansas City and St. Charles segments (long term), and slight increase in barges/ tugs in the St. Joseph segment.	• Change in views from construction activity (short term), presence of new facilities in the Kansas City and St. Charles segments (long term), and increase in barges/tugs in the St. Joseph and Waverly segments.	• Change in views from construction activity (short term) and presence of new facilities in the Kansas City and St. Charles segments (long term).

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Visual and Aesthetic Resources (continued)					
Visual impacts and changes to scenic vistas and routes, visual character, or visual quality (continued)	• Boater recreation-related river views decreased as a result of reduced boat ramp access (all segments except the Waverly segment).	• Views of trucks, equipment, and new plants in the long term at alternate sources.	• Views of trucks, equipment, and new plants in the long term at alternate sources.	• Views of trucks, equipment, and new plants in long term at alternate sources. • Boater recreation-related river views decreased as a result of reduced boat ramp access (all segments except the Waverly segment).	• Boater recreation-related river views decreased as a result of reduced boat ramp access (Kansas City, Jefferson City, and St. Charles segments).
Changes in light or glare	• Increase in light and glare from additional barges/tugs (most pronounced for the St. Joseph and St. Charles segments) and from removal of vegetation and operation of new facilities in the Kansas City and St. Charles segments.	• Less light and glare because fewer barges/ tugs would be present. • Increased light and glare at new alternate source facilities in the long term.	• Increase in light and glare from additional barges/tugs (St. Joseph segment) and from removal of vegetation and operation of new facilities in the Kansas City and St. Charles segments. • Increased light and glare at new alternate source facilities in the long term.	• Increase in light and glare from additional barges/tugs (St. Joseph and Waverly segments) and from removal of vegetation and operation of new facilities in the Kansas City and St. Charles segments. • Increased light and glare at new alternate source facilities in the long term.	• Increase in light and glare from additional barges/tugs (Kansas City and St. Charles segments) and from removal of vegetation and operation of new facilities in the Kansas City and St. Charles segments.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Cultural Resources					
Direct effects related to damage to property resulting from dredging	• Potential direct effects if dredging occurs outside historically dredged areas.	• Potential direct effects from sand plant construction, dredging in the Mississippi or Kansas Rivers, and expanded dredging operations at floodplain open-pit mines or other upland alternate sources.	• Potential direct effects if dredging occurs outside historically dredging areas or if dredging exclusion zones are not maintained.	• Potential direct effects if dredging occurs outside historically dredging areas or if dredging exclusion zones are not maintained.	• Potential direct effects if dredging occurs outside historically dredging areas or if dredging exclusion zones are not maintained.
Indirect effects related to damage from river bed degradation, headcutting, erosion, and scouring of the river bed near bridge abutments	• Potential indirect effects to five documented cultural resources along tributaries as a result of headcutting and erosion. • Potential indirect effects to undocumented sites along perennial tributaries in areas of concentrated dredging.	• No indirect effects to resources located in the LOMR or along tributaries to the LOMR.	• No indirect effects to documented or undocumented cultural resources along tributaries.	• Potential indirect effects to five documented cultural resources along tributaries as a result of headcutting and erosion. • Potential indirect effects to undocumented sites along perennial tributaries in areas of concentrated dredging.	• Potential indirect effects to five documented cultural resources along tributaries as a result of headcutting and erosion. • Potential indirect effects to undocumented sites along perennial tributaries in areas of concentrated dredging.
Indirect effects related to cultural resource damage from sand plants and expansion of dredging to new locations beyond the Missouri River)	• Potential indirect effects to two documented cultural resources and potentially present undocumented resources at proposed sand plant locations.	• Potential indirect effects to two documented cultural resources and potentially present undocumented resources at proposed sand plant locations.	• Potential indirect effects to two documented cultural resources and potentially present undocumented resources at proposed sand plant locations.	• Potential indirect effects to two documented cultural resources and potentially present undocumented resources at proposed sand plant locations.	• Potential indirect effects to two documented cultural resources and potentially present undocumented resources at proposed sand plant locations.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Cultural Resources (continued)					
Indirect effects related to cultural resource damage from sand plants and expansion of dredging to new locations beyond the Missouri River) (continued)		• Potential indirect effects due to dredging in the Mississippi or Kansas Rivers, or from sand plant construction or expanded dredging operations at floodplain open-pit mines or other upland alternate sources.	• Potential indirect effects due to dredging in the Mississippi or Kansas Rivers, or from sand plant construction or expanded dredging operations at floodplain open-pit mines or other upland alternate sources.	• Potential indirect effects due to dredging in the Mississippi or Kansas Rivers, or from sand plant construction or expanded dredging operations at floodplain open-pit mines or other upland alternate sources.	
Air Quality and Climate Change					
Construction emissions	• Minimal direct temporary emissions of volatile organic compounds (VOC), nitrogen oxides (NOX), carbon monoxide (CO), and particulate matter (PM) in the Kansas City and St. Charles segments from construction of new sand and gravel facilities.	• Direct temporary emissions of VOC, NOX, CO, and PM in alternate source locations requiring construction or expansion of sand and gravel facilities.	• Minimal direct temporary emissions of VOC, NOX, CO, and PM in the Kansas City and St. Charles segments from construction of new sand and gravel facilities. • Direct temporary emissions of VOC, NOX, CO, and PM in alternate source locations requiring construction or expansion of sand and gravel facilities.	• Minimal direct temporary emissions of VOC, NOX, CO, and PM in the Kansas City and St. Charles segments from construction of new sand and gravel facilities. • Direct temporary emissions of VOC, NOX, CO, and PM in alternate source locations requiring construction or expansion of sand and gravel facilities.	• Minimal direct temporary emissions of VOC, NOX, CO, and PM in the Kansas City and St. Charles segments from construction of new sand and gravel facilities.

Table 2.6-1 Summary of Impacts of the Proposed Action and Alternatives

Category of Impact	Proposed Action	No Action Alternative	Alternative A	Alternative B	Alternative C
Air Quality and Climate Change (continued)					
Conformity	• Long-term direct emissions of NOX in St. Louis County in excess of federal de minimis thresholds.	• Potential long-term direct emissions of NOX in alternates source locations in excess of federal de minimis thresholds.	• Potential long-term direct emissions of NOX in alternate source locations in excess of federal de minimis thresholds.	• Potential long-term direct emissions of NOX in alternates source locations in excess of federal de minimis thresholds.	• No effect.
Diesel particulate matter (DPM)	• Negligible long-term indirect exposure of existing and new sensitive receptors to DPM from increased dredging.	• Potentially adverse long-term indirect exposure of existing and new sensitive receptors to DPM from increased dredging at alternate sources.	• Negligible long-term indirect exposure of existing and new sensitive receptors to DPM from increased dredging in the St. Joseph and Waverly segments. • Potentially adverse long-term indirect exposure of existing and new sensitive receptors to DPM from increased dredging at alternate sources.	• Negligible long-term indirect exposure of existing and new sensitive receptors to DPM from increased dredging in the St. Joseph and Waverly segments. • Potentially adverse long-term indirect exposure of existing and new sensitive receptors to DPM from increased dredging at alternate sources.	• No effect.
Greenhouse gas (GHG) emissions	• High long-term direct GHG emissions from dredging of the LOMR. • Temporary direct GHG emissions from construction activities.	• Minimal long-term direct GHG emissions from dredging of alternate sources. • Temporary direct GHG emissions from construction activities.	• Moderate long-term direct GHG emissions from dredging of the LOMR and alternate sources. • Temporary direct GHG emissions from construction activities.	• Moderate long-term direct GHG emissions from dredging of the LOMR and alternate sources. • Temporary direct GHG emissions from construction activities.	• Low long-term direct GHG emissions from dredging of the LOMR. • Temporary direct GHG emissions from construction activities.

2.6.2.1 Summary of Impacts for the Proposed Action

The Proposed Action includes dredging at approximately twice recent levels (2004–2008 annual average) and more than twice the levels for any other alternative. Table 2.6-2 compares recent dredging with levels under the Proposed Action.

Table 2.6-2 Comparison of Dredging under the Proposed Action to 2004–2008 Annual Average Dredging by River Segment (tons/year)

Segment	Annual Average (2004–2008)	Proposed Action	Change
St. Joseph	326,928	1,150,000	350% increase
Kansas City	2,658,831	4,060,000	150% increase
Waverly	667,987	1,005,600	150% increase
Jefferson City	1,578,858	2,750,000	175% increase
St. Charles	1,649,326	4,384,400	270% increase
Total dredging[a]	6,891,930	13,350,000	

[a] Sum of Dredgers request by segment – the total amount authorized would be limited to approximately 11.6 million tons per year.

The geomorphology analysis found that the segments with the greatest potential for continued degradation are the Kansas City, Jefferson City, and St. Charles segments. Proposed dredging in all three segments is substantially higher (from 150 to 270 percent) than recent levels. Environmental resources that are directly affected by dredging activities or by dredging-related river bed degradation and changes in water surface elevations showed the greatest increase in impact or risk of impact under the Proposed Action.

The primary impacts that are expected to occur under the Proposed Action include the following.

Geology and Geomorphology – Coupled with a localized decrease in sediment availability at dredging locations, dredging under the Proposed Action is expected to cause moderate to substantial long-term river bed degradation in all but the Waverly segment, slight to moderate decreases in low-flow water surface elevations in the Jefferson City segment, and moderate to substantial decreases in low-flow water surface elevations in all other segments except the Waverly segment. Increases in water surface elevations at high flows are expected to occur in all segments except the Waverly segment. The

Proposed Action may lead to increased river bed degradation and headcutting in tributaries adjacent to areas of concentrated dredging.

Infrastructure – Increases in maintenance costs and related utility rates for operation of water intake structures and water supply well are likely to occur in all but the Waverly segments. The risk of failure of levee and BSNP structures also would be increased in all segments except the Waverly segment. The risk of structural damage to bridge, pipeline, and cable crossings would be increased in the Kansas City segment.

Navigation and Transportation – Under the Proposed Action, barge traffic would increase on the river in areas where dredging activity occurs, with related increased risks to navigation.

Water Resources – Under the Proposed Action, suspended sediment in the water column would increase at dredging sites, with an accompanying minor increase in the risk of surface water contaminants.

Aquatic Resources – The Proposed Action would result in increased entrainment and fish noise avoidance behavior at dredge sites, and a moderate decrease in habitat connectivity and loss of available shallow-water habitat in the segments with the most river bed degradation.

Wetlands, Floodplains, and Terrestrial Ecology – The Proposed Action would result in some long-term conversion of groundwater-dependent wetlands in the segments with the most river bed degradation; the loss of riparian and wetland habitats would mirror river bed elevation changes and associated groundwater and wetland impacts.

Federally Listed Species – For the pallid sturgeon, the Proposed Action would result in increased entrainment in dredge intakes, decreased habitat connectivity in degraded reaches, and a minor local improvement in habitat conditions. Impacts on the other federally listed species in the Project area with the potential to be affected by dredging would be negligible.

Land Use and Recreation – The increase in dredges and barges under the Proposed Action would result in an increased conflict with recreational boaters. A minor increase in the risk of washout of land-based recreation trails during high-flow events would take place in Jefferson City, but no change or a decreased risk would be experienced in the other segments.

Economics and Demographics – Under the Proposed Action, economic output, labor income, and employment would change little from existing conditions.

Noise – The Proposed Action would result in an increase in long-term noise exposure at residences and businesses near the river dredging locations and sand plants.

Visual and Aesthetic Resources – The increased number of barges visible on the river under the Proposed Action would increase the visual intrusion of dredging activities on the visual landscape. There would be a minor increase in vessel glare.

Cultural Resources – The Proposed Action would increase the potential for exposure of unidentified cultural sites in areas with river bed degradation or erosion.

Air Quality and Climate Change – Long-term direct emissions of NO_X would cause St. Louis County to exceed the federal *de minimis* NO_X threshold. Long-term exposure to diesel particulate matter (DPM) would be negligible. Long-term greenhouse gas (GHG) emissions would substantially increase under the Proposed Action.

Impacts to all the environmental resources described above would result from localized effects of the dredging activity (both the presence and the operation of the dredging equipment) or indirect impacts associated with dredging-related river bed degradation or changes in surface water elevations. To the extent that dredging would be more widely distributed throughout each segment, the localized impacts of dredging would be reduced, as would be the risk for increased river bed degradation and changes to water surface elevations. The impacts that may be reduced by broader distribution of dredging locations include those associated with infrastructure, water resources, navigation and transportation, and some impacts to federally listed species.

2.6.2.2 Summary of Impacts for the No Action Alternative

Under the No Action Alternative, all commercial dredging of sand and gravel on the LOMR would cease (Table 2.4-1). It is expected that ongoing demand for these commodities would then be supplied from currently operating or newly established alternate sources. Although dredging-related effects in the LOMR would be reduced or eliminated under the No Action Alternative, increased production at existing alternate sources of sand and gravel in the short term and potential development of new sources in the long term would increase ongoing impacts or result in new impacts at the alternate source locations. Facilities that would increase production to offset the loss of sand and gravel from the LOMR would do so in response to market conditions (i.e., price), availability of reserves to be mined, and transportation costs. Because decisions to increase production are made individually by facility owners, the facilities that would provide offsetting sand and gravel supplies cannot be specifically identified, nor can the

impacts associated with specific facilities be defined. However, generic impacts based on the type of production are known. Increased production at existing alternate sources may deplete these reserves more quickly, forcing development of new sources (open-pit mines in the floodplain or additional instream mines). Based on the information available, it is estimated that existing alternate sources may have sufficient reserves to be able to increase production in the short term (up to approximately 5 years) in order to offset lost production from the LOMR. In the long term, however, existing alternate sources are expected to be sufficiently depleted or reduced in capacity to require development of new alternate sources of supply in order to meet the regional demand for sand and gravel.

The primary impacts that are expected to occur under the No Action Alternative include the following.

Geology and Geomorphology – Under the No Action Alternative, the current trend of river bed degradation and its associated effects of lower water surface elevations during low-flow conditions and increased water surface elevations during higher flow would be expected to slow and possibly reverse in those portions of the LOMR experiencing substantial river bed degradation (principally, the Kansas City, Jefferson City, and St. Charles areas). The absence of dredging is expected to result in slight to moderate aggradation in the St. Joseph, Jefferson City, and St. Charles segments. Moderate to substantial aggradation is likely to occur in the Kansas City segment.

Infrastructure – The risk of failure or damage to infrastructure facilities would decrease under the No Action Alternative.

Land Use and Recreation/Aquatic Resources/Wetlands, Floodplains, and Terrestrial Ecology/Federally Listed Species –To the extent that new alternate sources of sand and gravel are developed in the long term to offset losses of production for the LOMR, a potential reduction in prime farmland, habitat, or wetlands could occur from conversion of these lands to sand and gravel mining operations under the No Action Alternative.

Economics and Demographics – Economic changes of the greatest magnitude would occur under the No Action Alternative. Economic output would be reduced by approximately 133 percent, labor income by approximately 43 percent, and employment by approximately 166 percent in the primary sand and gravel market served by the LOMR. On a statewide basis, however, offsetting gains in economic output, income, and employment are projected to occur by shifting of employment to the transportation sector (trucking). Consequently, a net statewide increase in economic activity would occur under the No Action Alternative.

Noise/Visual and Aesthetic Resources – Dredging-related noise and visual impacts to residents adjacent to areas along the river where dredging operations had previously occurred would be eliminated under the No Action Alternative. Increases in noise and related visual impacts would be expected to occur at existing alternate sources that increase production or in areas adjacent to any new facilities that are developed.

Air Quality and Climate Change – Under the No Action Alternative, changes in air quality would result from increased air emissions from highway transportation of sand and gravel from alternate sources and increased potential fugitive dust emissions from increased production at alternate sources.

2.6.2.3 Summary of Impacts for Alternative A

Dredging under Alternative A would be reduced by approximately 60 percent from the 2004–2008 annual average level (Table 2.4-1); consequently, river bed degradation and all of the associated direct and indirect impacts on environmental resources affected by dredging would be reduced.

The primary impacts that are expected to occur under Alternative A include the following.

Geology and Geomorphology – With continued dredging, a potential slight increase in river bed degradation is possible in all segments under Alternative A, except the Waverly segment. Associated with this potential increase in river bed degradation is the potential for a slight decrease in low-flow water surface levels in all segments, except the St. Charles segment; and the potential for a slight increase in high-flow water surface levels in the Kansas City, Jefferson City, and St. Charles segments.

Infrastructure – Little to no effect and decreased risk to all infrastructure facilities are associated with Alternative A.

Navigation and Transportation – Although overall river traffic would decrease under Alternative A, there would be a minor increased risk of navigation hazards during low-flow conditions in areas of existing river bed degradation, principally in the Kansas City, Jefferson City, and St. Charles segments.

Water Resources – Alternative A would result in minor improvements in water quality and stabilization of alluvial aquifer levels.

Aquatic Resources/Wetlands, Floodplains, and Terrestrial Ecology/Federally Listed Species – Under Alternative A, the availability and connectivity of habitat generally would not change or could increase.

Land Use and Recreation/Visual and Aesthetic Resources/Noise/Air Quality and Climate Change – Under Alternative A, the increased utilization of existing open-pit mining operations and truck transportation to supply sand and gravel to make up for lost production from the LOMR would result in increased air and noise emissions. Longer term development of new alternate sources could involve conflicts with adjacent land uses and impacts to visual resources.

Economics and Demographics – Under Alternative A, economic output would be reduced by approximately 62 percent, labor income by approximately 57 percent, and employment by approximately 74 percent in the primary sand and gravel market area served by the LOMR. On a statewide basis, however, offsetting gains in economic output, income, and employment are projected to occur because of shifting of employment to the transportation sector (trucking). Consequently, a net statewide increase in economic activity would occur under Alternative A.

The dredging-related effects to other resources analyzed are expected to continue with no change, or changes are expected to be negligible under Alternative A.

2.6.2.4 Summary of Impacts for Alternative B

Under Alternative B, dredging would be approximately 30 percent less than the 2004–2008 annual average (Table 2.4-1). Dredging-related effects to environmental resources would be reduced under Alternative B compared to existing levels, but not as much as under Alternative A.

The primary impacts that are expected to occur under Alternative B include the following.

Geology and Geomorphology – Under Alternative B, slight to moderate river bed degradation is possible in all segments except the Waverly segment, where slight degradation may occur. Alternative B would result in a slight to moderate decrease in water surface levels under low-flow conditions in the Jefferson City and St. Charles segments, and a slight to moderate decrease in the St. Joseph and Kansas City segments. All segments are expected to experience a slight increase in water surface elevations at high flows.

Infrastructure –Maintenance costs and related utility rates for operation of water intake structures would increase in all but the Waverly segment. The potential exists for a decrease in water supply well performance in the St. Joseph and Kansas City segments. The risk of failure of levee and BSNP structures also would be increased in all segments except the Waverly segment. The risk of structural damage to bridge, pipeline, and cable crossings would be increased in the Kansas City segment.

Navigation and Transportation – Despite a decrease in overall river traffic under Alternative B, there would be a minor increased risk of navigation hazards during low-flow conditions in areas of existing river bed degradation, principally in the Kansas City, Jefferson City, and St. Charles segments.

Water Resources – Alternative B would result in minor improvements in water quality and lessening of the effects of river bed degradation on alluvial aquifer levels.

Aquatic Resources/Wetlands, Floodplains, and Terrestrial Ecology/Federally Listed Species – Potential loss of wetland acreage during periods of low flow in some segments. Minor improvements in shallow-water habitat and habitat connectivity would result under Alternative B, potentially improving conditions for the pallid sturgeon.

Land Use and Recreation/Visual and Aesthetic Resources/Noise/Air Quality and Climate Change – Under Alternative B, increased utilization of existing open-pit mining operations and truck transportation to supply sand and gravel to make up for lost production from the LOMR would result in increased air and noise emissions. Longer term development of new alternate sources could involve conflicts with adjacent land uses and impacts to visual resources.

Economics and Demographics – Under Alternative B, economic output would be reduced by approximately 17 percent, labor income by approximately 20 percent, and employment by approximately 18 percent in the primary sand and gravel market area served by the LOMR. On a statewide basis, however, offsetting gains in economic output, income, and employment are projected to occur by shifting of employment to the transportation sector (trucking). Consequently, a net statewide increase in economic activity would occur under Alternative B.

The dredging-related effects to other resources analyzed are expected to continue with no change, or changes are expected to be negligible under Alternative B.

2.6.2.5 Summary of Impacts for Alternative C

Under Alternative C, dredging would continue at the same level as the 2004–2008 period (Table 2.4-1). Continuation of recent dredging is expected to continue the current level of impacts or impact trends in all resource areas and generally represents no change from the existing condition.

The primary impacts that are expected to occur under Alternative C include the following.

Geology and Geomorphology – Alternative C involves the continued risk of moderate to substantial river bed degradation in the Kansas City, Jefferson City, and St. Charles segments; slight river bed degradation may occur in the St. Joseph segment. A similarly substantial decrease in surface water elevations at low flows and a slight increase in surface water elevations at high flows are expected to occur in the Kansas City, Jefferson City, and St. Charles segments. Tributary degradation may occur near continually degrading portions of the LOMR.

Infrastructure – Maintenance costs and related utility rates for operation of water intake structures would increase in all but the Waverly segment. The potential exists for a decrease in water supply well performance in the St. Joseph and Kansas City segments. The risk of failure of levee and BSNP structures also would be increased in all segments except the Waverly segment. The risk of structural damage to bridge, pipeline, and cable crossings would be increased in the Kansas City segment.

Navigation and Transportation – Alternative C would result in an increased navigation hazard risk in segments where river bed degradation may continue, principally in the Kansas City, Jefferson City, and St. Charles segments.

Water Resources – Alternative C would result in a potential decrease in alluvial groundwater levels in segments with continued river bed degradation, principally in the Kansas City and Jefferson City segments.

Aquatic Resources/ Wetlands, Floodplains, and Terrestrial Ecology/Federally Listed Species – Under Alternative C, some loss of habitat connectivity (aquatic), wetlands, and riparian habitat would occur in areas with river bed degradation, changes in channel cross section, and changes in water surface elevations—principally, in the Kansas City, Jefferson City, and St. Charles segments.

All dredging-related effects to the other resources analyzed are expected to continue with no change, or changes are expected to be negligible under Alternative C.

2.7 ENVIRONMENTALLY PREFERRED ALTERNATIVE

2.7.1 Introduction

The Council on Environmental Quality (CEQ) Guidelines for implementing NEPA require that the lead federal agency must identify all alternatives considered in reaching its decision and specify the alternative(s) that were considered to be environmentally preferable (40 CFR Section 1505.2[b]). The environmentally preferable alternative is the alternative that will promote the national environmental

policy as expressed in NEPA's Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment and that best protects, preserves, and enhances historic, cultural, and natural resources.

2.7.2 Identification of the Environmentally Preferred Alternative

To identify the Environmentally Preferred Alternative, the results of the environmental consequences analysis were reviewed. In particular, the variability of impacts to environmental resources within each segment for each alternative was considered. This review found that, for most resources areas, impacts either did not vary substantially or they varied in direct relationship to geomorphic impacts (primarily changes in surface water levels and river bed degradation). This result is reasonable given that impacts to most resource areas are indirect impacts that arise from the direct effects of dredging on geomorphology. One resource area where the results were not patterned after geomorphology was economics. Economics impacts were primarily driven by increased use of alternate sand and gravel resources to offset reduced dredging. Another exception was infrastructure. Generally, the potential physical effect of dredging on infrastructure is directly related to the changes in surface water levels and river bed degradation, but the amounts and values of infrastructure vary between segments. Consequently, the actual physical and economic effect of dredging on infrastructure varied among segments.

While approval of the Proposed Action is the most economically desirable alternative from the perspective of the dredging and construction industry, it would likely result in continued—and in some cases substantial—river bed degradation, especially in areas where dredging has historically occurred. Natural and human environmental resources directly and indirectly affected by bed degradation would be similarly negatively impacted under the Proposed Action. Conversely, denial of all dredging permit applications, the No Action Alternative, would likely result in negative socioeconomic impacts to communities along the river as a result of short-term and long-term changes to the sand and gravel industry and other industries dependent on them. In addition, impacts under the No Action Alternative would also occur from development of additional alternate sand and gravel sources and increased use of existing land-based mine operations to replace the lost sand source. The exact nature of these secondary impacts cannot be predicted with certainty because the development of those replacement sources would occur over time at locations not yet known.

A range of alternative dredging levels was evaluated – Alternatives A, B, and C – for each segment of the river. Based on information on past bed degradation, current trends in local bed degradation, and human and natural resources potentially affected within each segment, an Environmentally Preferred

Alternative was identified for each river segment that the USACE believes would best protect the biological and physical environment, and would meet the intent of NEPA Section 101. This composite of Alternatives A, B, and C was developed to be responsive to information on the likely impacts to environmental resources from differing levels of dredging for each river segment individually, as presented in Chapters 2, 4, and 5 of the EIS and as summarized in Table 4.2-7.

In developing the Environmentally Preferred Alternative, each river segment was evaluated separately, and the alternative that would allow the largest amount of dredging while minimizing the risk of future bed degradation was selected. In the Draft EIS, it was recognized that the localized impacts of dredging would be reduced, as would be the risk for increased river bed degradation and associated environmental impacts, by more widely distributing dredging activity in each segment. The relationship between localized dredging intensity (i.e., tons per mile/year, tons per river reach/year) and the basis for potential limits on localized dredging intensity are explained in the following section.

Prohibiting the use of cutter-head dredges is discussed in Section 6.2.2 as a potential permit restriction. Two of the currently authorized Dredgers (Holliday Sand & Gravel Company, L.L.C. and Capital Sand Company, Inc.) use six dredges with cutter heads. Removing the cutter heads from these six dredges or replacing the dredges with non-cutter-head dredges would cost the Dredgers a substantial amount. The combination of segment limits, limits on localized dredging intensity, and a monitoring and reevaluation process should limit degradation in each segment to no more than 2 feet in the short term and no more than 4 feet in the long term. Also, because of the reduced segment limit in the Kansas City segment, the Dredger there may not need to dredge as deeply to obtain sufficient sand that meets the required material specifications. The localized dredging intensity limits would have the same effect on dredging operations in the other segments. Because prohibiting the use of cutter-head dredges would be a costly and unnecessary restriction, this condition is not included as part of the Environmentally Preferred Alternative. Limiting the depth of dredging would fulfill the same purpose; this could be more easily and cost effectively accomplished by the Dredgers with the addition of a relatively inexpensive sensor to the existing dredge monitoring and reporting systems. Although prohibiting the use of cutter-head dredges is not included in the Environmentally Preferred Alternative, the restriction may be considered in the Section 404(b)(1) analysis and ROD.

The USACE recognizes that the current state of knowledge of the dynamics of the Missouri River system, its geomorphic processes, and river bed degradation dynamics is incomplete. Evaluation of alternatives and selection of the Environmentally Preferred Alternative include the use and interpretation of sediment transport equations and underlying data, the results of which include some

level of uncertainty. While the results and the interpretation of the effects of bed degradation are based on the best currently available scientific data, sediment transport and estimates of previous bed degradation are indicators rather than accurate predictors of future degradation.

A process to monitor key variables in the LOMR system throughout the 5-year permit cycle would provide information needed to determine whether dredging levels or permit restrictions should be adjusted. Such a monitoring and reevaluation process would allow the uncertainty inherent in the modeling and analysis of bed degradation to be addressed. It also would reduce the risk of potentially significant impacts, increasing the confidence that adjustments could be made to address impacts while they are relatively small.

2.7.3 Description of the Environmentally Preferred Alternative

The USACE identified the Environmentally Preferred Alternative based on its review of the impact analyses found in Chapters 4 and 5 and the potential mitigation measures found in Chapter 6. The Environmentally Preferred Alternative (Table 2.7-1) is a composite alternative. As previously noted, for most resource areas except economics, impacts either did not vary substantially or they varied in direct relationship to the impacts on river geomorphology. The alternative selected for each segment would reduce or hold to a nominal level the negative environmental effects of dredging particularly on bed degradation, infrastructure, and environmental resources while seeking to minimize the negative socioeconomic impacts on the local and regional economy and the sand and gravel industry. It was determined that the Environmentally Preferred Alternative should be the highest annual dredging amount that would result in no more than slight degradation, or less than approximately 2 feet in the short term and long term in each segment. Table 2.7-1 shows the total annual allowable amount of dredging per segment as part of the Environmentally Preferred Alternative.

Based on the alternatives selected for each segment, total allowable dredging would be a maximum of 5,880,000 tons per year over all five river segments (Table 2.7-1). This represents a reduction in total dredging of approximately 1,120,000 tons from the previous 5-year period average of 7,003,287 tons. Total dredging amounts, when compared to the 5-year period of 2004–2008, would be significantly reduced in the Kansas City segment, would remain the same in the Jefferson City and St. Charles segments, and would increase in the St. Joseph and Waverly segments.

Table 2.7-1 Selected Alternatives by River Segment for the Environmentally Preferred Alternative

Segment	Alternative	Total Annual Allowable Dredging (tons/year)	Average Annual Dredging 2004–2008 (tons/year)	Percent Change
St. Joseph	B	860,000	326,928	+163
Kansas City	A	540,000	2,520,107[a]	-79
Waverly	B	1,140,000	815,505[a]	+40
Jefferson City	C	1,630,000[b]	1,633,852[a]	-
St. Charles	C	1,710,000[b]	1,706,895[a]	-
Total		5,880,000	7,003,287	-16

[a] Following completion of the Draft EIS, corrections to the dredging records initially submitted by the individual dredgers occurred. These corrections increased the average annual dredging amounts in the Waverly, Jefferson City, and St. Charles segments, and reduced the annual average dredging amounts in the St. Joseph and Kansas City segments. Comparison of the average annual amounts given in Tables 2.4-1 and 2.7-1 show the differences. Review of the results of the geomorphic analysis determined that the changes were not substantial and would not affect the findings of the impact assessment reported in Chapter 4 or Appendix A. Therefore, the updated dredging amounts have been given in Table 2.7-1 and used by the U.S. Army Corps of Engineers (USACE) in identification of the Environmentally Preferred Alternative but have not been revised in any other sections of the Final EIS.

[b] Total annual allowable dredging amounts under Alternative C for each segment were based on the average annual dredging that had occurred from the years 2004 through 2008. Because the USACE selected Alternative C for the Jefferson City and St. Charles segments as part of the Environmentally Preferred Alternative, the update average annual dredging amounts for these segments were incorporated into the Total Annual Allowable Dredging Amounts for the Environmentally Preferred Alternative.

Descriptions of the alternatives selected for each segment and the rationale for potential limits on localized dredging intensity are explained in the following sections.

3.5.1.1 St. Joseph Segment (Alternative B)

Under Alternative B, dredging in the St. Joseph Segment would increase from the average annual 326,928 tons per year to 860,000 tons per year, with the condition that dredging would be distributed more broadly throughout the segment. During the period 2004–2008, dredging occurred primarily between RM 445 and RM 455 in the St. Joseph area. Under this segment alternative, dredging would be extended further upriver and downriver from the area historically dredged near St. Joseph. Dredging activity would be expected to increase in the lower portion of the segment, where it abuts the Kansas City segment due to its proximity to the Kansas City market. The mitigating effect of spreading out dredging is anticipated to reduce the level of river bed degradation in the segment to no more than slight bed degradation in the short term and slight to moderate bed degradation in the long term, and to reduce potential changes in low-flow and high-flow surface water elevations. Alternative B would result in the greatest increase in labor income of any alternative for the St. Joseph segment, primarily due to an increase in truck transportation of sand and gravel to market. A modest increase in employment

would occur. Mitigation of bed degradation impacts under Alternative B, including low-flow water surface elevations, is also expected to minimize operational and structural risks to water intakes, levees, BSNP structures, and other infrastructure in the St. Joseph segment.

3.5.1.2 Kansas City Segment (Alternative A)

The Kansas City segment has shown a substantial amount of river bed degradation in the last 20 years, leading to substantial impacts on infrastructure and environmental resources that would continue to be at risk should dredging not be reduced. Under Alternative A, dredging in the Kansas City segment would decrease from the average annual 2,520,107 tons per year to 540,000 tons per year. Dredging at this reduced level is expected to reduce degradation to the "slight degradation to slight aggradation" category in the short term and long term. Dredging would continue to occur throughout the length of the segment, as it has in the past. Low-flow and high-flow water surface elevations could increase or decrease in the short term and would likely increase slightly in the long term. Economic activity (labor income) would be reduced on the order of $15 million annually, and job losses may be on the order of 300 persons as a result of reduced dredging in this segment. However, the operational and structural risks to water intakes, levees, BSNP structures, and other infrastructure in the Kansas City segment should not increase under Alternative A.

3.5.1.3 Waverly Segment (Alternative B)

The Waverly segment has shown limited overall river bed degradation in the last 20 years and has a lower potential for impacts to environmental and human environment resources resulting from bed degradation. Dredging currently occurs at low intensity in this segment. Under Alternative B, dredging would increase from the average annual 815,505 tons per year to 1,140,000 tons per year. To minimize the potential for localized bed degradation with this increase, dredging would need to be spread throughout the segment, as described in Section 2.7.4. Low-flow water surface elevations are likely to increase or decrease slightly in the short term and decrease slightly in the long term. High-flow water surface elevations are likely to remain unchanged. Alternative B would result in the greatest increase in labor income of any alternative for the Waverly segment primarily due to an increase in truck transportation of sand and gravel to market. A modest increase in employment would occur. No impacts to water intakes, levees, BSNP structures, or other infrastructure in the Waverly segment are anticipated under Alternative B.

3.5.1.4 Jefferson City Segment (Alternative C)

The Jefferson City segment has not manifested substantial overall bed degradation and associated impacts to date. Under Alternative C, dredging would be maintained at the recent level of approximately 1,630,000 tons per year. The highest intensity of recent dredging has been in a 10-mile reach of the river that includes Jefferson City, where higher levels of bed degradation have occurred. To reduce bed degradation throughout this segment to the slight aggradation or slight degradation category in the short term and long term at the level of dredging proposed under Alternative C, dredging activities would be required to be spread throughout the segment, as described in Section 2.7.3. Distribution of dredging throughout the segment would also likely minimize any future changes in low-flow and high-flow water surface elevations. Alternative C would result in the least reductions in economic activity and employment of all the alternatives for the Jefferson City segment. Reduction of bed degradation impacts, including low-flow water surface elevations, is also expected to result in little if any additional operational and structural risks to water intakes, levees, BSNP structures, and other infrastructure in the Jefferson City segment.

3.5.1.5 St. Charles Segment (Alternative C)

Under Alternative C, dredging in the St. Charles segment would be maintained at the recent level of approximately 1,710,000 tons per year. Recent dredging has been most intense at several locations in the St. Charles segment between RM 0 and RM 99. To maintain the recent level of annual dredging while reducing future bed degradation to a level of slight aggradation or degradation in the short term and long term would require dredging activities to be more broadly spread out throughout the segment, as described in Section 2.7.3. Distribution of dredging throughout the segment would also likely minimize any future changes in low-flow and high-flow water surface elevations. Alternative C would result in little to no change from current economic conditions. A reduction in bed degradation impacts, including low-flow water surface elevations, is also expected to result in little if any new operational and structural risks to water intakes, levees, BSNP structures, and other infrastructure in the St. Charles segment.

2.7.4 Limits on Localized Dredging Intensity

Alternatives selected for each segment to form the Environmentally Preferred Alternative are based on the condition that dredging would be distributed more broadly throughout the segment than has occurred under past dredging practices (except the Kansas City segment, where the total dredging amount would be significantly reduced). If dredging were not distributed more broadly and were

allowed to remain concentrated around the existing sand plants, the level of future river bed degradation and associated direct and indirect impacts under these alternatives would be expected to be locally moderate to substantial. The level of expected future bed degradation and associated direct and indirect impacts can be reduced by (1) reducing the approved annual dredging volumes, especially in the areas with the highest levels of bed degradation as presented above; and (2) distributing dredging more broadly along the length of the river to reduce localized dredging intensity. Thus, in addition to designation of a total dredging amount for each segment, target levels for dredging intensity and how those limitations could be applied were also reviewed. The analytical basis for these target levels is discussed in Section 3.4.6.3 and Appendix A.

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). 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 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.

Applying the target level of dredging intensity in conjunction with the total annual allowable dredging amounts for each segment listed in Table 2.7-1 would provide uniform dredging intensity levels for the entire LOMR system. Table 2.7-2 shows dredging levels from 2004 to 2008, the number of miles dredged in concentrated dredging reaches, and the maximum dredging intensity that occurred during this period in any 1 mile within the dredging reaches. The table also shows the effect of applying a 60,000-tons/mile/year target level to the Environmentally Preferred Alternative for each segment and the resulting number of miles of dredging in each segment that would occur under the uniform dredging intensity of 60,000 tons/mile/year.

Applying the 60,000-tons/mile/year dredging target to the Environmentally Preferred Alternative would result in the area dredged increasing for St. Joseph and Waverly segments, due in part to the increased dredging amounts scheduled for these segments. In all other segments, the total area dredged would be reduced. For the Kansas City segment, this reduction would occur due to the significant decrease in the total amount of dredging allowed. For the Jefferson City and St. Charles segments, the area dredged would be reduced as a result of the reduction in peak dredging intensity and increased dredging in less utilized areas while still resulting in less area dredged when compared to historical patterns.

Table 2.7-2 Dredging by River Segment under the Environmentally Preferred Alternative with Intensity Target

Segment	Overall Length (miles)	2004–2008 Average Annual Dredging per River Segment (tons)	Approximate Number of Miles Dredged 1998–2007 (miles)	Maximum Dredging Intensity 2004–2008 (annual tons/mile)	Annual Allowable Dredging under Environmentally Preferred Alternative (tons/year)	Miles Dredged at 60,000-Tons/ Mile/Year Target (miles)
St. Joseph	107	326,928	9	92,836	860,000	14.3
Kansas City	34	2,658,831	28	304,694	540,000	9.0
Waverly	107	677,987	7	155,825	1,140,000	19.0
Jefferson City	120	1,578,858	34	272,049	1,630,000	27.2
St. Charles	130	1,649,326	35	245,672	1,710,000	28.5
Total	498	6,891,930	113		5,880,000	98.0

2.7.5 Monitoring and Adaptive Management Framework

Integral to the Environmentally Preferred Alternative, which seeks effective protection against further river bed degradation and eventual recovery of degraded reaches of the river, is a monitoring and reevaluation process. The purpose of this process would be to identify degradation trends and evaluate their relationship to dredging activity. This information would be used to determine whether dredging levels or restrictions need to be modified.

As discussed in Section 6.3.1, low-flow water surface elevation and hydroacoustic bed elevation data (HBED) are two types of data that could be gathered to show river bed aggradation or degradation. Both have their advantages and disadvantages.

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. Its main disadvantage is the level of error and uncertainty resulting from the low number of physical measurements, the level of accuracy of the USGS stage and flow estimates, the interpolation of surface elevations and flow estimates between USGS gage stations, and normalization of the flows at the time of the survey to the CRP flow.

The advantages of using HBED for monitoring purposes are that it measures river 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 include high collection and data processing costs, the fact that water surface elevation data collected during HBED surveys would need to be normalized to a standard flow, the fact that the surface of the river bed varies with the flow, and the fact that a rigorous statistical analysis has not yet been done to determine what spatial density of sampling points and number of transects is sufficient to accurately show actual degradation or aggradation.

Based on the issues previously stated, the USACE has determined that, as part of the Environmentally Preferred Alternative, low-flow water surface elevation data should be collected every year and HBED surveys should be conducted every 5 years for the lower 498 miles of the LOMR. These data would be used to identify reaches that degraded or aggraded over the previous 5 years, to guide the adjustment of dredging in those reaches for the next 5-year permit cycle.

2.8 REFERENCES

2.8.1 Printed Literature

MDNR (Missouri Department of Natural Resources). 2009b. Land Reclamation Program 2006–2007 Bi-Annual Report, Publication 2302. March.

USGS (U.S. Geological Survey). 2009b. 2007 Minerals Yearbook, Sand and Gravel, Construction, Advance Release. March.

USGS (U.S. Geological Survey). 2009c. 2006 Minerals Yearbook, Illinois. June.

2.8.2 Personal Communications

IDNR (Illinois Department of Natural Resources). 2010. List of active aggregate operators in Illinois, dated May 8, 2009. Provided to Steve Pavich, ENTRIX, Inc., on February 24, 2010.

KDOT (Kansas Department of Transportation). 2009. Email communication from Curt Niehaus (KDOT) to Steve Pavich, ENTRIX, Inc., on December 30, 2009.

KSCC (Kansas State Conservation Commission). 2010. Letter listing floodplain pit operations in Eastern Kansas. Provided by Dennis Baker, Mined Land Reclamation Program Manager (KSCC) to Steve Pavich, ENTRIX, Inc., dated January 4, 2010.

MDNR (Missouri Department of Natural Resources). 2009a. Database of permitted mining operations in Missouri. Provided by Bill Zeaman, Chief, Non-Coal Unit, Land Reclamation Program, Division of Environmental Quality (MDNR), to Steve Pavich, ENTRIX, Inc., on October 23, 2009.

MDNR (Missouri Department of Natural Resources). 2009c. Public scoping letter from MDNR with letter attachment from Missouri Department of Transportation, dated January 29, 2009.

MoDOT (Missouri Department of Transportation). 2010. List of all Class A sand source approvals that have been requested for MoDOT use over the past 2 years. Provided by Travis Koestner, Assistant State Construction and Materials Engineer (MoDOT) to Steve Pavich, ENTRIX, Inc., on January 8, 2010.

USACE (U.S. Army Corps of Engineers, St. Louis District). 2010. Summary of permitted dredging operations on the Mississippi River. Provided by Charles Frerker, Regulatory Project Manager (USACE, St. Louis District) to Steve Pavich, ENTRIX, Inc., on January 5, 2010.

USGS (U.S. Geological Survey). 2009a. 2007 Mineral Yearbook tables for the State of Missouri. Provided in electronic format by Wallace P. Bolen (USGS) on December 15, 2009.

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