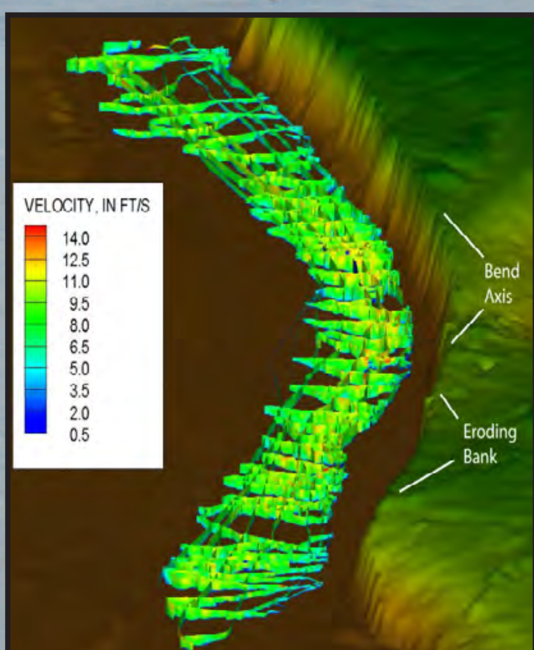
USGS
science for a changing world

Prepared in cooperation with the Matanuska Susitna Borough

Bathymetric and Hydraulic Survey of the Matanuska River near Circle View Estates, Alaska



Open-File Report 2008–1359

U.S. Department of the Interior
U.S. Geological Survey

Cover: Three-dimensional plot showing measured flow velocities collected with an ADCP on the Matanuska River, Alaska (inset) and photograph showing ADCP deployment using a combination of tethered and manned boats for surveying in high velocities and shallow water of the Matanuska River. (Photograph taken by Joshua Morse, USGS, on August 7, 2006.)

Bathymetric and Hydraulic Survey of the Matanuska River near Circle View Estates, Alaska

By Jeffrey S. Conaway

Prepared in cooperation with the Matanuska-Susitna Borough

Open-File Report 2008–1359

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
Mark D. Myers, Director

U.S. Geological Survey, Reston, Virginia: 2008

For product and ordering information:
World Wide Web: http://www.usgs.gov/pubprod
Telephone: 1-888-ASK-USGS

For more information on the USGS--the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment:
World Wide Web: http://www.usgs.gov
Telephone: 1-888-ASK-USGS

Suggested citation:
Conaway, J.S., 2008, Bathymetric and hydraulic survey of the Matanuska River near Circle View Estates, Alaska: U.S. Geological Survey Open-File Report 2008–1359, 20 p.

Contents

Abstract 1
Introduction....1
Purpose and Scope 2
Site Description....2
Methods....6
Data Processing....7
Hydraulic Data....7
Spur Dike Section 8
Natural Bank Section....12
Summary....18
References Cited....18
Appendix A. Bathymetric and Streamflow Velocity Data Collected at the Spur Dikes, Matanuska River near Circle View Estates, Alaska 19
Appendix B. Bathymetric and Streamflow Velocity Data Collected at the Eroding Bank, Matanuska River near Circle View Estates, Alaska 19

Figures

Figure 1. Map showing location of the Matanuska River and Circle View Estates near Palmer, Alaska 3
Figure 2. Graph showing maximum, mean, and minimum daily mean discharge of the Matanuska River near Palmer, Alaska 4
Figure 3. Photographs showing views of bank section looking downstream and bank material at base of slope immediately after bank failure on the Matanuska River near Circle View Estates, Alaska 5
Figure 4. Photograph showing ADCP deployment using a combination of tethered and manned boats for surveying in high velocities and shallow water of the Matanuska River, Alaska 6
Figure 5. Graph showing discharge for the Matanuska River near Palmer, Alaska, August 7-10, 2006 7
Figure 6. Image showing interpolated depth-averaged velocities along dikes and downstream bank section of the Matanuska River near Circle View Estates, Alaska 8
Figure 7. Image showing interpolated bathymetric dataset for dikes and bank section of the Matanuska River near Circle View Estates, Alaska 9
Figure 8. Map showing river data points and polygons used to select data from the spur dikes on the Matanuska River near Circle View Estates, Alaska 10
Figure 9. Three-dimensional view of measured flow velocities and depth-averaged velocities vectors at dike 4 on the Matanuska River near Circle View Estates, Alaska 11
Figure 10. Velocity profile collected at the nose of dike 4 on the Matanuska River near Circle View Estates, Alaska 11
Figure 11. Plot showing surveyed bank locations for the Matanuska River near Circle View Estates, Alaska, August 8, 2006.... 12

Figures—Continued

Figure 12. Plot showing surveyed bank locations for the Matanuska River near Circle View Estates, Alaska, August 8, 2006 ... 13
Figure 13. Three-dimensional plot showing measured flow velocities collected along the bank section of the Matanuska River near Circle View Estates, Alaska ... 14
Figure 14. Plot showing surveyed bank points, river data points, and polygons used to select data from the bend apex and eroding bank sections on the Matanuska River near Circle View Estates, Alaska ... 15
Figure 15. Vertical profiles of measured downstream velocity upstream of the apex of a bend of the Matanuska River near Circle View Estates, Alaska ... 16
Figure 16. Vertical profiles of measured downstream velocity at the apex of a bend of the Matanuska River near Circle View Estates, Alaska ... 17

Tables

Table 1. Discharges for selected recurrence intervals for the Matanuska River near Palmer, Alaska ... 4
Table 2. Summary of sediment data collected by the U.S. Geological Survey at gaging station 15284000, Matanuska River near Palmer, Alaska, 2003 ... 5
Table 3. Summary statistics for data collected at the nose of dikes 2, 3, and 4, Matanuska River near Circle View Estates, Alaska ... 9
Table 4. Summary statistics for data collected at the bend apex and in front of the naturally eroding bank, Matanuska River near Circle View Estates, Alaska ... 16

Conversion Factors and Datums

Conversion Factors

Multiply	By	To obtain
cubic foot per second	0.02832	cubic meter per second (m^3/s)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
millimeter (mm)	0.03937	inch (in.)
square mile (mi^2)	2.590	square kilometer (km^2)

Datums

Vertical coordinate information in this report are orthometric heights computed from ellipsoid heights using GEIOD03-Alaska.

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Bathymetric and Hydraulic Survey of the Matanuska River near Circle View Estates, Alaska

By Jeffrey S. Conaway

Abstract

An acoustic Doppler current profiler interfaced with a differentially corrected global positioning system was used to map bathymetry and multi-dimensional velocities on the Matanuska River near Circle View Estates, Alaska. Data were collected along four spur dikes and a bend in the river during a period of active bank erosion. These data were collected as part of a larger investigation into channel processes being conducted to aid land managers with development of a long-term management plan for land near the river. The banks and streambed are composed of readily erodible material and the braided channels frequently scour and migrate. Lateral channel migration has resulted in the periodic loss of properties and structures along the river for decades.

For most of the survey, discharge of the Matanuska River was less than the 25th percentile of long-term streamflow. Despite this relatively low flow, measured water velocities were as high as 15 feet per second. The survey required a unique deployment of the acoustic Doppler current profiler in a tethered boat that was towed by a small inflatable raft. Data were collected along cross sections and longitudinal profiles. The bathymetric and velocity data document river conditions before the installation of an additional spur dike in 2006 and during a period of bank erosion. Data were collected along 1,700 feet of river in front of the spur dikes and along 1,500 feet of an eroding bank.

Data collected at the nose of spur dikes 2, 3, and 4 were selected to quantify the flow hydraulics at the locations subject to the highest velocities. The measured velocities and flow depths were greatest at the nose of the downstream-most spur dike. The maximum point velocity at the spur dike nose was 13.3 feet per second and the maximum depth-averaged velocity was 11.6 feet per second. The maximum measured depth was 12.0 feet at the nose of spur dike 4 and velocities greater than 10 feet per second were measured to a depth of 10 feet.

Data collected along an eroding bank provided details of the spatial distribution and variability in magnitude of velocities and flow depths while erosion was taking place. Erosion was concentrated in an area just downstream of the apex of a river bend. Measured velocities and flow depths were greater in the apex of the bend than in the area of maximum bank erosion. The maximum measured velocity was 12.9 feet per second at the apex and 11.2 feet per second in front of the eroding bank. The maximum measured depth was 10.2 feet at the apex and 5.2 feet in front of the eroding bank.

Introduction

The Matanuska River in south-central Alaska drains an area of 2,100 mi^2 that includes portions of the Chugach and Talkeetna Mountains (fig. 1). The river originates upstream of the Matanuska Glacier and is extensively braided throughout most of its course. The river near its mouth is characterized by a complex system of interconnected channels that migrate across a 1-mi wide braid plain. The banks and streambed are composed of readily erodible noncohesive glacial and fluvial sediments and the channels frequently scour and migrate. Lateral channel migration has resulted in the periodic loss of properties and structures along the river for decades. At the time of this study, an investigation into channel processes was being conducted to aid land managers with development of a long-term management plan for land near the river.

Previous studies have relied on historical data from aerial photographs to determine rates of bank erosion (MWH, 2004). These types of analyses are of limited application on the Matanuska River because of the dynamics of the river and the relatively short historical record. The U.S. Geological Survey (USGS) is currently coupling the historical data with a process-based investigation of bank erosion. Erosion rates in the fluvial environment are controlled by a number of factors that vary spatially and temporally. These factors include the flow depth, the velocity magnitude and direction, the size of the bank material and its erodibility, the sediment concentration in the river, the type and density of bank vegetation, and the size and slope of the bank. Measurements of flow hydraulics at eroding banks and the development of bank erodibility parameters will improve upon the purely historical studies.

This study focused on flow hydraulics in a reach near Circle View Estates, a subdivision on the river's left bank 4 mi downstream of Palmer. In the past, erosion in this area of the river resulted in the loss of property and structures. Four spur dikes were installed in 1992 to restrict future erosion and encourage deposition. During the summer of 2006, the river was actively eroding the bank about 500 ft downstream of the last spur dike. An additional spur dike was installed in 2006. It was constructed about 350 ft downstream of dike 4. The in-stream data were collected prior to construction of this spur dike to document the channel hydraulics along the existing spur dikes and along the actively eroding banks. These data can be used as a baseline to evaluate the effects that spur dike 5 may have on downstream bank erosion.

The in-stream data were collected from a moving boat August 7–9, 2006. An acoustic Doppler current profiler (ADCP) interfaced with a differentially corrected global positioning system (DGPS) was used to map bathymetry and measure three-dimensional water velocities along the spur dikes and in the area of active bank erosion. Data were collected along cross sections, perpendicular to the direction of flow, and along longitudinal profiles, parallel to the flow. The longitudinal profile data provided a means to assess the velocities and directions of flows that contribute most to streambank erosion. Cross-section data were used to quantify the flow magnitudes in various parts of the channel and to delineate flow velocities across the channel. Survey points were collected with a survey grade global positioning system along the streambank to document bank position and to measure water-surface elevations.

Purpose and Scope

The purpose of this study was (1) to collect hydraulic and bathymetric data along an actively eroding streambank to help characterize bank erosion on the river, and (2) to collect hydraulic and bathymetric data along four spur dikes as a baseline of conditions at the time. This report describes the general characteristics of the Matanuska River, methodology of data collection and data processing, and presents the results from the field surveys. Velocity varies in both magnitude and direction and the variation is not consistent over time. The bathymetry of braided channels also constantly varies as the channel adjusts to changing flow conditions. Data presented in this report represent a snapshot of the variations and no attempt was made to quantify variations in flow velocity or bathymetry over time. This report is not an assessment of the effectiveness of the spur dikes or their influence on downstream channel conditions.

Site Description

The Matanuska River near Palmer, Alaska, drains an approximately 2,100 mi^2 basin that is bordered by the Chugach Mountains to the south and the Talkeetna Mountains to the north (fig. 1). Twelve percent of the Matanuska River basin is covered by glaciers. The Matanuska River originates upstream of the Matanuska Glacier and terminates about 75 mi downstream in the Knik Arm of upper Cook Inlet. The river is extensively braided throughout most its length except in a few areas where bedrock or tributary fans confine the channel. The entire length of the river was glaciated during Wisconsin time and unconsolidated glacial deposits are extensive in the river corridor. This area is less than 50 mi from Anchorage and has seen rapid population growth in the last several decades.

The USGS collects continuous stage and discharge data for the Matanuska River at gaging station 15284000. This station is about 5 mi upstream of the study area. Data have been collected at this gaging station from 1949 to 1973, 1985 to 1986, 1991 to 1992, and May 2000 to present (U.S. Geological Survey, 1949–2007). Annual mean streamflow for the period of record is 3,900 ft^3/s. The maximum peak flow of 82,100 ft^3/s occurred on August 10, 1971, during a lake breakout (fig. 2). The maximum non-outburst peak flow of 46,000 ft^3/s occurred on September 22, 1995. Discharges for selected recurrence intervals for the Matanuska River are listed in table 1. Suspended- and bedload-sediment data were last collected by the USGS in 2003 (table 2). The median particle diameter of the bed material ranged from 2.0 to 25.6 mm (very fine gravel to coarse gravel) (U.S. Geological Survey, 2004).

The study reach is located along the left bank of a braid plain that is approximately 1 mi wide. The braided channel in this location is subject to rapid changes in location and flow distribution. The channel was located primarily along the right bank of the braid plain until the late 1980s when it shifted nearly 5,000 ft to the left bank near the Circle View Estates. Bank erosion and the resulting loss of property and structures led to the construction of four spur dikes in 1992 to limit future loss from erosion. For purposes of this report, the study reach is separated into two sections referred to as the spur dikes and natural bank sections.

Data were collected along 1,700 ft of the river in front of the four spur dikes installed in 1992, referred to here as dikes 1-4 (from upstream to downstream). The dikes extend 250–400 ft perpendicular to the bank and are spaced 400–600 ft apart. The upstream edges and noses were armored with riprap to prevent erosion. The dikes are designed to protect a length of bank roughly equivalent to the distance that they extend into the channel. By design, the dikes direct flow toward the thalweg of the river and away from the streambank. Areas of low water velocity develop between the dikes, resulting in sediment deposition.

Base from U.S. Geological Survey digital data, 1:63,360
Universal Transverse Mercator projection, Zone 6

Figure 1. Location of the Matanuska River and Circle View Estates near Palmer, Alaska.

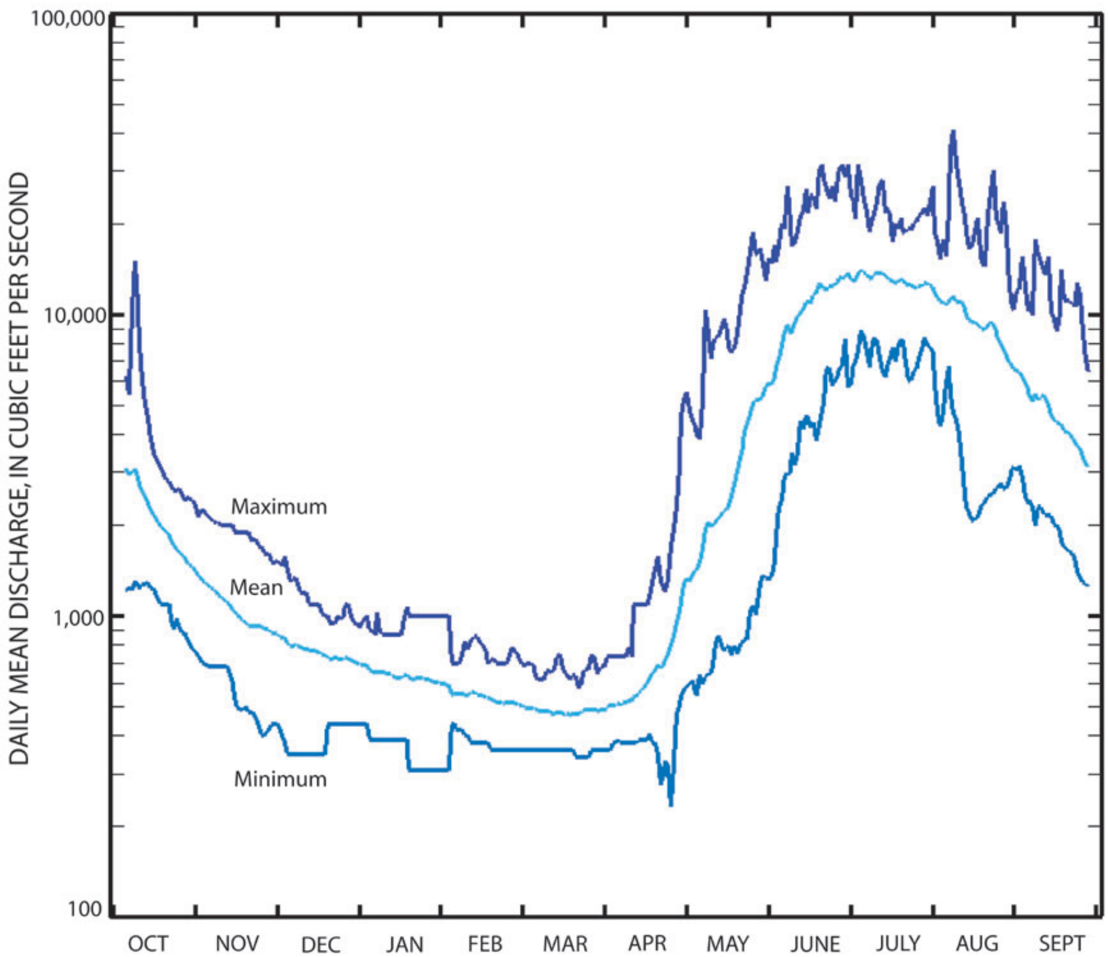


Figure 2. Maximum, mean, and minimum daily mean discharge of the Matanuska River near Palmer, Alaska. USGS gaging station 15284000. Period of data collection, 1949–73, 1985–86, 1991–92, and 2000–2007.

Table 1. Discharges for selected recurrence intervals for the Matanuska River near Palmer, Alaska.

[Discharges were computed by Curran and others (2003). **Abbreviations:** ft^3/s, cubic feet per second]

Recurrence interval (years)	Discharge (ft^3/s)
2	23,900
5	30,200
10	34,300
25	39,500
50	43,300
100	47,000
200	50,700
500	55,700

A comparison site, representing more natural conditions, was established at an actively eroding bank 400 ft downstream of dike 4. The 400 ft of bank between the dike 4 and the start of the bank section was stable during the survey and is lined with mature vegetation. The bank section was 1,500 ft long and is a natural bend in the river. The left bank was a vertical to near vertical slope that extended approximately 15 ft above the river surface (fig. 3). The right bank was a low relief gravel bar. The streambanks near Circle View Estates are readily erodible and are composed primarily of unconsolidated, noncohesive gravels, cobbles, and coarse sand that were derived from glacial drift or river alluvium. Vegetation on the top of the bank primarily was grass and brush with sparse small trees.

Table 2. Summary of sediment data collected by the U.S. Geological Survey at gaging station 15284000, Matanuska River near Palmer, Alaska, 2003.

[**Abbreviations:** ft^3/s, cubic foot per second; ton/d, ton per day; mg/L, milligram per liter; –, no data]

Date	Discharge (ft^3/s)	Bedload median diameter (d_{50})(mm)	Bedload discharge (ton/d)	Suspended-sediment concentration (mg/L)	Suspended-sediment discharge (ton/d)	Total sediment discharge (ton/d)
06-10-03	8,650	not collected	not collected	2,220	51,800	–
07-02-03	14,700	24.8	4,830	2,400	95,400	100,000
07-16-03	16,200	23.7	660	2,690	118,000	119,000
08-12-03	14,700	25.6	1,360	2,850	113,000	114,000
09-18-03	2,410	5.7	16	77	501	517
10-24-03	1,840	2.0	27	75	372	399

Figure 3. Views of bank section looking downstream and bank material at base of slope immediately after bank failure (inset photograph) on the Matanuska River near Circle View Estates, Alaska.

Methods

Channel bathymetry and flow velocities were collected with a 1,200 kilohertz ADCP interfaced with a mapping grade DGPS that was mounted directly above the ADCP. The ADCP and DGPS were mounted on a small trimaran that was towed by an inflatable boat (fig. 4). The trimaran is easily deployed and has a low draft that allowed data to be collected in shallow areas of the channel. The DGPS data were corrected in real-time from a base station that was set up on one of the spur dikes. Data were collected along cross sections and longitudinal transects. Processing of the data required a series of computer programs to extract velocity and bathymetry information from the raw ADCP and DGPS files and statistical software to smooth and interpolate the data.

The ADCP has four acoustic transducers that are oriented at 20° from the center of the instrument. Acoustic pulses are transmitted from each beam and reflected from particles in the water column and from the streambed. Frequency differences between the transmitted and received acoustic pulses are measured to determine the relative magnitude and direction of the three-dimensional water-velocity components. The ADCP can measure velocities throughout the water column with the exception of an area near the transducer face and to within 6 percent of the depth to the bottom. Velocities are estimated in the unmeasured section of the water column by the ADCP software (RD Instruments, 2003) using established methods (Simpson, 2001). Measured velocities in the water column are averaged within vertical depth cells or bins, with the size of the bins defined by the user. In this study, a bin size of 0.33 ft was used. The relative movement of the boat-mounted ADCP is computed by using the Doppler shift of the bottom tracking acoustical pulses reflected off the streambed. However, bottom-tracking velocities can be biased by sediment movement along or near the streambed. An external DGPS was used for this study to measure the velocity of the boat-mounted ADCP to minimize the errors associated with sediment moving along the streambed.

The mapping grade DGPS data were differentially corrected from a base station that was set on a benchmark on dike 2. The accuracy of the mapping grade DGPS with a real-time differential correction is submeter (Trimble Navigation Limited, 2006). Corrections were broadcast to the rover receiver at 1-second intervals. Coordinates for the bench mark were determined using a Real-Time Kinematic GPS (RTK-GPS) with an accuracy of ±0.033 ft ±1 ppm in the horizontal and ±0.066 ft ±1 ppm in the vertical (Trimble Navigation Limited, 2001). The RTK-GPS also was used to collect shoreline profiles and to delineate the edge of the streambank. Horizontal coordinate information was referenced to the North American Datum of 1983 (NAD83), Alaska State Plane Zone 4, in feet. All elevations are orthometric heights converted from ellipsoid heights using GEIOD03 (Alaska).

Water-surface elevations were surveyed at the beginning and end of each day of data collection in front of dike 2 by leveling from the established benchmark. The left edge of water was surveyed through the reach to determine water-surface slope at the spur dikes and downstream at the bank section. The measured depths from the ADCP were subtracted from the daily water-surface elevations and corrected for the surveyed slope.

Figure 4. ADCP deployment using a combination of tethered and manned boats for surveying in high velocities and shallow water of the Matanuska River, Alaska.

Data Processing

ADCP data were registered to positional data and then initially processed using a custom algorithm developed by Dinehart and Burau (2005). The algorithm was used to filter, smooth, and register the velocity vectors with the GPS coordinates. Channel bathymetry were extracted from the ADCP data to separate the individual depths for each beam of the ADCP and calculate coordinates for each depth from the central position of the ADCP. These depths were then subtracted from the surveyed water-surface elevations and corrected for water-surface slope. A total of 71,828 velocity measurements and 31,254 bathymetry measurements were made along the spur dikes and bank section.

The unsteady nature of the flow and difficulties in data collection required extensive data processing to develop continuous velocity and bathymetric surfaces. Data and plots in this report are presented as either measured or interpolated. The interpolated data were generated using geostatistical software to smooth and interpolate elevation and velocity data across a grid for each area. A grid cell dimension of 3.2 ft was selected based on the density of data collected and a spherical kriging was used for interpolation of data across the grids. Kriging is an estimation procedure that computes values for unsampled areas based on the values of points surrounding the unsampled areas and is routinely used to interpolate within datasets where a relation exists from point to point.

Aerial photographs and a Light Detection and Ranging (LIDAR) dataset were used as the base maps for the figures in this report. The aerial photographs were taken on June 26, 2004, and October 15, 2006, at discharges of 23,900 and 6,480 ft^3/s, respectively. The LIDAR data were collected on October 12, 2006, at a discharge of 7,590 ft^3/s.

Hydraulic Data

Discharge data for the Matanuska River at gaging station 15284000 for August 7-10, 2006, are summarized in figure 5. During the period of data collection, discharge recorded at this upstream gaging station decreased to less than the 25th

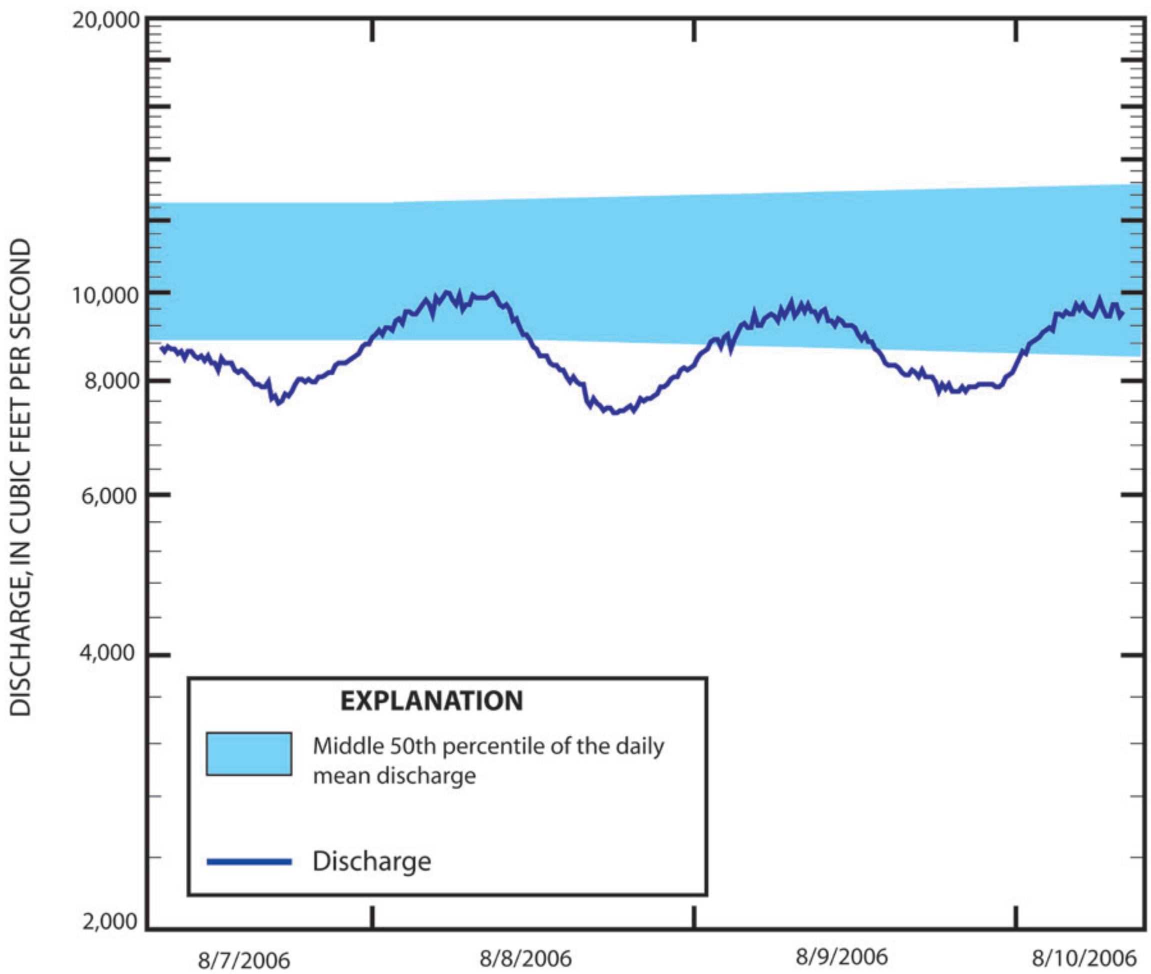
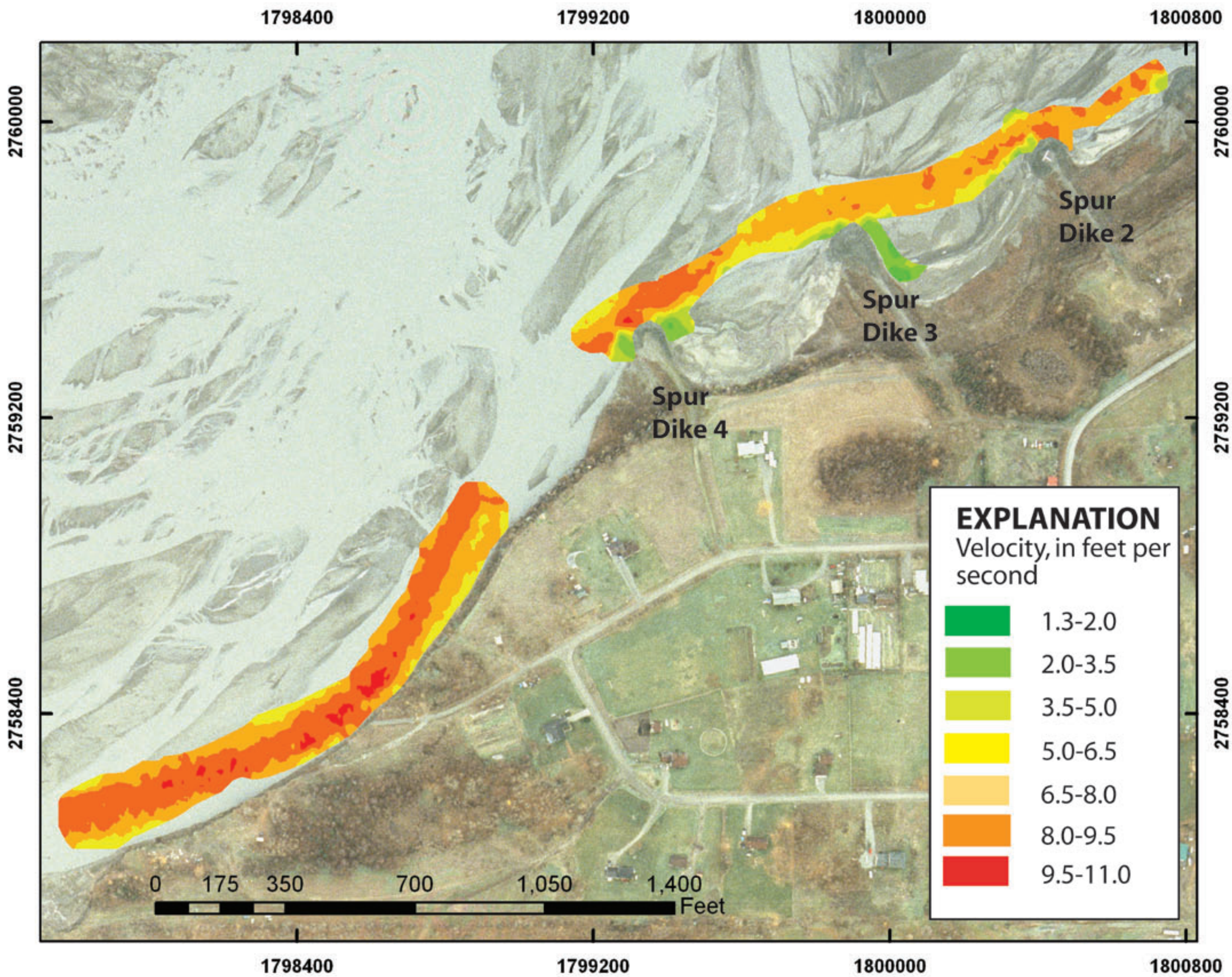


Figure 5. Discharge for the Matanuska River near Palmer, Alaska, August 7-10, 2006.

percentile of long-term discharge during the low flow portion of the daily diurnal fluctuation in flow. The discharge at the upstream gaging station was 8,890 ft^3/s on the afternoon of August 9, 2006. At the same time, discharge was 2,800 and 6,270 ft^3/s in a braid channel at dike 1 and at the upstream end of the natural bank section, respectively. These discharges represent 31 and 71 percent of the total discharge on August 9, 2006. There are no significant tributaries to the river between the gaging station and the study area. The surveyed water-surface slopes at the spur dikes and bank section were 0.003 and 0.002 ft/ft, respectively.

Spur Dike Section

Channel bathymetry and streamflow velocity were measured in the channel that passed in front of the four spur dikes (appendix A). The highest flow velocities and depths were measured at the nose of the spur dikes although the lowest measured velocities were towards the streambank just upstream and downstream of each dike. The maximum measured velocity was 13.3 ft/s and the area with the overall highest velocities was at the nose of spur dike 4 (fig. 6). The maximum measured depths also were at the nose of the spur



Base photograph taken October 14, 2006.
North American Datum of 1983 (NAD83), Alaska State Plane Zone 4, in feet

Figure 6. Interpolated depth-averaged velocities along dikes and downstream bank section of the Matanuska River near Circle View Estates, Alaska. Flow direction is from right to left.

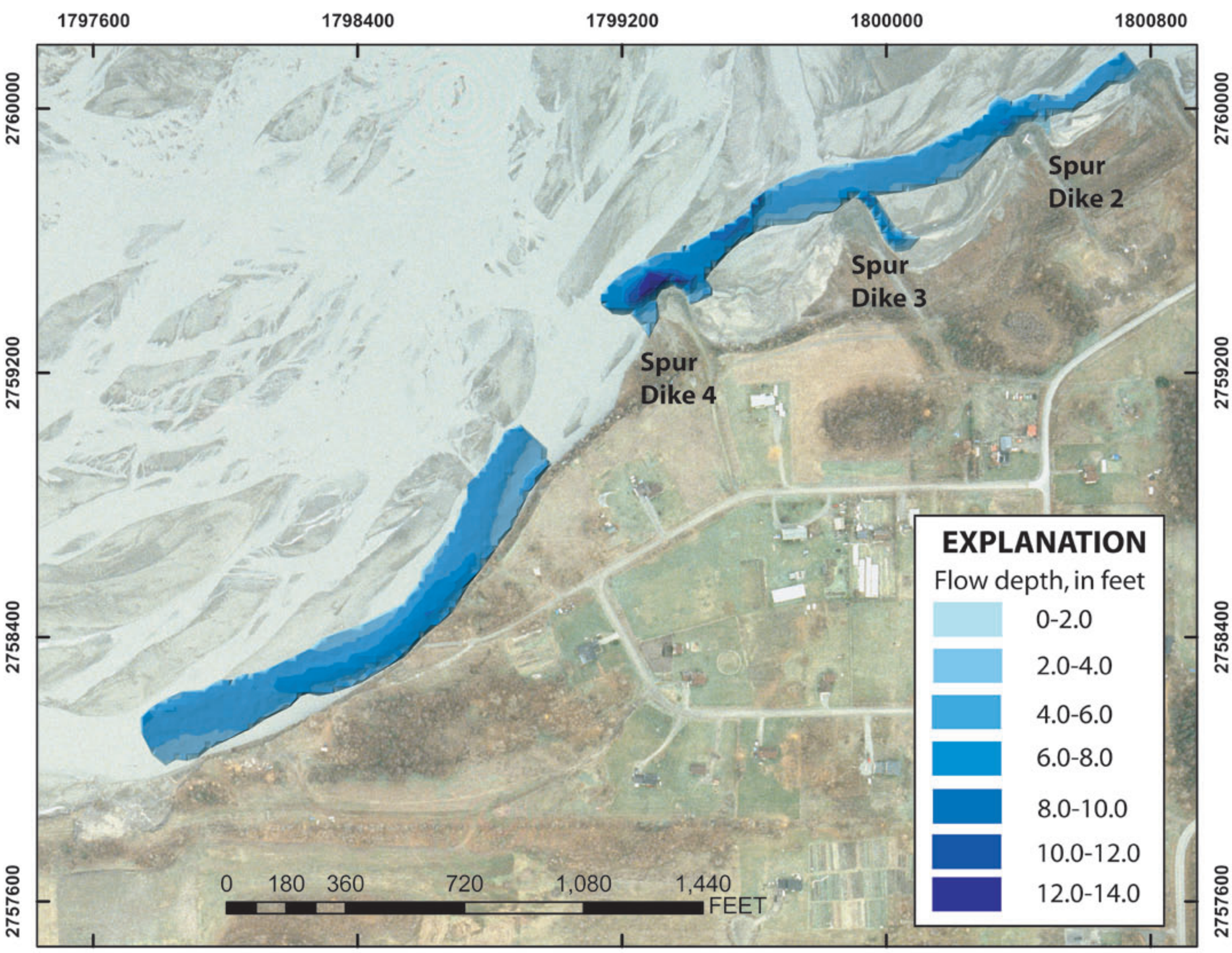
dikes and correspond to the areas with the highest velocities. As expected, the maximum measured depth was at the nose of spur dike 4 (fig. 7) and measured 12.0 ft.

A subset was selected from the spur dike dataset to characterize the hydraulics at the nose of the dikes. Areas around dikes 2, 3, and 4 were first defined by polygons extending 50 ft into the main channel from the nose of each dike (fig. 8). Flow data collected within each polygon was then analyzed. The highest measured velocity near the noses of the dikes was 13.3 ft/s and the highest depth-averaged velocity was 11.6 ft/s (table 3).

Table 3. Summary statistics for data collected at the nose of dikes 2, 3, and 4, Matanuska River near Circle View Estates, Alaska.

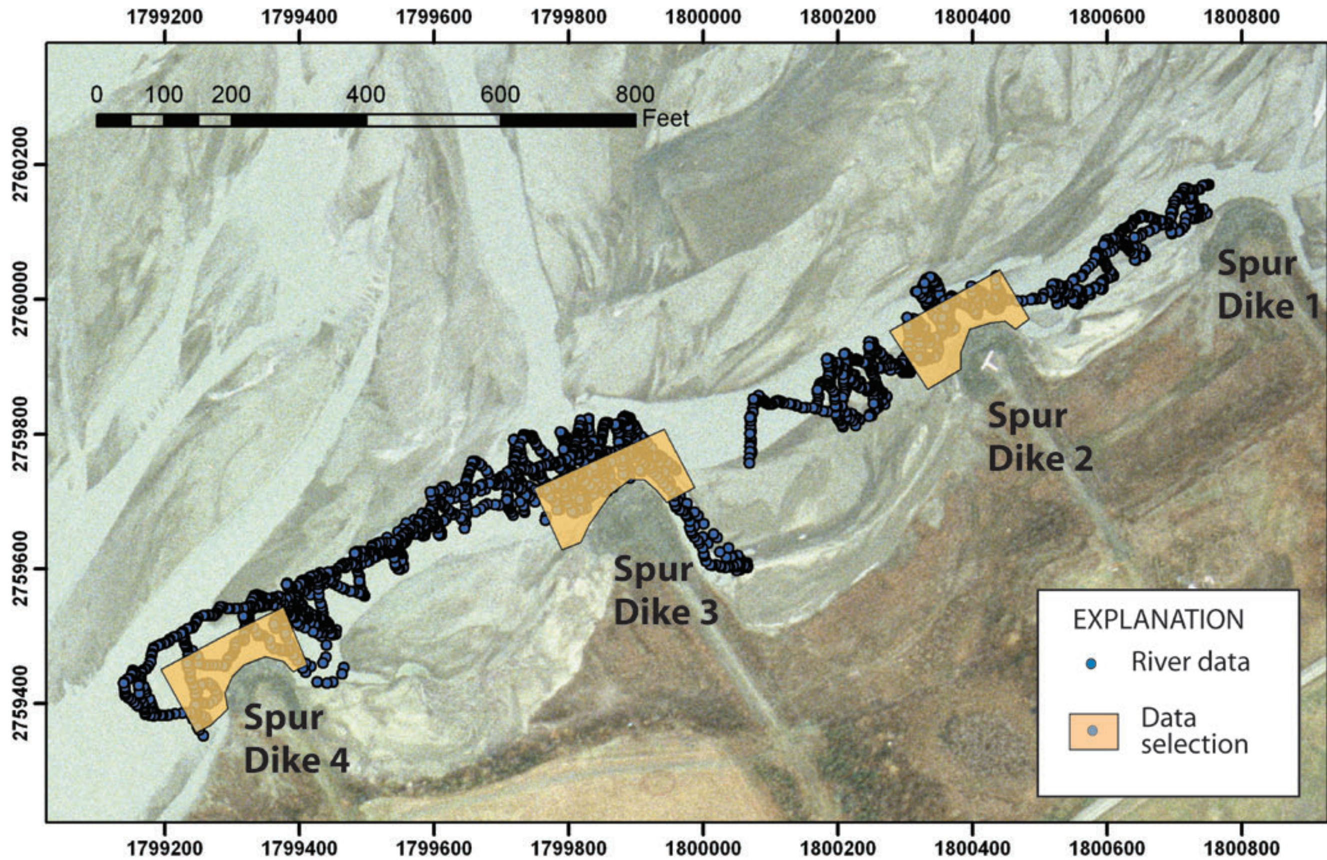
[**Abbreviations**: ft, foot; ft/s, foot per second]

	Depth (ft)	Velocity (ft/s)	Depth-averaged velocity (ft/s)
Minimum	0.1	0.0	0.3
Maximum	12.1	13.3	11.6
Average	5.2	6.8	7.1



Base photograph taken October 14, 2006.
North American Datum of 1983 (NAD83), Alaska State Plane Zone 4, in feet

Figure 7. Interpolated bathymetric dataset for dikes and bank section of the Matanuska River near Circle View Estates, Alaska. Flow direction is from right to left.



Base photograph taken October 14, 2006.
North American Datum of 1983 (NAD83), Alaska State Plane Zone 4, in feet

Figure 8. River data points and polygons used to select data from the spur dikes on the Matanuska River near Circle View Estates, Alaska. Flow direction is from right to left.

ADCP data collected at spur dike 4 were plotted with the LIDAR data to visualize the velocity distribution in front of the dike (fig. 9). At the nose of the spur dike, a zone of high velocity extended through most of the water column with measured velocities greater than 10 ft/s persisting to a depth of 10 ft (fig. 10). The total depth at this location was 13.7 ft. The ADCP was able to measure down to a depth of 12.1 ft where the velocity was 4.7 ft/s. The depth-averaged flow vectors at the dike indicate water approaching the dike directly before being redirected towards the center of the channel. The largest velocity vectors were those that were redirected into the channel at the nose of the dike.

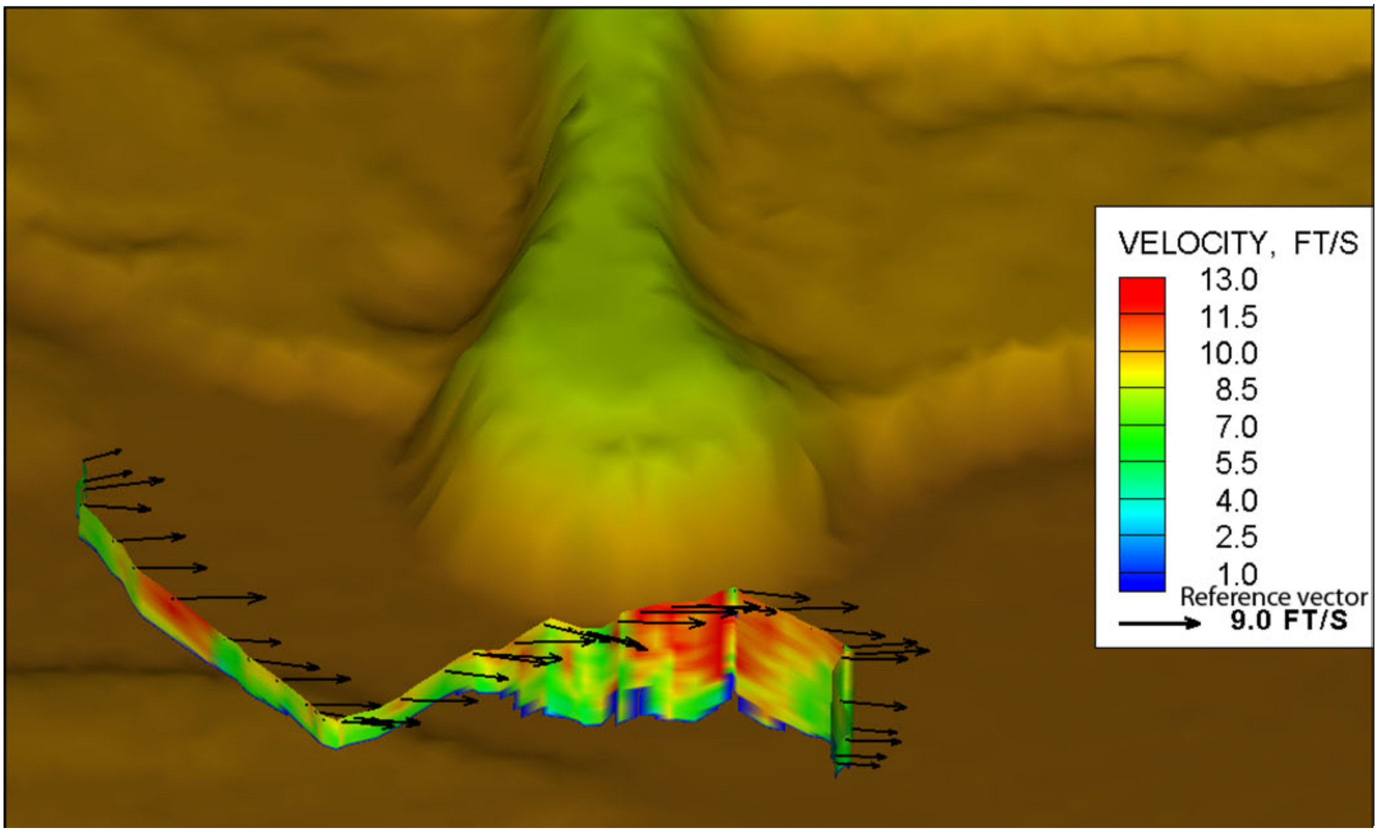


Figure 9. Three-dimensional view of measured flow velocities and depth-averaged velocities vectors at dike 4 on the Matanuska River near Circle View Estates, Alaska. Base digital elevation model created from LIDAR data that were collected on October 12, 2006.

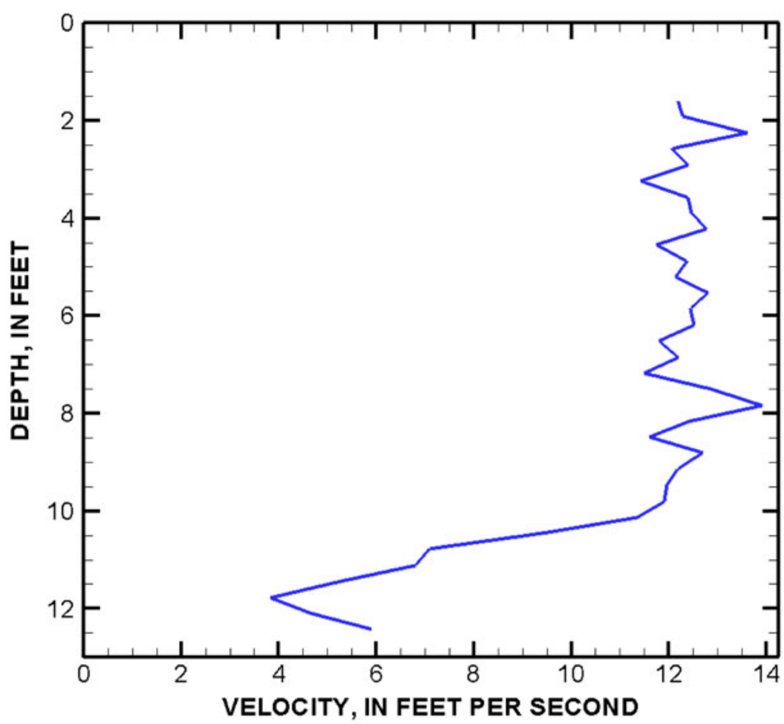


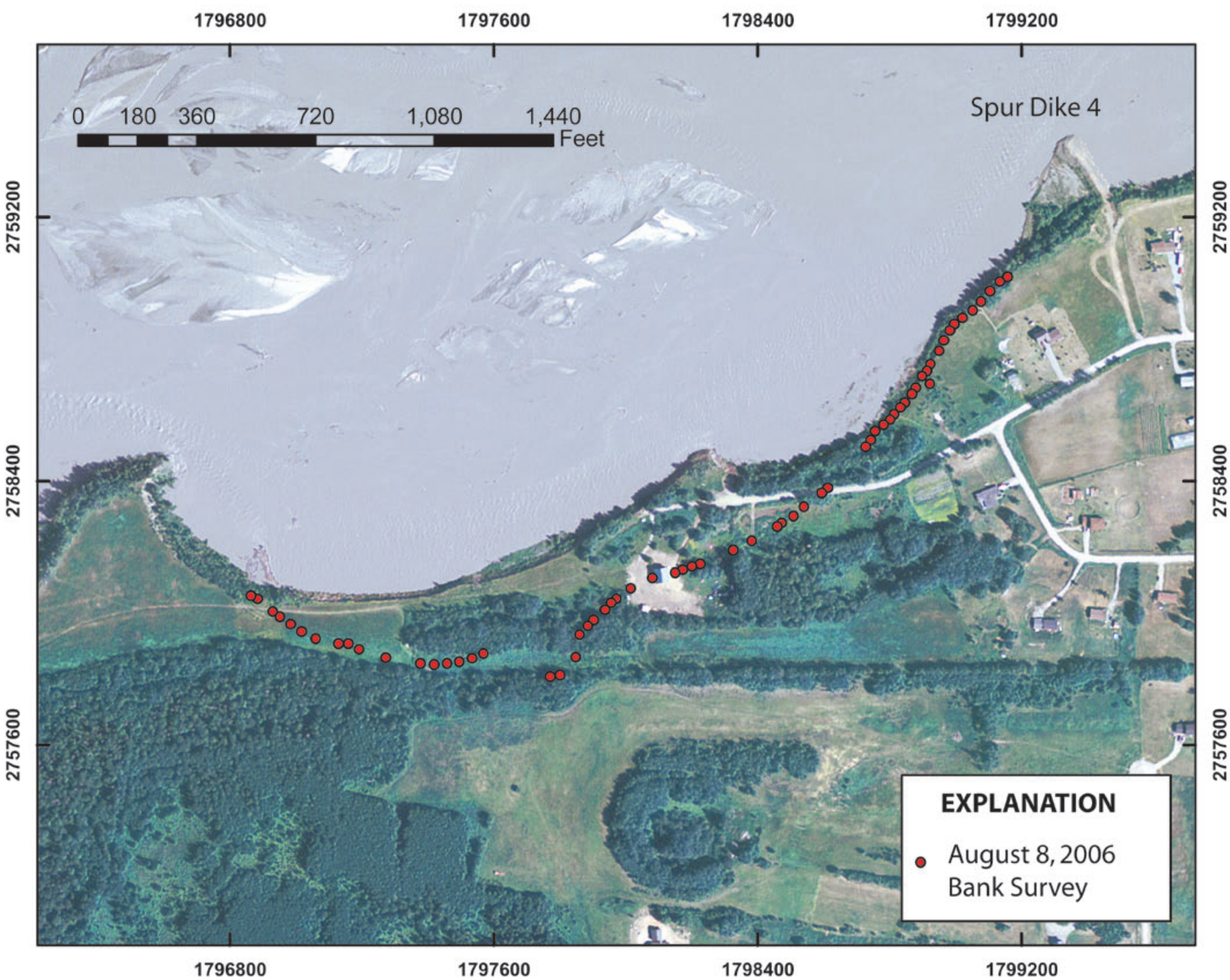
Figure 10. Velocity profile collected at the nose of dike 4 on the Matanuska River near Circle View Estates, Alaska.

Natural Bank Section

Channel bathymetry and streamflow velocity were measured along 1,500 ft of river, at a location 400 ft downstream of dike 4 where the streambank was actively eroding (appendix B). Data were collected to within 5 to 10 ft from the left edge of water, which was as close to the bank as possible given the flow conditions and instability of the bank.

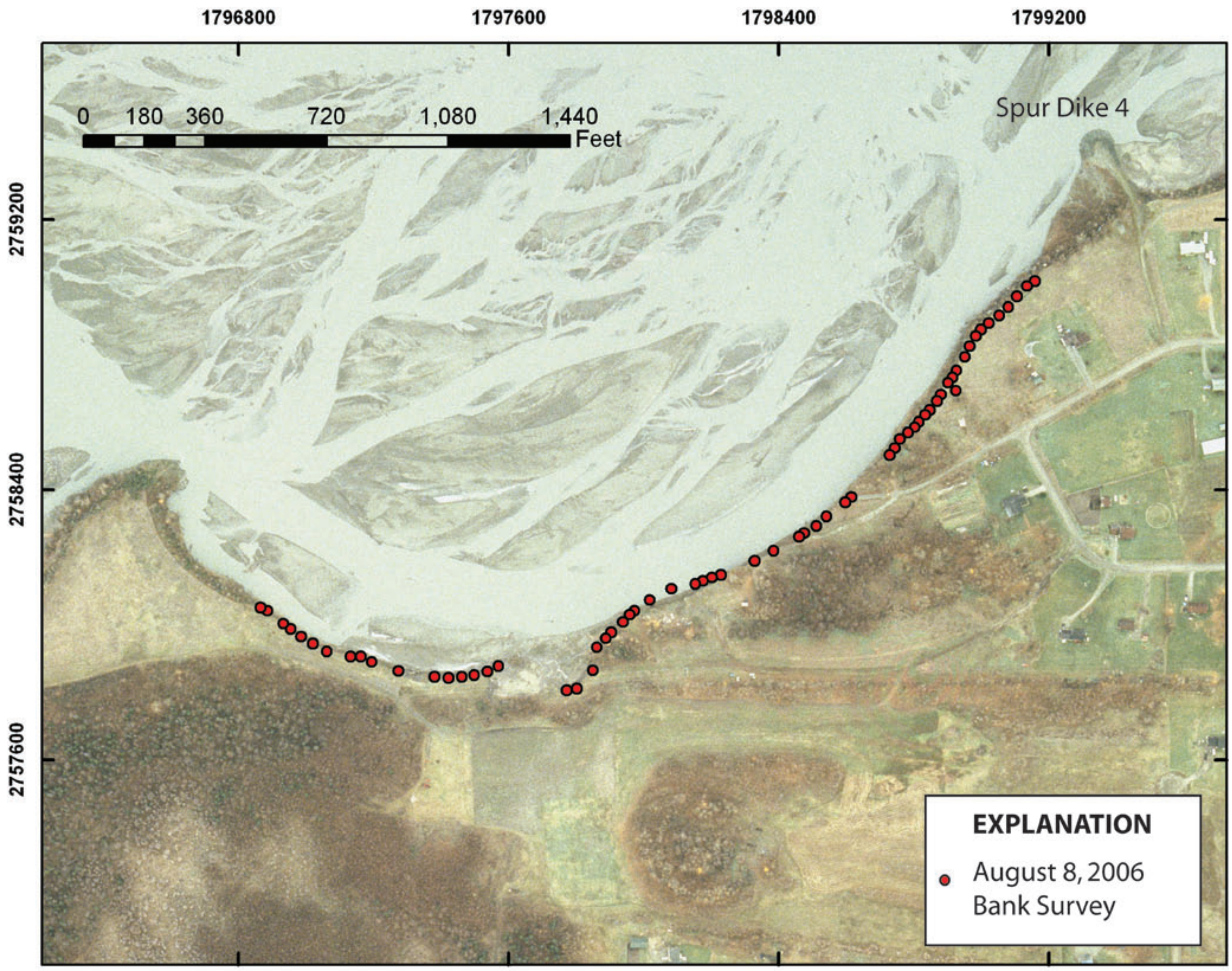
The top of the bank was surveyed on August 8, 2006, to document the position and elevation of the bank during the survey. A maximum of 400 ft of lateral channel migration was measured from the bank position in the 2004 aerial photograph to the surveyed bank position (figs. 11 and 12). Approximately 25 ft of bank erosion was measured over a 24-hour period from August 18–19, 2006, at a discharge of 27,900 ft^3/s. The recurrence interval of this discharge was estimated between 2 and 5 years using procedures outlined by Curran and others (2003).

Flow depths and velocities were greatest at the apex of the river bend (fig. 13). Here, the maximum measured depth was 10.2 ft (fig. 7), the maximum measured velocity was 15.0 ft/s, and the maximum depth-averaged velocity was greater than 11.0 ft/s (fig. 6). During the survey, the streambank at the apex of the bend was stable and bank failure



Base photograph taken June 26, 2004.
North American Datum of 1983 (NAD83), Alaska State Plane Zone 4, in feet

Figure 11. Surveyed bank locations for the Matanuska River near Circle View Estates, Alaska, August 8, 2006. Flow direction is from right to left.



Base photograph taken October 14, 2006.
North American Datum of 1983 (NAD83), Alaska State Plane Zone 4, in feet

Figure 12. Surveyed bank locations for the Matanuska River near Circle View Estates, Alaska, August 8, 2006. Flow direction is from right to left.

was observed just downstream of this apex. This process is common for river bends where bank failure followed by point-bar deposition downstream of the apex drives the downstream migration of meanders (Leopold and others, 1964).

During data collection, the bank was eroding in a repeating process. The toe of the bank was eroded and transported away by the river until the bank reached a slope that ranged from near vertical to overhanging. The bank would then fail in sections that extended several feet back from the edge and were about 1 to 20 ft in length. This material would then temporarily protect the bank and direct flow towards the center of the channel until the material was eroded from the base of the slope and another failure would occur at periods ranging from 5 to 30 minutes (fig. 3).

Two subsets were selected from the bank section dataset to characterize the hydraulics associated with the process of bank erosion. Flow data collected just in front of the bank were selected from (1) the apex of the river bend where velocities and flow depths were greatest and (2) the location with active bank failure. Data were selected by defining polygons that extended 60 ft from the surveyed top of bank (fig. 14). The top of the bank was used as a reference rather than the edge of water because both the bank slope and the starting point of data collection with respect to the edge of water varied considerably along the section. Velocity, depth-averaged velocity, and depth were all greater at the apex of the bend (table 4). The section with active bank failure was shallower because of the constant supply of sediment from the bank.

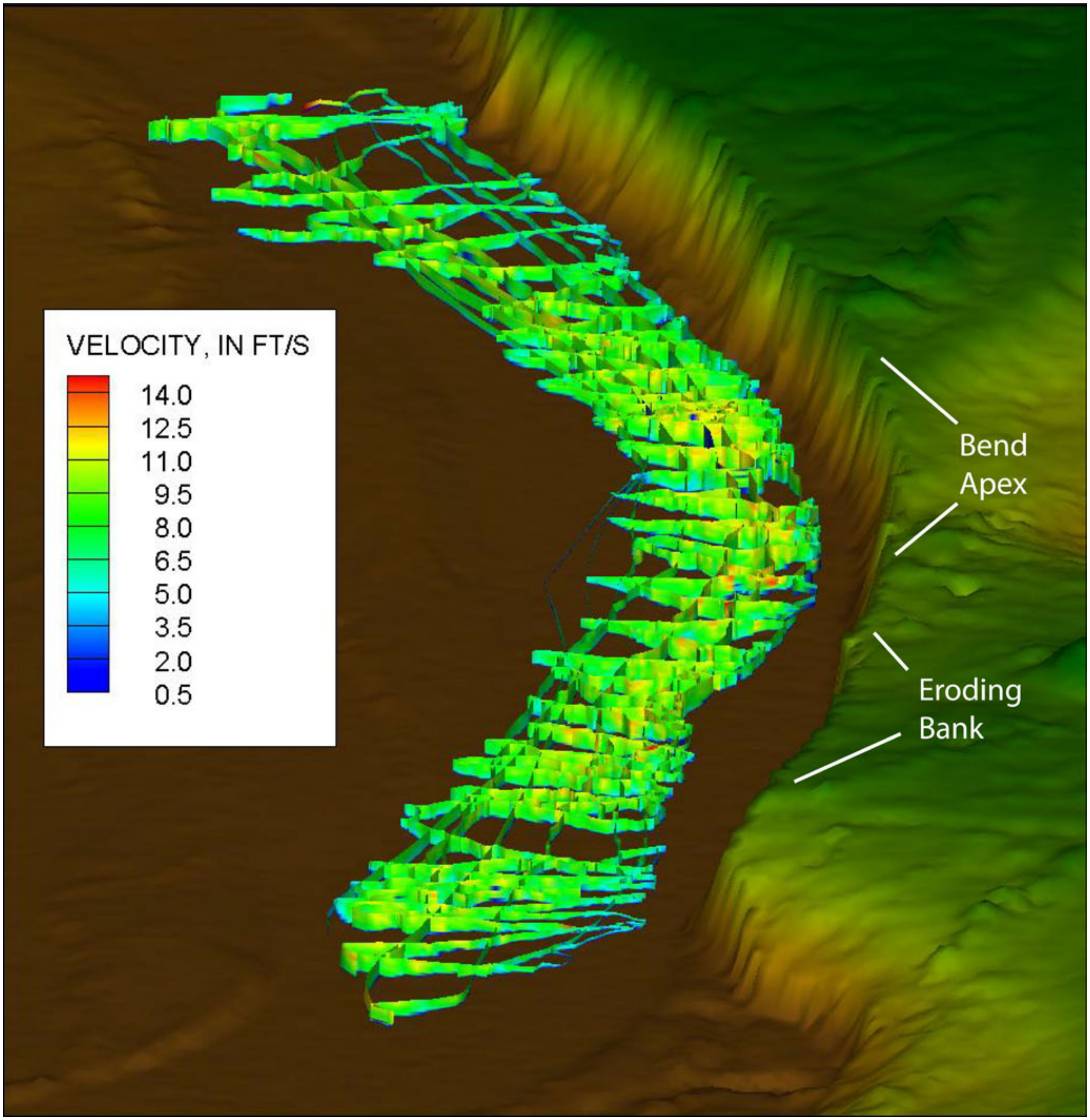
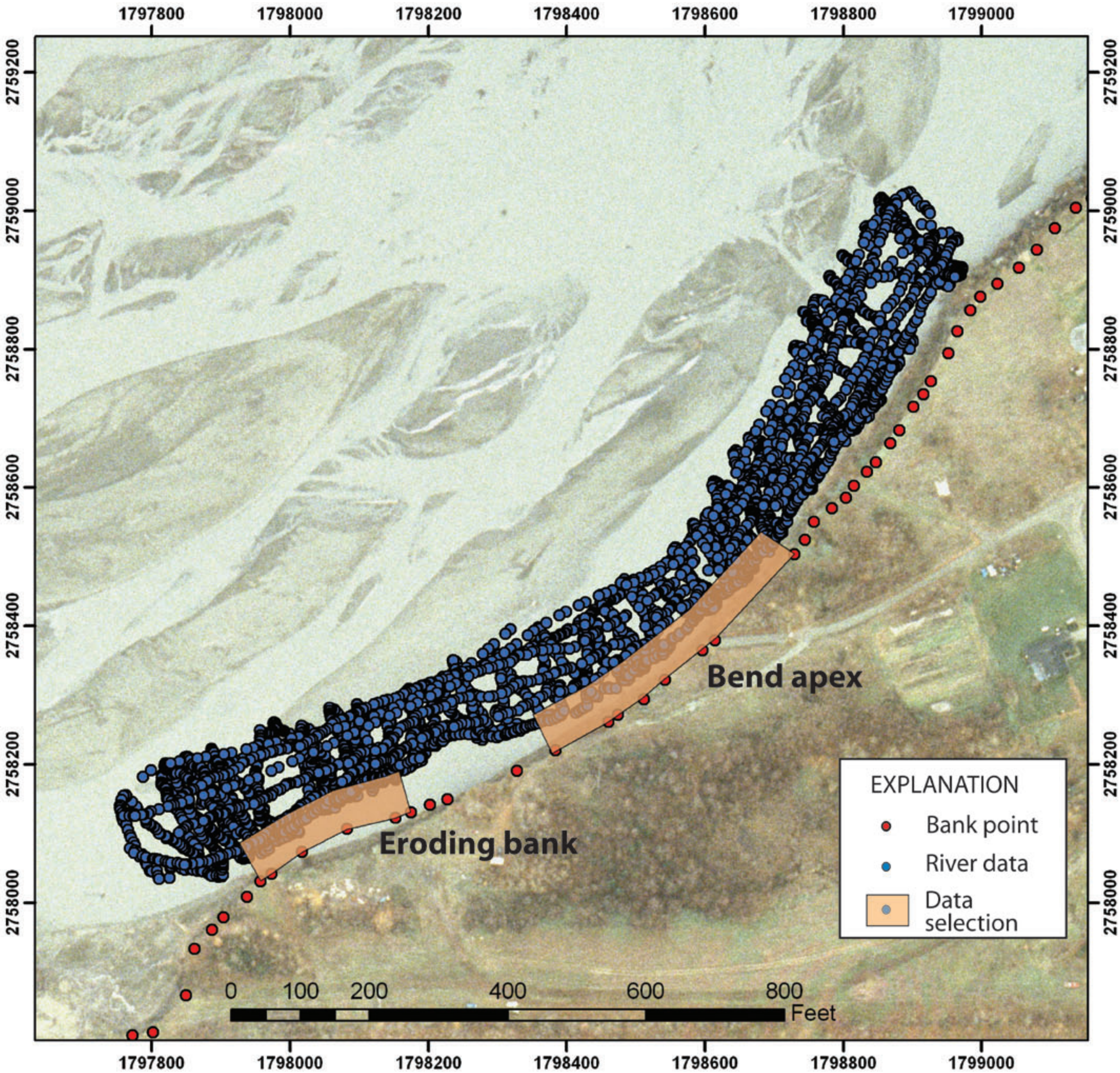


Figure 13. Measured flow velocities collected along the bank section of the Matanuska River near Circle View Estates, Alaska. Base digital elevation model created from LIDAR data that were collected on October 12, 2006. Flow direction is from top to bottom.



Base photograph taken October 14, 2006.
North American Datum of 1983 (NAD83), Alaska State Plane Zone 4, in feet

Figure 14. Surveyed bank points, river data points, and polygons used to select data from the bend apex and eroding bank sections on the Matanuska River near Circle View Estates, Alaska. Flow direction is from right to left.

Table 4. Summary statistics for data collected at the bend apex and in front of the naturally eroding bank, Matanuska River near Circle View Estates, Alaska.

[**Abbreviations**: ft, foot; ft/s, foot per second]

Location		Depth (ft)	Velocity (ft/s)	Depth-averaged velocity (ft/s)
Bend axis	Minimum	2.3	1.3	1.3
	Maximum	10.2	12.9	11.8
	Average	5.9	8.2	7.9
Eroding bank	Minimum	2.7	2.4	2.9
	Maximum	5.2	11.2	10.8
	Average	4.0	7.2	7.1

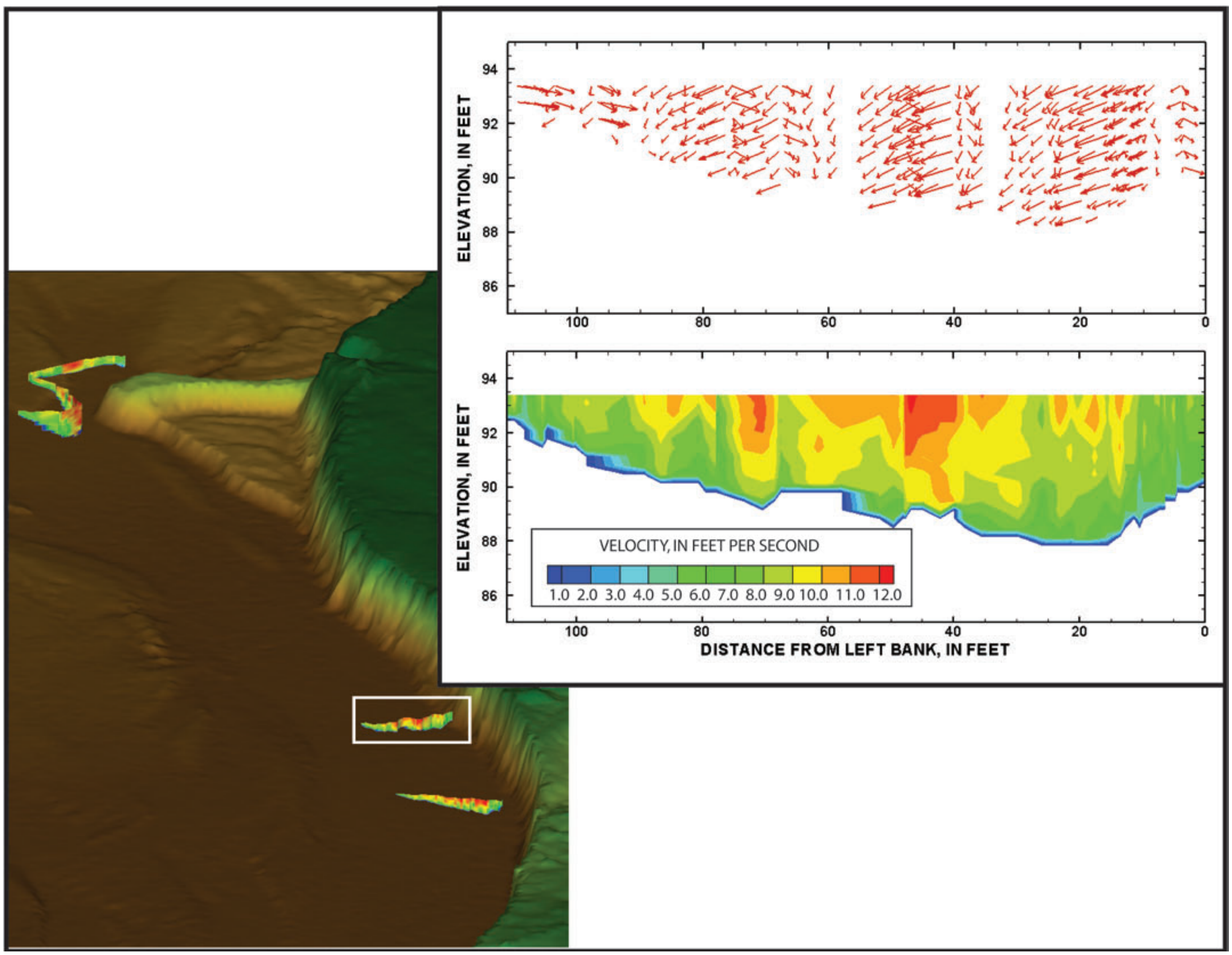


Figure 15. Vertical profiles of measured downstream velocity upstream of the apex of a bend of the Matanuska River near Circle View Estates, Alaska. Cross section location is indicated by the white box in the three-dimensional view of the cross sections and LIDAR data.

Two cross sections were selected to display the measured velocities at the apex of the bend. The first cross section measured at the upstream end of the bend indicates the highest measured velocities were in the center of the channel (fig. 15). The water velocity vectors were not uniform in direction and were not pointed into the bank at the left edge of the section. In contrast, water velocities at the second cross section at the apex of the bend were highest near the left bank (fig. 16). Flow direction here generally was directed towards the outside of the bend. In all cross sections surveyed, the areas of highest velocity did not occur just along the bank (fig. 12). The slower velocities along the bank are likely the product of channel roughness along the bank and turbulence along the edge of flow.

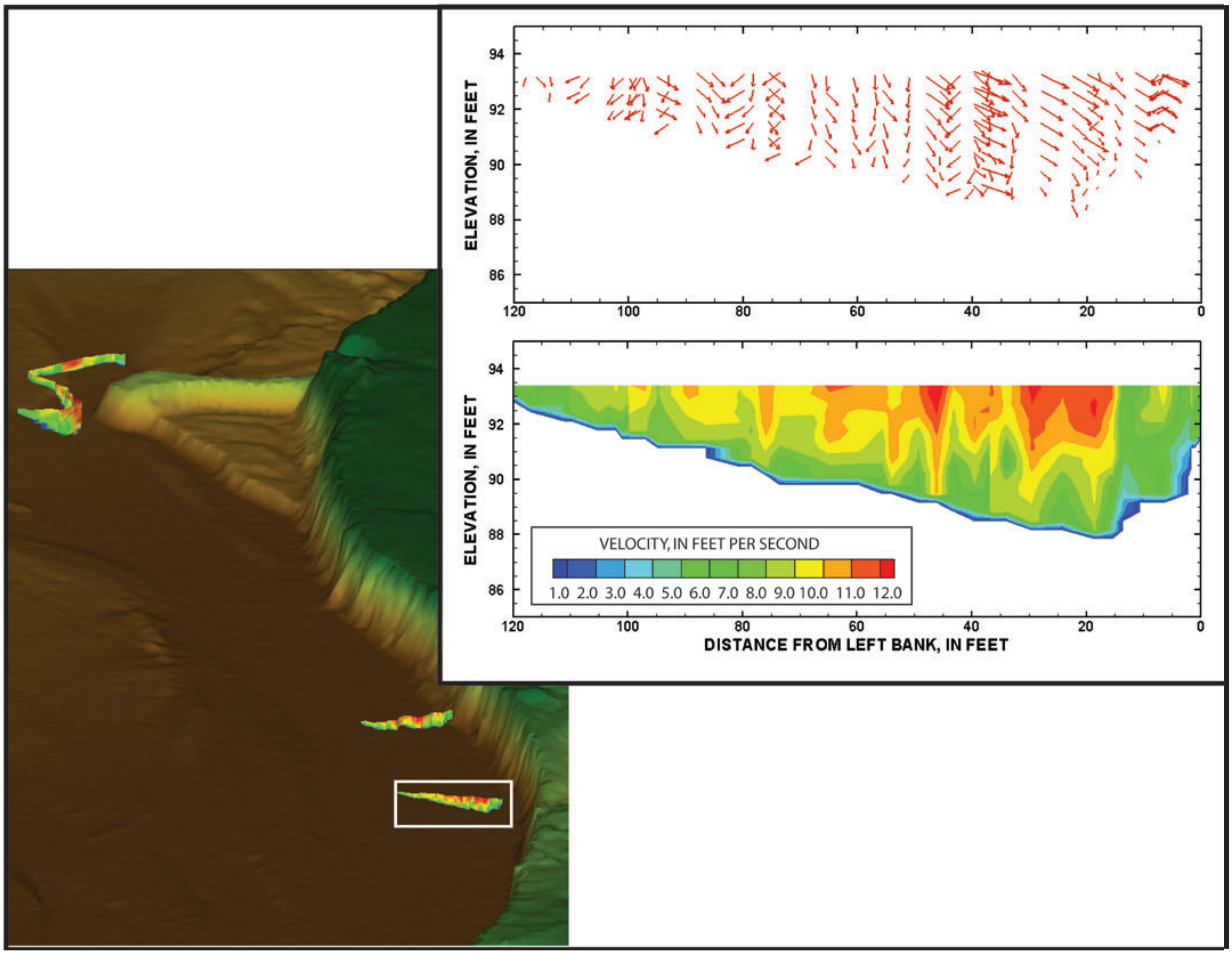


Figure 16. Vertical profiles of measured downstream velocity at the apex of a bend of the Matanuska River near Circle View Estates, Alaska. Cross section location is indicated by the white box in the three-dimensional view of the cross sections and LIDAR data.

Summary

This report presents the methodology and results from a bathymetric and velocity survey along four spur dikes and a bend of the Matanuska River near Circle View Estates, Alaska. Data were collected at this location to document channel conditions prior to installation of a fifth spur dike and to collect hydraulic data along a river bend when erosion was occurring. Data were collected along cross sections and longitudinal profiles using an ADCP interfaced with a DGPS. A total of 71,828 velocity measurements and 31,254 bathymetry measurements were made August 7–9, 2006.

During most of the survey, streamflow at gaging station 15284000 was less than the 25th percentile of long-term discharge. The discharge on the afternoon of August 9, 2006, was 8,890 cubic feet per second, with 31 and 71 percent of that discharge measured at the spur dikes and bank section, respectively. Despite the low flow, measured velocities were in excess of 15 feet per second and the bank was rapidly eroding.

Streamflow hydraulics at the spur dikes were characterized by high velocities and the greatest depths at the nose of the dikes and lower velocities and shallower depths occurring between dikes. The maximum measured velocity was 15.6 feet per second and the area with the overall highest velocities was at the nose of spur dike 4. The maximum measured depth was 12.0 feet at the nose of spur dike 4 and velocities greater than 10 feet per second were measured to a depth of 10 feet. The measured velocity vectors at the nose of the dikes generally were pointing towards the center of the channel.

Bathymetry and water velocity were measured along 1,500 feet of a bend in the river with active bank erosion. Flow depths and velocities were greatest at the apex of the river bend, but bank erosion was concentrated downstream of this apex. The near-bank streamflow hydraulics were analyzed by selecting data within 60 feet of the top of the bank along the apex of the bend and along the bank where erosion was occurring. Along the apex of the bend, the maximum channel depth was 10.2 feet, and the maximum velocity and depth-averaged velocity were 12.9 and 11.8 feet per second, respectively. Downstream of the apex, where active bank erosion was occurring, the maximum flow depth was 5.2 feet, and the maximum velocity and depth-averaged velocity were 11.2 and 10.8 feet per second, respectively.

The bathymetric and velocity data document channel conditions prior to the installation of additional spur dikes and during a period of bank erosion. These data will aid in the process-based investigation of erosion hazards on the Matanuska River.

References Cited

Curran, J.H., Meyer, D.F., and Tasker, G.D., 2003, Estimating the magnitude and frequency of peak streamflows for ungaged sites on streams in Alaska and conterminous basins in Canada: U.S. Geological Survey Water-Resources Investigations Report 03-4188, 101 p.

Dinehart, R.L., and Burau, J.R., 2005, Repeated surveys by acoustic Doppler current profiler for flow and sediment dynamics in a tidal river: Journal of Hydrology, v. 314, issues 1-4, p. 1-21.

Leopold, Luna B., Wolman, M.G., and Miller, J.P., 1964, Fluvial processes in geomorphology: San Francisco, W.H. Freeman and Co., 522 p.

MWH , 2004, Matanuska river erosion assessment: Design study report: Prepared for the U.S. Department of Agriculture Natural Resources Conservation Service, 76 p.

Simpson, M.R., 2001, Discharge measurements using a broad-band acoustic Doppler current profiler: U.S. Geological Survey Open-File Report 01-1, 347 p.

Trimble Navigation Limited, 2001, Trimble Survey Controller Reference Manual, Version 7.60, Revision A: Sunnyvale, California, Trimble Navigation Limited, variously paged.

Trimble Navigation Limited, 2006, Trimble GPS Pathfinder Pro XRS Receiver Datasheet: Sunnyvale, California, Trimble Navigation Limited, 2 p.

RD Instruments, 2003, WinRiver user's guide—USGS version: San Diego, CA, RD Instruments P/N 957-6096-00, 156 p.

U.S. Geological Survey, 1949–2007, Water resources data for Alaska, water years 1948–2007: U.S. Geological Survey Water-Data Report 48-1 to 70-1 and AK-71-1 to AK-07-01 (published annually; AK designation not used before 1971; since 2000, accessible online at http://wdr.water.usgs.gov/).

U.S. Geological Survey, 2004, Water resources data-Alaska-water year 2003: U.S. Geological Survey Water-Data Report AK-03-1, 445 p.

Appendixes—The following appendixes are data files stored in Microsoft© Excel, and are available for download at http://pubs.usgs.gov/of/2008/1359/

Appendix A. Bathymetric and Streamflow Velocity Data Collected at the Spur Dikes, Matanuska River near Circle View Estates, Alaska.

Appendix B. Bathymetric and Streamflow Velocity Data Collected at the Eroding Bank, Matanuska River near Circle View Estates, Alaska.

This page left intentionally blank

Prepared by the USGS Publishing Network,
Linda Rogers
Bobbie Jo Richey

For more information concerning the research in this report, contact the
Director, Alaska Science Center
U.S. Geological Survey
4210 University Drive|
Anchorage, Alaska 99508
http://alaska.usgs.gov

Conaway— **Bathymetric and Hydraulic Survey of the Matanuska River near Circle View Estates, Alaska**—Open-File Report 2008–1359