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Bed-Load and Water Surface Measurements during the 2011 Mississippi River Flood at Vicksburg, Mississippi

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Profile Comparison Plot

MRG&P

Mississippi River
Geomorphology &
Potamology Program

Bed-Load and Water Surface Measurements during the 2011 Mississippi River Flood at Vicksburg, Mississippi

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Abstract

The U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Field Data Collection and Analysis Branch collected bathymetry data and water surface elevations during the 2011 Flood. According to the gage at Vicksburg, MS, the flood peaked at a stage of 57.1 and a flow of 2,310,000 cubic feet per second (cfs) on 17 May 2011, both the highest of record. The reported water surface data include a continuous water surface profile from river mile (RM) 597 to RM 362 and water surface measurements in the vicinity of the Yazoo Backwater levee and Vicksburg, MS. Bathymetry data were also collected and include five sets of surveys, compatible with the Integrated Section Surface Difference over Time Version 2 (ISSDOTv2) method of measuring bed-load transport. These five sets were surveyed at flow rates between 1.6 million and 2.3 million cfs. ISSDOTv2 was used to calculate bed-load transport for the five sets of data. These new bed-load data populate the Lower Mississippi River bed-load rating curve at higher flows and provide a higher level of confidence in the higher-flow portions of the curve. The resulting curve can be a powerful tool for inferring past bed-load transport and predicting future transport.

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Preface

The study documented in this report was conducted as part of the Mississippi River Geomorphology and Potamology (MRG&P) Program; Project 127672, “Bedload Measurement.” The MRG&P is sponsored by Headquarters, U.S. Army Corps of Engineers (USACE), and is managed by the USACE Mississippi Valley Division (MVD) in Vicksburg, MS. The MRG&P Technical Director was Dr. Ty Wamsley. The MVD Commander was MG Richard G. Kaiser. The MVD Director of Programs was Mr. Jim Bodron.

The Mississippi River Commission provided Mississippi River engineering direction and policy advice. The Commission members were MG Richard G. Kaiser, USACE, President; the Honorable Sam E. Angel; the Honorable Norma Jean Mattei, PhD; RDML Shepard Smith, National Oceanic and Atmospheric Administration; BG Mark Toy, USACE-LRD; and BG Paul E. Owen, USACE-SWD.

At the time of publication, Mr. Jeffrey R. Eckstein was the Acting Director of the U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory.

COL Bryan S. Green was the Commander of ERDC, and Dr. David W. Pittman was the Director.

Unit Conversion Factors

Multiply	By	To Obtain
feet	0.3048	meters
feet	5280	miles
tons (2,000 pounds, mass)	907.1847	kilograms
cubic feet	0.02831685	cubic meters

1 Introduction

Background

The flood on the Mississippi River during the summer of 2011 was a flood of record with 57.1 feet (ft) being read on the Vicksburg gage according to rivergages.com. Measured flow rates at Vicksburg, MS, reached 2.3 million cubic feet per second (cfs) during the flood. Due to the severity and low probability of similar events, the Mississippi Valley Division funded numerous data collection efforts near Vicksburg during this period. The data collected includes the following:

- approximately 2 miles of multi-beam bathymetry collected below the Vicksburg Bridge to determine the ISSDOTv2 bed load measurement site
- five sets of repetitious bathymetric surveys compatible with the ISSDOTv2 bed-load calculation method
- continuous Mississippi River water surface profile from Rosedale, MS, to Natchez, MS (280 miles) on 18 May 2011
- water surface elevations along the Yazoo Backwater levee from the mainline Mississippi River levee to the Steele Bayou Drainage Structure to assist in forecasting backwater levee overtopping potential
- water surface super-elevation measurements at several Mississippi River locations in the vicinity of Vicksburg, MS.

Objective

The objective of this study is to document the water surface measurements along with bed-load measurements that are calculated from the collected bathymetric data.

Approach

The approach for calculating bed load transport was to apply the Integrated Section Surface Difference over Time Version 2 (ISSDOTv2) method. ISSDOTv2 is a numerical code that calculates bed-load transport in sand-bed rivers by using multiple bathymetric surveys to track dune scour and deposition. The method is documented in more detail in Abraham et al. (2011). The method has been widely utilized on the Lower

Mississippi River (LMR) providing a large dataset of measurements (Figure 1). This 2011 data will provide data points at higher flows where there is currently a lack of measurements. The blue dashed lines on Figure 1 represent the flow rates at which the new data were obtained.

Figure 1. LMR bed-load rating curve.

2 Data Collection

Bathymetry and bed-load transport measurements

Approximately 2 miles of multi-beam bathymetry was collected below the Interstate-20 Bridge at Vicksburg, MS, on 13 May 2011 to determine the best location to collect data for the ISSDOTv2 calculations. The location of this 2-mile reach (RM 434.5–432.5) is shown in Figure 2 outlined by the blue box. The data from May 13 are plotted below in Figure 3. The 2 miles contained a consistent formation of dunes along the entire length. Large dunes can be seen in the center of the channel extending towards the right descending bank to the outer extents of the data. Smaller dune formations occur along the thalweg. The ISSDOTv2 method requires sequential surveys to calculate a bed-load transport value, so trips were taken on the following dates near RM 433, which is outlined in red in Figure 2:

1. 16 May 2011
2. 19 May 2011
3. 27 May 2011
4. 31 May 2011
5. 3 Jun 2011.

Figure 2. Vicksburg bathymetry measurement locations.

Figure 3. 13 May 2011 dune field survey.

On each trip in 2011, four repeated surveys were taken over approximately a 3- to 4-hour time period. Appendix A includes one set of combined bathymetric surveys and example profiles for each 2011 trip. Results of the 2011 measurements are reported as tons per day (tpd) in Table 1 along with the results of surveys conducted in 2012, 2013, and 2016 at the Vicksburg, MS, site. All eight measurements were computed using the current version of the ISSDOTv2 code to ensure consistency among the results. When combined with the existing measurements, these new datasets produce a rating curve at Vicksburg, MS (Figure 4). These new measurements at Vicksburg, MS, were added to the LMR bed-load curve (Figure 5) providing greater data density at higher flows. The two highest points recorded during a flow of 2,280 and 2,270 thousand cubic feet per second (kcfs) have a difference of 75,000 tpd. There is some variability to be expected, but this large difference shows that flow is not the only dependent factor and that further analysis could help produce a better predictive function.

Table 1. Vicksburg bed-load measurements.

Date	Flow (kcfs)	Bedload (tpd)
16-May-11	2,280	277,322
19-May-11	2,270	202,509
26-May-11	2,000	183,970
31-May-11	1,760	118,233
3-Jun-11	1,640	113,448
3-Oct-12	261	6,936
29-Apr-13	1,132	52,047
15-Jan-16	1,880	160,947

Figure 4. Vicksburg bed-load measurements.

Figure 5. Mississippi River bed-load rating curve.

These bed-load rating curves can be used in conjunction with a hydrograph to estimate past sediment delivery at a location. Applying the rating curve to a hydrograph and creating a bed load (tons per day) vs. time curve and then integrating produces a total sediment delivered as bed load for that time period. An example is given below where this method was used to combine the Vicksburg rating curve with yearly hydrographs from the U.S. Geographical Survey (USGS) gage at Vicksburg to calculate total bed load transported past Vicksburg for each water year (October 1–September 31) from 2009–2017 (Figure 6).

Figure 6. Bed-load delivery at Vicksburg, MS, using the bed-load rating curve for 2009–2017.

Water surface elevation

Water surface profile from Rosedale, MS, to Natchez, MS

On 18 May 2011, Coastal and Hydraulics Laboratory (CHL) personnel collected a water surface profile (Figure 7) on the Mississippi River from the mouth of the White River at River Mile 597 to below Natchez, MS, at River Mile 362. The data were collected on May 18 from 1030 to 1800 CDT because the 2011 flood was expected to crest at Vicksburg, MS, that day. The water surface profile with river mile is plotted in Figure 8.

Comparisons were made along the profile at locations where U.S. Army Corps of Engineers gages are located (Table 2). Appendix B includes the data from the profile in tabular form.

Figure 7. 18 May 2011 water surface elevations.

Figure 8. Mississippi River water surface profile.

Table 2. Water surface profile comparisons at gage locations.

River Mile	18 May 11		From Gage		CHL Profile
	UTC ¹	CDT ²	NGVD 29 ³	NAVD 88 ⁴	NAVD 88
553.5	1700	1200	149.44	149.05	149.1
531	1745	1245	138.87	138.68	138.6
435.7	2035	1535	103.18	103.03	102.8
363.3	2307	1807	79.10	79.16	78.8

¹ Coordinated Universal Time² Central Daylight Time³ Sea Level Datum of 1929⁴ North American Vertical Datum of 1988

Yazoo Backwater levee water surface elevations

The CHL Field Data Collection and Analysis Branch took water surface measurements along the Yazoo Backwater levee from the mainline Mississippi River levee up past the Steel Bayou Drainage Structure. These trips took place on the 6th, 10th, and 11th of May 2011. The locations of all survey points and the dates they were collected are depicted in Figure 9. Table 3 summarizes all measurements, and Figure 10 to Figure 15 consist of plan and profile plots of the measurements for each day.

Figure 9. Yazoo Backwater levee water surface elevation survey points and dates.

Table 3. Yazoo Backwater levee water surface elevations.

Date/Time	Northing	Easting	Elevation	Levee Station
5/6/2011 15:00	1070809.98	2104618.09	98.51	0
5/6/2011 15:06	1071775.80	2105288.95	98.25	1400
5/6/2011 15:11	1073087.93	2106268.42	98.17	3000
5/6/2011 15:19	1074614.98	2107883.90	98.21	5700
5/6/2011 15:26	1074752.46	2108110.95	98.22	6000
5/6/2011 15:31	1075009.18	2110103.75	98.34	8000
5/6/2011 15:35	1074964.44	2112080.09	98.22	10000
5/6/2011 15:40	1074480.07	2113971.26	98.15	12000
5/6/2011 16:00	1070809.78	2104618.23	98.48	0
5/6/2011 17:00	1075868.54	2124423.53	97.84	23000
5/6/2011 17:05	1076358.59	2122506.61	97.86	21000
5/6/2011 17:09	1076168.30	2120522.57	97.87	19000
5/6/2011 17:12	1075942.85	2118558.99	97.92	17000
5/6/2011 17:16	1075036.41	2116769.81	98.10	15000
5/6/2011 17:20	1074472.18	2113985.72	98.10	12000
5/6/2011 17:52	1076008.53	2125333.95	97.86	24000

Date/Time	Northing	Easting	Elevation	Levee Station
5/6/2011 17:57	1076635.43	2128258.84	97.84	27000
5/6/2011 18:00	1081292.16	2130234.80	97.95	32000
5/6/2011 18:04	1084144.99	2134411.98	97.82	37000
5/10/2011 11:40	1076026.15	2125287.20	101.90	24000
5/10/2011 11:45	1076452.64	2127366.09	101.87	26000
5/10/2011 11:52	1078373.56	2129327.53	101.85	29000
5/10/2011 11:53	1081243.90	2130198.65	101.90	32000
5/10/2011 11:58	1082987.72	2132607.47	101.80	35000
5/10/2011 12:06	1084682.64	2135213.07	101.84	38000
5/10/2011 12:11	1086241.75	2137635.88	101.85	41000
5/10/2011 12:20	1087697.41	2140242.72	101.94	44000
5/10/2011 12:24	1089360.46	2142727.75	101.86	47000
5/10/2011 12:30	1091256.51	2145047.75	101.87	50000
5/10/2011 12:37	1093160.18	2147370.86	101.77	53000
5/10/2011 12:42	1094440.50	2148931.93	101.82	55000
5/10/2011 13:15	1096943.45	2150490.48	101.70	58000
5/10/2011 13:22	1099869.70	2151094.85	101.59	61000
5/10/2011 14:41	1096947.84	2150491.08	101.80	58000
5/10/2011 14:48	1094440.98	2148931.63	101.91	55000
5/10/2011 14:53	1091256.86	2145047.81	101.99	50000
5/10/2011 14:57	1088141.34	2141133.92	101.91	45000
5/10/2011 15:02	1085702.92	2136795.25	102.03	40000
5/10/2011 15:06	1082975.70	2132589.52	101.97	35000
5/10/2011 15:12	1079355.72	2129602.14	101.96	30000
5/10/2011 15:17	1076279.33	2126471.98	101.88	25000
5/10/2011 15:24	1076350.05	2122042.40	101.91	20500
5/11/2011 12:46	1073951.71	2099242.82	105.21	61700
5/11/2011 12:56	1073323.00	2100390.43	105.25	63000
5/11/2011 13:02	1072257.31	2102081.93	104.96	65000
5/11/2011 13:06	1071743.12	2102927.38	104.84	66000
5/11/2011 13:10	1071151.22	2103737.31	104.75	67000
5/11/2011 13:17	1070997.08	2103952.21	104.73	67300
5/11/2011 13:21	1070864.76	2104139.77	104.75	67500

Date/Time	Northing	Easting	Elevation	Levee Station
5/11/2011 13:50	1070673.98	2104408.05	104.78	67800
5/11/2011 12:15	1070672.89	2104408.83	104.81	67800
5/11/2011 13:45	1070773.39	2104572.94	103.58	200
5/11/2011 12:06	1070773.48	2104573.35	103.67	200
5/11/2011 14:38	1074702.74	2107187.19	103.58	5200
5/11/2011 14:34	1074735.44	2107373.99	103.46	5200

Figure 10. 06 May 2011 Yazoo Backwater levee water surface measurements (NAVD 88).

Figure 11. 06 May 2011 Yazoo Backwater profile (legend indicates time data were recorded).

Figure 12. 10 May 2011 Yazoo Backwater levee water surface measurements (NAVD 88).

Figure 13. 10 May 2011 Yazoo Backwater profile (legend indicates time data were recorded).

Figure 14. 11 May 2011 Yazoo Backwater levee water surface measurements (NAVD 88).

Figure 15. 11 May 2011 Yazoo Backwater profile.

The 11 May 2011 data include measurements on both the mainline levee and the backwater levee. For the water surface profile for this day (Figure 15), the backwater levee stations continue with the mainline levee numbering instead of starting at station zero. For the data collected on 11 May 2011, there is an obvious irregular drop in the profile near station 68,000 ft where the backwater levee and the mainline levee connect. A member of the

collection team observed this drawdown in the field. Water was seen rushing over the spur dike (Figure 16) with the downstream water elevation lower than upstream of the dike. The floodwaters during the 2011 Flood would be much higher than this image, which is from 30 July 2015. The Vicksburg gage reading was 11 ft higher during the peak of the flood than it was the date this image was recorded.

Figure 16. Spur dike location (image is from 30 July 2015).

Water surface super elevations in vicinity of Vicksburg, MS

CHL also measured water surface elevation along the Mississippi River at different locations near Vicksburg, MS. Data were collected the 12th, 13th, and 16th of May 2011. Some of these were super elevation measurements with water levels being recorded on opposite sides of the channel to determine the setup or increase in elevation across the channel. These measurement locations were estimated in the field. The water surface measurements are mapped for each date in Figure 17 to Figure 19 and tabulated in Table 4. Super elevations and corresponding setup are reported in Table 5.

Figure 17. 12 May 2011 Vicksburg water surface measurements.

Figure 18. 13 May 2011 Vicksburg water surface measurements.

Figure 19. 16 May 2011 Vicksburg water surface measurements.

Table 4. Water surface elevations at Vicksburg, MS.

Date/Time	State Plane Coordinate System MS WEST 2302 Survey (feet)		NAVD 88 (feet)
	Northing	Easting	Elevation
5/12/2011 17:36	1032599	2122979	101.43
5/12/2011 17:49	1039280	2126686	101.82
5/13/2011 11:43	1034386	2119542	102.08
5/13/2011 11:49	1031538	2117933	101.24
5/13/2011 11:58	1026332	2119273	100.06
5/13/2011 12:03	1025681	2121473	101.24
5/13/2011 12:10	1022720	2120226	100.51
5/13/2011 12:15	1024248	2117962	99.68
5/16/2011 16:28	1014109	2107642	101.58
5/16/2011 16:48	1022617	2120063	102.71
5/16/2011 16:51	1024021	2117747	101.85
5/16/2011 16:54	1026118	2118927	102.13
5/16/2011 16:59	1024895	2121264	102.87
5/16/2011 17:05	1034768	2118784	104.63
5/16/2011 17:07	1031351	2117576	103.53

Table 5. Super elevations and setup.

Location	River Mile	13 May 2011			16 May 2011		
		Right Bank	Left bank	Setup	Right Bank	Left bank	Setup
In bend	438	101.24	102.08	0.84	103.53	104.63	1.1
Upstream bridge	436	100.60	101.24	0.64	102.13	102.87	0.74
Downstream bridge	436.5	99.68	100.51	0.83	101.85	102.71	0.86

3 Conclusions

Processing of the 2011 bathymetry data proved very useful. These new data allowed bed-load calculations to populate the rating curves at extreme high-flow events. The data continued to follow the same trend observed in prior data with bedload continuing to increase significantly as flow increases. Both the Vicksburg and the Lower Mississippi River (LMR) rating curve are now bounded by two extreme events, the 2011 Flood and the 2012 drought. These rating curves can be a powerful tool to look at past sediment delivery and predict future sediment delivery given a future forecasted hydrograph.

The Vicksburg data matches well with the LMR data and is a good representation of the LMR. Future measurements at this site would be beneficial to continue to populate the rating curves and build a larger database of bed-load observations. This database could be used for further investigations such as determining other factors besides flow that influence bed-load transport. Continuous measurements over a year would produce a significant amount of data and would also allow the ability to see the evolution of dunes and how they grow and shrink during a hydrograph. This can somewhat be seen in the 2011 data in Appendix A. As flow rates decrease, the large dunes began to decrease in size. This morphing appears to be driven by smaller dunes translating over the tops of the larger dunes as can be seen in the 03 June 2011 survey and profiles in Appendix A.

Continuous improvements of the method, such as fewer data requirements, along with the close proximity of the Vicksburg site to the U.S. Army Engineer Research and Development Center, could make continuous bed-load measurements more economically feasible. The main variables affecting this would be the total length of time (e.g., 1 year) and the interval (e.g., weekly).

The water surface measurements also provide a significant amount of data. The water surface profile provides a continuous dataset along the Mississippi River between Rosedale, MS, and Natchez, MS, that is also consistent with the gage observations during the 2011 Flood. This provides high spatial fidelity water surface elevations during an extreme event. The water surface measurements at the Yazoo Backwater levee captured a unique phenomenon as a drawdown occurred at the levee intersection with the mainline levee. This data can be very useful in better

understanding and predicting the localized energy loss and levee overtopping potential at this location. The super elevation measurements near the Vicksburg bridge captured a 1-foot higher water surface elevation on the left bank (descending) than the right bank (descending) in the bend of the river during an extreme flood.

References

Abraham D., R. Kuhnle, and A. J. Odgaard. 2011. "Validation of Bed-Load Transport Measurements with Time-Sequenced Bathymetric Data." *ASCE Journal of Hydraulic Engineering* 137(7): 723–728.

Appendix A: Dune Survey and Profile Plots

This appendix consists of an example dune survey and an example dune translation profile for each survey date. The plan views are a combination of seven surveyed swaths that are numbered 1 through 7 from right descending bank to the left. The profiles represent a longitudinal section. The numbers in the legend of the profiles represent the swath number and the time of the survey.

Figure 20. 15 May 2011 dune field.

Figure 21. 15 May 2011 example profile.

Figure 22. 19 May 2011 dune field.

Figure 23. 19 May 2011 example profile.

Figure 24. 26 May 2011 dune field.

Figure 25. 26 May 2011 example profile.

Figure 26. 31 May 2011 dune field.

Figure 27. 31 May 2011 example profile.

Figure 28. 03 June 2011 dune field.

Figure 29. 03 June 2011 example profile.

Appendix B: Water Surface Profile Data

This appendix includes tabulated information for the water surface profile from river mile 597 to 362.

River Mile	GPS Time (seconds)	Easting SP (feet)	Northing SP (feet)	Elevation Geoid 03	Standard Deviation	Latitude	Longitude	Ellipsoid Ht U.S. Survey (feet)
362	343754	1952484.99	747626.678	78.248	0.056	31.550843	-91.437943	-6.526
362.5	343390	1954853.22	749311.734	78.461	0.056	31.555540	-91.430396	-6.503
363	343214	1956717.59	750574.389	78.622	0.056	31.559062	-91.424452	-6.297
363.5	343046	1958843.23	751930.217	78.580	0.062	31.562847	-91.417672	-6.291
364	342910	1960560.34	753402.469	79.275	0.062	31.566940	-91.412207	-5.427
364.5	342847	1961961.15	755595.401	79.595	0.075	31.573005	-91.407779	-3.859
365	342806	1962508.69	757963.112	79.457	0.072	31.579528	-91.406096	-4.473
365.5	342765	1963041.89	760478.812	79.571	0.075	31.586457	-91.404463	-4.202
366	342723	1963259.13	763057.611	79.673	0.075	31.593551	-91.403846	-3.917
366.5	342680	1963518.33	765612.64	80.182	0.072	31.600581	-91.403094	-3.395
367	342636	1963666.43	768196.789	80.479	0.072	31.607687	-91.402700	-3.225
367.5	342594	1963931.00	770704.854	80.762	0.075	31.614588	-91.401929	-2.971
368	342554	1964344.09	773132.783	80.831	0.075	31.621273	-91.400678	-3.031
368.5	342511	1964719.60	775815.373	81.037	0.072	31.628656	-91.399556	-2.618
369	342467	1964935.33	778492.211	81.115	0.075	31.636019	-91.398947	-2.518
369.5	342411	1964686.02	781318.369	80.287	0.066	31.643780	-91.399837	-3.352
370	342355	1964412.81	784244.251	81.028	0.079	31.651815	-91.400806	-2.524
370.5	342309	1964474.56	787102.292	80.815	0.075	31.659672	-91.400698	-2.998
371	342264	1964569.56	789873.948	81.511	0.072	31.667293	-91.400479	-2.140
371.5	342225	1964723.48	792272.99	81.651	0.075	31.673891	-91.400060	-1.934
372	342186	1965079.30	794614.377	82.003	0.075	31.680336	-91.398990	-1.740
372.5	342138	1965259.81	797423.724	82.534	0.072	31.688062	-91.398498	-0.832
373	342093	1965559.96	799986.588	82.916	0.072	31.695115	-91.397614	-0.763
373.5	342048	1966000.92	802273.389	82.814	0.072	31.701412	-91.396268	-0.708
374	341991	1966629.22	804652.263	82.841	0.066	31.707967	-91.394322	-0.820
374.5	341939	1967423.23	806877.901	83.635	0.072	31.714105	-91.391839	-0.106
375	341884	1968611.44	809085.06	83.465	0.072	31.720204	-91.388087	0.108
375.5	341839	1969992.27	811224.443	83.871	0.072	31.726120	-91.383714	0.135

River Mile	GPS Time (seconds)	Easting SP (feet)	Northing SP (feet)	Elevation Geoid 03	Standard Deviation	Latitude	Longitude	Ellipsoid Ht U.S. Survey (feet)
376	341753	1971462.05	813481.481	83.965	0.069	31.732363	-91.379057	0.692
376.5	341705	1972688.72	816004.499	84.168	0.072	31.739330	-91.375189	0.721
377	341658	1973893.76	818501.869	84.495	0.072	31.746226	-91.371390	1.053
377.5	341611	1974872.83	821065.714	84.687	0.079	31.753298	-91.368320	1.198
378	341564	1975770.43	823616.689	84.807	0.082	31.760333	-91.365510	1.259
378.5	341439	1976519.76	826354.918	85.096	0.085	31.767879	-91.363183	1.539
379	341398	1976656.59	828750.026	85.195	0.098	31.774465	-91.362816	1.742
379.5	341354	1976986.28	831314.385	85.260	0.102	31.781522	-91.361833	1.678
380	341309	1977436.29	833923.754	85.503	0.105	31.788706	-91.360464	2.016
380.5	341264	1977841.90	836526.628	85.481	0.105	31.795870	-91.359238	1.986
381	341219	1978389.82	839074.409	85.648	0.112	31.802887	-91.357552	2.153
381.5	341171	1978939.68	841822.212	85.814	0.112	31.810454	-91.355865	2.314
382	341124	1979627.39	844494.921	86.058	0.115	31.817818	-91.353733	2.524
382.5	341079	1980297.75	847046.051	86.295	0.115	31.824847	-91.351652	2.873
383	341035	1980960.81	849548.496	86.425	0.115	31.831742	-91.349593	2.914
383.5	340988	1981575.26	852165.827	87.082	0.121	31.838952	-91.347693	3.611
384	340940	1982955.18	854428.859	87.308	0.125	31.845207	-91.343318	3.803
384.5	340896	1985144.21	855603.842	87.397	0.128	31.848492	-91.336305	3.907
385	340851	1987407.28	856809.459	87.474	0.128	31.851863	-91.329053	3.957
385.5	340809	1989618.51	857716.563	87.580	0.128	31.854412	-91.321959	4.043
386	340765	1992132.75	858069.744	87.501	0.135	31.855445	-91.313873	3.962
386.5	340721	1994704.31	858021.647	87.599	0.138	31.855377	-91.305590	4.110
387	340676	1997303.71	858143.436	87.675	0.131	31.855775	-91.297223	4.174
387.5	340631	1999872.71	858320.98	87.790	0.131	31.856326	-91.288955	4.261
388	340584	2002481.65	858652.535	87.947	0.128	31.857300	-91.280563	4.364
388.5	340538	2005022.20	858929.539	87.969	0.128	31.858122	-91.272389	4.415
389	340492	2007557.59	859440.554	88.020	0.125	31.859586	-91.264238	4.414
389.5	340444	2010181.25	860111.376	88.218	0.121	31.861492	-91.255807	4.616
390	340391	2012922.97	861529.834	88.446	0.121	31.865454	-91.247016	4.908
390.5	340348	2015154.12	862817.755	88.292	0.118	31.869046	-91.239864	4.666
391	340303	2017458.60	864280.568	88.452	0.115	31.873119	-91.232481	4.946
391.5	340258	2019591.40	865943.943	88.684	0.108	31.877739	-91.225655	5.001
392	340213	2021741.36	867581.362	88.990	0.108	31.882289	-91.218773	5.354

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392.5	340167	2023458.14	869701.058	89.533	0.105	31.888153	-91.213298	5.801
393	340123	2024926.32	871861.607	89.718	0.102	31.894124	-91.208625	5.932
393.5	340079	2026041.15	874118.39	89.665	0.098	31.900352	-91.205091	5.948
394	340037	2027020.13	876400.682	89.670	0.092	31.906647	-91.201996	5.975
394.5	339994	2027849.88	878837.819	89.491	0.092	31.913364	-91.199385	5.833
395	339949	2028417.88	881383.028	89.930	0.089	31.920372	-91.197620	6.226
395.5	339902	2029059.31	883996.743	89.714	0.089	31.927570	-91.195620	6.048
396	339852	2029193.26	886963.896	89.862	0.085	31.935729	-91.195265	6.375
396.5	339808	2029848.62	889510.813	89.724	0.085	31.942743	-91.193218	5.976
397	339766	2030505.91	891949.429	90.348	0.089	31.949461	-91.191161	6.571
397.5	339724	2031332.20	894329.509	91.031	0.085	31.956020	-91.188558	7.244
398	339681	2032357.79	896604.141	91.332	0.085	31.962295	-91.185309	7.530
398.5	339641	2033662.42	898522.968	91.446	0.085	31.967597	-91.181152	7.860
399	339603	2035248.27	900128.525	91.619	0.082	31.972044	-91.176079	8.030
399.5	339558	2037462.34	901570.827	91.489	0.085	31.976056	-91.168975	7.716
400	339519	2039394.71	902782.1	92.090	0.082	31.979426	-91.162774	8.200
400.5	339485	2041320.03	903386.005	91.889	0.085	31.981126	-91.156580	7.921
401	339446	2043614.61	903837.319	92.326	0.085	31.982414	-91.149192	8.578
401.5	339395	2046606.40	904175.915	92.518	0.089	31.983407	-91.139552	8.831
402	339347	2049417.47	904431.876	92.508	0.085	31.984168	-91.130492	8.622
402.5	339300	2052018.92	905092.826	92.577	0.079	31.986037	-91.122118	8.837
403	339262	2054211.12	905316.636	92.815	0.082	31.986696	-91.115054	9.161
403.5	339217	2056784.08	905868.228	92.986	0.079	31.988263	-91.106769	9.344
404	339169	2059392.11	906916.333	93.055	0.075	31.991194	-91.098381	9.277
404.5	339122	2061501.02	908688.753	93.190	0.079	31.996107	-91.091620	9.406
405	339081	2063234.00	910361.128	93.120	0.075	32.000737	-91.086068	9.241
405.5	339035	2065202.20	912237.37	93.459	0.079	32.005932	-91.079761	9.833
406	338988	2066729.84	914546.425	93.749	0.075	32.012307	-91.074884	9.951
406.5	338943	2067859.36	916940.155	93.881	0.075	32.018908	-91.071293	10.006
407	338898	2068934.03	919302.053	94.152	0.075	32.025420	-91.067878	10.220
407.5	338852	2070108.33	921704.916	94.556	0.075	32.032047	-91.064142	10.704
408	338802	2071163.83	924385.138	94.817	0.075	32.039434	-91.060794	10.917
408.5	338751	2071994.32	927139.23	95.085	0.075	32.047019	-91.058174	11.146

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409	338693	2072079.19	930352.59	95.502	0.072	32.055853	-91.057970	11.532
409.5	338643	2071205.98	932934.64	95.639	0.072	32.062934	-91.060844	11.646
410	338599	2070255.88	935077.403	95.762	0.072	32.068806	-91.063958	11.750
410.5	338553	2068800.20	936995.285	95.924	0.072	32.074050	-91.068699	11.900
411	338503	2066827.07	938747.517	95.988	0.072	32.078829	-91.075107	11.941
411.5	338454	2064761.08	940495.355	96.003	0.069	32.083594	-91.081816	11.936
412	338408	2062990.65	942405.545	96.051	0.069	32.088811	-91.087575	12.016
412.5	338357	2061215.09	944732.426	96.142	0.069	32.095172	-91.093360	12.136
413	338311	2059795.78	946949.42	96.340	0.069	32.101238	-91.097994	12.230
413.5	338268	2058457.95	948981.623	96.747	0.069	32.106798	-91.102360	12.628
414	338228	2057205.00	950914.388	97.081	0.072	32.112086	-91.106451	12.920
414.5	338106	2058200.77	956449.449	97.693	0.072	32.127319	-91.103363	13.506
415	338085	2059329.08	956799.59	97.697	0.072	32.128303	-91.099727	13.500
415.5	338050	2061119.11	957548.591	97.875	0.069	32.130397	-91.093962	13.682
416	337991	2064193.93	958076.902	97.807	0.069	32.131908	-91.084042	13.609
416.5	337940	2066936.68	957525.994	97.868	0.066	32.130446	-91.075170	13.652
417	337898	2069163.95	956529.609	97.779	0.066	32.127750	-91.067954	13.583
417.5	337855	2071603.61	955788.05	97.979	0.066	32.125757	-91.060058	13.776
418	337810	2074094.43	954892.182	98.165	0.066	32.123340	-91.051993	13.968
418.5	337770	2076398.79	954590.398	98.371	0.066	32.122553	-91.044544	14.208
419	337731	2078659.93	954609.954	98.448	0.066	32.122647	-91.037241	14.322
419.5	337702	2080316.11	954943.017	98.613	0.066	32.123593	-91.031899	14.462
420	337669	2082163.29	955301.67	98.654	0.062	32.124611	-91.025940	14.406
420.5	337640	2083672.30	956057.475	98.696	0.062	32.126715	-91.021082	14.415
421	337607	2085292.00	957066.015	98.750	0.062	32.129516	-91.015871	14.687
421.5	337564	2086884.78	959011.622	98.908	0.062	32.134891	-91.010765	14.680
422	337518	2088557.69	961136.195	99.023	0.062	32.140759	-91.005404	14.778
422.5	337478	2089996.22	962877.993	99.180	0.062	32.145572	-91.000792	14.965
423	337409	2090759.46	966381.144	99.325	0.066	32.155213	-90.998396	15.038
423.5	337363	2090769.57	968991.953	99.393	0.069	32.162390	-90.998415	15.090
424	337314	2090902.51	971784.803	99.444	0.072	32.170069	-90.998042	15.072
424.5	337271	2091024.40	974291.458	99.399	0.072	32.176961	-90.997698	15.092
425	337228	2091278.59	976812.588	99.362	0.069	32.183894	-90.996927	14.996

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425.5	337183	2091608.76	979461.138	99.663	0.069	32.191180	-90.995912	15.141
426	337138	2092390.26	982041.525	99.830	0.066	32.198286	-90.993437	15.336
426.5	337093	2093377.43	984514.91	99.967	0.066	32.205101	-90.990295	15.699
427	337051	2094546.67	986732.043	100.147	0.062	32.211214	-90.986559	15.697
427.5	337009	2095153.54	989132.495	100.100	0.062	32.217822	-90.984644	15.594
428	336962	2095316.14	991868.176	100.559	0.062	32.225344	-90.984172	16.058
428.5	336916	2095777.73	994538.33	100.763	0.062	32.232691	-90.982731	16.260
429	336873	2096622.61	996943.434	100.973	0.059	32.239316	-90.980046	16.410
429.5	336817	2098694.02	999313.741	101.078	0.059	32.245865	-90.973393	16.522
430	336759	2100164.54	1002222.548	101.273	0.059	32.253884	-90.968692	16.675
430.5	336715	2101499.76	1004416.556	101.385	0.059	32.259937	-90.964415	16.821
431	336670	2102952.38	1006615.387	101.404	0.059	32.266004	-90.959758	16.735
431.5	336627	2104396.59	1008760.124	101.539	0.059	32.271922	-90.955126	17.043
432	336584	2106032.68	1010799.198	101.749	0.059	32.277552	-90.949871	16.944
432.5	336542	2107892.39	1012583.975	101.643	0.059	32.282487	-90.943887	17.143
433	336500	2109887.27	1014213.519	101.714	0.059	32.286997	-90.937462	16.893
433.5	336459	2111853.23	1015783.996	102.089	0.059	32.291344	-90.931129	17.461
434	336417	2113859.87	1017380.403	102.055	0.059	32.295763	-90.924664	17.344
434.5	336374	2115896.22	1019062.509	102.249	0.059	32.300417	-90.918104	17.482
435	336331	2117838.20	1020875.663	102.035	0.059	32.305429	-90.911851	17.244
436	333341	2120642.65	1025543.641	103.236	0.089	32.318301	-90.902855	18.500
436.5	333283	2121654.63	1027886.265	103.704	0.095	32.324755	-90.899619	19.013
437	333210	2122170.55	1030816.754	104.625	0.092	32.332817	-90.897999	19.867
437.5	332925	2119838.78	1031567.234	104.609	0.075	32.334846	-90.905561	18.841
438	332515	2116433.83	1032519.164	104.334	0.075	32.337412	-90.916601	18.552
438.5	332440	2114520.96	1033605.823	104.891	0.089	32.340370	-90.922813	20.123
439	332395	2112094.04	1034420.995	105.206	0.092	32.342574	-90.930686	20.378
439.5	332353	2109705.18	1034909.356	105.367	0.092	32.343879	-90.938429	20.549
440	332310	2107184.57	1035199.468	105.725	0.092	32.344637	-90.946596	20.910
440.5	332266	2104578.92	1035561.806	105.672	0.095	32.345592	-90.955039	20.706
441	332223	2102028.68	1035869.558	105.793	0.089	32.346397	-90.963302	21.217
441.5	332178	2099361.67	1036426.987	105.912	0.092	32.347885	-90.971948	21.281
442	332134	2096803.82	1037057.131	105.875	0.092	32.349575	-90.980242	20.957

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442.5	332089	2094255.53	1037869.089	106.533	0.095	32.351764	-90.988510	21.781
443	332045	2092033.25	1039184.077	106.738	0.089	32.355341	-90.995732	21.946
443.5	332001	2090247.37	1040921.201	107.256	0.092	32.360085	-91.001550	22.520
444	331959	2089717.06	1043173.271	107.169	0.092	32.366266	-91.003313	22.415
444.5	331922	2090241.74	1045237.632	106.952	0.092	32.371949	-91.001655	22.194
445	331882	2090804.05	1047474.11	107.238	0.095	32.378106	-90.999879	22.495
445.5	331845	2091415.30	1049477.11	107.360	0.095	32.383621	-90.997940	22.576
446	331805	2092106.52	1051607.346	107.466	0.092	32.389488	-90.995744	22.700
446.5	331757	2092897.98	1054203.24	107.613	0.089	32.396636	-90.993232	22.772
447	331708	2093038.13	1056984.022	108.026	0.092	32.404282	-90.992833	23.374
447.5	331663	2091742.84	1059217.089	107.902	0.089	32.410398	-90.997075	23.271
448	331618	2090223.15	1061410.834	107.892	0.092	32.416401	-91.002043	23.214
448.5	331572	2088337.69	1063305.96	107.956	0.085	32.421577	-91.008191	23.298
449	331520	2086500.80	1065269.114	107.810	0.082	32.426941	-91.014184	22.900
449.5	331384	2084202.62	1066568.125	108.741	0.069	32.430471	-91.021659	23.029
450	331235	2081727.39	1067626.102	108.483	0.069	32.433335	-91.029703	22.720
450.5	331082	2079088.84	1068451.006	108.481	0.069	32.435554	-91.038272	22.834
451	330975	2076663.49	1069304.477	108.887	0.089	32.437856	-91.046151	24.171
451.5	330929	2074289.50	1070327.704	108.809	0.089	32.440624	-91.053867	23.941
452	330880	2071601.49	1071159.841	108.643	0.089	32.442861	-91.062598	23.960
452.5	330834	2069136.89	1071963.469	108.956	0.085	32.445024	-91.070604	24.265
453	330783	2066872.60	1072948.261	108.878	0.089	32.447687	-91.077966	24.899
453.5	330679	2064522.45	1074388.438	108.923	0.075	32.451600	-91.085616	24.552
454	330581	2062411.11	1075931.657	109.376	0.085	32.455800	-91.092496	25.057
454.5	330531	2060649.40	1077953.194	110.162	0.095	32.461322	-91.098254	25.508
455	330484	2059077.39	1079994.411	110.658	0.095	32.466901	-91.103398	26.063
455.5	330435	2057536.63	1082181.326	111.205	0.095	32.472881	-91.108444	26.719
456	330389	2056508.54	1084465.881	111.200	0.095	32.479139	-91.111832	26.623
456.5	330341	2055607.67	1086900.997	111.188	0.089	32.485814	-91.114811	26.679
457	330295	2055153.96	1089201.123	111.335	0.089	32.492127	-91.116337	26.822
457.5	330252	2055839.26	1091425.673	111.114	0.092	32.498254	-91.114167	26.591
458	330205	2056635.40	1093924.621	111.254	0.089	32.505139	-91.111644	26.869
458.5	330160	2057671.28	1096208.503	111.359	0.089	32.511436	-91.108338	26.740

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459	330113	2058955.08	1098484.474	111.931	0.092	32.517717	-91.104227	27.487
459.5	330062	2060192.36	1100975.584	112.068	0.089	32.524588	-91.100272	27.612
460	330012	2060925.83	1103558.411	112.262	0.089	32.531702	-91.097953	27.702
460.5	329956	2060994.70	1106505.991	112.775	0.092	32.539804	-91.097798	28.443
461	329904	2060456.57	1109187.143	112.953	0.092	32.547162	-91.099607	28.503
461.5	329858	2059391.65	1111393.566	112.932	0.095	32.553205	-91.103114	28.310
462	329808	2058691.90	1113980.475	113.092	0.095	32.560301	-91.105446	28.618
462.5	329766	2058015.35	1116155.378	113.212	0.098	32.566265	-91.107693	28.778
463	329718	2056805.05	1118434.571	113.234	0.095	32.572505	-91.111675	28.806
463.5	329671	2055315.74	1120482.427	113.283	0.102	32.578103	-91.116558	28.880
464	329622	2053514.18	1122410.779	113.600	0.108	32.583367	-91.122452	29.236
464.5	329573	2051752.05	1124306.404	113.941	0.112	32.588541	-91.128218	29.585
465	329522	2050230.97	1126523.846	114.062	0.112	32.594604	-91.133211	29.881
465.5	329473	2048533.91	1128480.731	113.975	0.115	32.599947	-91.138768	29.687
466	329426	2047082.87	1130505.826	114.297	0.125	32.605482	-91.143530	30.091
466.5	329382	2046153.53	1132646.451	114.208	0.128	32.611346	-91.146600	30.092
467	329336	2045209.20	1134935.497	114.518	0.135	32.617617	-91.149724	30.331
467.5	329294	2044543.16	1137122.324	114.773	0.138	32.623613	-91.151942	30.767
468	329246	2044172.58	1139700.582	114.862	0.141	32.630691	-91.153210	30.657
468.5	329196	2044363.68	1142377.836	114.976	0.144	32.638053	-91.152656	30.916
469	329140	2045214.16	1145301.306	115.433	0.138	32.646106	-91.149967	31.312
469.5	329084	2046720.34	1148023.675	115.361	0.141	32.653619	-91.145141	31.187
470	329023	2048826.29	1150560.601	115.859	0.138	32.660636	-91.138362	31.649
470.5	328968	2051389.97	1152069.596	116.053	0.151	32.664836	-91.130070	31.870
471	328917	2053752.57	1153447.755	116.252	0.144	32.668672	-91.122426	32.048
471.5	328867	2056504.39	1153931.426	115.735	0.144	32.670057	-91.113497	31.406
472	328821	2058949.32	1154762.248	116.009	0.151	32.672390	-91.105572	31.675
472.5	328772	2061601.11	1155317.948	116.109	0.164	32.673970	-91.096968	31.833
473	328653	2064106.79	1156166.014	115.986	0.118	32.676350	-91.088845	30.628
473.5	328503	2066423.17	1157344.447	116.495	0.115	32.679634	-91.081345	31.155
474	328368	2068475.05	1158865.206	116.356	0.112	32.683853	-91.074711	30.896
474.5	328313	2070359.46	1160715.396	116.689	0.141	32.688974	-91.068629	32.341
475	328269	2071692.24	1162930.314	116.830	0.138	32.695087	-91.064347	32.305

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475.5	328226	2072885.58	1165316.067	117.496	0.135	32.701666	-91.060521	33.117
476	328183	2074029.57	1167631.488	118.204	0.125	32.708051	-91.056854	33.865
476.5	328138	2074640.12	1170149.103	118.708	0.125	32.714982	-91.054925	34.104
477	328096	2074147.92	1172482.267	118.938	0.121	32.721385	-91.056577	34.435
477.5	328057	2072987.14	1174375.956	118.944	0.121	32.726568	-91.060393	34.497
478	328014	2071071.67	1175895.345	118.989	0.121	32.730708	-91.066656	34.578
478.5	327973	2068905.73	1176883.758	118.781	0.118	32.733383	-91.073721	34.370
479	327930	2066410.09	1177362.316	118.776	0.128	32.734650	-91.081847	34.368
479.5	327888	2063814.71	1177372.953	118.837	0.128	32.734628	-91.090286	34.391
480	327847	2061262.61	1177352.71	118.832	0.128	32.734522	-91.098585	34.377
480.5	327803	2058535.38	1177144.584	119.159	0.131	32.733896	-91.107448	34.881
481	327758	2055780.88	1176895.656	119.729	0.135	32.733156	-91.116398	35.422
481.5	327714	2053110.33	1176854.118	120.113	0.135	32.732987	-91.125081	35.825
482	327665	2050448.63	1176961.425	120.474	0.138	32.733227	-91.133739	36.286
482.5	327620	2048147.96	1177581.403	120.899	0.135	32.734883	-91.141235	36.720
483	327575	2046409.09	1179179.836	120.801	0.138	32.739240	-91.146929	36.701
483.5	327530	2045293.71	1181272.255	120.914	0.141	32.744967	-91.150609	36.919
484	327480	2044360.84	1183687.734	120.817	0.125	32.751585	-91.153703	36.609
484.5	327405	2043448.50	1186420.621	120.909	0.102	32.759076	-91.156739	35.962
485	327351	2043109.90	1188862.097	121.161	0.118	32.765779	-91.157903	37.080
485.5	327301	2043072.73	1191692.126	121.289	0.128	32.773556	-91.158095	37.179
486	327254	2042968.62	1194457.861	121.582	0.128	32.781155	-91.158504	37.381
486.5	327211	2043056.35	1196974.93	121.854	0.121	32.788074	-91.158282	37.609
487	327165	2043484.52	1199634.899	122.040	0.115	32.795394	-91.156957	38.001
487.5	327120	2044160.47	1202200.789	122.083	0.115	32.802460	-91.154822	37.860
488	327075	2044651.55	1204782.578	122.241	0.112	32.809566	-91.153289	38.068
488.5	327033	2045443.36	1207124.248	122.563	0.105	32.816018	-91.150771	38.492
489	326993	2046263.83	1209315.943	122.763	0.108	32.822059	-91.148156	38.571
489.5	326945	2047166.89	1211991.588	123.075	0.105	32.829431	-91.145284	38.850
490	326890	2048695.85	1214781.212	123.149	0.102	32.837130	-91.140376	38.915
490.5	326841	2050592.46	1216808.627	123.303	0.105	32.842742	-91.134252	39.067
491	326794	2052603.49	1218550.602	123.600	0.098	32.847571	-91.127747	39.340
491.5	326746	2054737.28	1220247.394	123.785	0.095	32.852278	-91.120841	39.529

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492	326698	2056880.09	1221909.501	123.945	0.092	32.856889	-91.113904	39.645
492.5	326656	2058754.18	1223400.071	124.023	0.089	32.861024	-91.107838	39.722
493	326606	2060941.34	1225188.713	124.146	0.085	32.865983	-91.100758	39.784
493.5	326561	2063116.94	1226498.61	124.168	0.082	32.869627	-91.093704	39.757
494	326517	2064962.39	1228222.876	124.347	0.075	32.874402	-91.087734	40.103
494.5	326473	2066755.46	1230111.016	124.512	0.075	32.879626	-91.081938	40.175
495	326430	2068552.30	1231937.625	124.875	0.072	32.884681	-91.076128	40.458
495.5	326385	2070209.33	1234022.489	124.989	0.075	32.890443	-91.070778	40.566
496	326339	2071691.15	1236313.465	125.286	0.072	32.896767	-91.066003	41.005
496.5	326290	2072786.17	1238976.266	125.396	0.072	32.904106	-91.062495	41.016
497	326242	2072696.50	1241849.582	125.305	0.072	32.912001	-91.062852	41.047
497.5	326200	2072444.80	1244400.972	125.628	0.072	32.919008	-91.063730	41.450
498	326155	2071762.41	1246994.239	126.040	0.069	32.926122	-91.066012	41.698
498.5	326112	2070609.42	1249291.907	126.296	0.072	32.932415	-91.069822	42.124
499	326067	2069231.41	1251598.52	126.514	0.072	32.938727	-91.074366	42.375
499.5	326023	2067312.05	1253460.303	126.584	0.075	32.943807	-91.080664	42.393
500	325976	2064824.79	1254830.349	126.626	0.079	32.947523	-91.088803	42.510
500.5	325934	2062418.50	1255685.647	126.685	0.082	32.949826	-91.096666	42.606
501	325892	2060000.17	1256338.42	126.927	0.082	32.951572	-91.104565	42.832
501.5	325848	2057440.63	1256950.461	127.128	0.089	32.953202	-91.112923	43.039
502	325804	2054861.30	1257484.84	127.407	0.089	32.954618	-91.121343	43.482
502.5	325757	2052154.96	1258107.867	127.760	0.092	32.956274	-91.130181	43.789
503	325708	2049389.48	1258571.806	128.297	0.092	32.957491	-91.139207	44.327
503.5	325652	2046331.87	1259187.924	128.799	0.21	32.959120	-91.149190	44.916
504	325607	2044532.29	1260867.349	129.085	0.217	32.963697	-91.155099	45.230
504.5	325568	2043592.43	1262801.012	129.013	0.207	32.968990	-91.158212	45.200
505	325520	2043209.68	1265408.173	128.883	0.207	32.976147	-91.159527	45.090
505.5	325472	2042774.76	1267997.181	129.069	0.213	32.983253	-91.161011	45.320
506	325424	2042750.76	1270654.967	129.009	0.203	32.990556	-91.161158	45.310
506.5	325385	2043303.86	1272742.772	128.693	0.207	32.996306	-91.159407	44.945
507	325346	2043952.10	1275026.028	129.173	0.21	33.002595	-91.157352	45.440
507.5	325304	2044655.25	1277506.882	129.698	0.203	33.009428	-91.155122	46.172
508	325258	2045393.65	1280211.039	130.002	0.21	33.016875	-91.152782	46.427

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508.5	325207	2045977.35	1283220.176	130.548	0.21	33.025157	-91.150954	47.067
509	325165	2046113.52	1285760.508	130.506	0.207	33.032141	-91.150574	46.923
509.5	325118	2045715.97	1288492.446	130.609	0.207	33.039640	-91.151941	47.050
510	325075	2044943.09	1290867.948	130.486	0.203	33.046152	-91.154523	46.888
510.5	325031	2043845.10	1293238.2	130.750	0.213	33.052642	-91.158167	47.241
511	324986	2042880.05	1295836.308	131.098	0.223	33.059761	-91.161383	47.593
511.5	324944	2041939.04	1298300.278	131.350	0.203	33.066512	-91.164518	47.882
512	324898	2041060.56	1301024.311	131.901	0.207	33.073979	-91.167455	48.427
512.5	324853	2040488.56	1303699.094	132.641	0.194	33.081317	-91.169392	49.234
513	324805	2040245.77	1306473.256	133.265	0.184	33.088936	-91.170257	49.864
513.5	324756	2041176.89	1309106.616	133.424	0.187	33.096193	-91.167285	50.030
514	324707	2042835.73	1311352.888	133.618	0.18	33.102402	-91.161927	50.230
514.5	324658	2044957.46	1313113.318	133.669	0.18	33.107286	-91.155045	50.276
515	324613	2047333.74	1314354.422	133.668	0.174	33.110747	-91.147317	50.212
515.5	324570	2049778.62	1315275.126	133.637	0.174	33.113329	-91.139356	50.254
516	324528	2052267.43	1315825.265	133.835	0.164	33.114894	-91.131242	50.357
516.5	324482	2054984.50	1316328.637	134.161	0.161	33.116333	-91.122382	50.700
517	324436	2057662.00	1316752.646	134.483	0.151	33.117554	-91.113648	50.901
517.5	324393	2060090.48	1317496.093	134.797	0.154	33.119646	-91.105736	51.319
518	324353	2062017.72	1318897.969	134.819	0.141	33.123538	-91.099475	51.358
518.5	324313	2063604.66	1320669.274	134.962	0.128	33.128437	-91.094334	51.475
519	324272	2064873.75	1322799.936	135.125	0.131	33.134318	-91.090239	51.368
519.5	324232	2065916.14	1324992.517	135.193	0.121	33.140364	-91.086886	51.489
520	324191	2066729.31	1327347.754	135.395	0.118	33.146853	-91.084285	51.758
520.5	324146	2067250.96	1330041.643	135.561	0.105	33.154266	-91.082644	51.912
521	324100	2067452.43	1332826.846	135.768	0.102	33.161924	-91.082050	52.062
521.5	324059	2067588.11	1335324.78	135.941	0.105	33.168792	-91.081665	52.224
522	324017	2067480.89	1337868.391	136.171	0.102	33.175780	-91.082075	52.509
522.5	323975	2066936.96	1340385.213	136.143	0.095	33.182686	-91.083912	52.461
523	323935	2066173.34	1342740.599	136.336	0.098	33.189143	-91.086463	52.730
523.5	323891	2065109.06	1345258.926	136.378	0.138	33.196043	-91.090001	52.647
524	323845	2063995.61	1347859.935	136.685	0.098	33.203169	-91.093702	52.916
524.5	323801	2062994.31	1350360.27	136.821	0.098	33.210020	-91.097035	53.038

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525	323757	2062091.64	1352816.905	137.013	0.098	33.216753	-91.100045	53.221
525.5	323711	2061313.98	1355263.71	137.486	0.092	33.223461	-91.102646	53.642
526	323666	2060110.90	1357490.043	137.750	0.095	33.229555	-91.106633	53.893
526.5	323619	2058924.58	1359856.607	137.932	0.095	33.236034	-91.110570	54.130
527	323574	2057760.39	1362128.506	137.982	0.092	33.242254	-91.114433	54.159
527.5	323523	2056230.54	1364549.728	138.068	0.092	33.248876	-91.119495	54.263
528	323474	2054942.22	1366989.858	138.186	0.085	33.255555	-91.123769	54.349
528.5	323427	2053514.12	1369252.441	138.324	0.089	33.261743	-91.128497	54.473
529	323382	2052032.30	1371396.264	138.264	0.089	33.267603	-91.133398	54.466
529.5	323336	2050541.32	1373654.198	138.616	0.085	33.273777	-91.138332	54.882
530	323291	2048675.43	1375621.026	138.220	0.089	33.279142	-91.144486	54.334
530.5	323248	2046862.35	1377412.47	138.502	0.089	33.284026	-91.150464	54.690
531	323201	2045009.52	1379245.631	138.397	0.085	33.289024	-91.156574	54.615
531.5	322873	2043394.24	1381300.192	139.070	0.082	33.294635	-91.161912	55.228
532	322831	2041781.27	1383291.345	139.694	0.085	33.300071	-91.167242	55.822
532.5	322791	2040344.85	1385151.28	140.213	0.082	33.305151	-91.171992	56.377
533	322743	2038840.34	1387370.484	140.746	0.079	33.311216	-91.176974	56.893
533.5	322689	2037969.46	1390207.813	141.247	0.079	33.318993	-91.179900	57.381
534	322595	2039711.77	1394930.694	141.427	0.079	33.332011	-91.174322	57.452
534.5	322530	2042302.55	1397426.246	141.509	0.079	33.338926	-91.165906	57.434
535	322477	2044798.87	1398987.566	141.594	0.082	33.343271	-91.157773	57.493
535.5	322430	2047021.82	1400405.091	141.584	0.079	33.347214	-91.150532	57.410
536	322382	2049483.09	1401585.179	141.644	0.079	33.350510	-91.142503	57.433
536.5	322340	2051677.13	1402698.053	142.044	0.082	33.353615	-91.135347	57.770
537	322296	2053868.31	1404189.286	142.193	0.075	33.357759	-91.128209	57.905
537.5	322252	2055746.45	1406049.441	142.472	0.079	33.362910	-91.122105	58.102
538	322208	2057538.73	1407945.682	142.939	0.079	33.368158	-91.116282	58.518
538.5	322164	2058781.56	1410237.228	143.133	0.079	33.374481	-91.112268	58.733
539	322121	2059356.59	1412680.54	143.253	0.079	33.381207	-91.110444	58.790
539.5	322074	2059203.84	1415358.169	143.349	0.082	33.388562	-91.111010	58.803
540	322024	2058627.25	1418132.943	143.575	0.082	33.396175	-91.112967	59.156
540.5	321981	2058854.17	1420565.069	143.881	0.075	33.402863	-91.112283	59.378
541	321937	2059194.26	1423013.343	144.009	0.079	33.409598	-91.111229	59.514

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541.5	321892	2058894.24	1425503.198	144.118	0.079	33.416434	-91.112273	59.523
542	321844	2058317.99	1428092.432	144.140	0.079	33.423538	-91.114225	59.655
542.5	321795	2057872.11	1430755.437	144.267	0.075	33.430846	-91.115752	59.627
543	321745	2057415.64	1433385.167	144.494	0.079	33.438064	-91.117313	59.922
543.5	321696	2057121.01	1436066.309	144.599	0.075	33.445425	-91.118345	59.999
544	321645	2056935.71	1438708.497	144.705	0.075	33.452682	-91.119018	59.994
544.5	321595	2056730.00	1441216.701	144.956	0.075	33.459570	-91.119754	60.314
545	321537	2056198.82	1443900.735	145.250	0.075	33.466935	-91.121563	60.627
545.5	321469	2054916.45	1446625.44	145.102	0.075	33.474396	-91.125835	60.445
546	321417	2053619.80	1448926.859	145.508	0.075	33.480693	-91.130145	60.995
546.5	321342	2051217.17	1451483.412	145.645	0.075	33.487667	-91.138089	61.094
547	321280	2048761.35	1453145.246	145.804	0.075	33.492181	-91.146185	61.328
547.5	321200	2046468.52	1454330.038	145.763	0.066	33.495387	-91.153736	60.144
548	321065	2044152.57	1455920.608	145.933	0.069	33.499708	-91.161373	60.379
548.5	320937	2041566.60	1457404.721	145.805	0.072	33.503729	-91.169894	61.356
549	320844	2038826.06	1458574.014	146.371	0.089	33.506881	-91.178915	62.160
549.5	320801	2036480.72	1459505.002	146.419	0.092	33.509386	-91.186633	61.823
550	320758	2034214.61	1460654.426	146.545	0.092	33.512494	-91.194098	62.048
550.5	320715	2032033.35	1461945.14	147.035	0.095	33.515990	-91.201289	62.607
551	320671	2029946.62	1463472.292	147.167	0.102	33.520139	-91.208177	62.800
551.5	320627	2027922.74	1465167.486	147.206	0.105	33.524750	-91.214864	62.856
552	320582	2026144.04	1467264.444	147.388	0.108	33.530470	-91.220758	63.060
552.5	320535	2024589.18	1469624.974	147.386	0.105	33.536920	-91.225927	63.044
553	320491	2023436.23	1472004.009	147.860	0.112	33.543430	-91.229777	63.523
553.5	320411	2022270.00	1474475.709	148.755	0.082	33.550194	-91.233675	63.415
554	319983	2022283.88	1478360.451	149.735	0.112	33.560869	-91.233740	65.466
554.5	319947	2023609.59	1479949.387	149.629	0.105	33.565267	-91.229434	65.260
555	319900	2025918.30	1481447.977	149.718	0.108	33.569440	-91.221898	65.338
555.5	319852	2028691.73	1481974.115	149.914	0.112	33.570951	-91.212809	65.462
556	319806	2031427.14	1481878.757	150.120	0.105	33.570752	-91.203827	65.659
556.5	319762	2034026.52	1481685.103	150.357	0.105	33.570280	-91.195289	65.892
557	319719	2036499.36	1481520.889	150.587	0.105	33.569885	-91.187167	66.056
557.5	319674	2039033.33	1481683.467	150.791	0.102	33.570388	-91.178853	66.250

River Mile	GPS Time (seconds)	Easting SP (feet)	Northing SP (feet)	Elevation Geoid 03	Standard Deviation	Latitude	Longitude	Ellipsoid Ht U.S. Survey (feet)
558	319627	2041630.66	1482240.36	151.065	0.102	33.571977	-91.170342	66.502
558.5	319585	2043972.13	1482929.45	151.169	0.105	33.573922	-91.162674	66.603
559	319541	2046279.29	1484094.342	151.233	0.108	33.577174	-91.155130	66.664
559.5	319497	2048436.86	1485567.036	151.439	0.105	33.581267	-91.148085	66.909
560	319453	2050366.76	1487338.744	151.560	0.105	33.586177	-91.141794	66.881
560.5	319406	2052141.81	1489492.711	151.929	0.105	33.592134	-91.136021	67.266
561	319358	2053552.02	1491897.282	152.177	0.108	33.598772	-91.131452	67.482
561.5	319313	2054030.78	1494444.741	152.277	0.108	33.605782	-91.129944	67.600
562	319270	2053691.05	1496902.981	152.488	0.108	33.612530	-91.131122	67.783
562.5	319223	2052834.92	1499461.533	152.665	0.108	33.619542	-91.133999	67.997
563	319178	2051477.26	1501643.941	152.757	0.115	33.625510	-91.138514	68.093
563.5	319134	2049759.75	1503465.408	152.840	0.105	33.630479	-91.144202	68.188
564	319090	2047820.12	1505121.308	152.817	0.112	33.634987	-91.150617	68.200
564.5	319039	2045482.09	1507090.211	152.747	0.115	33.640346	-91.158349	68.143
565	318991	2043318.17	1509018.922	152.964	0.112	33.645599	-91.165509	68.373
565.5	318951	2041441.64	1510391.373	153.182	0.118	33.649328	-91.171711	68.617
566	318916	2039570.87	1511204.862	153.102	0.125	33.651522	-91.177879	68.562
566.5	318874	2037088.93	1511959.734	153.176	0.118	33.653540	-91.186055	68.641
567	318832	2034555.45	1512670.24	153.409	0.121	33.655435	-91.194399	68.921
567.5	318789	2032011.55	1513429.273	153.722	0.121	33.657462	-91.202778	69.142
568	318744	2029401.40	1514137.337	154.093	0.115	33.659347	-91.211375	69.495
568.5	318701	2027117.59	1515187.817	154.832	0.118	33.662180	-91.218909	70.409
569	318646	2024737.69	1517199.931	155.384	0.118	33.667653	-91.226787	71.027
569.5	318592	2024194.10	1520109.429	155.741	0.115	33.675635	-91.228656	71.413
570	318539	2024351.19	1522748.153	156.053	0.118	33.682889	-91.228215	71.673
570.5	318484	2024434.93	1525243.629	156.132	0.115	33.689748	-91.228011	71.753
571	318150	2027066.33	1528176.025	156.311	0.118	33.697868	-91.219443	71.923
571.5	318097	2029551.65	1529512.396	156.314	0.115	33.701599	-91.211311	71.885
572	318042	2032295.76	1530196.444	156.378	0.115	33.703542	-91.202308	71.944
572.5	317996	2034914.01	1529936.059	156.400	0.112	33.702887	-91.193693	71.902
573	317955	2037299.65	1529553.369	156.706	0.115	33.701890	-91.185839	72.170
573.5	317911	2039869.97	1529540.495	157.161	0.108	33.701912	-91.177389	72.595
574	317862	2042561.56	1530120.895	157.473	0.105	33.703567	-91.168555	72.939

River Mile	GPS Time (seconds)	Easting SP (feet)	Northing SP (feet)	Elevation Geoid 03	Standard Deviation	Latitude	Longitude	Ellipsoid Ht U.S. Survey (feet)
574.5	317813	2044905.88	1531429.013	157.681	0.098	33.707214	-91.160882	73.148
575	317763	2046792.54	1533415.291	157.653	0.102	33.712713	-91.154731	73.072
575.5	317718	2047982.55	1535654.465	157.645	0.098	33.718892	-91.150877	73.111
576	317676	2048453.33	1538032.823	157.971	0.108	33.725438	-91.149391	73.435
576.5	317631	2048926.32	1540645.834	158.329	0.102	33.732628	-91.147903	73.791
577	317588	2049613.32	1543127.633	158.715	0.102	33.739462	-91.145708	74.183
577.5	317542	2050884.28	1545534.393	158.952	0.102	33.746103	-91.141590	74.429
578	317497	2052617.85	1547503.54	159.192	0.102	33.751551	-91.135938	74.525
578.5	317451	2054526.77	1549430.176	159.478	0.098	33.756886	-91.129707	74.840
579	317401	2056664.83	1551108.652	159.566	0.095	33.761544	-91.122716	75.035
579.5	317358	2058419.71	1552574.426	159.854	0.098	33.765608	-91.116979	75.279
580	317272	2060804.49	1553856.859	160.049	0.082	33.769182	-91.109165	74.509
580.5	317188	2063166.17	1554834.099	160.472	0.095	33.771916	-91.101418	75.846
581	317140	2065765.01	1555658.573	160.521	0.095	33.774234	-91.092887	75.854
581.5	317094	2068400.54	1555953.646	160.631	0.092	33.775098	-91.084222	75.958
582	317048	2071044.00	1556066.638	160.826	0.092	33.775461	-91.075526	76.125
582.5	317002	2073678.97	1556297.835	161.031	0.089	33.776148	-91.066861	76.342
583	316955	2076309.37	1556796.004	161.353	0.092	33.777568	-91.058217	76.657
583.5	316911	2078551.33	1557837.624	161.595	0.092	33.780474	-91.050864	76.897
584	316867	2080495.19	1559285.394	161.659	0.092	33.784489	-91.044500	76.951
584.5	316823	2081707.89	1561330.514	161.967	0.095	33.790132	-91.040555	77.265
585	316769	2082064.59	1564171.643	161.770	0.092	33.797946	-91.039446	77.090
585.5	316715	2081371.39	1567027.643	161.789	0.092	33.805780	-91.041792	77.113
586	316664	2080311.00	1569648.762	161.879	0.089	33.812963	-91.045342	77.221
586.5	316614	2078733.28	1571936.326	161.908	0.095	33.819219	-91.050588	77.273
587	316567	2077175.86	1574126.751	161.916	0.095	33.825208	-91.055766	77.312
587.5	316520	2075685.47	1576380.927	162.326	0.095	33.831373	-91.060726	77.726
588	316472	2074232.54	1578720.679	162.675	0.095	33.837774	-91.065564	78.084
588.5	316426	2073274.21	1581137.251	162.802	0.098	33.844396	-91.068777	78.221
589	316377	2072827.55	1583862.213	162.900	0.098	33.851875	-91.070312	78.331
589.5	316324	2072838.18	1586859.745	163.106	0.098	33.860112	-91.070348	78.539
590	316262	2073639.35	1590256.407	163.332	0.095	33.869461	-91.067789	78.777
590.5	316206	2075353.43	1592923.486	163.570	0.098	33.876823	-91.062205	79.017

River Mile	GPS Time (seconds)	Easting SP (feet)	Northing SP (feet)	Elevation Geoid 03	Standard Deviation	Latitude	Longitude	Ellipsoid Ht U.S. Survey (feet)
591	316160	2077304.76	1594697.504	163.429	0.098	33.881736	-91.055818	78.883
591.5	316119	2078867.36	1596460.259	163.498	0.098	33.886610	-91.050710	78.999
592	316077	2080399.93	1598371.596	163.543	0.102	33.891891	-91.045704	78.982
592.5	316030	2082320.70	1600322.508	163.930	0.102	33.897288	-91.039419	79.404
593	315985	2084372.54	1601966.49	163.944	0.098	33.901844	-91.032695	79.439
593.5	315938	2086252.61	1603968.843	164.318	0.098	33.907381	-91.026544	79.769
594	315892	2087138.22	1606403.57	164.222	0.102	33.914088	-91.023679	79.771
594.5	315783	2089753.69	1608800.416	164.790	0.102	33.920722	-91.015112	80.229
595	315724	2091171.26	1611616.906	164.981	0.102	33.928487	-91.010500	80.471
595.5	315650	2089731.56	1615030.38	165.035	0.108	33.937841	-91.015321	80.505
596	315564	2085848.30	1617124.269	165.213	0.105	33.943523	-91.028170	80.720
596.5	315516	2083360.82	1617931.452	165.281	0.112	33.945694	-91.036389	80.741
597	315469	2080793.07	1618485.591	165.436	0.108	33.947168	-91.044868	80.934

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14. ABSTRACT <p>The U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Field Data Collection and Analysis Branch collected bathymetry data and water surface elevations during the 2011 Flood. According to the gage at Vicksburg, MS, the flood peaked at a stage of 57.1 and a flow of 2,310,000 cubic feet per second (cfs) on 17 May 2011, both the highest of record. The reported water surface data include a continuous water surface profile from river mile (RM) 597 to RM 362 and water surface measurements in the vicinity of the Yazoo Backwater levee and Vicksburg, MS. Bathymetry data were also collected and include five sets of surveys, compatible with the Integrated Section Surface Difference over Time Version 2 (ISSDOTv2) method of measuring bed-load transport. These five sets were surveyed at flow rates between 1.6 million and 2.3 million cfs. ISSDOTv2 was used to calculate bed-load transport for the five sets of data. These new bed-load data populate the Lower Mississippi River bed-load rating curve at higher flows and provide a higher level of confidence in the higher-flow portions of the curve. The resulting curve can be a powerful tool for inferring past bed-load transport and predicting future transport.</p>					
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