

APPENDIX A

**M&T/Llano Seco Long-Term Water
Reliability Study**

**These photos are examples of rock spurs
in use throughout the United States**



STATE OF CALIFORNIA
 THE RESOURCES AGENCY
 DEPARTMENT OF WATER RESOURCES
 NORTHERN DISTRICT

SACRAMENTO RIVER
 COLUSA, CA (River Mile 143)
 TO

Data source: 20
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<http://www.a>

Glenn Colusa Irrigation District completed a Sacramento River project in 2002-2003. One phase of their project included five spur dikes immediately upstream and on the opposite bank of their pump intake channel. These spur dikes were 75 feet long and 150 feet apart. They were installed to maintain the river in its current location. They are barely visible immediately upstream of the RM 206 X.



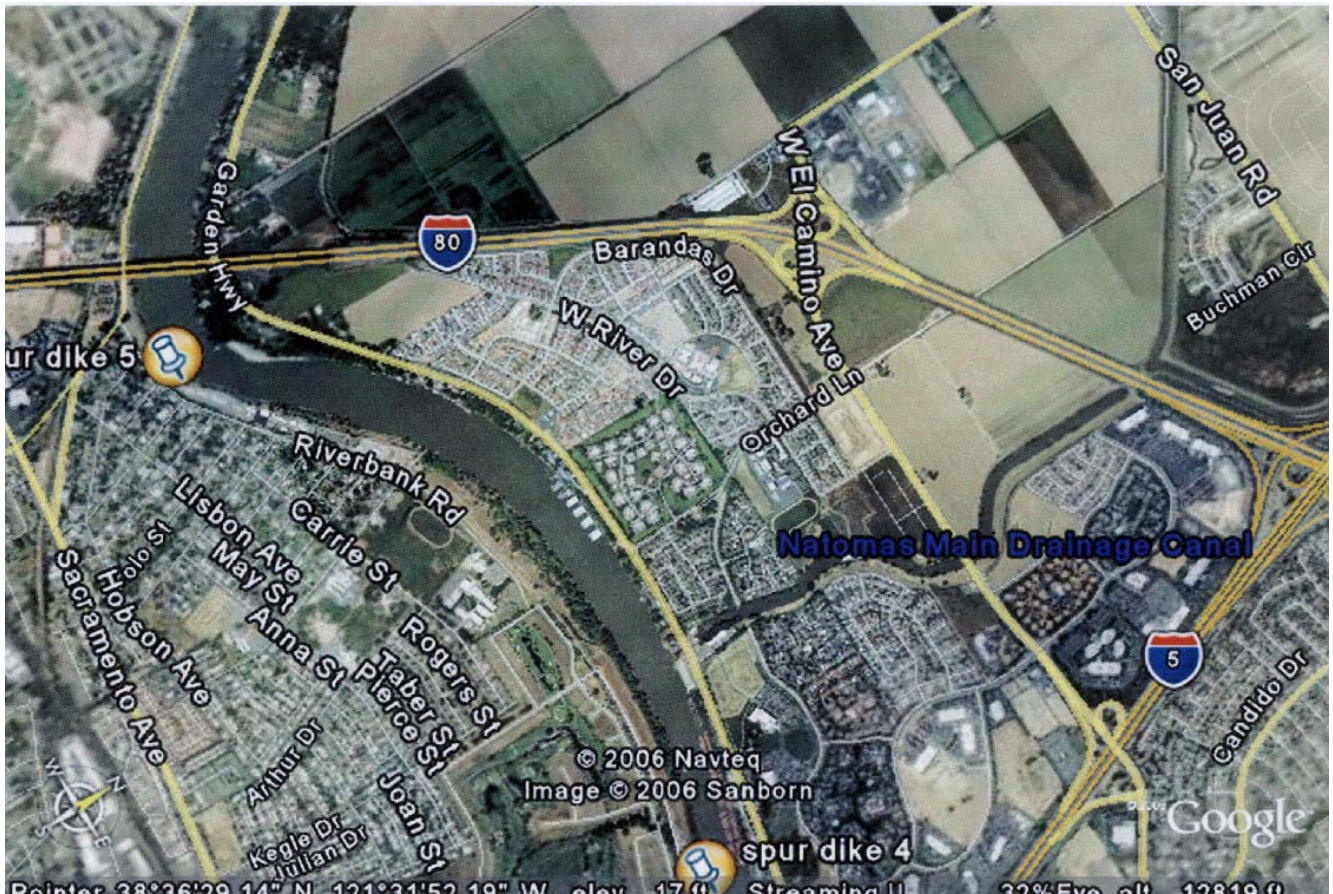
This is a photo taken April 6, 2006, of the Butte City Bridge and State Highway 162. In 2004, CalTrans installed a series of four dikes upstream from the bridge on the west bank of the river. The gravel bar that had formed upstream of the bridge was forcing the main channel of the river into the west footing of the bridge. The total project cost was about \$3.4 million with the construction costs about \$2.4 million. The split of the costs is about \$600,000 per dike with the sheetpile cost of about \$400,000 and the rock at \$200,000.



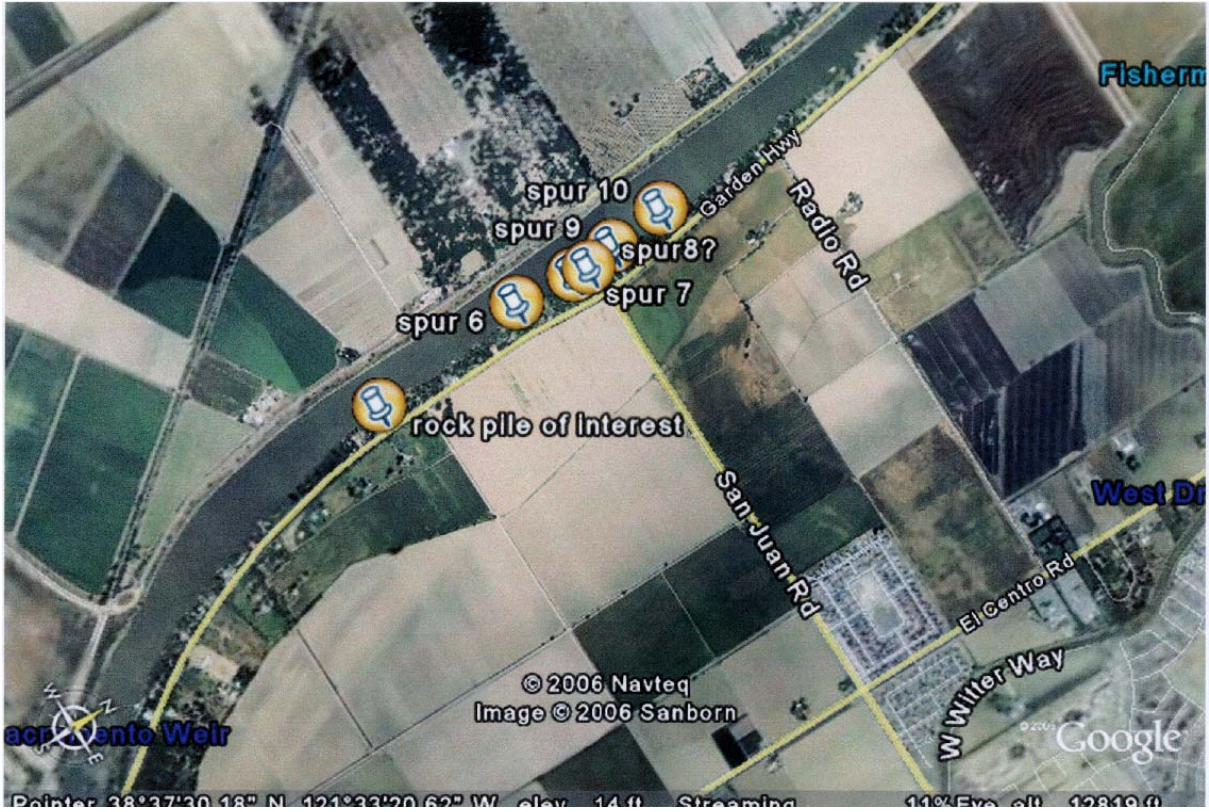
These spur dikes are on the Yuba River below the Daguerre Point Dam. The location is in Yuba County, east of Marysville and off of Highway 20. They were in place for the 1997 flood where the Yuba River had flood flows in excess of 150,000 cfs. They date back to the 1980s or before.



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The next six photos show a number of spur dike locations from where the Feather and Sacramento Rivers meet, down to Sacramento. These are satellite photos so the locations may not be exact, but in any event, there are a great number of them. Spur dike location 21 was zoomed in on and they are very apparent. They were installed at least 60 years ago and are low-elevation features that were placed in the Sacramento River for two reasons: (1) to hasten degradation of the channel into the hydraulic mining, and (2) to provide a low-water navigation channel.





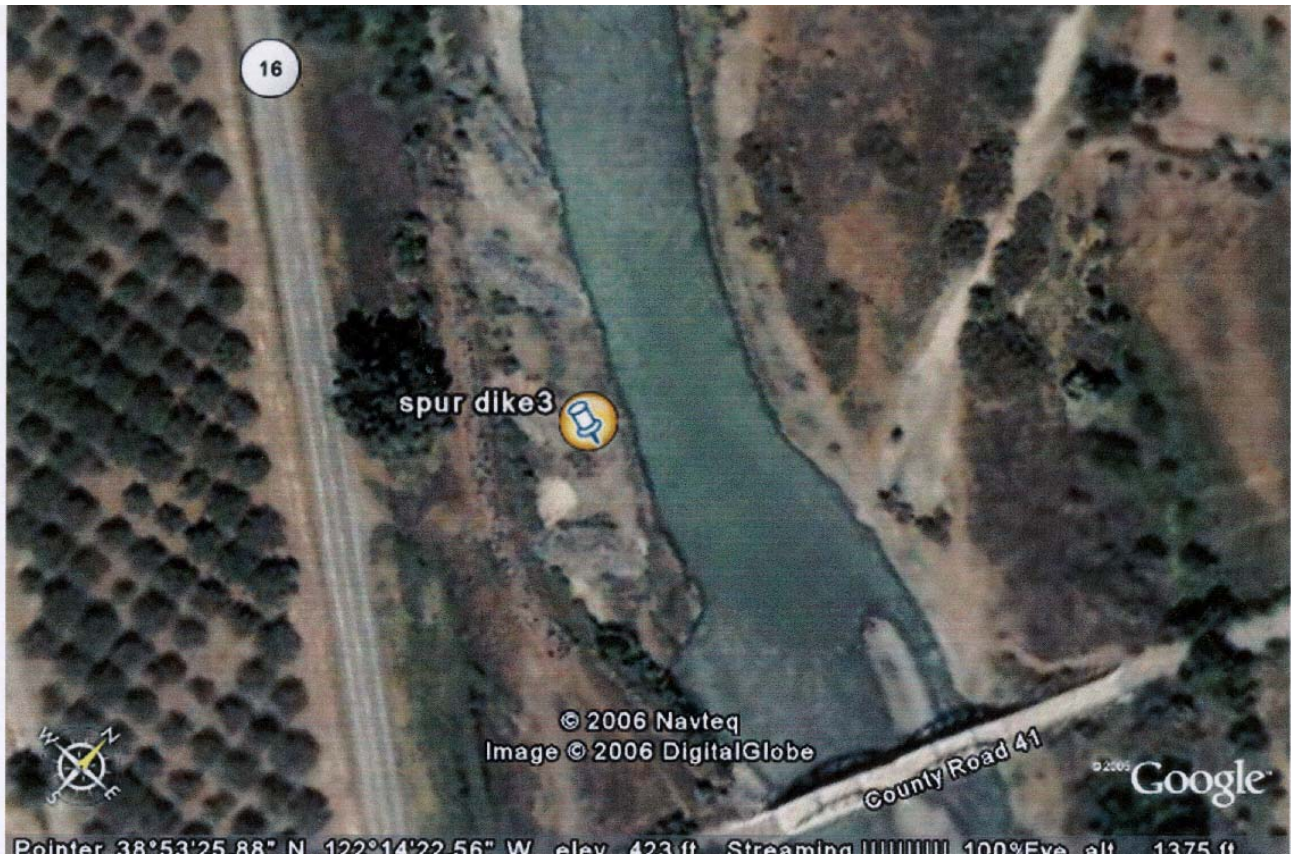




The Sacramento River immediately down-river from where the Feather River empties into it. This is a close-up of the many spur dikes in this vicinity of the river.



Cache Creek and I-505 in Yolo County. These dikes were installed by CalTrans and the gravel-mining operations in the area.



Cache Creek and State Highway 16 in Yolo County immediately north of the town of Rumsey. This was a CalTrans spur dike project completed in 1997.



Cache Creek in Yolo County near State Highway 16 and County Road 57. This NRCS spur dike project was done in 1997 and was completed to protect homes, a park, and a bridge.



Smith River 2002 CalTrans Bank Stabilization Project. Location was State Highway 197, 1.6 km south of Highway 101. At the toe of the bank protection, 2-ton boulder clusters with root wads were installed.



These rock dikes are located in the Chetco River in southwest Oregon. They are near Brookings, Oregon, and about four miles from the ocean. Notice the vegetation growing up in the dike.



This photo is of rock groins installed on the Bogacheil River near Forks, Washington, in 1999. The Corps installed six rock groins on an outside corner of the river for an erosion project. The river had flooded up and over the bank in this area several times since 1999, but there has not been additional bank loss. Prior to the groins being installed, the river had moved 200 feet landward over two flood seasons.



The groins were installed on the Yakima River near the City of Yakima, Washington in 1997. The river was eroding the toe of the levee and the groins were installed as erosion protection. There have been several floods on the Yakima since 1997 and the groins have held up well and are still functioning as designed.



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This spur dike location is the Wilmarth Powerplant on the Minnesota River, downstream from Mankato. The gravel bar was threatening to cover the powerplant's cooling water intake. In 1988, a study was commissioned by the Northern States Power Company and was completed by the University of Minnesota. A total of eight alternatives were tested in detail. As a result of the study, three spur dikes were installed on the opposite bank of the river and have performed as designed

This photo was taken in 1989 and the next photo was taken after the spurs were constructed.



Wilmarth Powerplant on the Minnesota River with rock spurs barely visible on the bank opposite the Powerplant. 1997 photo.

Impermeable Dikes – Stone



US Army Corps
of Engineers

Coastal and Hydraulics Laboratory - ERDC

Mississippi River Dike Field



US Army Corps
of Engineers

Coastal and Hydraulics Laboratory - ERDC

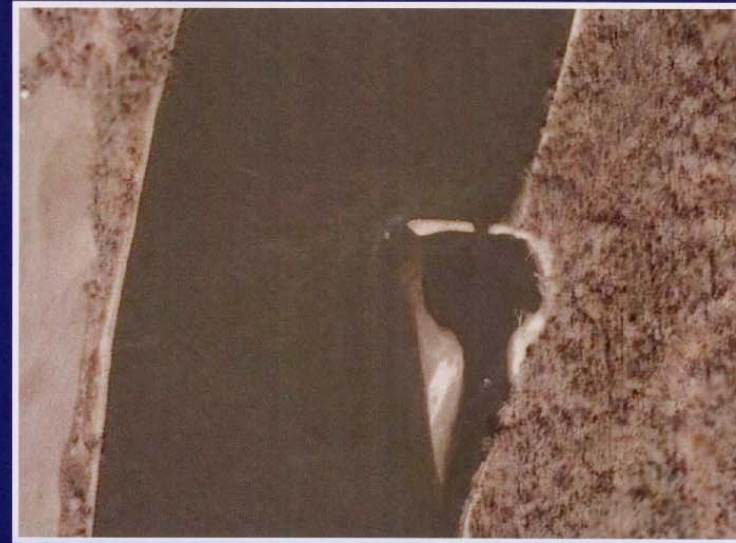
Impermeable Dikes - Stone



US Army Corps
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Coastal and Hydraulics Laboratory - ERDC

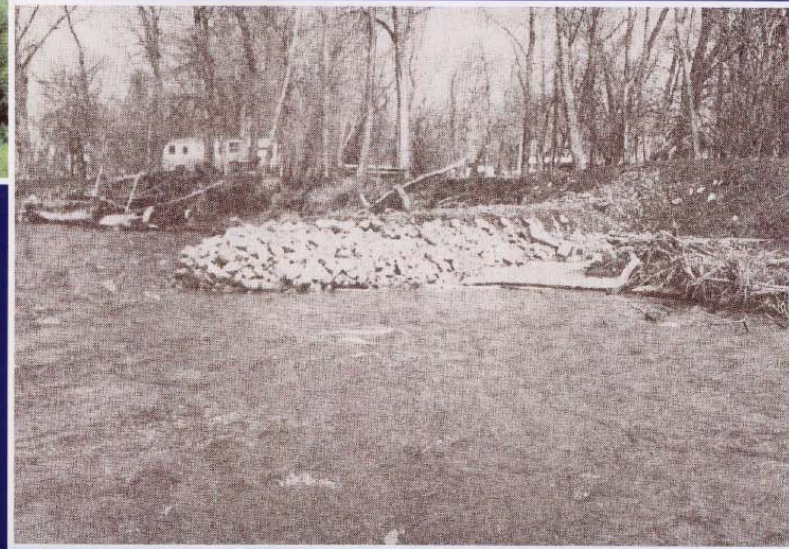
Missouri River Notched Dikes



US Army Corps
of Engineers

Coastal and Hydraulics Laboratory - ERDC

Hard Points



US Army Corps
of Engineers

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