DOGTOOTH BEND CHEVRON
POST- CONSTRUCTION MONITORING COMPLETION REPORT
2012 SURVEY RESULTS




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US Army Corps of Engineers
St. Louis District®

Open River
Mississippi River
River Miles 32 - 36

INTRODUCTION

The U.S. Army Corps of Engineers (USACE), St. Louis District (District) conducted post-construction biotic (fish) and abiotic (sediment, water quality, bathymetry, and velocity) sampling to compare the fish assemblages and the physical habitat within an experimental and a control site. The experimental site is comprised of an innovative chevron coined the Runway Chevron located near Mississippi River Mile (RM) 36L. The control site consisted of 3 traditional chevron located near RM 32 (Exhibits 1 and 2).

Under the American Recovery and Reinvestment Act (2010), USACE constructed 7 chevrons (in two fields) near river miles 36 and 32 to reduce dredging and create a more self-sustaining navigation channel. These structures are designed to permanently alter the pattern of scour and deposition around them. Additionally, the Runway Chevron, which has longer notched legs, may affect scour and deposition differently than traditional chevron dikes, thus potentially creating more diverse habitat for various aquatic species. The purpose of this monitoring study is to assess the fish community and physical conditions (i.e., depth, flow, and sediment) that were created after construction of these structures, and to determine if the Runway Chevron provides different physical conditions resulting in different sediment patterns and fish usage. This study will provide preliminary data in assessing the benefits of constructing runway chevrons, provide information to assist decision making, and to inform design of future river training structures elsewhere in the Middle Mississippi River.

This report provides a summary of fish and water quality data collected during the fall (November 2011), spring (April 2012), and summer (July 2012), as well as bathymetry, Acoustic Doppler Current Profiler (ADCP) velocity, and sediment collected during the summer (July 2012).

METHODS

Study Location

The study sites are located along the right descending bank (RDB) and left descending bank (LDB) of the Middle Mississippi River in the open river section. The experimental site, coined the Runway Chevron Field, is adjacent to Santa Fe Chute (RM 35.9L – 36.7L). The control site, coined the Standard Chevron Field, is located at RM 32.4R to 32.6R (Exhibits 1 and 2).

Sampling Dates

Post-construction sampling for fish assemblage and water quality occurred during the fall (November 28-30, 2011), spring (April 30-May 2, 2012), and summer (July 30-31, 2012).

Fish & Water Quality

Fish sampling procedures are modified from those used by the Upper Mississippi River Restoration Environmental Management Program (UMRR-EMP) Long Term Resource Monitoring Program (Gutreuter et. al. 1995). A multi-method (i.e., daytime electrofishing and benthic trawling) approach was used to increase the likelihood of sampling the entire fish community in the survey area (Sheehan and Rasmussen 1993). All fish sampling was conducted under the scientific collection permits provided by the Missouri Department of Conservation. A total of 35 separate electrofishing runs, and 21 trawling runs were performed in fall, spring and summer for one year post-construction. However, not all electrofishing and trawling runs were completed during the summer due to low water and exposed sand bars. All fish collected were identified to species and length measurements (mm) were recorded before returning to the river. All sampling occurred when the structures were exposed (< 17.5 feet Thebes gauge) and when weather conditions were safe. During the fall and spring samples, water levels resulted in the structures being partially submersed (i.e., partial submersion of navigation side chevron legs); however this did not inhibit fish and water quality sampling (Photos 1 and 2). In the summer, low water levels resulted in extensive sand bars which did inhibit some fish and water quality sampling along the bank side of chevrons (Photo 3).

Photo 1. Navigation side leg of chevron in the Standard Chevron Field (RM 32) partially submerged. Thebes gage at 15.48 feet. November 30, 2011.

Photo 2. Navigation side left of chevron in the Runway Chevron Field (RM 36) partially submerged. Thebes gage at 17.35 feet. April 30, 2012.

Photo 3. Standing on island within the legs of the Runway Chevron (36.2L) looking upstream. Thebes gage 9.39 feet. July 19, 2012.

Daytime electrofishing (DC pulse rate of 120) was conducted at each chevron (seven chevrons total). Each chevron was sampled in five areas (runs) to include: outside of the chevron along the navigation side leg, outside of the bank side leg, inside the chevron along the navigation leg, inside the chevron along the bank side leg, and below the chevron where the island would typically form (Exhibit 3). For sampling the outside and inside of the chevron, the navigation and bank runs began at the most upstream point of the chevron (midpoint) and proceeded downstream to the tip of the leg completing the run. For sampling the runway chevron, the inside and outside runs extended through the "runway" legs, but did not sample the open water "notches" between leg segments. For sampling the island, the run started at the bank side upstream end and proceeded to the downstream navigation side, traveled upstream to the upstream navigation side of the island and finished at the downstream bank side of the island. These five runs were completed at each of the seven chevrons.

An 8 foot mini-Missouri trawl (Herzog et al. 2009), constructed of a 19.05 mm inner mesh unit enclosed by a 4.76 mm outer mesh was attached to the bow of the boat with approximately 75 foot towlines was used. Trawling was conducted in the three areas around each chevron: outside of the navigation side leg, outside of the bank side leg, and inside the chevron (Exhibit 4). Trawling was run downstream for approximately 2 minutes connecting marked waypoints.

Sampling efforts were also coordinated with the Missouri Department of Conservation (MDC) during Fall 2012. MDC set trot lines (24 hour set) along the area of the middle trawling transect for chevrons 1 through 4, and USACE and MDC exchanged data.

Water quality data was collected within each chevron field, on the day of but prior to, fish sampling in that area. A HydroLab unit was used to collect pH, conductivity (µS/cm) water temperature (°C), and dissolved oxygen (mg/L) at the surface of the water column (approximately 1-2 feet). Water velocity was recorded near the bank and navigation sides of each chevron leg. Turbidity was recorded using a secchi disk.

Bathymetry, Velocity, and Sediment

To characterize the river bottom, bathymetric data were collected using both channel cross-section (single-beam) and multiple transducer sweep (multi-beam) surveys. The single beam survey followed pre-existing survey transects that incorporate overlapping transects to validate data by comparing adjacent soundings from different transects. Utilizing pre-existing transects allows for comparison between surveys collected on different dates. These surveys used a boat mounted acoustic echo sounder to measure depth, a differential GPS to provide accurate position, and a computer to time-tag and record the depth and position data. All components were configured prior to the survey to reflect the particular survey vessel, sensor type, and

survey area. The Acoustic Doppler Current Profiler (ADCP) was mounted to the same survey vessel and collected with the multi-beam data.

Sediment samples were collected by ponar dredge in transects around the two chevrons in each of the fields. Sediments were classified into fines, sand, gravel, or cobble and assigned a size class of fine/small, medium, or coarse/large.

Data were summarized by chevron field (Runway vs. Standard) to compare any differences between these sites.

RESULTS

Based on sediment samples, the river bed is composed primarily of fines and fine sands at the Runway Chevron Field (RM 36) (Exhibit 5). Chevron 4 sediment did contain some coarse gravel and medium sand (Exhibit 5), while the Runway Chevron did have a few samples near the notches of the legs that contained medium and medium-large cobble (Exhibit 5). The Standard Chevron Field (RM 32) was composed primarily of fine sands to medium gravel on the outside of the chevrons, while the interior of the chevrons were dominated by fines (Exhibit 6). On Chevron 5, medium cobbles were sampled along the bankside leg of the chevron adjacent to the wing dike (Exhibit 6). A scour hole exists behind each of the chevrons with a sediment deposition zone downstream of each. There is a much larger deposition zone behind the Runway Chevron (36.2L) as compared to the standard chevrons. During the summer 2012 sample, large sandbars had formed at both study locations limiting the bathymetric and ADCP (average velocity in feet per second) surveys (Exhibits 7-11). However, based on personal observations during the summer sample, a secondary channel is forming within the Runway Chevron (Exhibit 12) even though the ADCP fails to capture this flow pattern. In addition to the 2012 physical monitoring, multibeam bathymetry was collected in July 2011 that covered part of the study area. These surveys are included as Exhibits 7a and 8a.

Water quality parameters were similar between the sites each season (Table 1). In general, the navigation side of each chevron had faster velocities as compared to the bank side of the chevron. The Runway Chevron had the fastest bank side velocity (4.44 mph) during the fall, and the slowest bank side velocity (0 mph) during the summer in comparison to all chevrons.

Table 1. Mean of water quality parameters measured in the Runway Chevron Field (RM 36) and Standard Chevron Field (RM 32) from November 2011 to July 2012.

Parameter	Runway Chevron Field			Standard Chevron Field		
	Fall	Spring	Summer	Fall	Spring	Summer
Temperature (°C)	8.85	18.16	30.10	8.29	18.39	29.90
pH	8.34	8.13	7.39	8.29	8.43	7.74
Specific Conductivity (µS cm^{-1})	504	520.5	--	499	530	--
Dissolved Oxygen (mg L^{-1})	10.19	8.22	7.30	10.17	8.19	6.74
Turbidity (secchi reading in inches)	10.6	8.0	12.7	11.0	8.0	12.0
Bank side water velocity (mph)	2.19	2.43	2.00	2.52	2.89	2.00
Navigation side water velocity (mph)	3.92	5.41	3.13	2.65	4.06	3.00
Water surface elevation (Thebes gage in feet)	15.59 (30 Nov 2012)	17.35 (30 Apr 2012)	9.5 (30 July 2012)	15.59 (30 Nov 2012)	17.35 (30 Apr 2012)	9.5 (30 July 2012)

Fish

A total of 850 individuals representing 12 families and 34 species were collected from the Runway Chevron Field over all seasons and gears (Table 2). A total of 582 individuals representing 12 families and 28 species were collected from the Standard Chevron Field over all seasons and gears (Table 3). Species collected unique to the Runway Chevron included River Redhorse, Orange Spotted Sunfish, Bullhead Minnow, Red Shiner, River Shiner, Sicklefin Chub, Freckled Madtom, Stonecat, and Chestnut Lamprey (Photo 3). Species collected unique to the Standard Chevron Field included Bighead Carp, Grass Carp, and Striped Mullet. Other uncommon species collected from both locations were the American Eel (Photo 5), Sauger (Photo 6), and Blue Sucker (Photo 7).

Photo 3. Chestnut Lamprey collected during Fall 2011 using electrofishing. One individual was collected along the inside of Chevron 4 in the Runway Chevron Field.

Photo 4. American Eel captured during Spring 2012 using electrofishing. Two individuals were collected from the inside of Chevron 4 in the Runway Chevron Field, and one individual collected along the navigation side of Chevron 6 in the Standard Chevron Field.

Photo 5. Sauger captured using electrofishing in both Fall and Spring. One individual was collected from the inside of Chevron 4 in the Runway Chevron Field (Spring) and one individual was collected from the inside of Chevron 6 in the Standard Chevron Field (Fall).

Photo 6. Blue Sucker collected during Spring 2012 using electrofishing. One individual was collected along the navigation side of the Runway Chevron (36.2L) and one individual was collected along the navigation side of Chevron 6 in the Standard Chevron Field.

For both the Runway Chevron Field and Standard Chevron Field the most common (>10% of total catch) families collected by electrofishing included Cyprinidae, Ictaluridae, and Sciaenidae (Table 4). In the Runway Chevron Field, the most dominant cyprinids included Common Carp (49% of all cyprinids) and Silver Carp (28% of all cyprinids), while in the Standard Chevron Field these two species represented 72% and 16% of all cyprinids, respectively. Ictalurids were dominated by Flathead Catfish (50% of all ictalurids in the Runway and 33% of all ictalurids in the Standard; Photo 7) and Blue Catfish (39% of all ictalurids in the Runway and 47% of all ictalurids in the Standard; Photo 8). In both areas, Freshwater Drum (Scianendiae) constituted 16% of the total catch in the Runway Chevron Field, and 19% of the total catch in the Standard Chevron Field.

Photo 7. A flathead catfish collected during Spring 2012 using electrofishing.

Photo 8. A blue catfish collected during Spring 2012 using Electrofishing.

For trawling, the majority of individuals collected occurred in the summer for both the Runway Chevron Field and Standard Chevron Field, with the dominant families being Cyprinidae, Ictaluridae, and Sciaenidae (Table 4). The most common species (>10% of total catch) collected in the Runway Chevron Field included year 0 Freshwater Drum (26%), Channel Shiner (18%), juvenile Blue Catfish (15%), and juvenile Channel Catfish (14%). For the Standard Chevron Field, the most common species included juvenile Blue Catfish (69%) and year 0 Freshwater Drum (27%).

No state or federally listed species were captured. However, the shovelnose sturgeon (Photo 9) is listed as a threatened species under the "Similarity of Appearances" provisions of the Endangered Species Act. The listing took place in order to protect the federally endangered pallid sturgeon where the populations of the two species overlap in portions of the Missouri and Mississippi River basins.

Photo 9. Shovelnose Sturgeon collected using trawling and trot lines.

CONCLUSIONS

Based on this initial evaluation, the Runway Chevron Field and Standard Chevron Field had similar fish communities, with the Runway Chevron Field having greater numbers of individuals and species (which may be due to larger sample area). In terms of physical habitat, all chevrons sampled have the characteristic deep scour hole and downstream depositional area (i.e., "island"). The Runway Chevron itself is developing a different flow pattern between the chevron legs creating a more diverse habitat. Further physical monitoring of the Runway Chevron is warranted to determine if this "secondary channel" and associated depositional areas persist into the future. A recent study conducted within the Middle Mississippi River has shown increased fish use and increased habitat diversity with chevrons as compared to open water[1]. Additional biological monitoring within the Runway Chevron and Standard Chevron fields would provide added information on how fish are using these river training structures and assist in determining if the Runway Chevron design provides further added benefit to habitat and fish diversity as compared to standard chevrons.

ACKNOWLEDGEMENTS

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[1] Schneider, B. 2012. *Changes in Fish Use and Habitat Diversity Associated with Placement of Three Chevron Dikes in the Middle Mississippi River.* M.S. Thesis, Southern Illinois University Edwardsville.

Table 2. Total fish count by family and species collected by gear in fall, spring, and summer for the Runway Chevron Field (RM 36).

RUNWAY CHEVRON FIELD	Electrofishing				Trawling				Trot Line	Total Over All Gears
Family & Species Name	Fall	Spring	Summer	Total	Fall	Spring	Summer	Total	Fall	
Acipenseridae					**1**	**1**	**1**	**3**	**42**	**45**
Shovelnose Sturgeon					1	1	1	3	42	45
Anguillidae		**2**		**2**						**2**
American Eel		2		2						2
Catostomidae	**6**	**8**	**14**	**28**						**28**
Black Buffalo	2	3	3	8						8
Blue Sucker		3	1	4						4
River Carpsucker	2		3	5						5
River Redhorse	1			1						1
Smallmouth Buffalo	1	2	7	10						10
Centrarchidae	**3**	**1**	**2**	**6**						**6**
Bluegill	2		1	3						3
Orange Spotted Sunfish	1			1						1
White Bass		1	1	2						2
Clupeidae	**12**	**1**	**23**	**36**						**36**
Gizzard Shad	12	1	21	34						34
Skipjack Herring			1	1						1
Threadfin Shad			1	1						1
Cyprinidae	**17**	**5**	**46**	**68**	**9**	**2**	**138**	**149**		**217**
Bullhead Minnow			1	1						1
Channel Shiner			1	1			62	62		63
Common Carp	12	4	17	33						33
Emerald Shiner			11	11			32	32		43
Red Shiner			2	2						2
River Shiner							1	1		1
Shoal Chub					7	2	18	27		27
Sicklefin Chub							1	1		1
Silver Carp	4	1	14	19						19
Silver Chub	1			1	2		24	26		27
Hiodontidae	**13**	**15**	**25**	**53**						**53**
Goldeye	13	15	25	53						53
Ictaluridae	**7**	**69**	**80**	**156**	**32**	**5**	**67**	**104**	**31**	**291**
Blue Catfish	4	47	9	60	30	3	18	51	25	136
Channel Catfish	2	9	7	18	1	1	44	46	6	70

Table 2 Continued

RUNWAY CHEVRON FIELD	Electrofishing				Trawling				Trot Line	
Family & Species Name	Fall	Spring	Summer	Total	Fall	Spring	Summer	Total	Fall	**Trot Line**
Flathead Catfish	1	13	64	78	1			1		79
Freckled Madtom							5	5		5
Stonecat						1		1		1
Lepisosteidae		**1**	**12**	**13**						**13**
Longnose Gar			3	3						3
Shortnose Gar		1	9	10						10
Percidae		**1**		**1**						**1**
Sauger		1		1						1
Petromyzontidae	**1**			**1**						**1**
Chestnut Lamprey	1			1						1
Sciaenidae	**11**	**24**	**31**	**66**			**91**	**91**		**157**
Freshwater Drum	11	24	31	66			91	91		157
Grand Total	**70**	**127**	**233**	**430**	**42**	**8**	**297**	**347**	**73**	**850**

Table 3. Total fish count by family and species collected by gear in fall, spring, and summer for the Standard Chevron Field (RM 32).

	Electrofishing				Trawling				Total Over All Gears
Family and Species Name	Fall	Spring	Summer	Total	Fall	Spring	Summer	Total	
Acipenseridae		**1**		**1**					**1**
Shovelnose Sturgeon		1		1					1
Anguillidae		**1**		**1**					**1**
American Eel		1		1					1
Catostomidae	**14**	**19**	**14**	**47**					**47**
Bigmouth Buffalo		3		3					3
Black Buffalo	1	7	4	12					12
Blue Sucker		1	1	2					2
River Carpsucker	1		1	2					2
Smallmouth Buffalo	12	8	8	28					28
Centrarchidae	**1**	**2**	**1**	**4**					**4**
Bluegill	1			1					1
White Bass		2	1	3					3
Clupeidae	**4**	**1**	**18**	**23**					**23**
Gizzard Shad	4	1	10	15					15
Skipjack Herring			2	2					2
Threadfin Shad			6	6					6
Cyprinidae	**8**	**17**	**14**	**39**	**3**	**1**	**6**	**10**	**49**
Bighead Carp			1	1					1
Channel Shiner							1	1	1
Common Carp	5	15	8	28					28
Emerald Shiner			3	3					3
Grass Carp			1	1					1
Shoal Chub					3	1	5	9	9
Silver Carp	3	2	1	6					6
Hiodontidae	**1**	**22**	**6**	**29**					**29**
Goldeye	1	22	6	29					29
Ictaluridae		**79**	**26**	**105**	**169**	**1**	**14**	**184**	**289**
Blue Catfish		45	4	49	169	1	12	182	231
Channel Catfish		20	2	22			2	2	24
Flathead Catfish		14	20	34					34
Lepisosteidae			**9**	**9**					**9**
Longnose Gar			3	3					3
Shortnose Gar			6	6					6
Mugilidae			**1**	**1**					**1**
Striped Mullet			1	1					1

Table 3 continued

	Electrofishing				Trawling				Total Over All Gears
Family and Species Name	Fall	Spring	Summer	Total	Fall	Spring	Summer	Total	
Percidae	**1**			**1**					**1**
Sauger	1			1					1
Sciaenidae	**3**	**49**	**6**	**58**			**70**	**70**	**128**
Freshwater Drum	3	49	6	58			70	70	128
Grand Total	**32**	**191**	**95**	**318**	**172**	**2**	**90**	**264**	**582**

Table 4. Comparison of Runway Chevron and Standard Chevron Fields percent of total catch by family and gear (electrofishing and trawling only) over all seasons. Dominant families (>10% of total catch) are bolded and shade gray.

Family	Electrofishing				Trawling			
	Runway		Standard		Runway		Standard	
	Total Count	% of Total Catch	Total Count	% of Total Catch	Total Count	% of Total Catch	Total Count	% of Total Catch
Acipenseridae (sturgeon)	0	0.00	1	0.31	3	0.86	0	0.00
Anguillidae (eels)	2	0.47	1	0.31	0	0.00	0	0.00
Catostomidae (suckers)	28	6.51	47	14.78	0	0.00	0	0.00
Centrarchidae (sunfish)	6	1.40	4	1.26	0	0.00	0	0.00
Clupeidae (herring)	36	8.37	23	7.23	0	0.00	0	0.00
Cyprinidae (minnows)	**68**	**15.81**	**39**	**12.26**	**149**	**42.94**	10	3.79
Hiodontidae (mooneyes)	**53**	**12.33**	29	9.12	0	0.00	0	0.00
Ictaluridae (catfish)	**156**	**36.28**	**105**	**33.02**	**104**	**29.97**	**184**	**69.70**
Lepisosteidae (gars)	13	3.02	9	2.83	0	0.00	0	0.00
Mugilidae (mullets)	0	0.00	1	0.31	0	0.00	0	0.00
Percidae (perch)	1	0.23	1	0.31	0	0.00	0	0.00
Petromyzontidae (lampreys)	1	0.23	0	0.00	0	0.00	0	0.00
Sciaenidae (drums)	**66**	**15.35**	**58**	**18.24**	**91**	**26.22**	**70**	**26.52**
TOTAL	**430**	**100.00**	**318**	**100.0**	**347**	**100.00**	**264**	**100.00**

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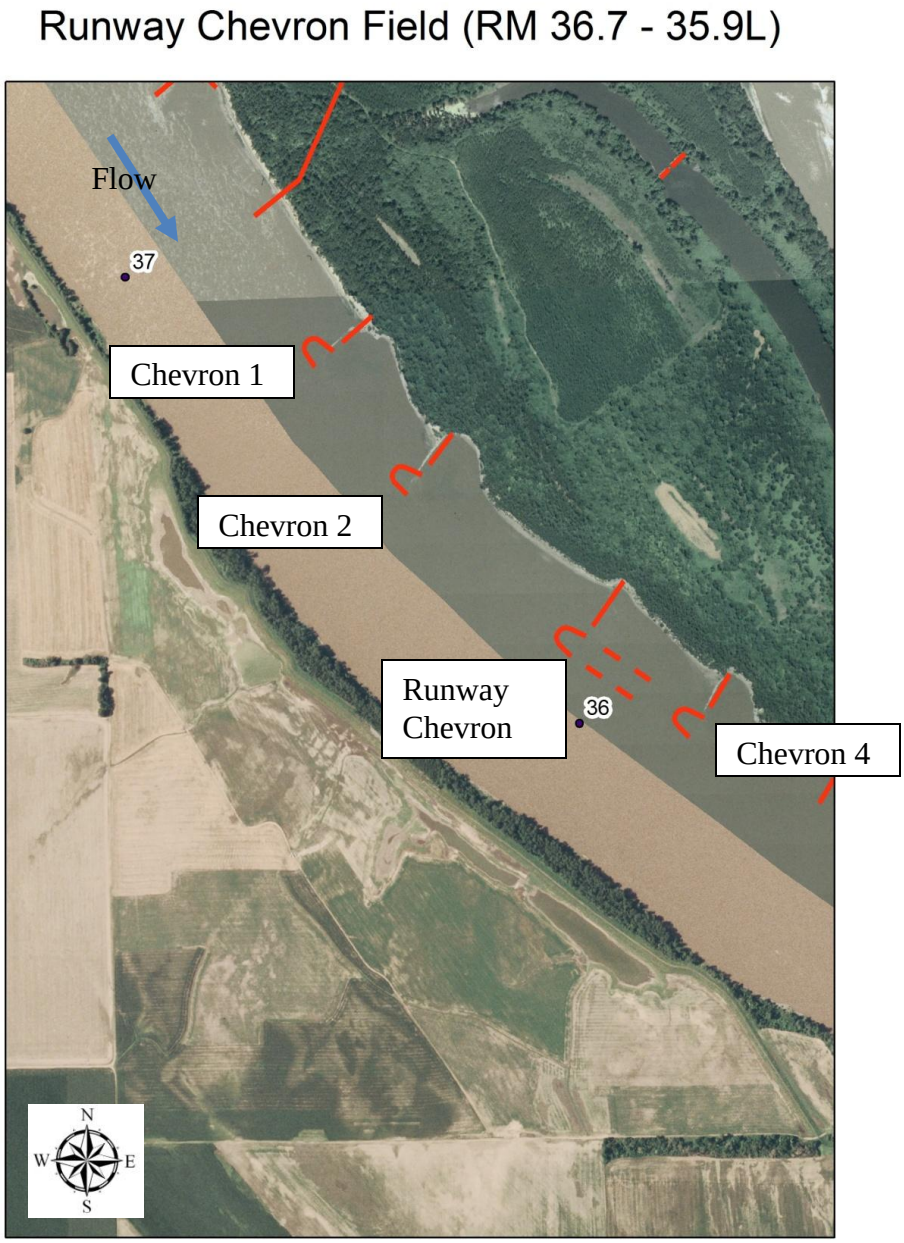

Exhibit 1. The runway chevron field project area near river mile 36.

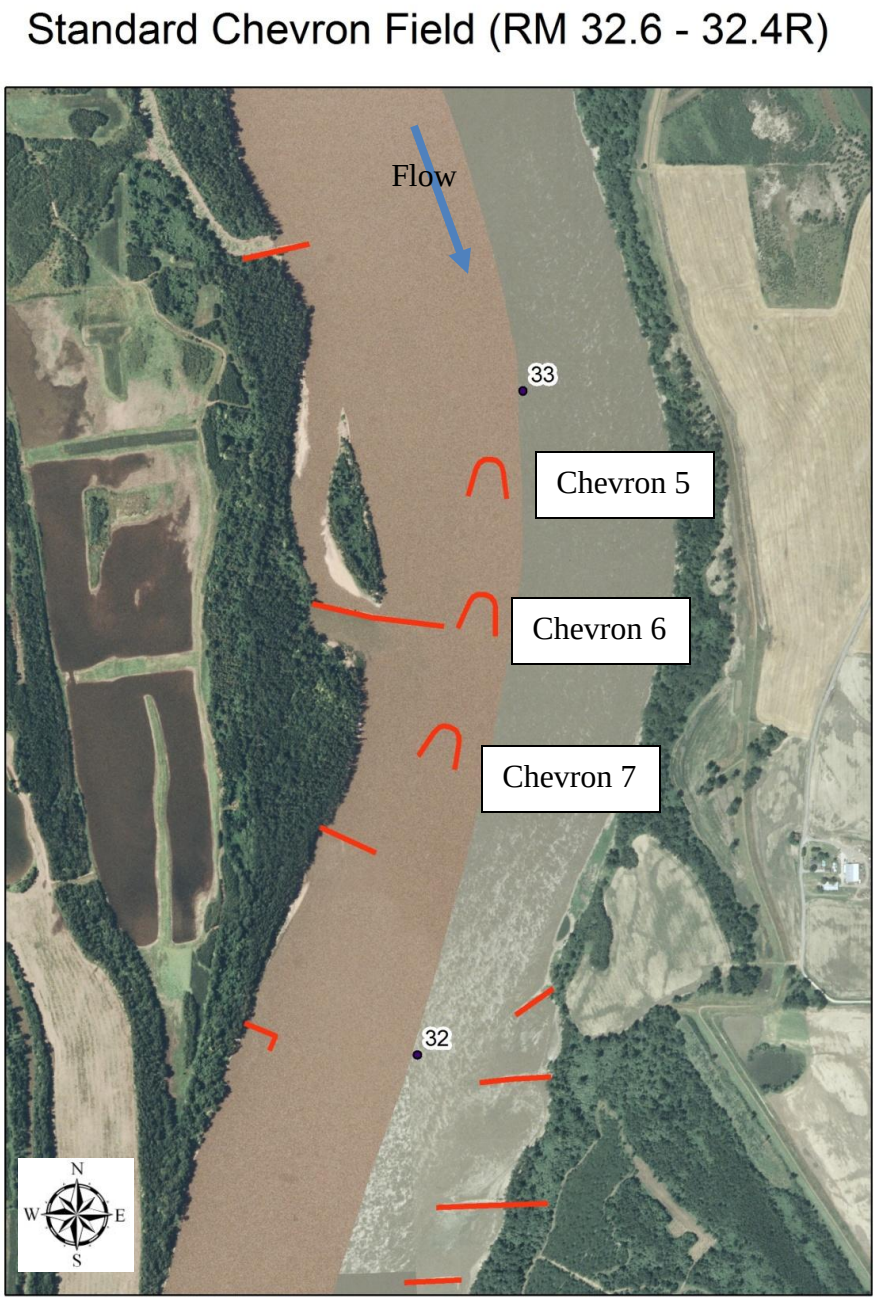

Exhibit 2. Standard chevron field project area near river mile 32.

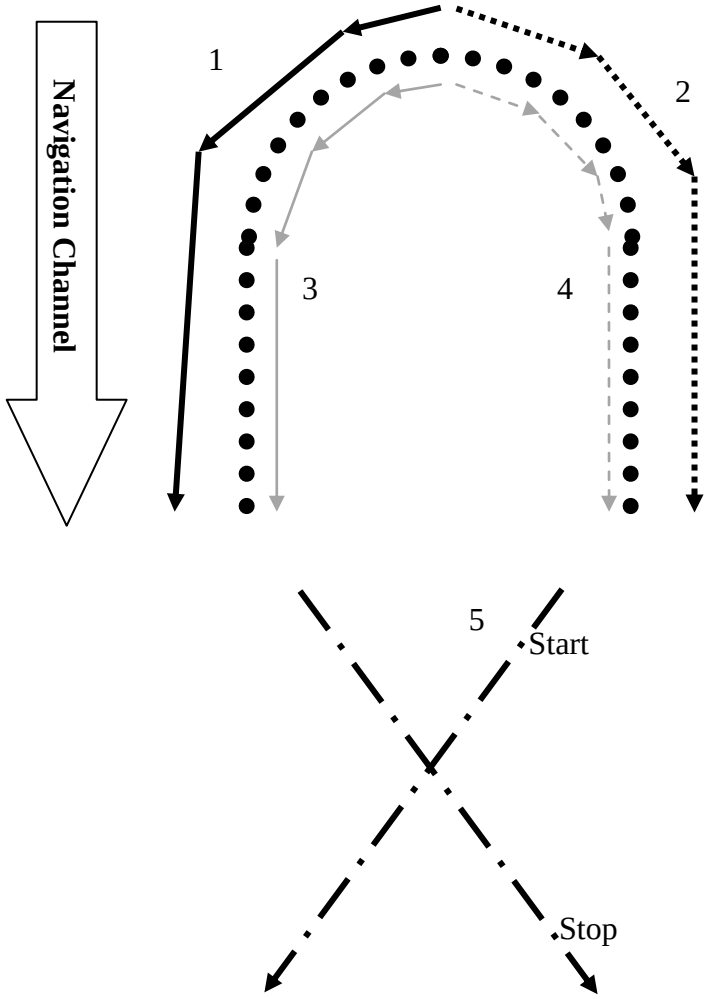

Exhibit 3. Example of electrofishing runs to sample the exterior structure on the navigation (black solid) and bank (black dotted) sides, interior structure navigation (grey solid) and bank side (grey dashed) and island (dot dash) of the chevron.

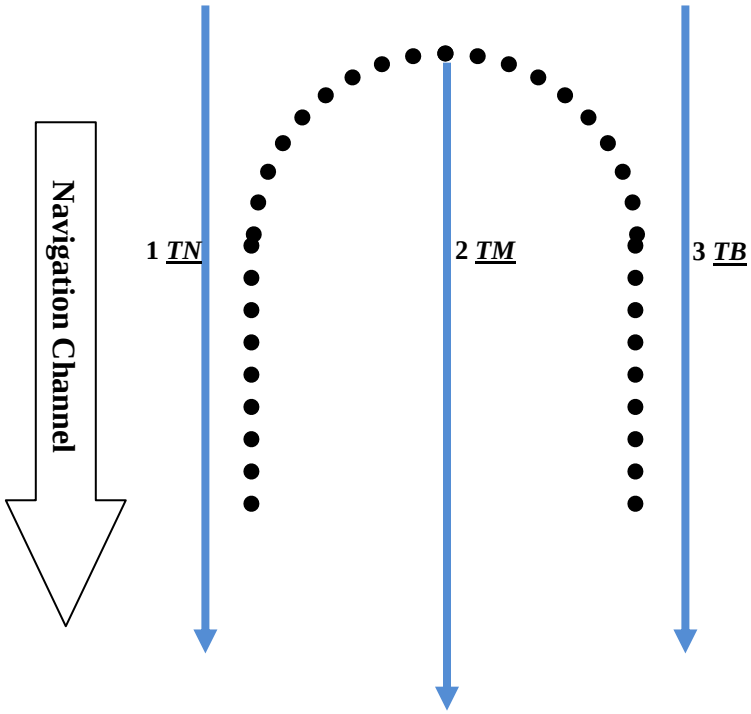

Exhibit 4. Example of trawling runs to sample inside and outside of the chevron. Transect beginning and end points are permanently set in the boat's navigation system.

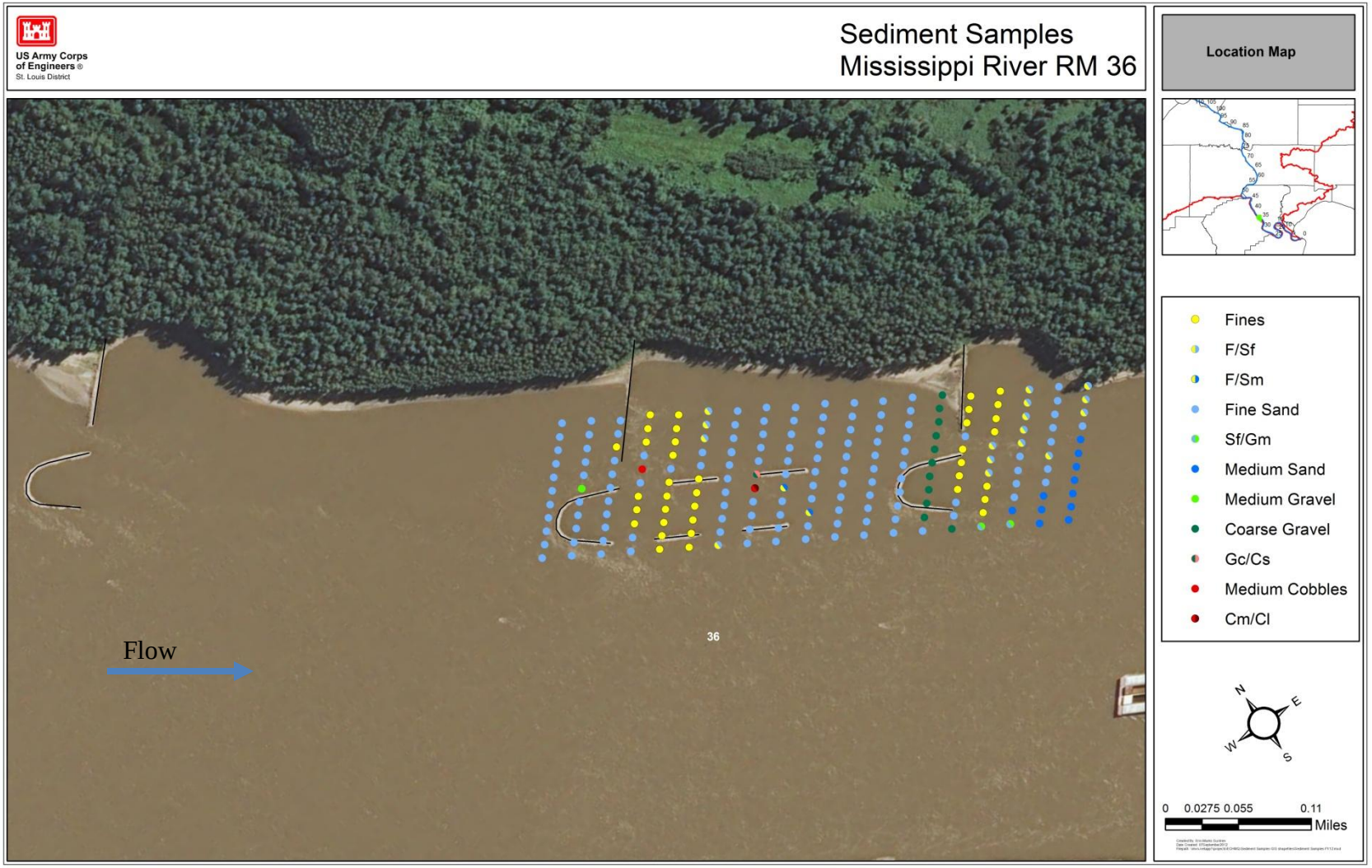

Exhibit 5. Sediment types collected within the Runway Chevron Field (RM 36).

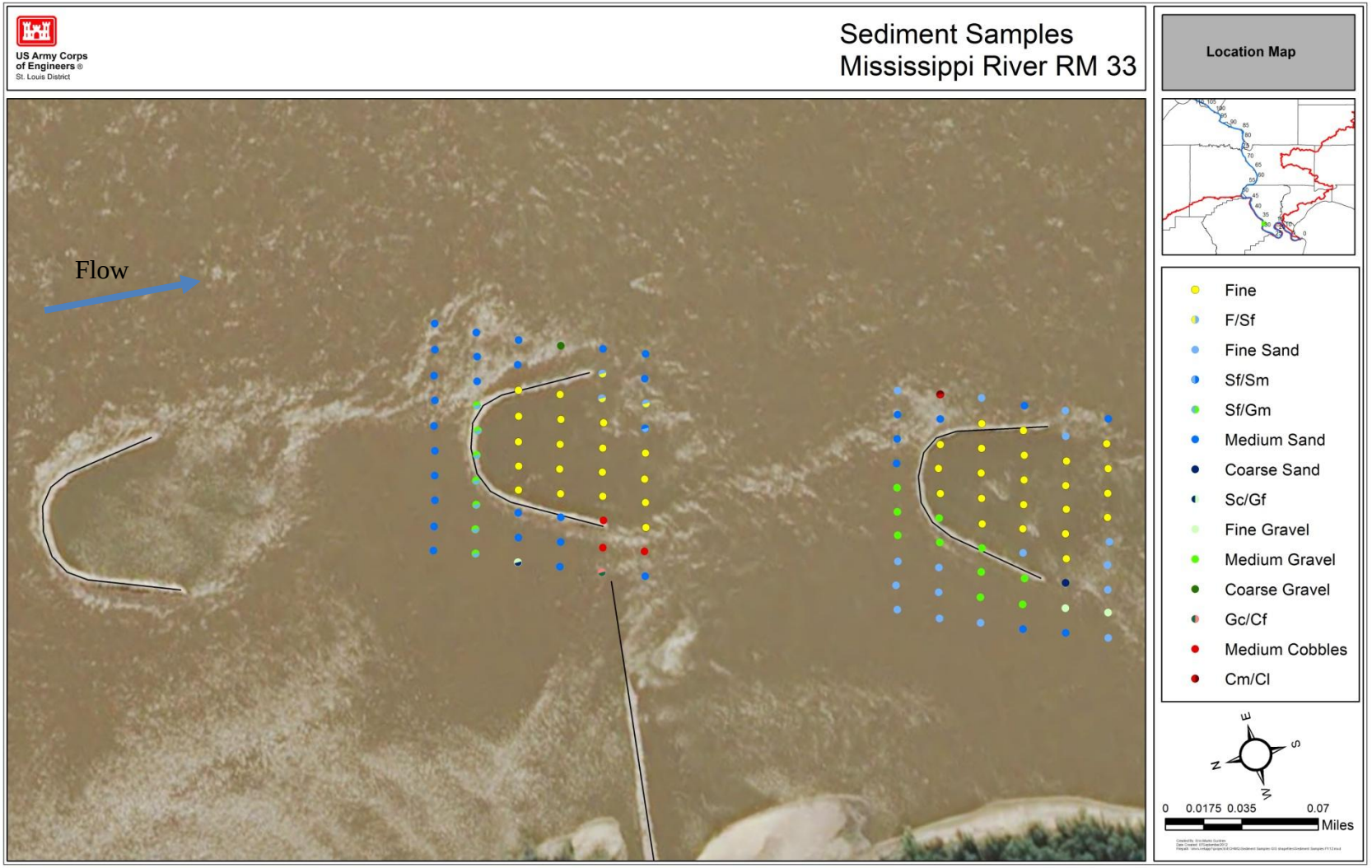

Exhibit 6. Sediment types collected within Standard Chevron Field (RM 32).

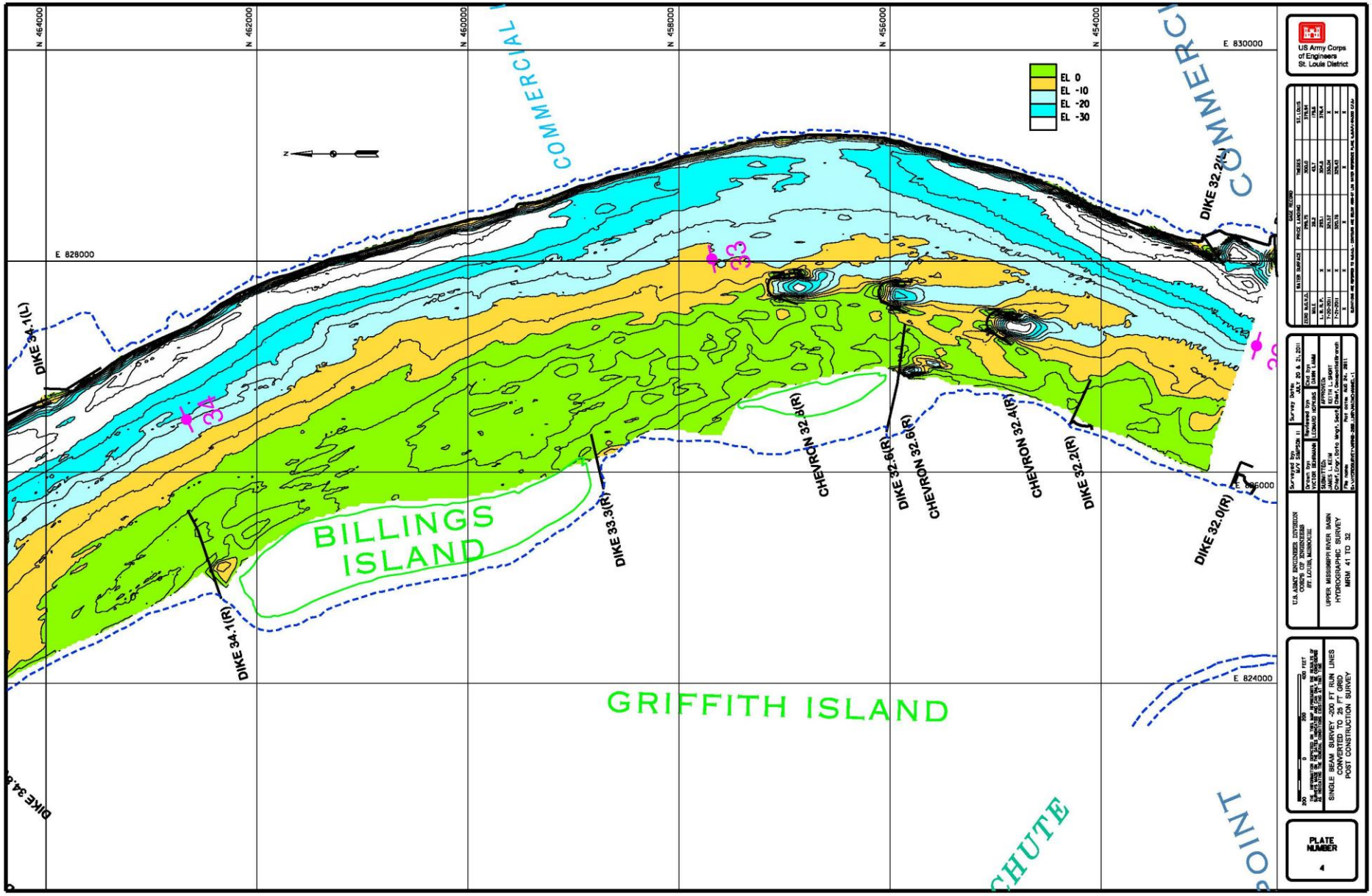

Exhibit 7a. Multibeam bathymetry of the Standard Chevron Field. Survey date 20-21 July 2011. Elevations are in feet compared to low water reference plane (LWRP).

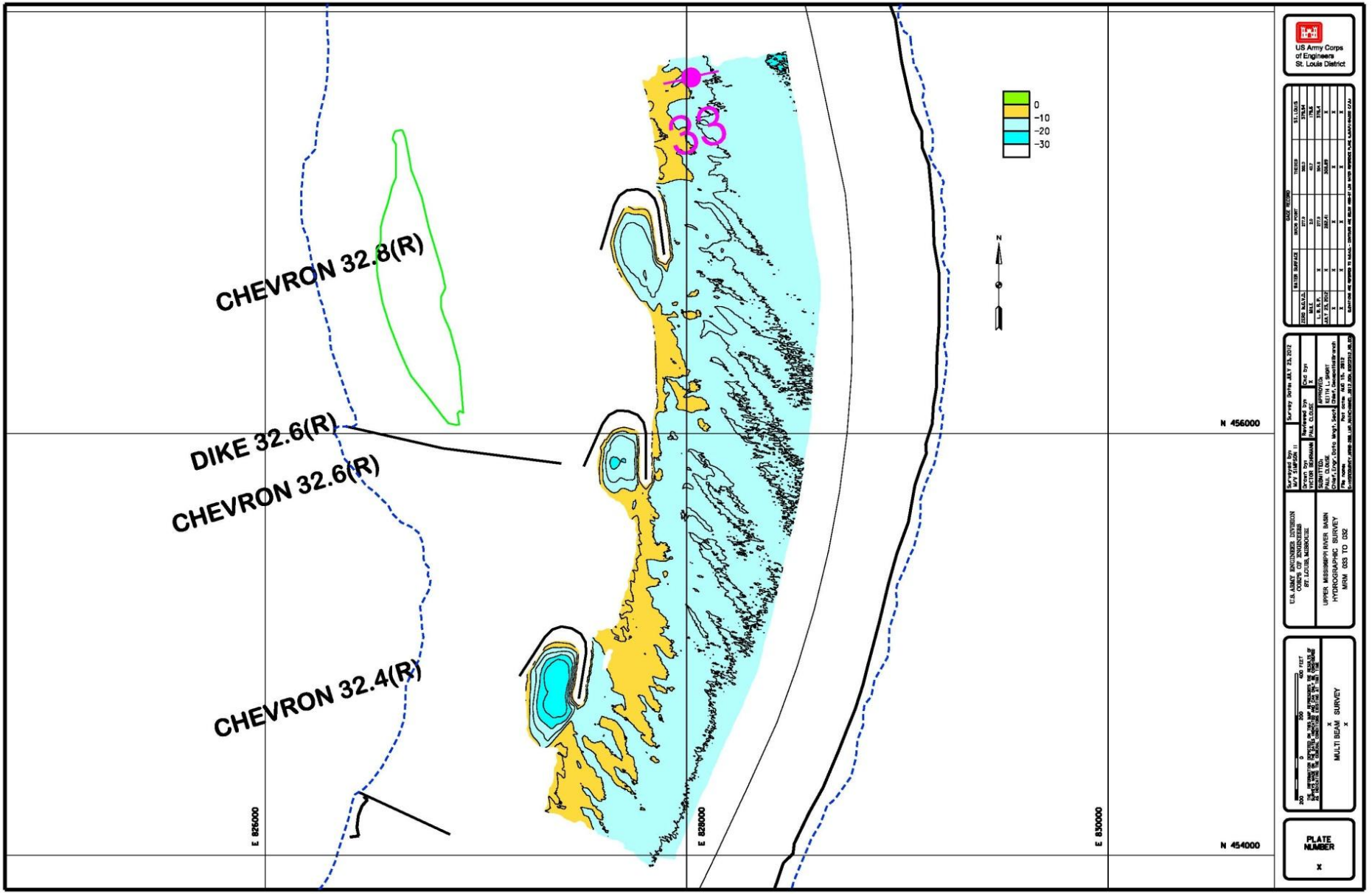

Exhibit 7b. Multibeam bathymetry of the Standard Chevron Field. Survey date 23 July 2012. Elevations are in feet compared to low water reference plane (LWRP).

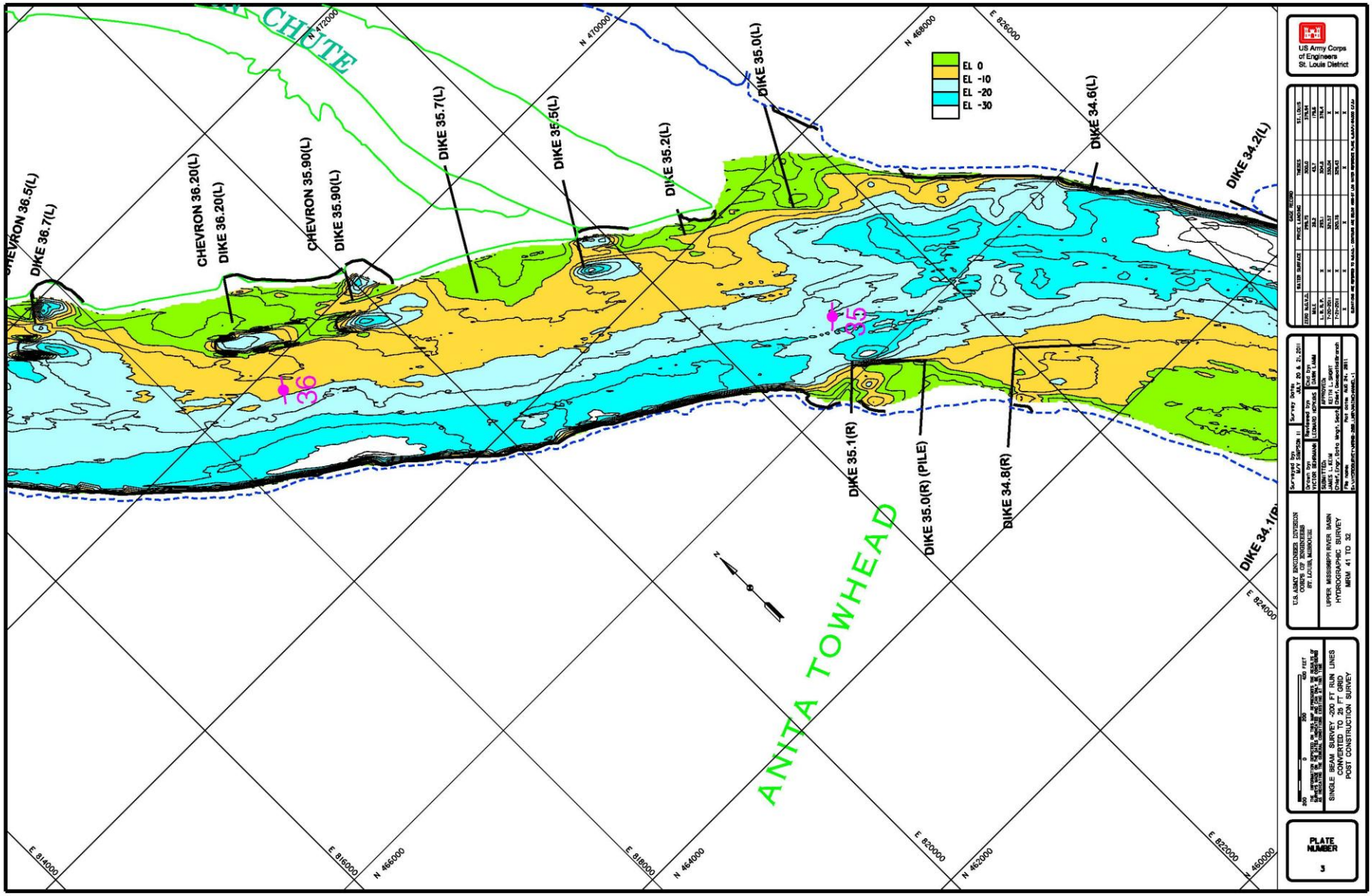

Exhibit 8a. Multibeam bathymetry of the Runway Chevron. Survey date 20-21 July 2011. Elevations are in feet compared to low water reference plane (LWRP).

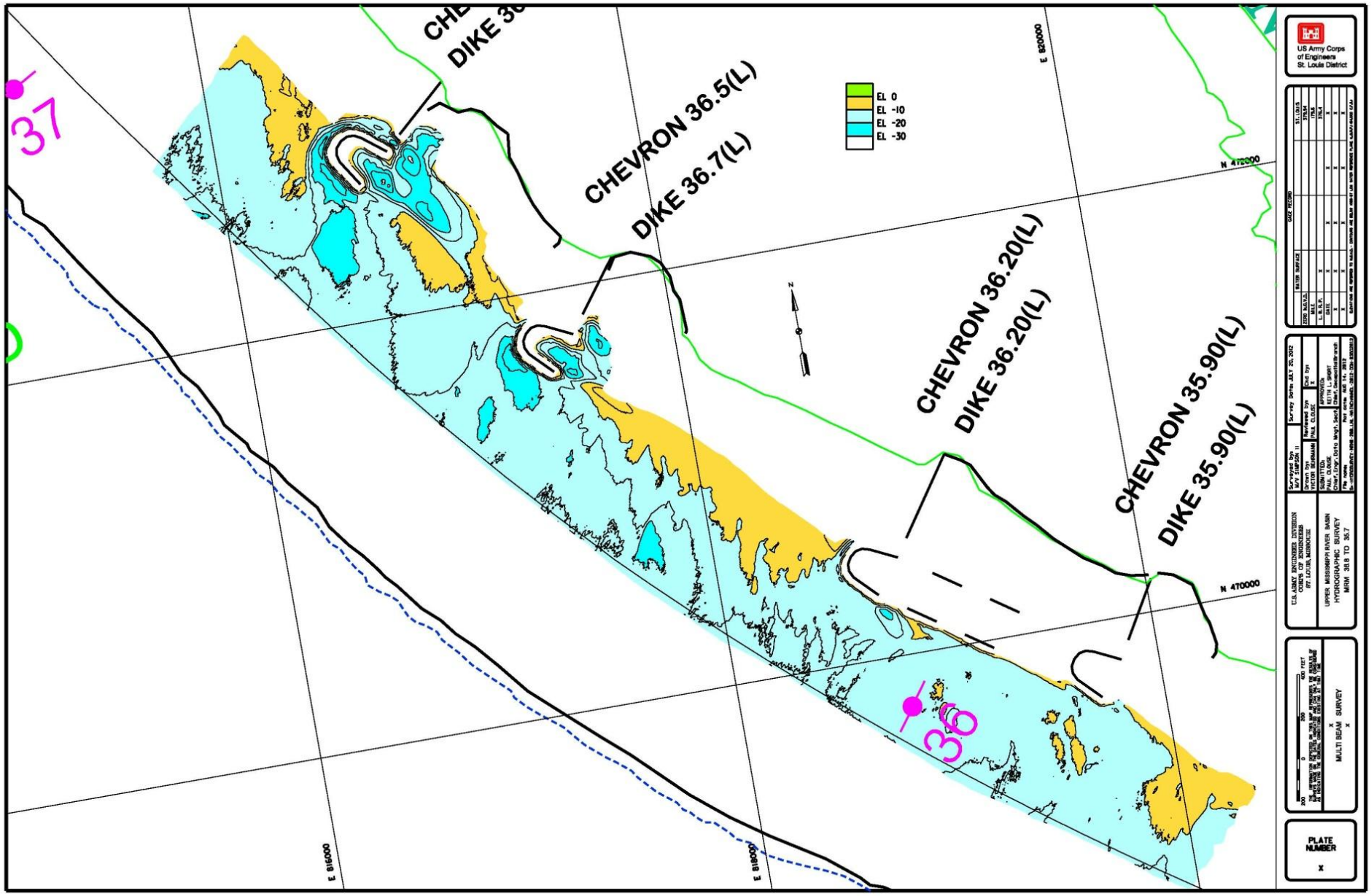

Exhibit 8b. Multibeam bathymetry of the Runway Chevron Field. Survey date 20 July 2012. Elevations are in feet compared to low water reference plane (LWRP).

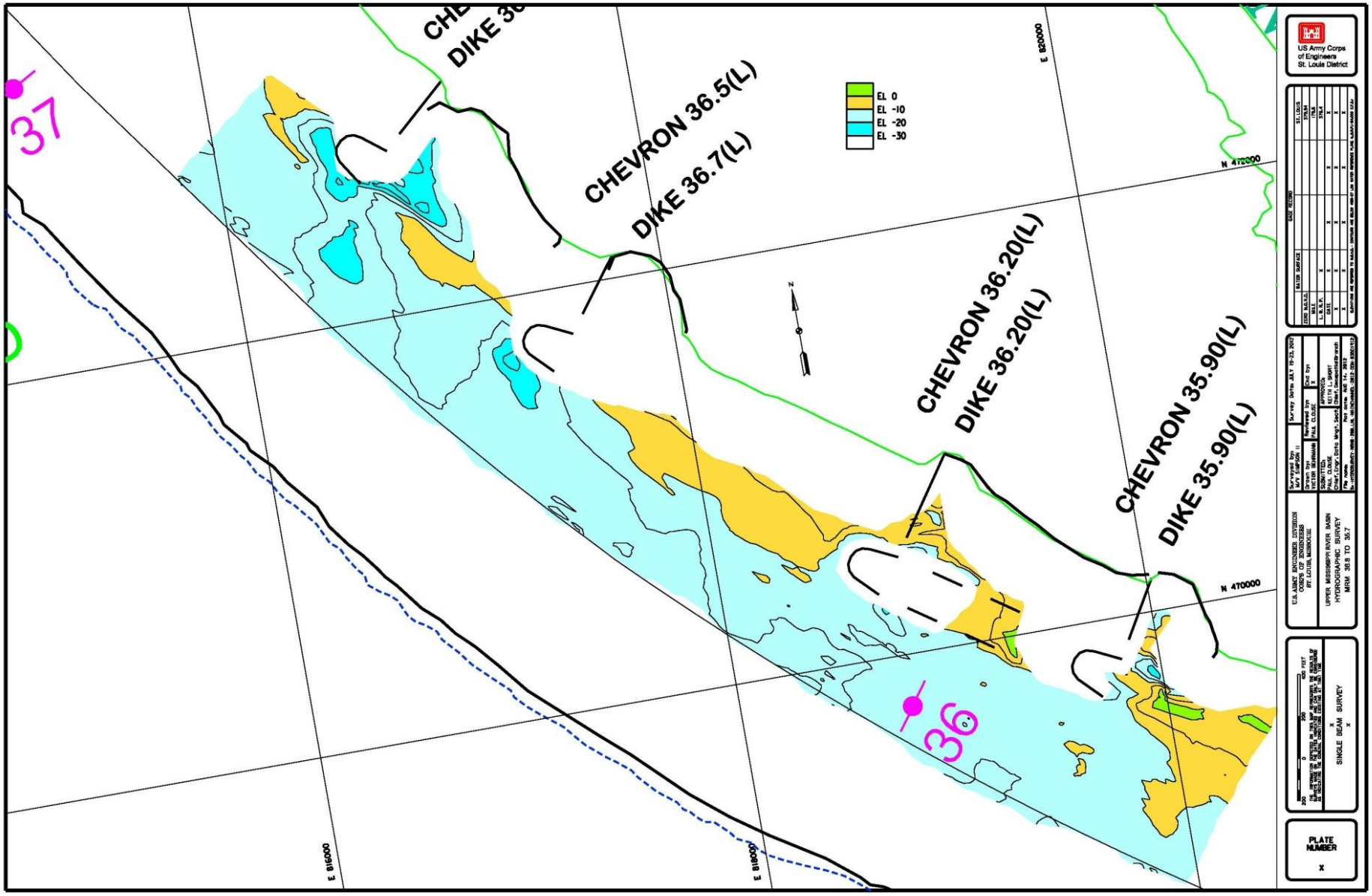

Exhibit 9. Single-beam bathymetry of the Runway Chevron Field. Survey 19-23 July 2012. Elevations are in feet compared to low water reference plane (LWRP). Note: single beam bathymetry covered more of the study area as compared to multi-beam.

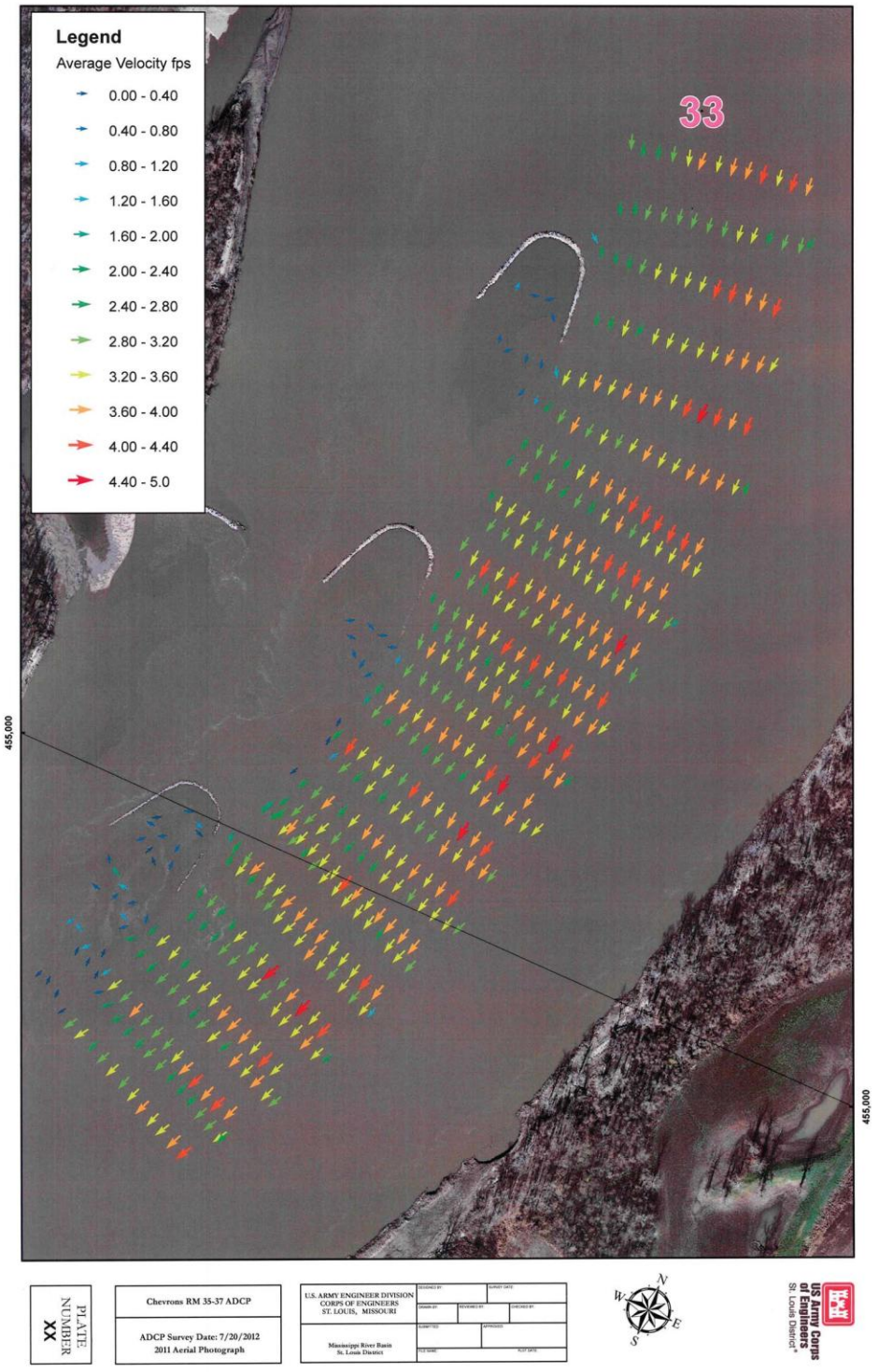

Exhibit 10. ADCP of standard chevron field. Survey date 20 July 2012. Thebes gage 9.31 feet.

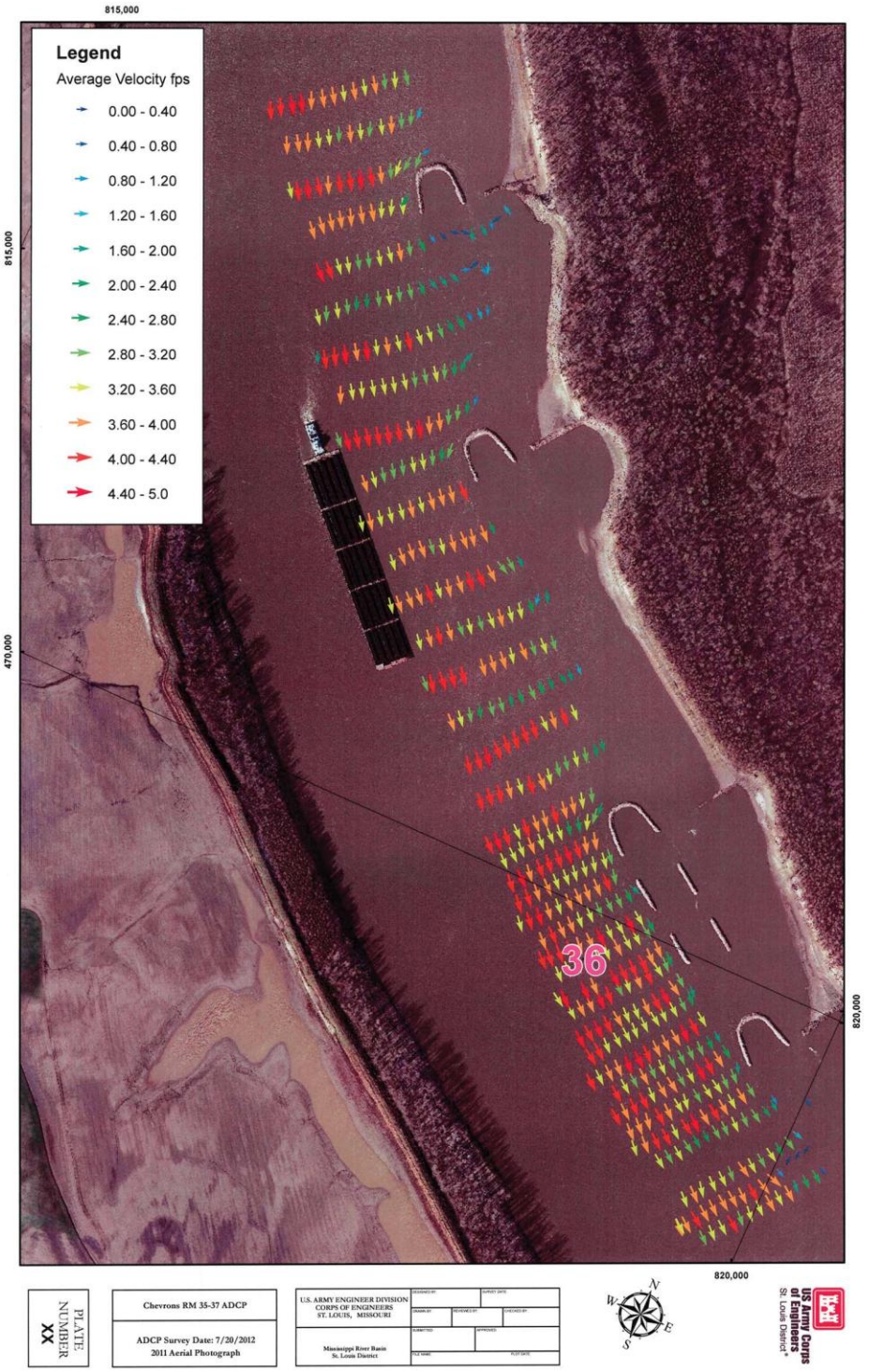

Exhibit 11. ADCP of Runway Chevron Field. Survey date 20 July 2012. Thebes gage 9.31 feet.

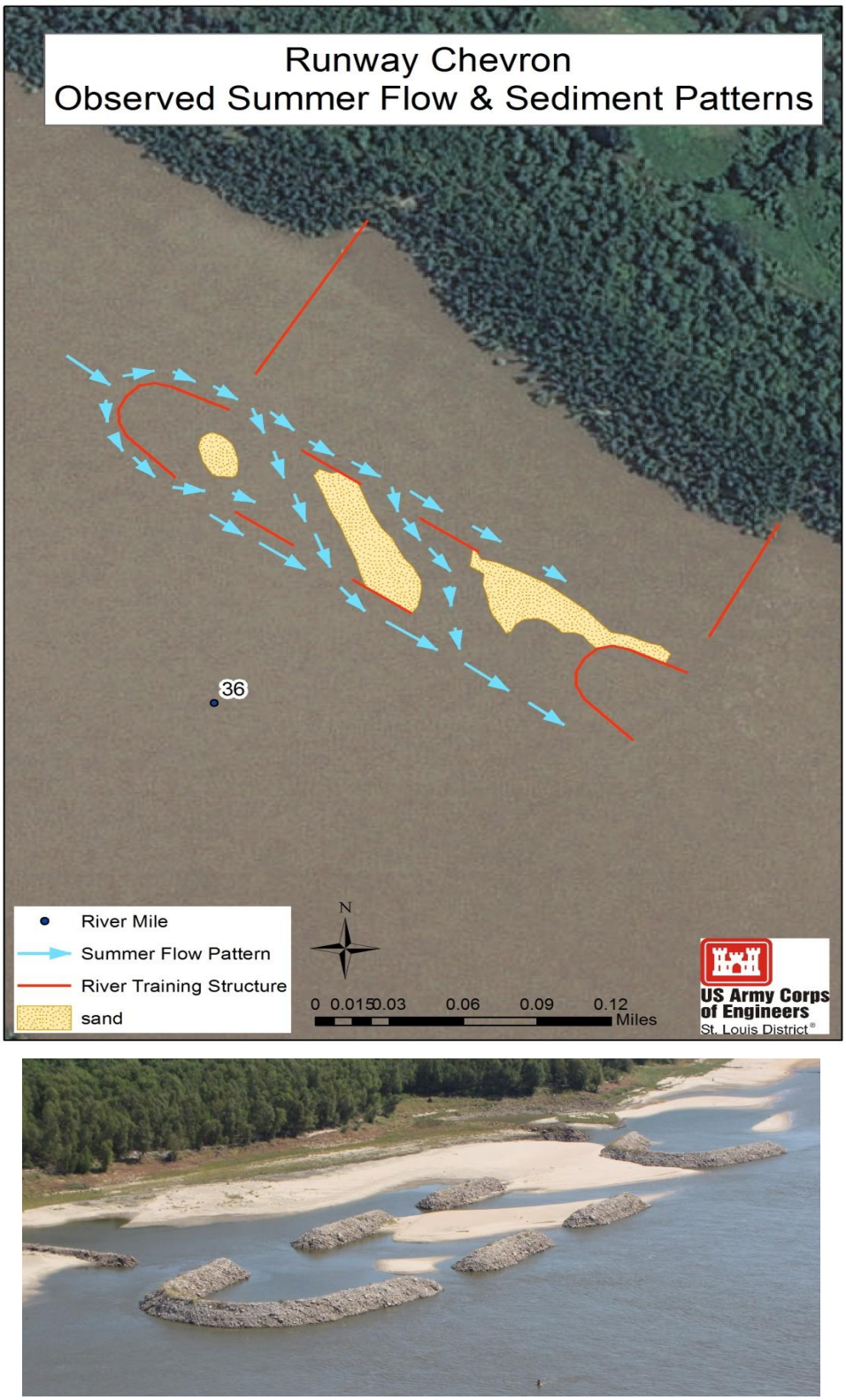

Exhibit 12. Observed flow and sediment patterns occurring at the Runway Chevron during summer 2012 sample. Photo taken on 24 September 2012. St. Louis gage -2.5 feet.