P3a. Descriptions (continued):

What follows are general descriptions of the canals recorded for this survey. Descriptions of individual canal recordation points and comparison points appear on the Linear Forms.

Canal Creek P-24-000090

Canal Creek (MR1-CC) is an irrigation canal that runs approximately 16 miles north to south from its origination point in Section 29 T5S/R14E MDBM where it branches off from the MID Main Canal. It terminates in the NE ¼ of Section 20 T7S/R13E where it flows into Black Rascal Creek. Canal Creek is a natural watercourse that has had irrigation water conveyed into it from the Main Canal since 1876. Today the route follows the natural route of the creek for much of its length. Small sections of Canal Creek have been realigned into straight segments with right angles and a "man-made" appearance. At many of the points recorded on this form the channel follows a generally natural alignment, but the banks and channel bottom have been dredged, graded, shaped, and maintained (See Linear Feature Records MR1-CC and Photographs 29, 30, 32).

This form does not evaluate Canal Creek in its entirety, but does address an approximately five mile section between the cities of Atwater and Merced within or near the study area (See Location Map 1). JRP recorded nine points along this segment, which is also the downstream portion of the canal. Canal Creek's junction with the Livingston Canal is located within or near the study area. The Livingston Canal receives much of Canal Creek's water at this junction and Canal Creek becomes a smaller facility from this point downstream. Upstream Canal Creek carries more water and is wide and shallow with banks that undergo routine maintenance and grading. Downstream from the Livingston Canal diversion, Canal Creek is narrow and deep in places with trees and shrubs growing on its banks. Some sections of the canal have a natural, riparian appearance, while in others extensive channel and bank alterations are apparent (See Linear Feature Record MR1-CC-1). There appears to be few diversions from Canal Creek below the Livingston Canal headgate. Many bridges pass over Canal Creek where it intersects with roads and railroads, and in at least one place a flume of a lateral canal passes over the Canal Creek (See Linear Feature Record MR1-CC-5 and Photograph 32).

There is a lateral headgate across Canal Creek at its junction with the Livingston Canal controlling the flow of Canal Creek downstream from this point. The exact construction date of the gate is unknown, although it is likely a modern structure. It consists of four vertical, rectangular, steel lift gates set in a poured concrete foundation with flaring wings. A roadway runs over the top of the structure (See MR1-CC-9).

Main Ashe Lateral/East Ashe Lateral Main Ashe = P-24-000088

The Main Ashe Lateral draws water from Canal Creek at the same point as the Livingston Canal diversion. The East Ashe Lateral branches off of the Main Ashe Lateral in Section 9, T7S/R13E MDBM (See Location Map 1). These two relatively small canals are only a few miles in length and function to transport water from Canal Creek to farm fields. Prevalent along their banks are metal gates that control the flow of water into the fields. Some sections of these laterals are unlined, while others are trapezoidal in cross section and concrete lined. Along their course, they pass under roadways by means of concrete culverts (See Linear Feature Records MR1-MA and MR1-EA and Photographs 31-36).

Bear Creek P-24-002046

Bear Creek is an irrigation canal that runs roughly northeast to southwest through the southern end of the study area. It is a natural watercourse that has had water conveyed into it via irrigation canals. The natural channel begins receiving canal water into its flow northeast of Merced from the Fairfield Canal (See Location Map 2). The creek then passes through agricultural land, the city of Merced, more agricultural land and ultimately drains into the San Joaquin River. Along its course is the Crocker Dam in Section 22 T7S/R13E MDBM southwest of Merced where Black Rascal Creek branches off from Bear Creek. This form addresses that portion of the creek intersecting SR 140.

The part of the canal surveyed for this project is roughly U shaped in cross section, unlined and has vegetation growing along its steep banks. Its channel has been dredged and its banks enhanced to form a berm or levee. The channel has a groomed appearance and has been deepened, widened, and realigned to make for more efficient water conveyance and flood control. In this area the canal passes through agricultural land irrigating orchards, pastures, and row crops (See Linear Feature Record MR1-BC-1).

Meadowbrook Lateral P-24-000574

The Meadowbrook Lateral is an irrigation canal running adjacent to Bear Creek, paralleling its east side (Location Map 2). It is approximately 20 feet wide and four feet deep. It is unlined and roughly U shaped in cross section and its banks show signs of erosion. Both sides of the channel are built up above the surrounding land. It has concrete and metal gate structures and a concrete culvert passing under SR 140. This form addresses that portion of the creek intersecting SR 140 (See Linear Feature Record MR1-MB-1 and Photograph 37).

Black Rascal Creek

Black Rascal Creek is an irrigation canal that runs roughly northeast-southwest from its origination point in the Sierra Nevada foothills northeast of the city of Merced (Location Map 3). The Creek passes through the northern part of the city of Merced and empties into the Bear Creek channel one half mile east of Crocker Dam. At Crocker Dam, Black Rascal Creek splits off from Bear Creek and continues in a generally southwesterly direction. Black Rascal Creek is a natural watercourse that has had water conveyed into it via irrigation canals. This form addresses that portion of the creek intersecting Gurr Road.

The role of this creek as a canal began around 1905 when the Crocker-Huffman Irrigation Company constructed the Livingston Canal, from which Black Rascal Creek drew water. This part of Black Rascal Creek is roughly U shaped in cross section and has vegetation growing along its unlined banks. Black Rascal Creek has a very regular, groomed appearance. Its banks have been raised above the surrounding farmland to form berms or levees and the banks have a uniform slope. The channel also appears straight and angular in alignment, within the segment addressed in this study. In this area the canal passes through agricultural land irrigating orchards, pastures, and row crops (See Linear Feature Record MR1-BR-1 and Photographs 38).

Hess Lateral

The Hess Lateral is a conveyance structure beginning at the Crocker Dam and continues parallel to the north side of Black Rascal Creek for approximately one and a half miles where it passes under the creek via siphon and parallels the south side (Location Map 3). At the point recorded for this survey, the canal is approximately 20 feet wide and ten feet deep. The unlined channel is roughly U shaped in cross section and has grassy vegetation growing on its banks, which are higher than the surrounding land. Access roads run on the berms both the north and south of the canal east of Gurr Road. The Hess Lateral terminates approximately one half mile west of Gurr Road, for a total length of about 2 miles (See Linear Feature Record MR1-HS-1).

Henderson Lateral P-24-001783

The Henderson Lateral is an irrigation canal that runs roughly north-south from its origination point in Section 18 T6S/R14E MDBM where it branches off from the MID's Main Canal. Its course is approximately eight miles, terminating in the SE1/4 of Section 10 T7S/R13E MDBM (Location Map 4). Portions of the Henderson Lateral's route follow natural watercourses, while others are of artificial construction. This form addresses that portion the lateral intersecting and parallel to Bellevue Road. This part of the canal is roughly U shaped in cross section and unlined, with a small amount of vegetation growing along its banks. It is heavily silted and shows signs of erosion. In this area the canal passes through agricultural land irrigating orchards, pastures, and row crops. There are access roads on both sides of the canal north of Bellevue Road (See Linear Feature Records MR1-HN and Photographs 39-44).

Mason-Curtis Lateral P-24-001899

The Mason-Curtis Lateral is an irrigation canal that runs roughly northeast-southwest from its origination point in Section 34 T6S/R13E MDBM where it branches off from the Henderson Lateral (Location Map 4). Its course is approximately one and a half miles long, terminating in the SE1/4 of Section 33 of the same township. The last half mile of the canal runs along Fox Road, and then turns to parallel Canal Creek, ultimately draining into the latter. This form addresses that portion the lateral parallel to Fox Road and Canal Creek. This part of the canal is U shaped in cross section, unlined, and overgrown with vegetation. In this area the canal passes through agricultural land irrigating orchards, pastures, and row crops (See Linear Feature Record MR1-MC-1).

Buhach Lateral P-24-000091

The Buhach Lateral is an irrigation canal that runs roughly north-south from its origination point in Section 6 T7S/R13E MDBM where it branches off from the MID's Livingston Canal (Location Map 5). The Buhach Lateral was built in the 1890s to serve the Buhach agricultural colony. This form addresses that portion the lateral intersecting Elliot Road. This part of the canal is roughly trapezoidal in shape and lined with concrete. In this area the canal passes through agricultural land irrigating orchards, pastures, and row crops (See Linear Feature Record MR1-BH-1 and Photographs 45, 46).

Drainage Ditch

This drainage ditch, built between 1957 and 1960 borders farm land in Sections 25, 26, 34 and 35, T6S/13E MDBM and is about four miles in total length (Location Map 6). Ditches such as these are common in Merced County and drain irrigation water from fields. The ditch is approximately 14 feet wide at the top and four feet deep. It is unlined and has some vegetation on its banks and shows signs of erosion and of recent excavation. This form addresses that portion the ditch perpendicular and parallel to Bellevue Road. The ditch at this point runs north/south between two fields in Section 35 and east/west parallel to Bellevue Road. Maps and field observation indicate that a portion of the original ditch has been piped and covered recently. The terminus was undetermined, but generally such ditches drain into a natural waterway or canal (Linear Feature Record MR1-DR-1 and Photographs 47, 48).

Livingston Canal P-24-000552

The Livingston Canal, constructed in 1879, begins in the SW1/4 of Section 4, T7S/R13E MDBM where it draws water from Canal Creek (Location Map 7). Livingston Canal irrigates land between the cities of Atwater and Livingston. This form addresses that portion of the canal at its junction with Canal Creek. At the points recorded for this survey, the canal has a uniform, trapezoidal shape with no vegetation growing on the banks and access roads along the sides. Some sections are lined with concrete or riprap, while others are unlined. The canal follows a circuitous route through residential areas in the city of Atwater as ti runs northwest away from the study area. There are periodic metal gates along the canal's course (See Linear Feature Records MR1-LC and Photographs 49, 50).

B10. Significance (continued):

Historic Context

San Joaquin Valley Irrigation

Stimulated largely by the relatively arid conditions of the region, settlers in the San Joaquin Valley were among the first American-era farmers in California to put in works specifically for irrigation. During the late 1850s and 1860s, their ditches were typically earthen, short, roughly made, and diverted water by means of temporary brush dams constructed across the lower courses of the streams running west out of the Sierra Nevada mountains. The earliest of these ditches were built in the vicinity of Visalia in 1852-1853; others spread out through the Kaweah River and Kings River deltas in the 1860s. Further north in the valley, where rain was more abundant and grain could be dry-farmed, irrigation development was slower. The great floods of 1862 and 1868 destroyed most early ditch systems, but San Joaquin Valley farmers continued to experiment with irrigation. Like other Californians, most early San Joaquin settlers in the period from 1850 through the 1860s were not particularly interested in investing time and money in irrigation, focusing instead on cattle raising and dry-farm cultivation of small grains to meet the economic opportunities created by the Gold Rush. By 1870 there were only about 60,000 irrigated acres in California.[1]

Challenges faced by early irrigators included California's porous soil, the limited technological knowledge of farmers, high cost of construction, scarce machinery, and conflicting concepts of water rights. Nevertheless, cycles of drought and flooding, an unstable wheat market, soil exhaustion, developing markets for irrigated crops, advancements in irrigation technology, and unreliable precipitation during the 1860s and 1870s led to a growing interest in irrigation. During this period, both private companies and groups of individual farmers attempted to expand and diversify irrigated agriculture. One of the first irrigation companies organized in the San Joaquin Valley was the Fresno Canal and Irrigation Company, which incorporated in 1870, and was providing water by 1872. Many other such companies formed in the 1870s and 1880s.[2]

As a result of conflicts over water and a desire to expand and diversify irrigation in California, by the 1880s many farmers and landowners became interested in forming irrigation districts. This groundswell culminated in the passage of the landmark Wright Act of 1887, which allowed for the formation of such districts. The Wright Act is significant because it provided the means for local democratic control over water and promoted irrigation as a means for community and regional development.[3] The first irrigation district organized under the Wright Act was the Turlock Irrigation District (TID), and unlike many other irrigation districts formed during the late nineteenth century, it has remained active throughout the

[1] JRP Historical Consulting Services, "Historic Mining, Hydroelectric, Irrigation, and Multi-purpose Canals of California, Volume 1: Historic Overview, Typology, and Discussion of Previously Inventoried Canals," 1995, 66 (hereafter, JRP, "Canals of California"); JRP Historical Consulting Services, "Water Conveyance Systems in California," for Caltrans, 2001, 11-12 (hereafter, JRP, "Water Conveyance Systems in California.")

[2] Paul H. Willison, "Past, Present, and Future of the Fresno Irrigation District," California State University, Fresno, Special Collections (August 1, 1980), 68, 76, 99, 102, 107.

[3] Thomas E. Malone, "The California Irrigation Crisis of 1886: Origins of the Wright Act" (Ph.D. diss., Stanford University, 1965), 13; Alan M. Patterson, *Land, Water and Power: The History of the Turlock Irrigation District, 1887-1987* (Glendale, Calif.: The Arthur H. Clark Company, 1987) 52-57; Frank Adams, *Irrigation Districts in California*. California Department of Public Works, Division of Engineering and Irrigation, Bulletin No. 21 (Sacramento, California State Printing Office, 1929), 180.

twentieth century. TID has evolved from a water conveyance organization dedicated to supplying water to local farmers to a multipurpose supplier of water and hydraulic power to a broad constituency.[4] The Modesto and Tulare irrigation districts were other early districts organized under the Wright Act.[5]

Forty-nine irrigation districts, mostly in the San Joaquin Valley, were organized under the Wright Act between 1887 and 1897, when the law was repealed in favor of revised irrigation district legislation. By the turn of twentieth century, there were over 2.6 million irrigated acres in California.[6] Despite this apparent success, a combination of unsympathetic large landowners, owners of riparian water rights, inadequate planning, inexperienced directors and opportunists within districts contributed to the failure of most Wright Act districts. Between 1897 and 1909, no new districts were formed. By the late 1920s only seven of the original districts were still in existence, including the Modesto, Turlock, and Tulare irrigation districts. Progressive legislation passed in 1911-1913 increased state supervision over district organization and financing, making investment in irrigation district bonds more attractive. Demand for agriculture products grew around this time and remained high throughout World War I resulting in a marked increase in district formation beginning in 1915; each year from 1917 to 1925, five or more districts were formed, including 18 in 1920. As a consequence of this resurgence, 94 irrigation districts were active in California by 1930.[7]

Merced Area Irrigation

Irrigation began in the Merced area with ditches in the bottomlands of the Merced River beginning in the 1850s. These were minor diversions from the Merced River constructed by farmers, which collectively irrigated between 1,500 and 2,000 acres by 1880.[8] Organized, large-scale irrigation in the Merced area began in 1870 when William G. Collier, William P. Sproul, and Stephen Bratzley organized the Robla Canal Company (RCC) in March 1870 and made the first major diversion of water from the Merced River to lands within the current Merced Irrigation District (MID). Collier, who conceived of the enterprise, came to California in 1853 and to Merced County in 1859. Trained as a surveyor and civil engineer, he served as surveyor for Merced County in the 1860s and had experience constructing irrigation canals on Bear Creek. Collier planned to divert water at the current location of the MID Main Canal diversion, and carry it across the uplands commanding the east side plains of the San Joaquin Valley to Bear Creek and beyond. Collier filed for an appropriative water right for his canal system in May 1873.[9]

The RCC, however, had a short history. In November of 1873, RCC sold its entire stock to the Farmers' Canal Company (FCC), which consisted of a group of landowners and farmers who had incorporated the previous May. FCC began to work on the Main Canal and extended it as rapidly as funding would permit. Constructed through hard gravelly soil, excavation costs doubled the original estimates and prevented the company from carrying out its plans as originally proposed. By

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[4] TID and the Wright Act have been the subject of extensive analysis in the annals of the state's water development history. This overview relies on T.E. Malone, "The California Irrigation Crisis of 1886: The Origins of the Wright Act" (Ph.D. Dissertation, Stanford University, 1965); JRP, "Water Conveyance Systems in California"; Donald Pisani, *From the Family Farm to Agribusiness: The Irrigation Crusade in California and the West* (Berkeley: University of California Press, 1984); and other sources as noted.

[5] JRP Historical Consulting, "Historic Resources Inventory and Evaluation Report: Turlock Irrigation District Upper Main Canal, Stanislaus County, California," May 2006.

[6] JRP, "Water Conveyance Systems in California," 14-15.

[7] Harmon S. Bonte, *Financial and General Data Pertaining to Irrigation, Reclamation and other Public Districts in California.* California Department of Public Works, Bulletin No. 37 (Sacramento: California State Printing Office, 1931), 27; *Cost of Irrigation Water in California*, California Department of Public Works, Division of Water Resources, Bulletin No. 36 (Sacramento: California State Printing Office, 1930), 12; California Statistics, 1911, 322 and 1913, 778; JRP, "Water Conveyance Systems in California," 14-15.

[8] C.E. Grunsky, *Irrigation Near Merced*, USGS, Water Supply Paper No. 19 (Washington: Government Printing Office, 1899), 33, 37-39; S.T. Harding, *Water in California* (Palo Alto: N-P Publications, 1960), 101.

[9] John Outcalt, *A History of Merced County, California* (Los Angeles: Historic Record Company, 1925), 333-334.

March 1876, however, the Main Canal had reached Canal Creek, a distance of about eight miles, and made water available for irrigation. The most impressive engineering achievement was an 11.5-foot wide by 9-foot high, 1600-foot long unlined tunnel in the foothills excavated through sandstone and cemented gravel at a cost of $20,000. The Main Canal itself, as constructed, was unlined and had a bed width of 20 feet. Its depth was four feet with a grade of one foot per mile. In 1879, FCC built a second conduit, the Livingston Canal, which diverted water from Canal Creek just east of present-day Atwater and extended to a point about two miles north of the town of Livingston (See Linear Feature Record MR1-LC). The company built a third canal, the Colony Branch Canal, also to serve the Atwater vicinity.[10]

FCC had planned on expanding its system south into the Merced area, but did not succeed in extending the Main Canal beyond Canal Creek. In 1882, FCC sold out to Charles Crocker and C.H. Huffman who organized the Merced Canal & Irrigation Company (MC&IC).[11] Huffman was a large grain-raiser in Merced County who owned vast tracts of land in the vicinity of Cressey north of Merced, while Charles Crocker was one of the founders of the Southern Pacific Railroad. In 1883, the new company, under the direction of its chief engineer Charles Barrent, enlarged the Main Canal to a bed width of 60 feet and the tunnel to 22 feet wide, adhering to the alignment of the old canal in all locations except near the head of the canal. The company extended the Main Canal beyond Canal Creek a distance of five miles in 1884 with the assistance of some 200 teams of mules and scrapers. The following year work began on a second tunnel in the foothills eight miles north of Merced. The tunnel was 30 feet wide, 13 feet high, and 2100 feet long; it was constructed with redwood timbers at a cost of about $70,000. In 1886-1887 another six miles of the Main Canal were completed terminating at a reservoir (present-day Yosemite Lake) that functioned primarily as a domestic water supply for the City of Merced. Water was turned into the reservoir through the completed Main Canal in February 1888. The Main Canal eventually continued southeastward from the reservoir.[12]

In April 1888, the Crocker-Huffman Land & Water Company (Crocker-Huffman) purchased MC&IC to furnish irrigation water for several colonies the company planned to develop in the Merced vicinity. By the 1890s, Crocker-Huffman irrigation water served its own Rotterdam, British, El Capitan, and Buhach colonies as well as V.C.M. Hooper's Yosemite Colony and the Southern Pacific's Bear Creek Colony. Crocker-Huffman furnished the purchasers of land a water right at the rate of $10-$20 per acre and $1-$2 per annum for water service under contract with a life of 50 years. Total irrigated acreage of the Crocker-Huffman system in 1899 was approximately 12,000 acres.[13]

Crocker-Huffman continued to expand its canal system in subsequent decades including construction of the Fairfield Canal and the Bradley, Merced, Hartley, and Robinson Laterals. The company also constructed the Henderson Lateral during the first decade of the twentieth century to draw water from the Crocker-Huffman Main Canal at a point northwest of Lake Yosemite and diverted it to the land lying between Atwater and Merced. By 1914, however, the Crocker-Huffman wanted to sell its holdings. At the time, its system watered about 50,000 acres of land reaching from northeast of Merced to Livingston and was appraised at approximately $1.5 million.[14] In general, Crocker-Huffman had allowed the system to

[10] Grunsky, *Irrigation Near Merced*, 34; Outcalt, *A History of Merced County*, 333-334; Kenneth R. McSwain, *History of the Merced Irrigation District* (Merced, Merced Irrigation District, 1978), 1-9.
[11] Adams, *Irrigation Districts in California*, 190.
[12] Grunsky, *Irrigation Near Merced*, 35.
[13] Grunsky, *Irrigation Near Merced*, 34-37; Outcalt, *History of Merced*, 333-338; Harding, *Water in California*, 101.
[14] Grunsky, *Irrigation Near Merced*, 34-37; Outcalt, *History of Merced*, 333-338; Harding, *Water in California*, 101; McSwain, *History of the Merced Irrigation District*, 9; Crocker-Huffman Land and Water Company, *Map Showing Lands and Canals of Crocker-Huffman Land & Water Company Near Merced, California*, 1912.

languish and did not keep up maintenance on the canals and other works. By 1919, the system as whole was in poor condition and long reaches of the system were overgrown with grass, willows, and other obstacles.[15]

It was during this period that local interests began agitating to form an irrigation district in the Merced area. Irrigation districts formed by local residents were being established in many areas of California in the 1910s and these districts often acquired earlier private enterprise irrigation systems. The most common transition occurred when the local citizens formed an irrigation district covering the area served and then purchased the commercial canals serving it. The Fresno, Consolidated, Merced, and Madera irrigation districts were among those formed through acquisition of nineteenth century systems.[16]

After years of effort, an irrigation district in Merced County came into being. Spearheaded by the Merced County Farm Bureau, elections in November 1919 created the Merced Irrigation District (MID), a district chartered for the purpose of providing irrigation water to lands in eastern Merced County and to generate electricity. One of the district's first actions was to hire John Debo Galloway, a prominent California water engineer, to find a reservoir site in the Sierra Nevada foothills to store flood waters for irrigation. Galloway chose a site in the Merced River Canyon as the location for the future Exchequer Dam and Lake McClure. District voters approved a $12 million bond issue to acquire the Crocker-Huffman system and construct the dam and reservoir in November 1921.[17]

The fledgling MID quickly embarked on an aggressive expansion and improvement program of the neglected former Crocker-Huffman system. MID constructed many miles of new canals during the 1920s, spending almost $5 million in construction on the lower portion of its system. The overwhelming majority of control structures in the canal system such as headgates were constructed of timber and MID set out to gradually replace these original structures with concrete in ensuing years. New construction included the Le Grand canal system, North Side Canal, rebuilt the Fairfield Canal, and many new small canals. By the end of the decade, MID owned 1,020 miles of canals and was the fifth largest district in California. Its Main Canal extended 17 miles, passed through two tunnels and had a capacity of about 1,500 cubic feet per second (cfs).[18] Only about ten miles of the district's more than 1,000 miles of canals were concrete lined by 1927.[19]

MID's most ambitious building program during the 1920s was the construction of the Exchequer Dam completed in 1926. The dam, built at a cost in excess of $5 million, created the Lake McClure reservoir capable of storing 289,000-acre feet of water. Like other districts that were beginning to build dams during this period, MID built a hydroelectric power plant at the base of Exchequer Dam and contracted to sell power to the San Joaquin Light and Power Corporation. Exchequer Dam was built across a narrow gap about seven miles above Merced Falls. Rising 326 feet above the Merced River, the water passed through the powerhouse or spillways and flowed down river to a point a few miles below Merced Falls. There, the old Crocker-Huffman diversion dam distributed water to the various district canals.[20]

During the 1930s, MID experienced financial difficulty as many district farmers became delinquent on their debts. In turn, MID could not pay its debts and declared bankruptcy. The district survived this trauma, however, by selling power from the Exchequer Dam and refunding its debts through the Reconstruction Finance Corporation under the specially enacted federal

[15] John D. Galloway, "Report on the Merced Irrigation District, Merced, California, 1920-1921," p. 511, Water Resources Center Archives, University of California, Berkeley; McSwain, *History of the Merced Irrigation District,* 15; Crocker-Huffman Land and Water Company, "Map Showing Lands and Canals of Crocker-Huffman Land & Water Company Near Merced, California," 1895, 1903, 1912.
[16] JRP, "Canals of California", 68; McSwain, *History of the Merced Irrigation District,* 15-16.
[17] Adams, *Irrigation Districts*, 190-195; McSwain, *History of the Merced Irrigation District,* 15.
[18] Adams, *Irrigation Districts*, 194-195.
[19] Adams, *Irrigation Districts*, 190, 195; Galloway, "Report on the Merced Irrigation District," 509.
[20] Adams, *Irrigation Districts*, 192-195; Harding, *Water in California*, 101; Pisani, *From Family Farm to Agribusiness*, 388.

law. Despite these difficulties, MID did manage to make improvements to its system in the 1930s, and undertook a program of creek cleaning and excavation. MID directors were also interested in implementing a flood control program, which included levee construction along area creeks.[21]

World War II halted work on the MID system, but this was a temporary interruption. The booming economy of the postwar years allowed the district to expand its system and continue to improve its infrastructure. A major component of this work was an accelerated program of canal concrete lining that began in 1946, with lining 10.1 miles of canal at various sites with concrete. Many of the canals built earlier in the century such as the Buhach Lateral (See Linear Feature Record MR1-BH-1), Atwater Lateral, Lingard Lateral, Hartley Lateral, and Arena Lateral were all lined with concrete in the ensuing years.

In addition to concrete lining, MID installed pipeline and realigned many canals in the 1940s and 1950s. The district's purchase of several new draglines at this time facilitated its ability to maintain and realign its many miles of earthen canals, and the use of this canal shaping equipment was the beginning of the end of the horse and Fresno scraper for the district. A dragline, consisting of a crane and bucket device used extensively in strip mining, gave the district the capacity to create smoother and more compacted canal alignments that had been possible previously.[22] The MID system was also fundamentally upgraded in the 1960s with construction of New Exchequer Dam and McSwain Dam, both of which greatly increased storage capacity while also supplying flood control and increasing power generation revenue. Improvements have continued up to the present on the MID.[23]

Canal Lateral Construction

Concrete linings were first used in canals in southern California in the 1880s when increasing value of water made it necessary to prevent conveyance losses in earth canals. The practice was largely confined to southern California until the early twentieth century. As water became more valuable in the Central Valley, seepage losses became an increasing concern for water companies and irrigation districts and in the first two decades of the 20th century, the practice rapidly spread throughout California. Frequently, old canals were improved by changes in alignment to correct hydraulic gradients before lining. Irrigation districts and private water companies in the Central Valley frequently opted for lining canal segments where conveyance losses by seepage were excessive because conversion of a canal system from an earthen ditch to a concrete canal was an expensive proposition.[24]

The trapezoidal cross-section became the typical shape of the concrete lined canal since the advent of the practice. A common means of obtaining this shape was to excavate a channel either by hand or horse-drawn scraper, grade the bottom, and then backfill earth around a wooden form. Concrete was then poured in sections using boards much the same way as a sidewalk, then hand screeded and finished. By the 1930s mechanized canal excavation was the norm, and by 1946, the sub-

[21] Harding, *Water in California*, 101; McSwain, *History of the Merced Irrigation District*, 102, 105.
[22] McSwain, *History of the Merced Irrigation District*, 52, 85, 86.
[23] McSwain, *History of the Merced Irrigation District*, 163, 170; JRP Historical Consulting, "Historic Resource Evaluation Report, Livingston Canal, Merced Irrigation District, Merced County, California," 1998, 5; USGS, *Atwater*, 15' quadrangle (Washington, D.C.: Government Printing Office, 1918); USGS, *Atwater*, 7.5' quadrangle (Washington, D.C.: Government Printing Office,1960).
[24] B.A. Etcheverry, *Lining of Ditches and Reservoirs to Prevent Seepage Losses*, California Agricultural Experiment Station, Bulletin No. 188 (Berkeley: Agricultural Experiment Station, 1907),148-159; Samuel Fortier, *Concrete Lining As Applied to Irrigation Canals*, US Department of Agriculture, Bulletin No. 126 (Washington: US Department of Agriculture, 1914).

grade slip-form concrete lining machine became the common method for larger lining jobs. It is likely that MID used both methods to line canals depending on cost of labor, availability of equipment, and length of canal.[25]

Individual Canal Histories and Evaluations

Canals are common elements of the landscape in California, particularly in the Central Valley, Salinas Valley, and other major agricultural regions of the state. Irrigation canals are difficult to assess for historic significance because they are at once very common property types but are also economically important to the communities they serve. It is necessary then, to approach evaluating canals in a different way than other resources.

The first consideration is that there are many irrigation canals in California's Central Valley. Although no comprehensive figures are available, there are hundreds of individually named canals and thousands of miles of irrigation facilities throughout the Central Valley. MID, for example, has nearly 800 miles of canals, organized in dozens of individually named units. Similar figures prevail for the dozens of irrigation districts throughout the Sacramento and San Joaquin valleys. This point provides a useful perspective on irrigation systems generally. Collectively, all of these irrigation canals helped to revolutionize agriculture in the region and the state. Individually, however, any one canal or system of canals is part of a vast system of such properties.

Second, it is important to appreciate irrigation canals as part of a class of infrastructure that delivers benefits to broad constituencies. Most public works projects fall into this category, including state and local road systems, railroads, municipal water systems, sewer systems, airports, and the like. Major utility features such as electric power generating plants, natural gas pipelines, and telephone service also fall into this category. In irrigated farming communities, irrigation canals have become vital elements of the infrastructure, and many have also developed as electric utilities in addition to their water deliveries. These elements of the infrastructure are obviously important to the communities they serve and society has come to depend on these vital elements to function.

These considerations are useful in appreciating how significance might be assessed for such properties. In a sense, every road, bridge, telephone line, canal, and sewer system is important. Unless judgment is exercised, however, each one might be seen as eligible for the National Register for its importance to the local community. To avoid that trivial conclusion, we must assess historical significance of such infrastructure elements relative to similar property types. For a road to be significant, for example, it must be shown to be important within the context of other roads, recognizing that each road has made some type of contribution to the community. A similar type of judgment must be exercised in evaluating irrigation canals.[26]

It is difficult to establish a single standard for what might constitute significance for an irrigation canal because there are several areas in which that significance might come into play. In general, however, a canal or system should convey some importance that is not common to other canals in the Central Valley or other region of the state. Pioneering construction could be significant if a canal was the first to bring irrigation water to a region. The Persian Ditch in Visalia, for example, was found to qualify for listing in the National Register because it was one of the first canals to be built in the San Joaquin Valley; it dates to the 1860s. Level of service might be another test. Several of the canals of the Bureau of Reclamation's

[25] Department of Irrigation Photograph Collection, Photograph # 710-B-a-114, 29 May 1929, Special Collections, University of California, Davis; Etcheverry, *Lining of Ditches and Reservoirs*, vol. 2, 118, 121, 156-160; US Bureau of Reclamation, *Lining For Irrigation Canals* (Denver: Bureau of Reclamation, 1952), 14-17; Michael Holleran, *Historic Context for Irrigation and Water Supply Ditches and Canals in Colorado* (Denver: University of Colorado at Denver, 2005), 59.
[26] JRP, "Water Conveyance Systems in California," 92-96.

***Recorded by** M.Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

Central Valley Project (CVP) have been found to qualify in this regard, on their basis of the sheer volume of water that they deliver, enough water in a single canal to change fundamentally the cropping pattern of a region. A canal could also be unusual for its design, either because it represents a breakthrough in canal engineering, or because it represents a rare example of an antiquated historic method of canal design. Some of the CVP canals were found to qualify because they represented breakthroughs in the design of very large canals, and, in fact, the CVP canals rival major rivers in their capacities. Several old stone lined canals in the San Bernardino-Riverside area have been found to qualify for the California Register because they are rare examples of this largely antiquated method of canal construction.

Another consideration in evaluating significance for canals is to establish a defensible period of significance. The period of significance should be defined to take into account the area of significance. If a canal is significant for its design, the period of significance should be restricted to the era in which the canal was built. If it is important for effect on cropping patterns, the period of significance should be restricted to the period when this change took place.

Finally, integrity should be assessed on the basis of the period of significance for a property as specified in the California Register of Historic Resources (CRHR) and, by reference, in the National Register guidelines and regulations. The resource must retain integrity to its potential period of significance if it is to meet the criteria for listing in either the CRHR or NRHP.

The long, linear shape of canals and the nature of the projects that compel their evaluation also make canal evaluations unique. Typically, a project's APE will only intersect a small portion of a canal. At these points the canal is recorded and evaluated. It is usually beyond the scope of a survey to consider an entire canal, or canal system. The standard procedure for evaluating linear features calls for recording the segment in the study area and at comparison points to show typical points of the canal that are representative of the segment. These additional recordation points allow the evaluation of the linear resource to be based upon a better understanding of the nature and general integrity of the feature. There have been several evaluations of MID canals and canal segments in the past, including some of the same canals evaluated on this form. Below is a table of the previous evaluations and attached at the end of this form are copies of the earlier forms.

P-24-	Previously Evaluated Canals in Merced Irrigation District			
	Date	Canal	Finding	Citation
001899	2005	Mason Curtis Lateral*	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Inventory And Evaluation Report, Bellevue Substation And Transmission Line Project."
001783	2005	Branch of Henderson Lateral*	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Inventory And Evaluation Report, Bellevue Substation."
001771	2004	Bellevue Ranch Canals	not eligible for CRHR	CalTrans, "Cultural Resources Survey and Assessment Report Woodside Group-Bellevue Ranch Project."
606, 1888	2001	Fairfield Canal	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Evaluation Report, Ten Canals of the Merced Irrigation District, Campus Parkway Project."
001889	2001	Tower Lateral	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Evaluation Report, Ten Canals." California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.

*Recorded by M.Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

P-24-	Previously Evaluated Canals in Merced Irrigation District			
	Date	Canal	Finding	Citation
001890	2001	Sells Lateral	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Evaluation Report, Ten Canals." California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
001891	2001	Yosemite Lateral	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Evaluation Report, Ten Canals." California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
001885	2001	Bradley Lateral	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Evaluation Report, Ten Canals." California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
001882	2001	Merced Lateral	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Evaluation Report, Ten Canals." California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
001883	2001	Robinson Lateral	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Evaluation Report, Ten Canals." California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
86&1884	2001; 2000	Hartley Lateral	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Evaluation Report, Ten Canals;" California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
001886	2001	Doane Lateral	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Evaluation Report, Ten Canals." California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
608&1887	2001	Le Grand Canal	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resource Evaluation Report, Ten Canals." California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
000092	2001	Atwater Canal	not eligible for NRHP	California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
000096	2000	Farmdale Lateral	not eligible for NRHP	California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
000085	2000	Koff Lateral	not eligible for NRHP	California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
1679& 574	7/1998; 9/1998	O'Donnell Lateral	not eligible for NRHP	JRP Historical Consulting, "Historic Resources Evaluation Report, O'Donnell Lateral, Merced Irrigation District;" CalTrans, "Historic Resources Evaluation Report, Rehabilitation of Bear Creek Bridge and the El Capitan Canal Bridge;" California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
574	1998	Meadowbrook Lateral*	not eligible for NRHP	CalTrans, "Historic Resources Evaluation Report, Rehabilitation of Bear Creek Bridge and the El Capitan Canal Bridge."
574	1998	McSwain Lateral	not eligible for NRHP	CalTrans, "Historic Resources Evaluation Report, Rehabilitation of Bear Creek Bridge and the El Capitan Canal Bridge."
577	1998	El Capitan Canal	not eligible for NRHP	CalTrans, "Historic Resources Evaluation Report, Rehabilitation of Bear Creek Bridge and the El Capitan Canal Bridge."
581	1998	Deane Canal	not eligible for NRHP	California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
	1998	Edendale Creek Turnout and Weir on Canal Creek	no NRHP evaluation/ HAER recordation	NPS, "Merced Irrigation District, Edendale Turnout and Weir," HAER No. CA-192-A.

P-24-	Previously Evaluated Canals in Merced Irrigation District			
	Date	Canal	Finding	Citation
000552	1998	Livingston Canal*	not eligible for NRHP or CRHR	JRP Historical Consulting, "Historic Resources Evaluation Report, Livingston Canal;" California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.
000088	1993	Main Ashe Lateral*	not eligible for NRHP	JRP Historical Consulting, "Historic Sites Survey and Evaluation on the Proposed Mojave Natural Gas Pipeline Mojave Pipeline Northern Extension."
000091	1993	Buhach Lateral*	not eligible for NRHP	JRP Historical Consulting, "Historic Sites Survey and Evaluation on the Proposed Mojave Natural Gas Pipeline Mojave Pipeline Northern Extension."
000090	1993	Canal Creek*	not eligible for NRHP	JRP Historical Consulting, "Historic Sites Survey and Evaluation on the Proposed Mojave Natural Gas Pipeline Mojave Pipeline Northern Extension."
000488	1992	Main Canal	eligible for NRHP	PAR Environmental Services, "National Register of Historic Places Significance Evaluation, Main Canal, Merced County;" California Office of Historic Preservation, "California Inventory of Historic Resources," Merced County.

* Canals also evaluated on this survey form.

Taking into account this general statement about canal evaluations, the historic context, and the description of the resources, the following section evaluates the potential significance and integrity of the various canal segments in the Merced Irrigation District.

Canals are rarely found eligible under two of the CRHR eligibility criteria (Criteria 2 and 4), discussed here for all of the canals evaluated. The other criteria are addressed by canal segment in the sections below. Under Criterion 2, a property must be associated with an important person's productive life and must be the property that is most closely associated with that person, qualities rarely found in engineering features. Furthermore, a property such as a dam that represents the work of a master engineer would be eligible under Criterion C, as the work of a master, rather than B, as representing an important person. There may be rare instances, however, when a water conveyance system would be eligible under Criterion B, notably when the person's association with the system is very strong and no properties more intimately associated with that person remain. Research did not reveal any individuals important in irrigation planning, construction, or engineering related to any of the canal segments evaluated on this form. Furthermore, none of the canals represent notable engineering accomplishments. Thus, even if there was an association with someone important, none of these canals would best represent their work. Therefore, none of the canal segments evaluated on this form are eligible for listing in the CRHR under Criterion 2 and none are considered a historic resource for the purposes of CEQA.

Under Criterion 4, a property must be likely to yield information important in history or prehistory. In order to be eligible under this criterion, the potential important information must be from the physical properties themselves. The properties most commonly found eligible under Criterion D are archeological sites; buildings, structures, and objects are infrequently found to be eligible for their information potential. A relevant example would be if a canal held potential information about construction techniques. Construction of the canals and the canal types represented on this form are well documented. Therefore, none of the canal segments in the MID evaluated on this form are eligible for listing in the CRHR under Criterion 4 and none are considered a historic resource for the purposes of CEQA.

Canal Creek

One of the first objectives of the FCC was to divert water from the Main Canal into the Canal Creek streambed north of the study area in Section 29 T5S/R14E MDBM. Downstream from this diversion, a portion of the channel now known as Canal Creek was a stream formerly known as Dry Creek. Water initially flowed through Canal Creek to the area northeast of Atwater in 1876 and it was the first canal in the FCC system to bring water out of the foothills for irrigation (Location Map 1).[27]

In 1879, the FCC built a major lateral, the Livingston Canal, off of Canal Creek at a point in Section 4, T7S/R13E between the current cities of Merced and Atwater (See Linear Feature Record MR1-LC and Location Map 8).[28] The entire flow of Canal Creek was diverted into the Livingston Canal for irrigation of lands west of this confluence.[29] South of this diversion, Canal Creek virtually stopped flowing. State engineer William Hammond Hall noted a small channel past this point the he described as a "ditch" which continued for about a mile.[30] By 1895, more than ten years after Crocker-Huffman acquired the former FCC system, Canal Creek had been extended further south below the Livingston Canal diversion, ultimately emptying into what is now Black Rascal Creek (Location Map 1). Canal Creek was realigned many times in subsequent decades both north and south of the head of Livingston Canal. Canal Creek also underwent periodic cleaning of brush and debris and channel excavation to facilitate efficient irrigation and reduce flooding. Levees were in place along Canal Creek above the Livingston Canal by 1915; below the canal they were constructed between 1946 and 1958.

After MID was formed and began their improvement program in 1920, the flow of Canal Creek above the Livingston Canal headgate was 400 second feet. At the time, it carried the second highest volume of water behind the Main Canal.[31] In the same year, acreage watered by Canal Creek and the Livingston Canal was 54,890 acres. This total constitutes more than half of the total acreage irrigated by canals in the MID system constructed before 1900.[32] A report in 1920 recommended the Canal Creek channel be improved below the Livingston Diversion as an outlet in the event of a breach in the Livingston Canal and to facilitate drainage, and eventually MID undertook this project. There is currently a lateral headgate into Canal Creek the junction with the Livingston Canal and the channel below this point appears to have been deepened, widened, and regularly maintained. Currently there are few diversions from Canal Creek upstream from the Livingston Canal and none below it (See Historic Photos, Figures 1, 2).[33]

In addition to the improvements discussed above, it is likely that the entire length of Canal Creek has undergone regular widening, excavating, and maintaining as needed. Within the study area, a major realignment of an approximately one mile

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[27] Grunsky, *Irrigation Near Merced,* 34.
[28] JRP, "Canals of California", 162.
[29] Galloway, "Report on the Merced Irrigation District," 509.
[30] Mark Howell, *Official Map of Merced County* (San Francisco: A.L. Bancroft, 1874); William Hammond Hall, *Detail Irrigation Map, Merced Sheet,* ([Sacramento]: California State Engineering Department, 1885); Charles D. Martin, *Official Map of Merced County* (San Francisco: Dakin Publising Company, 1888); Galloway, "Report on the Merced Irrigation District," 510, 672.
[31] Galloway, "Report on the Merced Irrigation District," 510, 672; 515, 520.
[32] Galloway, "Report on the Merced Irrigation District," 668, 669.
[33] Crocker-Huffman, *Map Showing Lands of the Crocker-Huffman Land & Water Company* (1895, 1903, 1912); USGS, *Atwater Quadrangle* (1918, 1948, 1960); McSwain, *History of the Merced Irrigation District*, 134-136, 143, 149, 141, 146, 159, 198, 201, 337, 149, 194, 200; A.E. Cowell, *Official Map of the County of Merced, California* (1909); Galloway, "Report on the Merced Irrigation District," 510, 672.

section near the intersection of Bellevue and Fox Road, occurred between 1960 and 1973. More recently the MID constructed a reservoir just north of Bellevue Road.[34]

Under Criterion 1, Canal Creek appears to have important associations with events or patterns of events that are important to our history from the date of its construction, through the initial phase of irrigated agriculture development in the 1890s, although it does not retain integrity to this period. Canal Creek was one of the pioneering irrigation canals under an organized system in the Merced-Atwater region. As the principal lateral from the Main Canal until the early twentieth century, it functioned to bring water out of the foothills 16 miles to arable land. Indeed, until extension of the Main Canal in the late 1880s, Canal Creek was longer than the Main Canal and the majority of the Main Canal's flow went into Canal Creek. In turn, all of Canal Creek's water flowed into the Livingston Canal spawning development between Atwater and the Livingston area. As such, Canal Creek played a central role in the development of irrigated agriculture and settlement patterns of this region.

Although Canal Creek is potentially significant under Criterion 1, the portion within the study area does not retain integrity to its period of significance. An approximately one mile segment of the canal in Section 33, T6S/R13E was realigned between 1960 and 1973, and a section below the Livingston diversion was realigned between 1946 and 1958 and its channel has also been dredged and its banks enhanced and shaped to form levees. These actions greatly diminish the integrity of design, materials, location, and workmanship of Canal Creek as an engineering feature.[35] In addition, the construction of Castle Air Force Base in 1941 diminished the integrity of setting. Therefore, the approximately five mile portion of Canal Creek evaluated on this form is not eligible for listing in the CRHR under Criterion 1 and is not considered a historic resource for the purposes of CEQA.

Under Criterion 3, Canal Creek is not important for its design, engineering, or method of construction. Being a natural waterway, is not a conventional canal. There was relatively little engineering involved in its initial conversion for use in conveying water. The practice of including natural waterways in engineered irrigation systems had been practiced in the San Joaquin Valley since the 1860s. It is possible that hand labor and scrapers were used on some portions of the canal, but these methods were also common in by the 1860s. When compared against other channels of this type, Canal Creek is typical and does not represent important design or engineering accomplishment or innovation. Therefore, Canal Creek is not eligible for listing in the CRHR under Criterion 3 and is not considered a historic resource for the purposes of CEQA.[36]

A 1993 report by JRP Historical Consulting titled "Historic Sites Survey and Evaluation on the Proposed Mojave Natural Gas Pipeline Mojave Pipeline Northern Extension" also evaluated a segment of Canal Creek and found it ineligible for the NRHP. See Attachment A for a copy of the form from that report.

Main Ashe/East Ashe Lateral

The Crocker-Huffman Company constructed the Main Ashe and East Ashe Laterals around 1890. These canals drew their water from Canal Creek near its junction with the Livingston Canal and served the Ashe Colony in the vicinity of Section 9, T7S/R13E. Like Canal Creek, portions of these laterals flow in former natural streambeds. Initial construction was by hand

[34] USGS, *Atwater Quadrangle,* 1960, 1987; WAC Corporation, Aerial Photographs of Merced County, 1985, Map Library, University of California, Davis; Merced Irrigation District, *Official Map of the Merced Irrigation District* (Merced: MID, 1973); Current aerial view from www.Google.com.
[35] Galloway, "Report on the Merced Irrigation District," photographs at end of report, no page number.
[36] Willison, "Past, Present, and Future of the Fresno Irrigation District," 78-79; Ingvart Teilman and W. H. Shafer, *The Historical Story of Irrigation in Fresno and Kings Counties in Central California* (Fresno: Williams and Son, 1943), 6.

labor and by horse and scraper. Major improvements were not made on these canals until after 1920 when MID began to generally upgrade the system. At some time MID lined portions of the Main Ashe Lateral, using methods similar to those shown in Figures 6-8.

Under Criterion 1, the Main Ashe Lateral and East Ashe Lateral do not have important associations with events or patterns of events that are important to our history. These structures were minor canals in a large system and did not play a major role in development of irrigated agriculture or settlement patterns of the Merced-Atwater region. Therefore, the Main Ashe Lateral and East Ashe Lateral are not eligible for listing in the CRHR under Criterion 1 and are not considered a historic resource for the purposes of CEQA.

Under Criterion 3, the Main Ashe Lateral and East Ashe Lateral are not important for their design, engineering, or method of construction. Constructed around 1890, the Main Ashe Lateral and East Ashe Lateral are common structural types. They were likely originally constructed by hand and by horse and scraper, methods common to the era. Subsequently, they were formed into a trapezoidal shape the Main Ashe Lateral was lined using established design and construction techniques. There is no indication the Main Ashe Lateral and East Ashe Lateral are important examples of the science of irrigation canal construction and maintenance. Therefore, the Main Ashe Lateral and East Ashe Lateral are not eligible for listing in the CRHR under Criterion 3 and are not considered a historic resource for the purposes of CEQA.

In addition to lacking significance, the Main Ashe Lateral and East Ashe Lateral also lack integrity. The concrete lining of the Main Ashe Lateral and the routine maintenance of the East Ashe Lateral diminish the integrity of design, materials, and workmanship of both canals. A 1993 report by JRP Historical Consulting titled "Historic Sites Survey and Evaluation on the Proposed Mojave Natural Gas Pipeline Mojave Pipeline Northern Extension" also evaluated a segment of the Main Ashe Lateral and found it ineligible for the NRHP. See Attachment B for a copy of the form from that report.

Bear Creek/Meadowbrook Lateral

Farmers began to divert water from Bear Creek onto their adjacent land via small, hand dug channels beginning in the 1860s. More intensive use of Bear Creek water did not begin until the later nineteenth century. The Crocker-Huffman Company constructed the Crocker Dam on Bear Creek in 1888 in Section 22, T7S/R13E MDBM, west of Merced outside the study area. Past the dam, Bear Creek split into two channels, both labeled "Bear Creek" at the time. The company also diverted Black Rascal Creek into Bear Creek just upstream from the Crocker Dam. This occurred at some point between 1885 and 1895, and likely coincided with construction of the dam. After 1915, the north channel downstream from Crocker Dam changed in name from "Bear Creek" to "Black Rascal Creek," which it holds to this day (Location Map 2).[37]

During the first decade of the twentieth century, the Crocker-Huffman Company enhanced the flow of Bear Creek with construction of the Fairfield Canal, which carried water from Lake Yosemite into Bear Creek at a point northeast of Merced. The water then flowed through Bear Creek and irrigated land along its course including the area southwest of Merced in the study area. Levees were in place along the banks of Bear Creek by 1915. In the 1920s, Bear Creek ceased receiving water from the Fairfield Canal after the MID realigned the latter to pass under Bear Creek and irrigate land south and east of Merced. Bear Creek currently receives water from the Applegate Lateral and Black Rascal Creek.[38]

[37] Willison, "Past, Present, and Future of the Fresno Irrigation District," 78-79; Teilman and Shafer, *The Historical Story of Irrigation in Fresno and Kings Counties*, 6; Hall, *Map of Irrigation Near Merced*, 1885; USGS, *Atwater Quadrangle*, 1918; McSwain, *History of the Merced Irrigation District*, 6.

[38] JRP, "Historic Resource Evaluation Report: Ten Canals of the Merced Irrigation District, Campus Parkway Project, Merced County, California, June 2001," 4; USGS, *Merced Quadrangle*, 1918, 1948, 1961, 1980.

Research did not reveal specific references to creek cleaning and excavation work on Bear Creek, but it is likely that it did occur in the 1930s, if not before. Use of machinery for canal excavation and cleaning was the norm, especially because of the availability of surplus equipment from World War I. MID rebuilt the Bear Creek side of Crocker Dam, where Black Rascal Creek splits off from Bear Creek in 1941. Sometime from 1946 to 1948, work concluded on the Meadowbrook Lateral, which commenced at Crocker Dam and ran parallel to Bear Creek on the east side (Figures 1-4). In the post-World War II years, MID has continued to maintain all of the waterways under its jurisdiction including Bear Creek and the Meadowbrook Lateral (Figures 3-5).[39]

Under Criterion 1, Bear Creek does not have important associations with events or patterns of events that are important to our history. By the time the Crocker-Huffman Company delivered water to Bear Creek for irrigation via the Fairfield Canal in the early twentieth century, the practice of using existing streambeds for this purpose was about 50 years old. Furthermore, extensive irrigation canals had been in place in the region for decades and there was no radical change in regional land use after Bear Creek became a conduit for canal water. In addition, prior to its stream being enhanced, farmers along Bear Creek had dug small canals from its channel, tapping its natural flow. Thus, land along parts of its course had been irrigated for some time. Bear Creek is not eligible for listing in the CRHR under Criterion 1 and is not considered a historic resource for the purposes of CEQA.

Under Criterion C, Bear Creek is not important for its design, engineering, or method of construction. Bear Creek, being a natural waterway, is not a conventional canal and there was relatively little engineering involved in its initial conversion for use as an irrigation canal. By 1915, it did have embankments constructed along its banks and portions of its channel were likely realigned. It was also periodically cleaned of brush and debris and possibly excavated. When compared against other channels of this type, Bear Creek is typical and does not represent important design or engineering accomplishment or innovation. The canals are useful irrigation conduits that display modern methods of canal maintenance and are generally workmanlike in their construction. There is no indication, however, that this canal is an important example of the science of irrigation canal construction and maintenance, Bear Creek and the Meadowbrook Lateral are not eligible for listing in the CRHR under Criterion 3 and are not considered historic resources for the purposes of CEQA.

In addition to lacking historic significance, Bear Creek lacks integrity to its potential period of significance. This period is defined as the first years after canal water was diverted into the creek for the purposes of irrigation. Routine maintenance performed on Bear Creek over the years has resulted in changes to the shape of the channel and banks. Additional changes affecting the integrity include the replacement of the Crocker Dam, an integral component of Bear Creek as an irrigation canal, the change in design of the related Fairfield Canal, and the construction of the Meadowbrook Lateral. These factors have diminished the integrity of materials, workmanship, setting, and design.

Under Criterion 1, the Meadowbrook Lateral does not have important associations with events or patterns of events that are important to our history. Constructed between 1946 and 1958, irrigation was already well established in the region and it did not drastically alter land use. Therefore, the Meadowbrook Lateral is not eligible for listing in the CRHR under Criterion 1 and is not considered a historic resource for the purposes of CEQA.

Under Criterion C, the Meadowbrook Lateral is not important for its design, engineering, or method of construction. Constructed between 1946 and 1958, the Meadowbrook Lateral is a common type as well, and such canals have existed in the region and in the MID since at least the early twentieth century. Therefore, the Meadowbrook Lateral is not eligible for listing in the CRHR under Criterion 3 and is not considered a historic resource for the purposes of CEQA. The

[39] McSwain, *History of the Merced Irrigation District*, 134-136, 143, 149, 141, 146, 159, 198, 201, 337; USGS *Atwater Quadrangle*, 1918; Holleran, *Historic Context for Irrigation*, 59.

Meadowbrook Lateral generally retains integrity to its potential period of significance defined as the years construction, but this canal lacks historic significance.

A 1998 report by Caltrans titled "Historic Resources Evaluation Report, Rehabilitation of Bear Creek Bridge and the El Capitan Canal Bridge" also evaluated the Meadowbrook Lateral and found it ineligible for the NRHP. It did not consider Bear Creek a cultural resource and did not evaluate it. See Attachment C for a copy of the form from that report.

Black Rascal Creek/Hess Lateral History

Black Rascal Creek first appears on maps in 1874 as a short, unnamed stream that began northeast of Merced and drained into open land to the north of that town. As irrigation became organized in the later nineteenth century, the Bradley Lateral, Fahrens Creek, and canals passing through the Yosemite Colony north of Merced, began to empty into Black Rascal Creek. About the same time the Crocker-Huffman Company lengthened the channel of Black Rascal Creek west of Merced connecting it with Bear Creek. Immediately west of this confluence the company also constructed the Crocker Dam in 1888 where the channel split into two channels (see above and Location Map 3). Canal Creek empties into Black Rascal Creek downstream from Crocker Dam.[40]

Black Rascal Creek remained part of the system after MID took control of irrigation in the Merced region. The recognition of Black Rascal Creek as a viable irrigation canal was apparent in 1920 when the MID made filings for water rights on Black Rascal Creek in the event that water might be brought to the Planada-Le Grand area northeast of Merced and conveyed to this creek.[41] By 1915, there were levees on both banks of the creek. Research did not reveal specific references to cleaning and excavation of Black Rascal Creek in the 1930s, but it is likely that it did occur at this time if not earlier. In the 1940s, MID performed excavation and "berm" removal on the creek. Reconstruction of the Black Rascal Creek side of Crocker Dam, where Black Rascal Creek splits off from Bear Creek, occurred in 1942. Regular maintenance has been performed on the channel and banks of Black Rascal Creek by MID. Some time between 1946 and 1958, work concluded on the Hess Lateral, which commenced at the Crocker Dam and ran parallel to Black Rascal Creek on the north side, then passed under the creek via a siphon and continued on the south side. Currently some of the flow of Black Rascal Creek is diverted to Bear Creek northeast of Merced (Figures 3-5).[42]

Under Criterion 1, Black Rascal Creek does not have important associations with events or patterns of events that are important to our history. By the time the Crocker-Huffman Company began diverting water into Black Rascal Creek from its canals north of Merced and altered its channel into Bear Creek, the practice of using existing streambeds as part of irrigation infrastructure was already well established in the region. Furthermore, extensive irrigation canals had already been in place in the area for decades and there was no radical change in regional land use after Black Rascal Creek became a conduit for canal water. Therefore, Black Rascal Creek is not eligible for listing in the CRHR under Criterion 1 and is not considered a historic resource for the purposes of CEQA.

Under Criterion C, Black Rascal Creek is not important for its design, engineering, or method of construction. Black Rascal Creek, being a natural waterway, is not a conventional canal and there was relatively little engineering involved in its initial conversion. As stated above, irrigators had been using and manipulating natural waterways to convey irrigation water since

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[40] Willison, "Past, Present, and Future," 78-79; Teilman and Shafer, *The Historical Story of Irrigation in Fresno and Kings Counties*, 6; Hall, *Map of Irrigation Near Merced,* 1885; USGS *Atwater Quadrangle*, 1918.
[41] McSwain, *History of the Merced Irrigation District* 19.
[42] McSwain, *History of the Merced Irrigation District,* 134-136, 143, 149, 141, 146, 159, 198, 201, 337; USGS, *Atwater Quadrangle,* 1918; JRP, "Historic Resource Evaluation Report: Ten Canals of the Merced Irrigation District," 4; USGS, *Merced Quadrangle,* 1918, 1948, 1961, 1980.

the 1860s and this conversion does not represent an engineering innovation. When compared against other channels of this type, Black Rascal Creek is typical and does not represent important design or engineering accomplishment or innovation. There is no indication that this canal is an important example of the science of irrigation canal construction and maintenance. Black Rascal Creek is not eligible for listing in the CRHR under Criterion 3 and is not considered a historic resource for the purposes of CEQA. In addition to lacking significance, Black Rascal Creek lacks integrity. Its channel has been excavated and its banks have been altered and enhanced degrading the integrity of design, materials, and workmanship. Construction of the Hess Lateral also diminished Black Rascal Creek's integrity of setting.

Under Criterion 1, the Hess Lateral does not have important associations with events or patterns of events that are important to our history. Constructed between 1946 and 1958, irrigation was already well established in the region and it did not drastically alter land use. The Hess Lateral is not eligible for listing in the CRHR under Criterion 1 and is not considered a historic resource for the purposes of CEQA.

Under Criterion C, the Hess Lateral is not important for its design, engineering, or method of construction. The Hess Lateral is a common type of lateral, and such canals have existed in the region and in the MID since at least the early twentieth century. The Hess Lateral appears to generally retain integrity, but lacks historic significance. Therefore, the Hess Lateral are not eligible for listing in the CRHR under Criterion 3 and is not considered a historic resource for the purposes of CEQA.

Henderson Lateral/Mason Curtis Lateral

The Henderson Lateral follows a natural creek channel for part of its course, which begins in Section 18 T6S/R14E MDBM off of the Main Canal and runs roughly north to south (Location Map 4). The Crocker-Huffman Company built the canal around 1910 to water land in the area northwest of Merced. Its alignment has remained largely unchanged since its original construction. As with all of the canals in the MID, the Henderson Lateral has received routine maintenance such as cleaning, excavating, and bank enhancement. Field observation at the time of this survey revealed that such actions continue to the present. The Henderson Lateral has a short branch canal that runs parallel to Bellevue Road on the south side to Franklin Road.[43]

The Mason Curtis Lateral, which branches off the Henderson Lateral north of Bellevue Road is an extension of the MID system likely constructed during the 1920s as part of the development of the Mason and Curtis Colony, a small subdivision located along the west side of Franklin road that was laid out during this time.[44] This lateral today crosses Fox Road north of Bellevue and then parallels and empties into Canal Creek. Between 1960 and 1973 the MID realigned the Mason Curtis Lateral near Fox Road, including piping a portion of the lateral.[45]

Under Criterion 1, the Henderson Lateral and the Mason Curtis Lateral do not have important associations with events or patterns of events that are important to our history. By the time the Crocker-Huffman Company constructed the Henderson Lateral in the early twentieth century, and MID constructed the Mason Curtis Lateral, extensive irrigation canals had already been in place in the region for decades and there was no significant change in regional land use after the Henderson Lateral

[43] McSwain, *History of the Merced Irrigation District,* 134-136, 143, 149, 141, 146, 159, 198, 201, 337, 149, 194, 200.
[44] McSwain, *History of the Merced Irrigation District*, 73; Crocker-Huffman, "Map Showing Lands and Canals of Crocker-Huffman Land & Water Company Near Merced, California," 1912; USGS, *Atwater Quadrangle*, 1918; Merced Irrigation District, "Official Map of the Merced Irrigation District, Merced County, California," 1927; USGS, *Atwater Quadrangle*, 1946.
[45] Adams, *Irrigation Districts*, 190, 195; USGS *Atwater Quadrangle,* 1948, 1960, 1987; Aerial image provided by Google.com; Merced Irrigation District, *Official Map of the Merced Irrigation District.*

or the Mason Curtis Lateral were built. Therefore, the Henderson Lateral and the Mason Curtis Lateral are not eligible for listing in the CRHR under Criterion 1 and are not considered a historic resource for the purposes of CEQA.

Under Criterion 3, the Henderson Lateral and the Mason Curtis Lateral are not important for their design, engineering, or method of construction. Conveying water through natural waterways had been practiced in the Merced area and the San Joaquin Valley for decades. In addition, small, lateral canals of this shape and dimensions were also very common. When compared against other channels of this type, the Henderson Lateral and the Mason Curtis Lateral are typical and do not represent important design or engineering accomplishment or innovation. There is no indication that these canals are an important example of the science of irrigation canal construction and maintenance. Therefore, the Henderson Lateral and the Mason Curtis Lateral are not eligible for listing in the CRHR under Criterion 3 and are not considered a historic resource for the purposes of CEQA.

In addition to lacking historic significance, the Henderson Lateral and the Mason Curtis Lateral lack integrity. The Henderson Lateral has had its channel altered at some point in the 1950s diminishing its integrity of design, materials, and workmanship. The Mason Curtis Lateral has also had its channel altered and part of it piped. Both canals have undergone routine maintenance further diminishing its integrity. In addition, recent construction of an earthen basin or reservoir near the Henderson Lateral crossing of Bellevue Road further degrades the integrity of setting.

A 2005 report by JRP Historical Consulting titled "Historic Resource Inventory And Evaluation Report, Bellevue Substation And Transmission Line Project" also evaluated the Henderson Lateral and the Mason Curtis Lateral and found them ineligible for the NRHP and CRHP. See Attachments D and E for copies of the form from that report.

Buhach Lateral

During the late nineteenth century the Crocker-Huffman Company established many agricultural colonies in the vicinity of Merced, including the Buhach Colony, created in the 1890s. The Buhach Lateral supplied water to this colony, tapping into the Livingston Canal to the north. From this point of origin, the canal flowed south through the Buhach Colony, then southwest before draining into Black Rascal Creek in the NE1/4 of Section 20 T7S/R13E MDBM (Location Map 5). The lateral functioned as an irrigation canal, watering colony fields, and continued to serve in that capacity in the ensuing decades. In the 1930s, the MID undertook a program of improvements to its system and lined many canals with concrete. This work continued into the 1940s and 1950s, when lining of the Buhach Lateral occurred. It remains a lined canal today and still delivers water to the fields of the area, although it currently empties into Canal Creek, just north of its confluence with Black Rascal Creek (Figures 6-8).[46]

Under Criterion 1, the Buhach Lateral does not have important associations with events or patterns of events that are important to our history. By the time the Crocker-Huffman Company built the Buhach Lateral to deliver water to it colony, the practice of irrigation in the region was about 30 years old. An extensive system of irrigation canals was already in place and the Buhach Lateral did not bring about a radical change in regional land use. Therefore, the Buhach Lateral is not eligible for listing in the CRHR under Criterion 1 and is not considered a historic resource for the purposes of CEQA.

Under Criterion 3, the Buhach Lateral is not important for its design, engineering, or method of construction. Constructed in the late 1890s, the Buhach Lateral, when compared against other channels of this type, is typical and does not represent any important design or engineering accomplishment or innovation. There is no indication that this canal is an important example of the science of irrigation canal construction and maintenance. Therefore, the Buhach Lateral is not eligible for

[46] Martin, *Official Map of Merced County*, 1888); USGS, *Atwater Quadrangle*, 1960 (1987).

listing in the CRHR under Criterion 3 and is not considered a historic resource for the purposes of CEQA. In addition to lacking historic significance, The Buhach Lateral also lacks integrity. It has been lined with concrete and had its alignment altered. These factors compromise its integrity of design, materials, and workmanship.

A 1993 report by JRP Historical Consulting titled "Historic Sites Survey and Evaluation on the Proposed Mojave Natural Gas Pipeline Mojave Pipeline Northern Extension." also evaluated the Buhach Lateral found it ineligible for the NRHP. See Attachment F for a copy of the form from that report.

Drainage Ditch

Drainage has been a problem in the irrigated areas of Merced County since the 1880s. The land is flat and does not naturally drain well. In addition, the ground water table is near the surface and it rose rapidly with irrigation. These factors, combined with intensive irrigation and the local soil type, can create water-logged fields. To resolve the issue, farmers formed drainage districts beginning in 1918 and employed drainage pumps and ditches to drain the fields. The ditches allow excess water to flow out of the fields and into irrigation ditches or natural waterways. MID constructed the drainage ditches in the study area sometime between 1957 and 1960. Since that time ditches have undergone routine maintenance and excavation and a section of it in Section 35 T6S/R13E MDBM just north of Bellevue Road has been piped (See Location Map 6 and Figures 9-11).[47]

Under Criterion 1, the drainage ditch does not have important associations with events or patterns of events that are important to our history. By the time the MID constructed this segment of ditch in the late 1950s the practice of constructing such ditches was already well established. This relatively small segment (approximately four miles) did not result in major changes to land use in the region and the drainage ditch is not eligible for listing in the CRHR under Criterion 1 and is not considered a historic resource for the purposes of CEQA.

Under Criterion 3, the drainage ditch is not important for its design, engineering, or method of construction. Historic photographs of other ditches from the 1920s reveal that this ditch does not represent an unusual, exceptional, or innovative design. The drainage ditch is not eligible for listing in the CRHR under Criterion 3 and is not considered a historic resource for the purposes of CEQA.

In addition to lacking historic significance, the drainage ditch also lack integrity. The recent piping and filling of a segment of the ditch as well as routine maintenance and excavation compromise its integrity of design, materials, and workmanship.

Livingston Canal

The Farmers' Canal Company constructed the Livingston Canal in 1879 using hand labor and horse-drawn scrapers. This method of construction would have created a channel with a shallow U-shape and timber control structures. Considering the general program of improvement undertaken by the MID in the 1920s, it is likely that some work was undertaken on the Livingston Canal at that time, and certainly the current headgate and canal lining date to much more recent years (See Linear Record Forms MR1-LC, Location Map 7, Figures 1 and 2, and Photographs 49 and 50). The canal was originally designed to take the entire flow of Canal Creek, and did so for many years. As such, it has watered a considerable amount of land

[47] McSwain, *History of the Merced Irrigation District,* 138; Adams, *Irrigation Districts*, 195; WAC Corporation, Aerial Photographs of Merced County, 1957, Map Library, University of California, Davis; USGS, *Atwater Quadrangle,* 1960.

between Atwater and Livingston and contributed to the agricultural development of that area. The Livingston Canal continues to be primary lateral canal in the MID system.[48]

Under Criterion 1, the Livingston Canal appears to have important associations with events or patterns of events that are important to our history from the date of its construction, through the initial phase of irrigated agriculture development in the 1890s, but does not retain historic integrity. The Livingston Canal was one of the pioneering irrigation canals under an organized system in the Merced-Atwater region. Since its construction it received almost the entire flow of Canal Creek and distributed it to farmland in the area between Atwater and Livingston spawning development. As such, the Livingston Canal played a central role in the development of irrigated agriculture and settlement patterns of this region.

Although the Livingston Canal appears to be potentially eligible under Criterion 1, the portion within the study area lacks integrity of design, materials, feeling, setting, and workmanship to its potential period of significance in the late nineteenth century. The canal has undergone significant alterations such as lining, shaping, and replacement of the original structures. Most of these changes occurred after the establishment of MID in 1919, including replacement of the headgate. Such replacement of gates, structures, and other equipment was common along the entire length of the canal. Furthermore, the construction of housing along the Livingston Canal has diminished its integrity of setting. This portion of the Livingston Canal evaluated on this form is not eligible for listing in the CRHR under Criterion 1 and is not considered a historic resource for the purposes of CEQA.

Under Criterion 3, the Livingston Canal is not important for its design, engineering, or method of construction. This canal is a common type, constructed by common methods. The canal was originally formed by Fresno scraper, but has subsequently been re-graded into a trapezoidal shaped cross section. The canal has been partially concrete lined. Both were established design and construction techniques by the 1890s and there is no indication that the Livingston Canal is an important example of irrigation canal construction and maintenance. Therefore, the Livingston Canal is not eligible for listing in the CRHR under Criterion 3 and is not considered a historic resource for the purposes of CEQA.

A 1998 report by JRP Historical Consulting titled "Historic Resource Evaluation Report, Livingston Canal, Merced Irrigation District, Merced County, California" evaluated a different segment of the canal and found it ineligible for the NRHP and CRHP. The California Office of Historic Preservation concurred with this finding. See Attachment G for a copy of the form from that report.

[48] JRP, "Historic Evaluation Report, Livingston Canal," December 1998, 5-6.

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

Historic Photographs

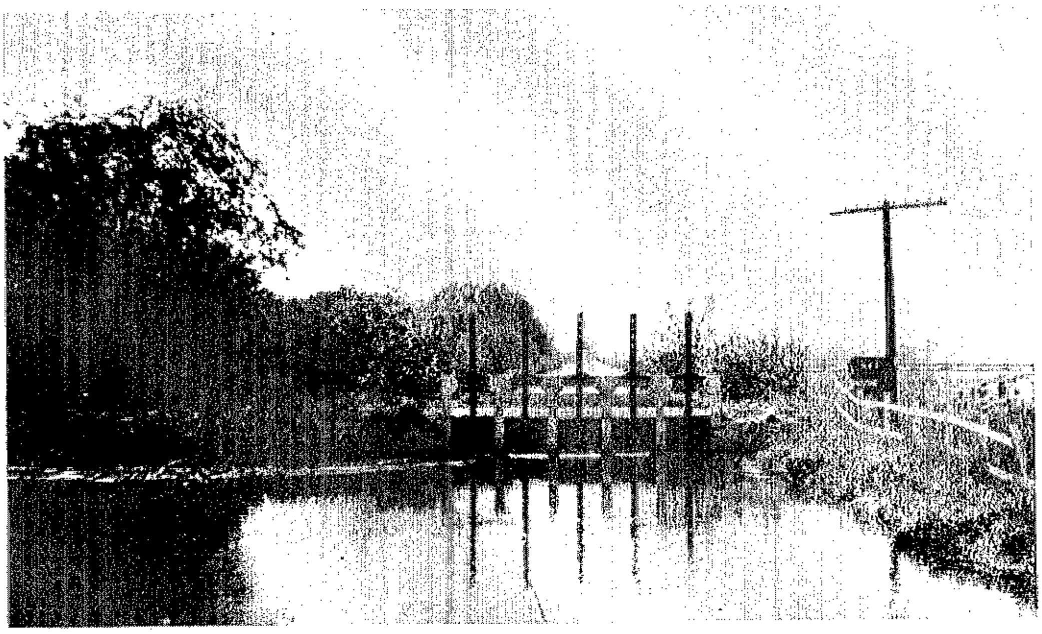

Figure 1. Canal Creek at headgate to Livingston Canal in 1920. (McSwain 29)

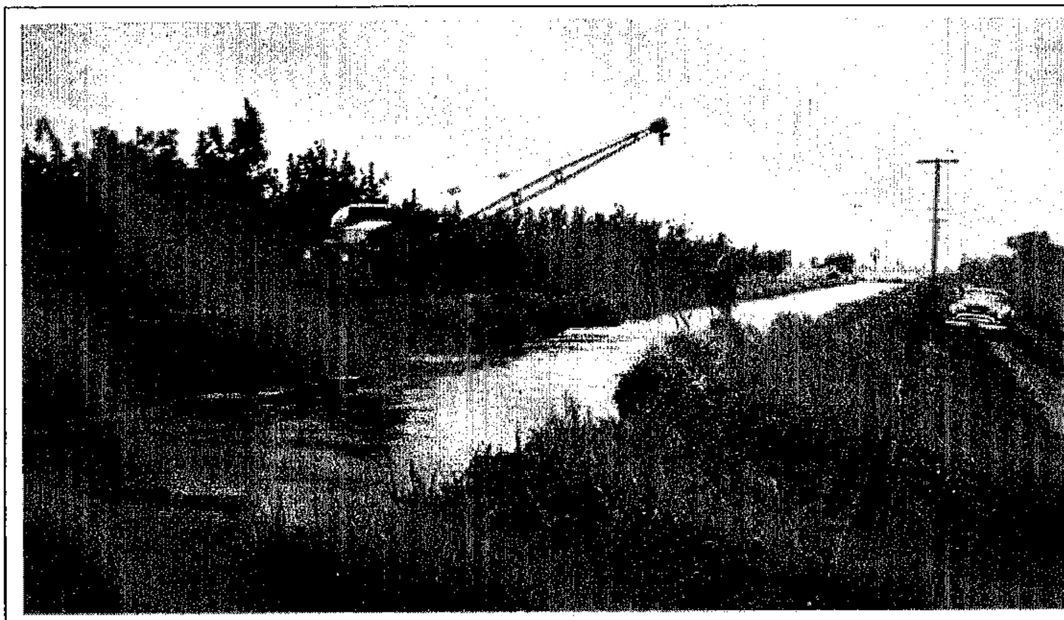

Figure 2. Crane cleaning weeds from an unknown canal in 1949. (McSwain 172)

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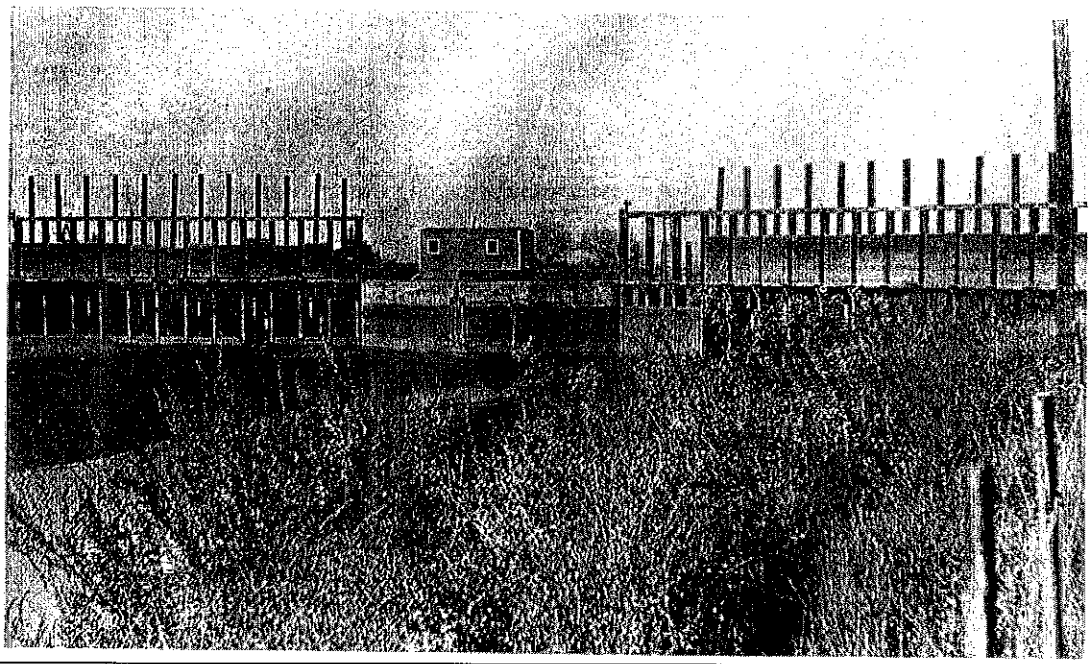

Figure 3. Upstream face of Crocker Dam across Bear Creek in 1913. (McSwain 6)

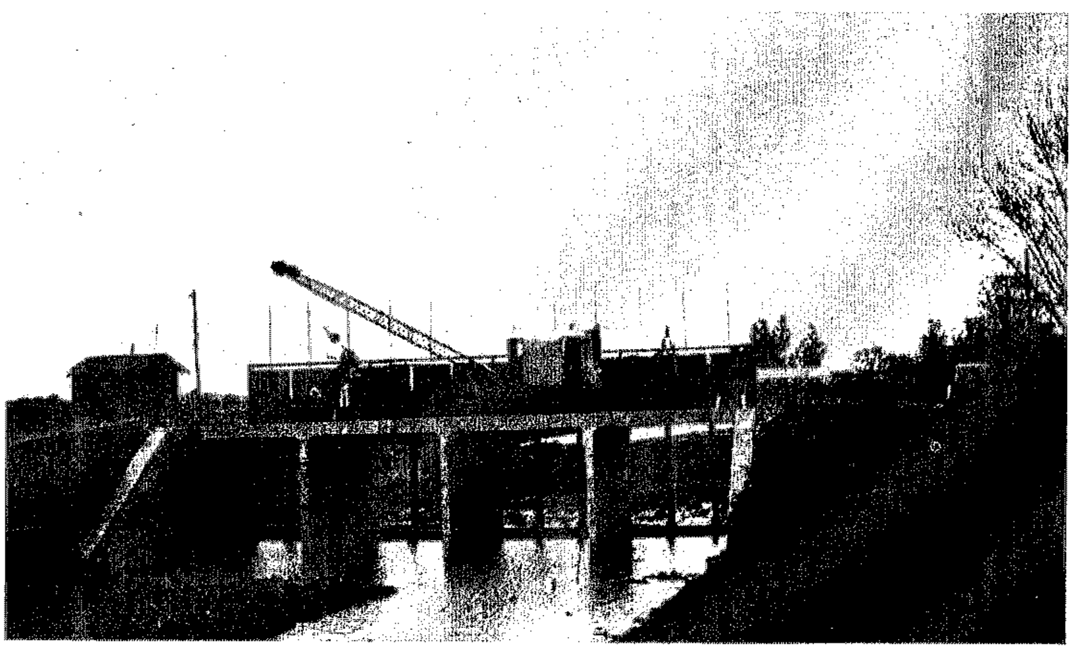

Figure 4. Bear Creek side of Crocker Dam as being rebuilt in 1940. (McSwain 145)

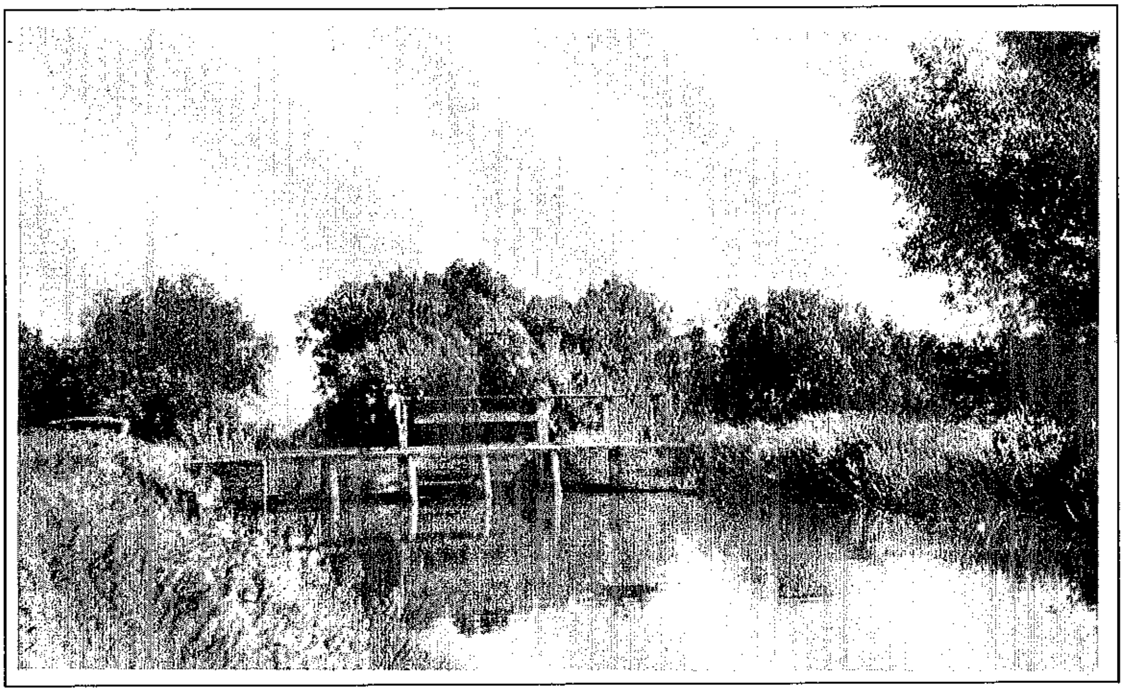

Figure 5. Spillway into Bear Creek from the Fairfield Canal in 1920. (McSwain 37)

Figure 6. Arena Canal being shaped for concrete lining in 1950. (McSwain 174)

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Figure 7. Concrete lining of unknown canal in 1930. (McSwain 105)

Figure 8. Newly lined McSwain Lateral in 1930.(McSwain, 102).

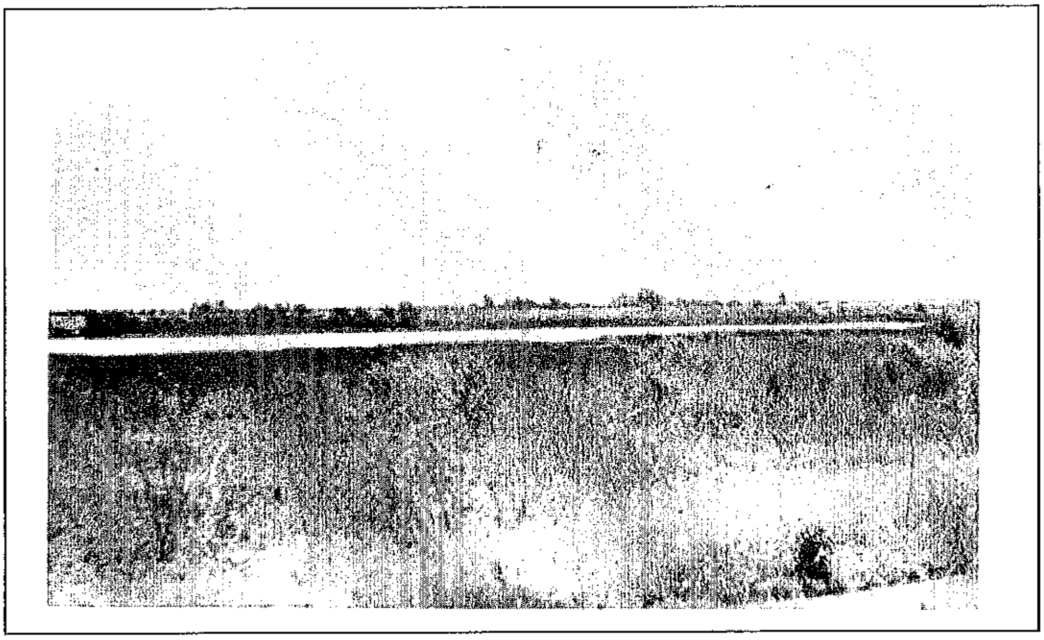

Figure 9. Photo from 1920 showing water-logged land north of Atwater. (McSwain, 33)

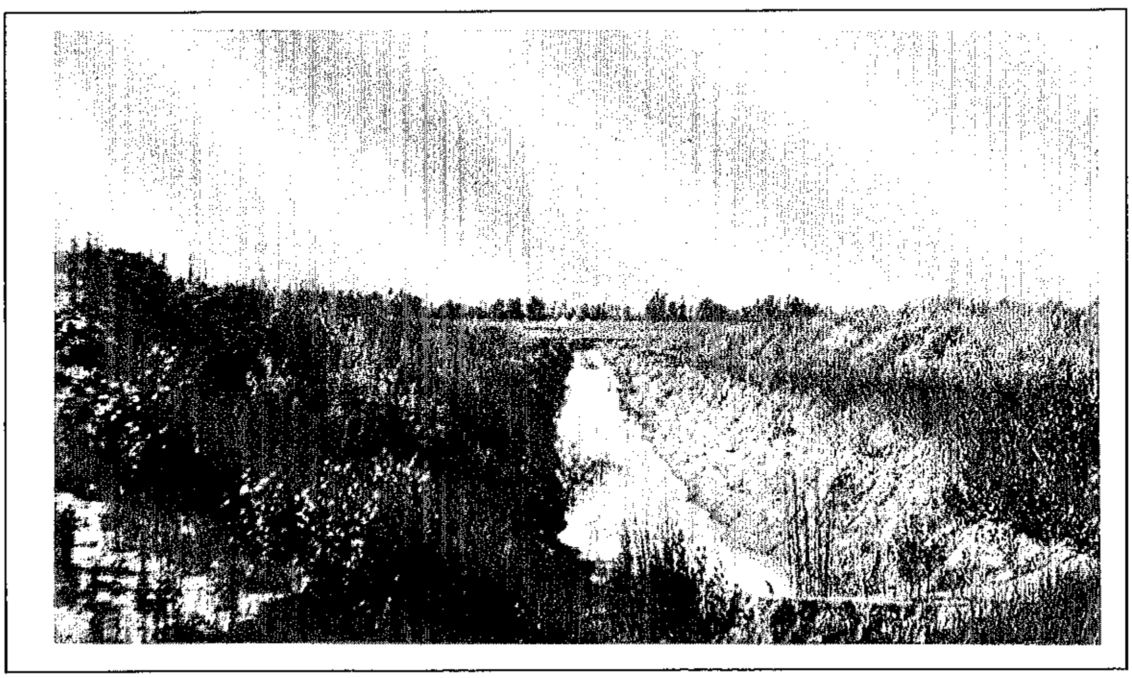

Figure 10. Photo from 1920 showing drainage ditch near Atwater. (McSwain, 35)

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

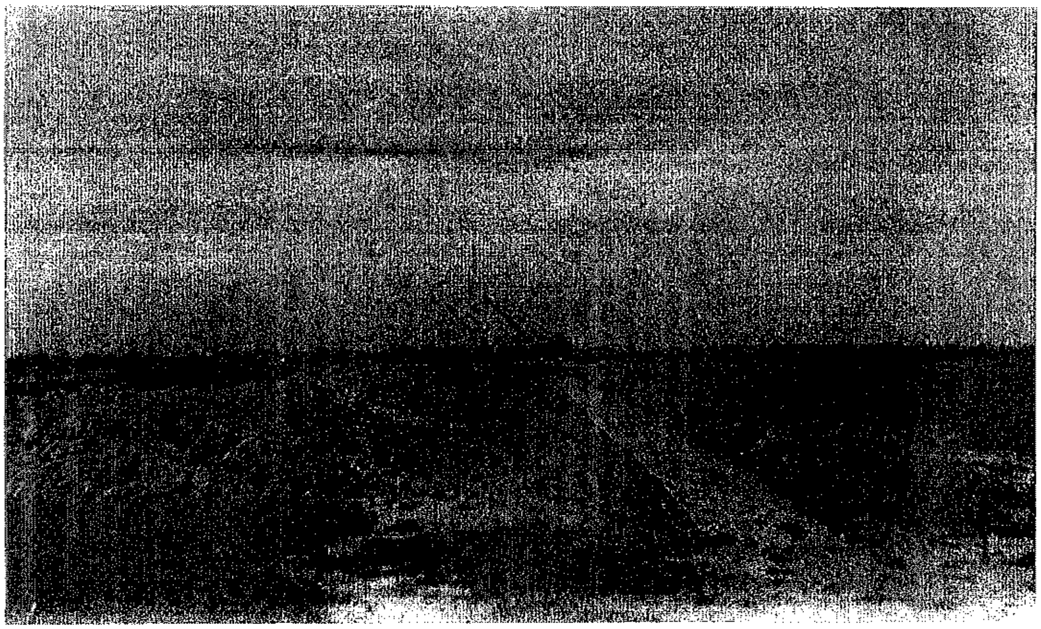

Figure 11. Dragline in 1929 digging a drainage ditch. (McSwain 95)

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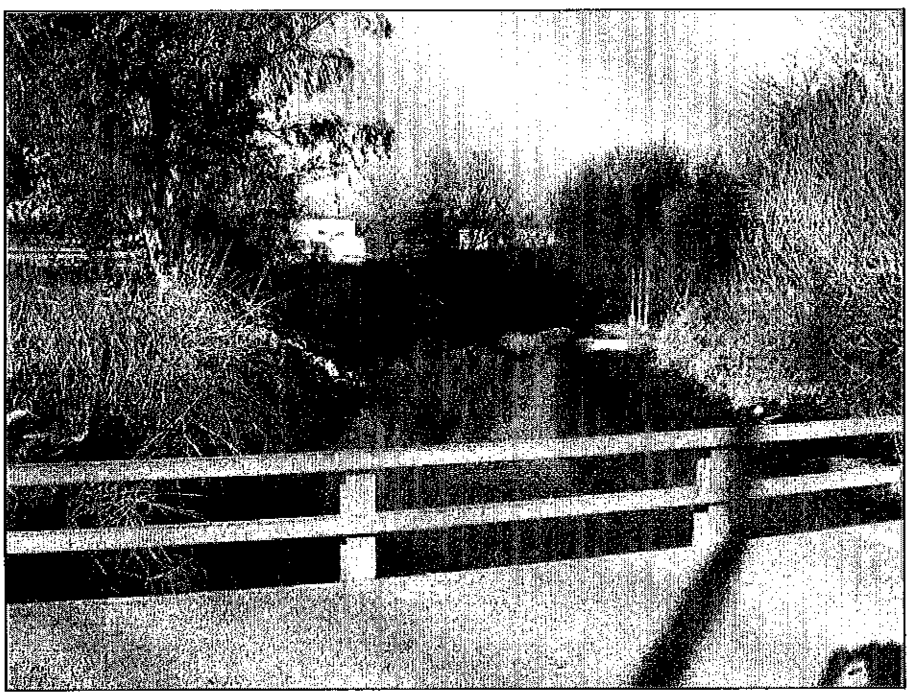
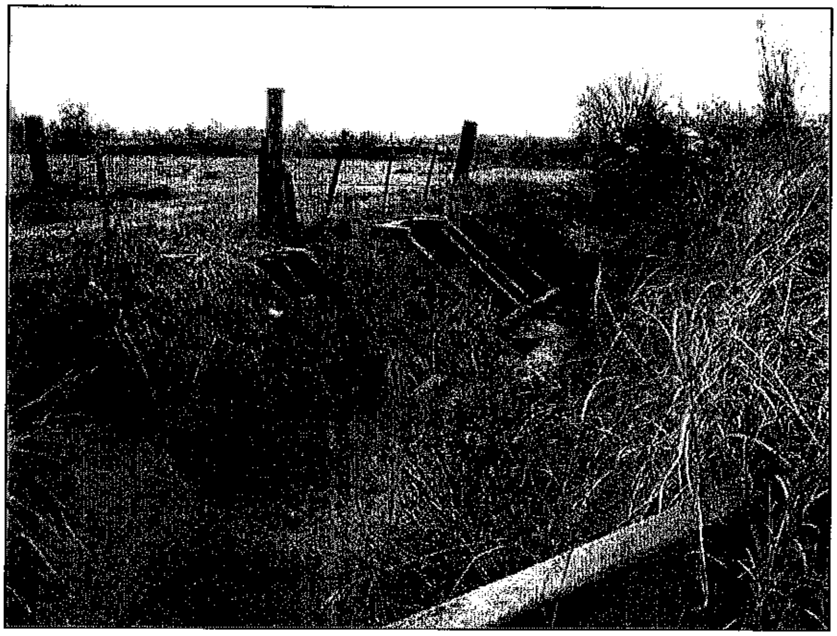
Field Survey Photographs

Photograph 29. Canal Creek at Fox Road (point CC1), camera facing west. 12/12/06

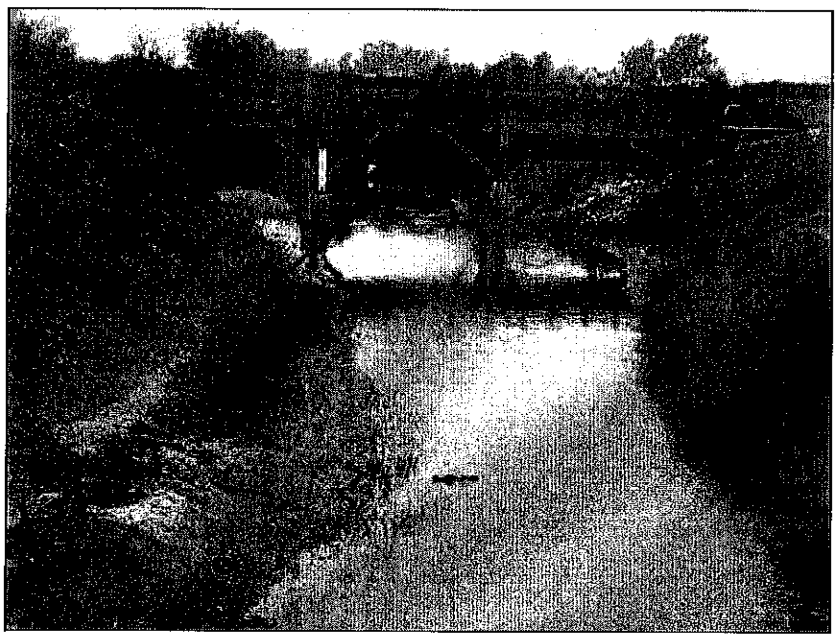


Photograph 30. Canal Creek at Ladino Road (point CC8), camera facing north. 1/22/07.

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

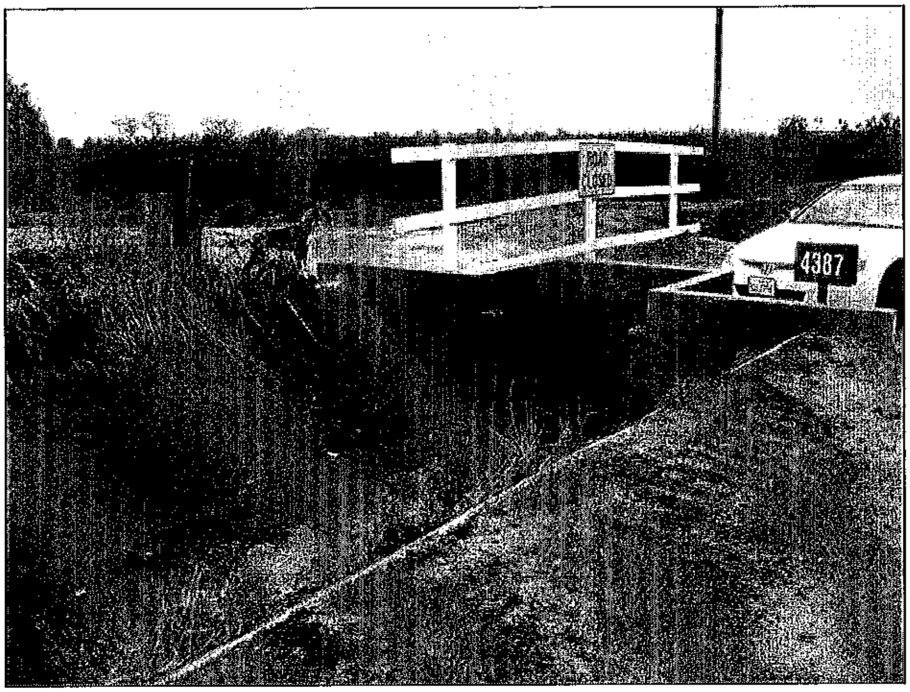


Photograph 31. Control gates on Main Ashe Lateral at point MA2, camera facing south. 12/12/06.

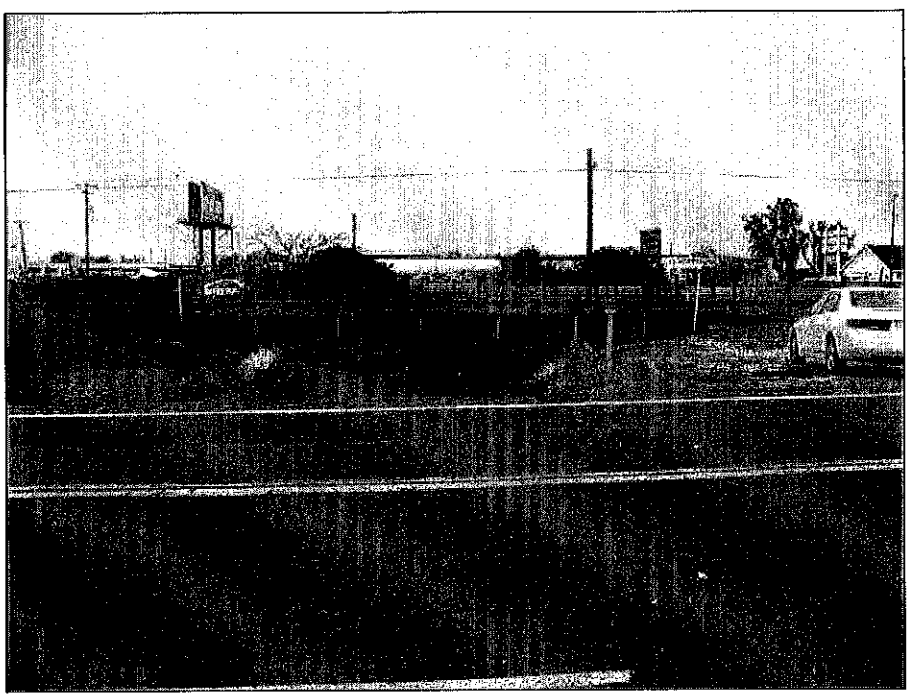


Photograph 32. Main Ashe Lateral Flume over Canal Creek at point MA2, camera facing south. 12/12/06.

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update



Photograph 33. Main Ashe Lateral showing slide gates at point MA3, camera facing southeast. 12/12/06.



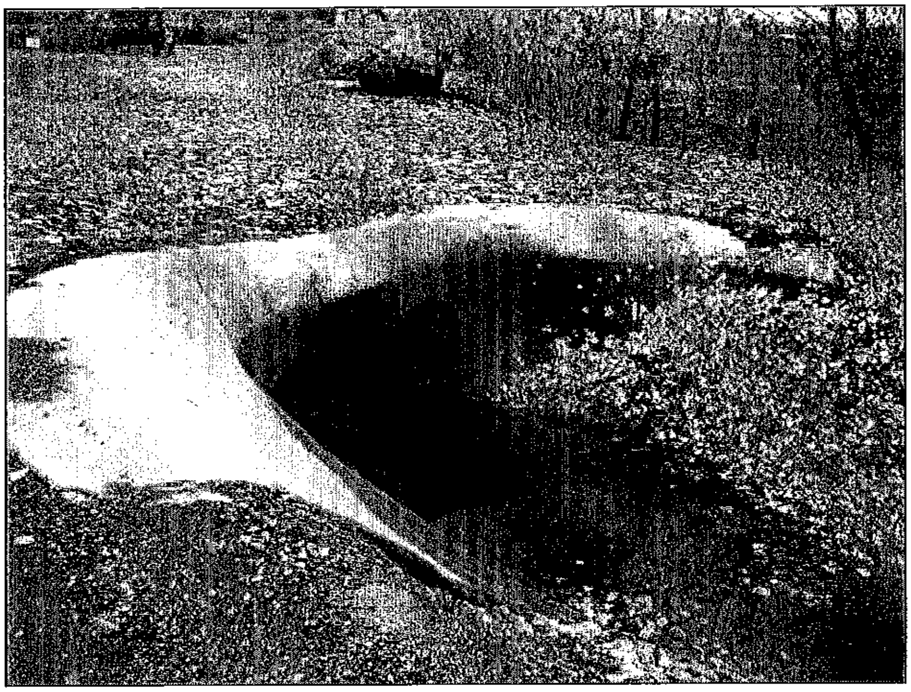
Photograph 34. Main Ashe Lateral at SP Avenue showing the canal passing under the UPRR at point MA4, camera facing north. 12/12/06.

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

Photograph 35. Main Ashe Lateral at SP Avenue showing concrete culvert passing under SP Avenue at point MA4, camera facing southeast. 12/12/06.

Photograph 36. East Ashe Lateral near Trinidade Road showing concrete and metal control gates at point EA6, camera facing southeast. 12/12/06

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

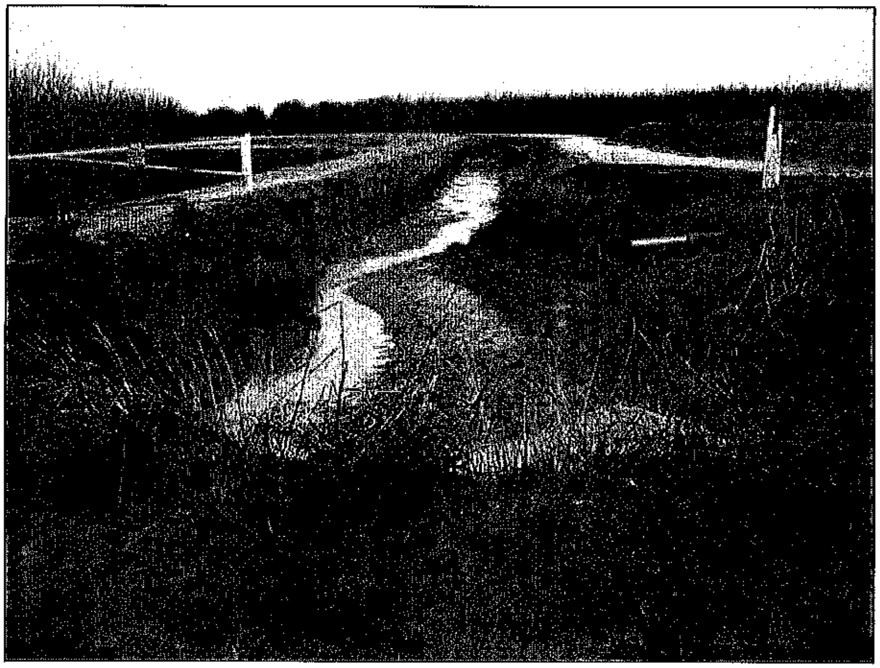


Photograph 37. Meadowbrook Lateral siphon pipes at point MB1, camera facing east. 12/12/06.

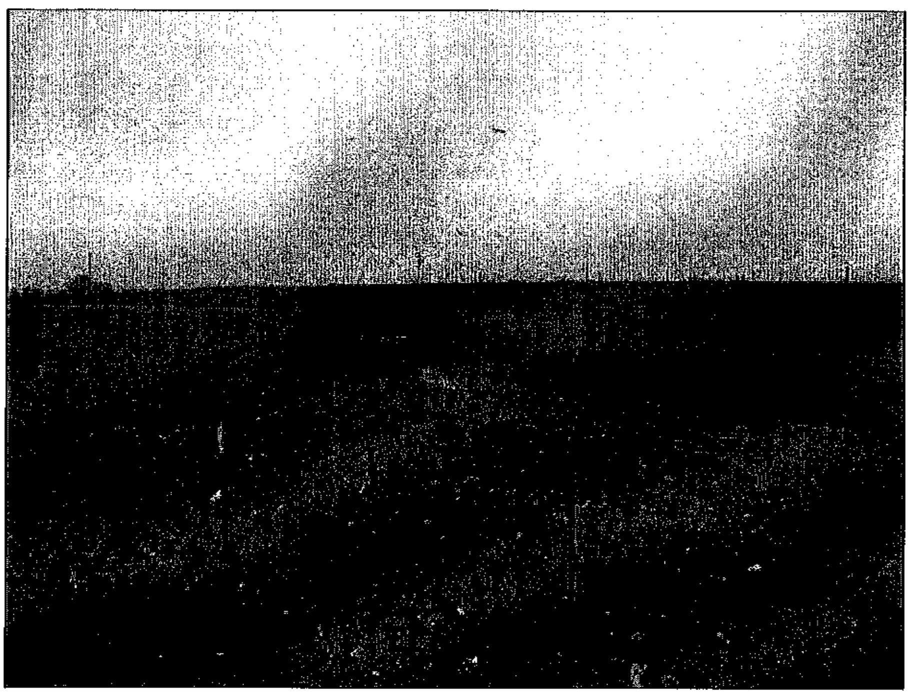
Photograph 38. Black Rascal Creek at point BR1, camera facing east. 12/12/06.

*Resource Name or # MR1

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

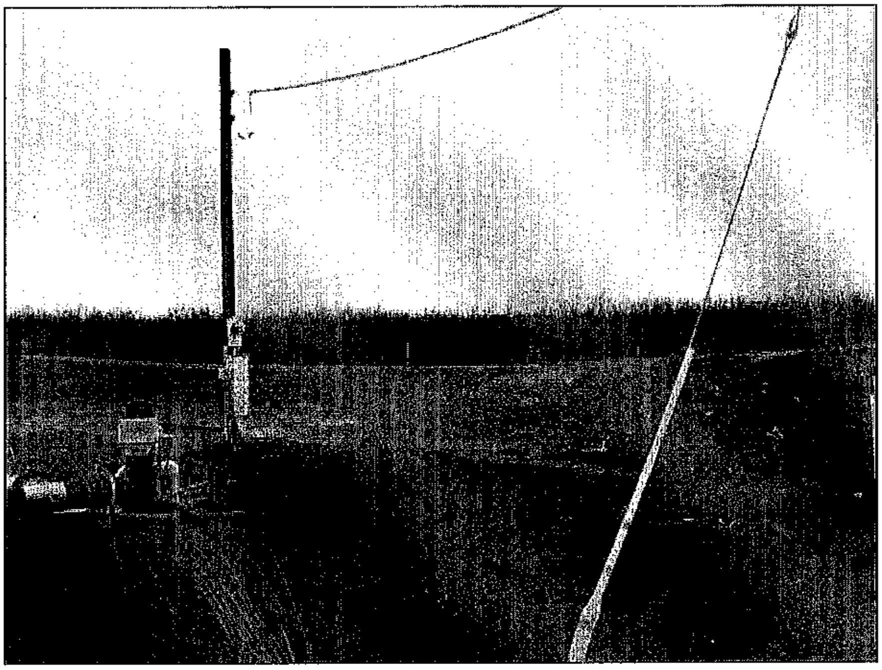


Photograph 39. Henderson Lateral at point HN1, camera facing north. 12/12/06.

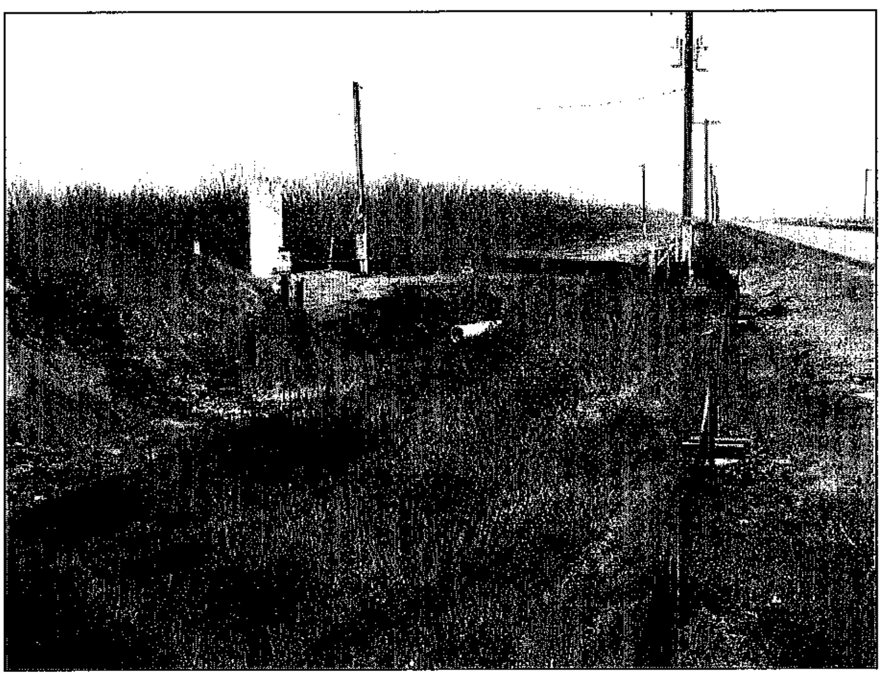


Photograph 40. Henderson Lateral at point HN1, camera facing southeast. 12/12/06.

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

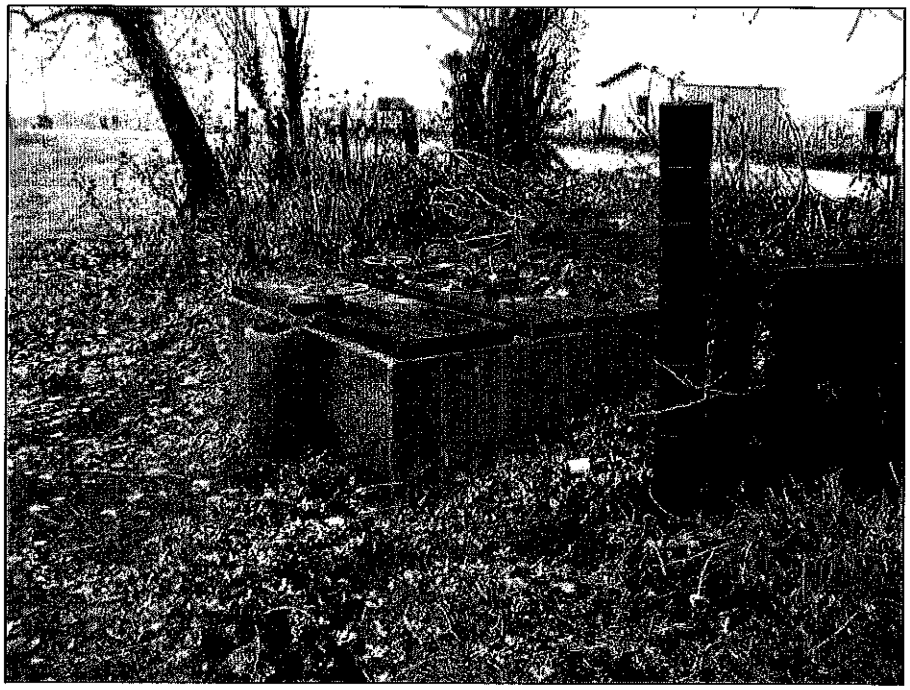


Photograph 41. Pump, lower left, timber supports for access road, lower right, fenced basin in background, camera facing northeast, near Henderson Lateral, point HN1. 12/12/06.



Photograph 42. Pump and vertical pipe near Henderson Lateral point HN1, camera facing northeast. 12/12/06.

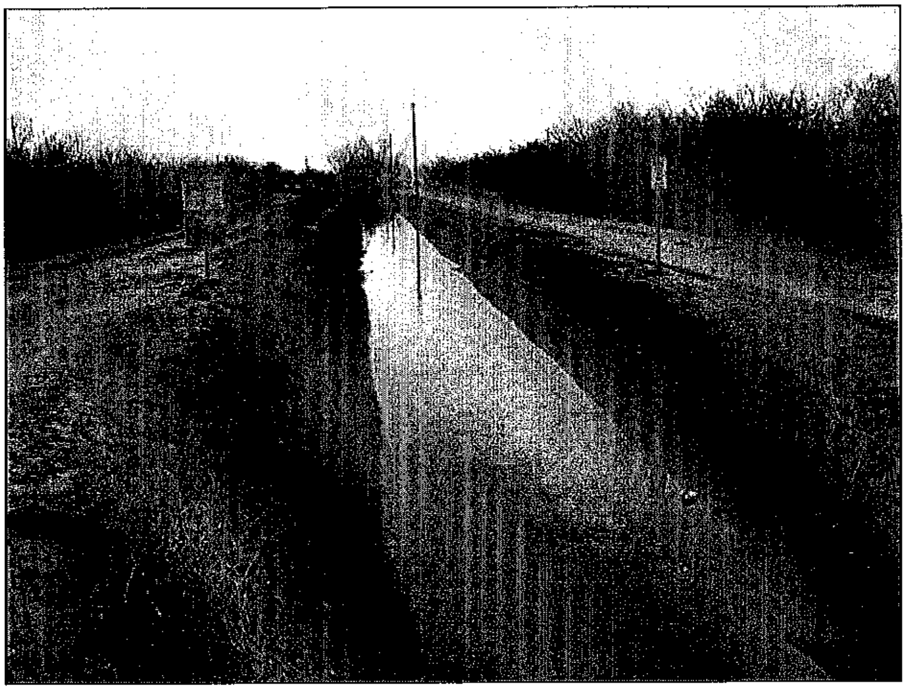
***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update



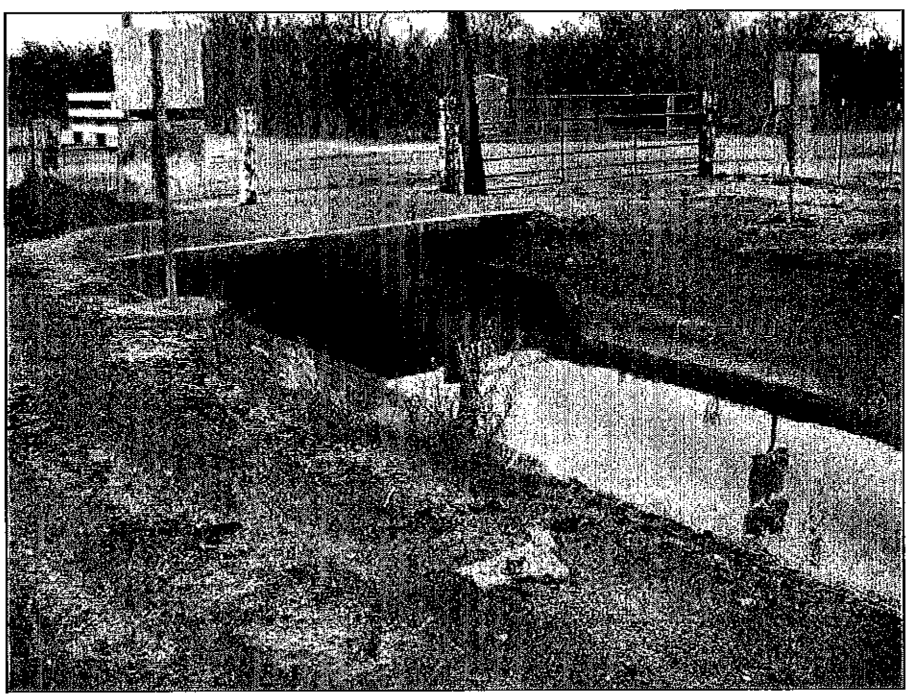
Photograph 43. Control Box at point HN2, camera facing northwest. 12/12/06.

Photograph 44. Pump at point HN2, camera facing northeast. 12/12/06.

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

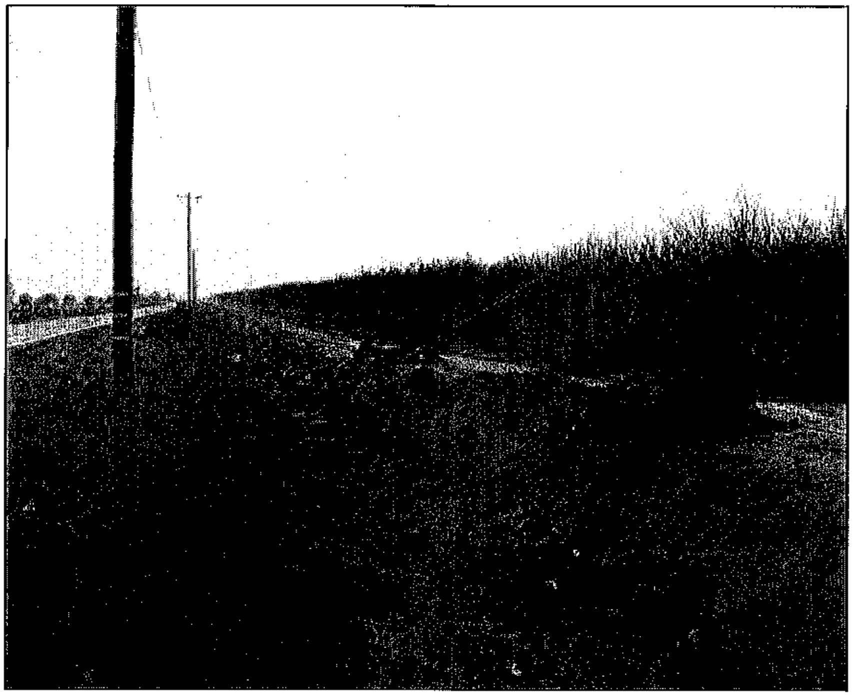


Photograph 45. Buhach Lateral at point BH1, camera facing north. 12/12/06.

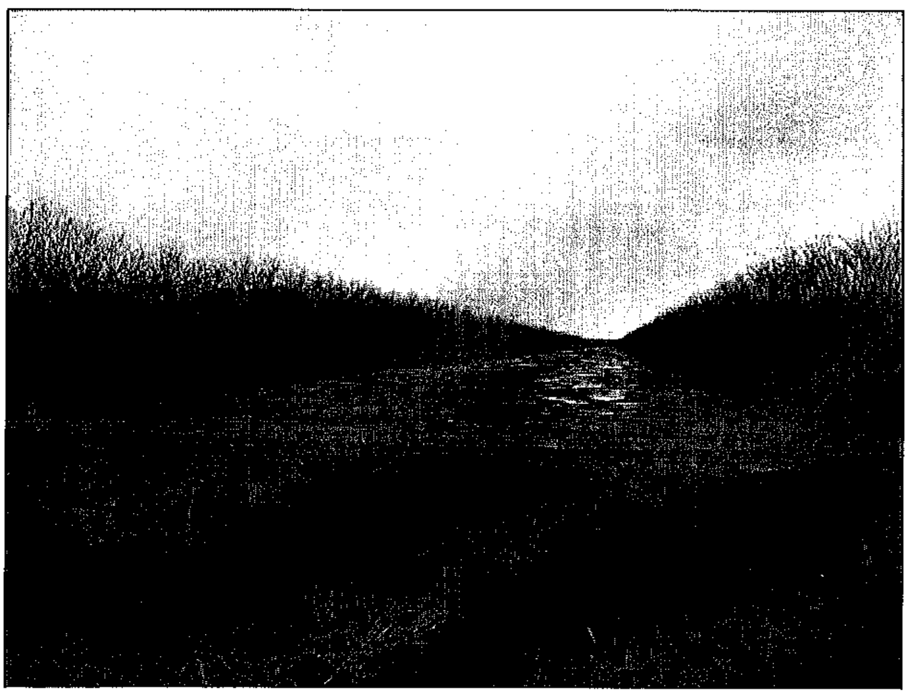


Photograph 46. Culvert under Elliot Avenue at point BH1, Buhach Lateral, camera facing northeast. 12/12/06.

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

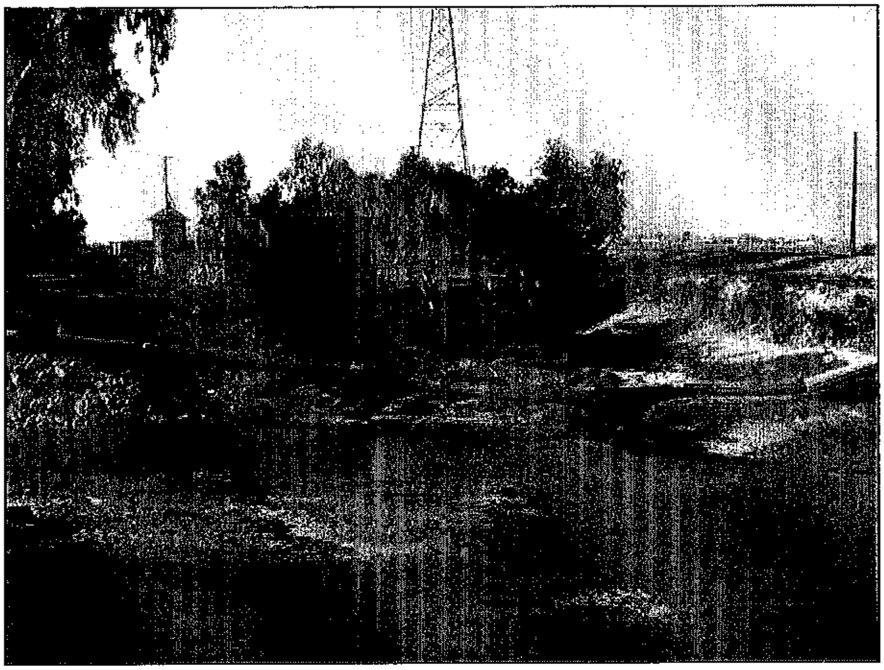


Photograph 47. Drainage Ditch at point DR1, camera facing west. 12/12/06

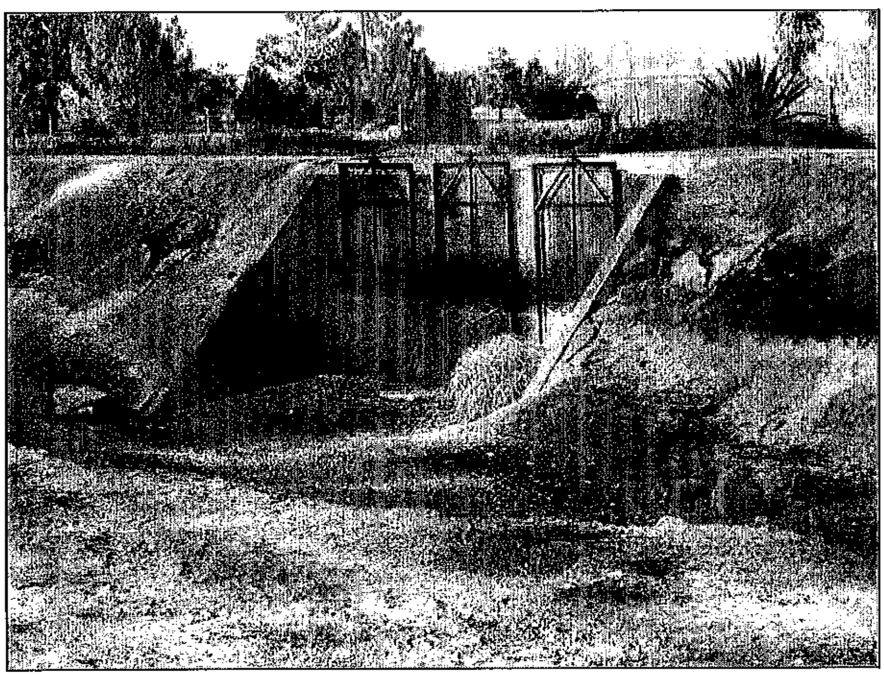


Photograph 48. Former site of an open drainage ditch that has been piped and covered (west of point DR1), camera facing north. 12/12/06.

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

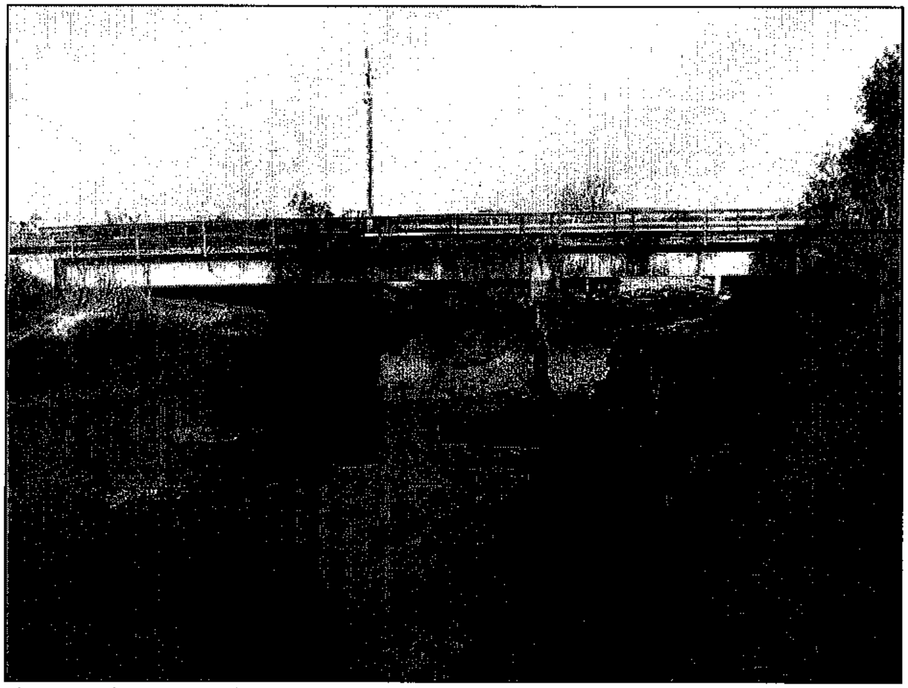


Photograph 49. Livingston Canal headgate (point LC1), Canal Creek in foreground camera facing west. 1/22/07.



Photograph 50. Lateral gates off of Livingston Canal (point LC1), camera facing northwest. 1/22/07.

***Recorded by** M. Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update



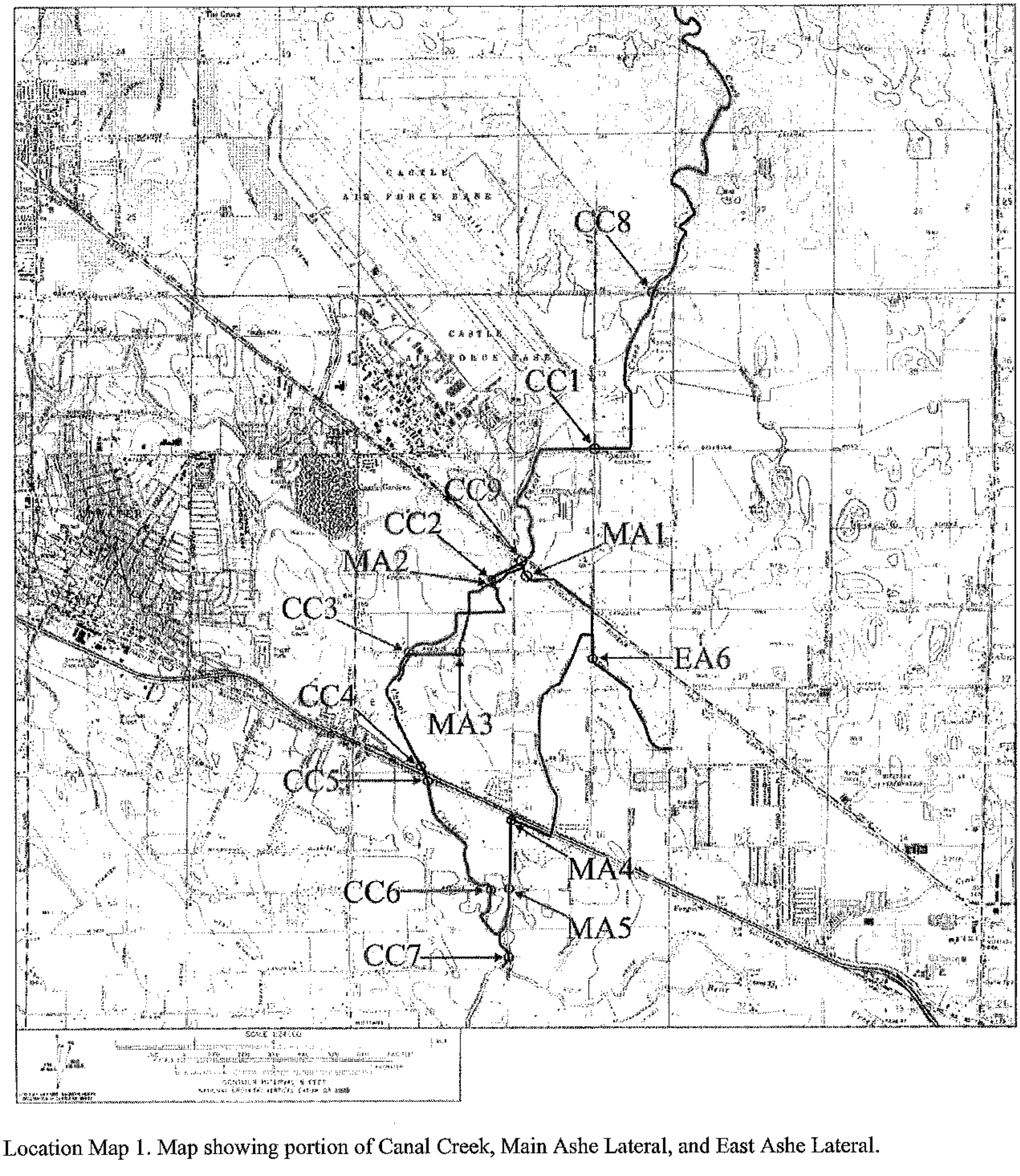
Photograph 51. Canal Creek passing at point CC9 passing under the SFBN railroad, camera facing northeast. 1/22/07.

*Resource Name or # MR1

*Recorded by: M.Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

Map Name: Atwater, California, 7.5' USGS Quadrangle — ***Date of Map:** 1960 (1987)

Map Name: Winton, California, 7.5' USGS Quadrangle — ***Date of Map:** 1961 (1987)



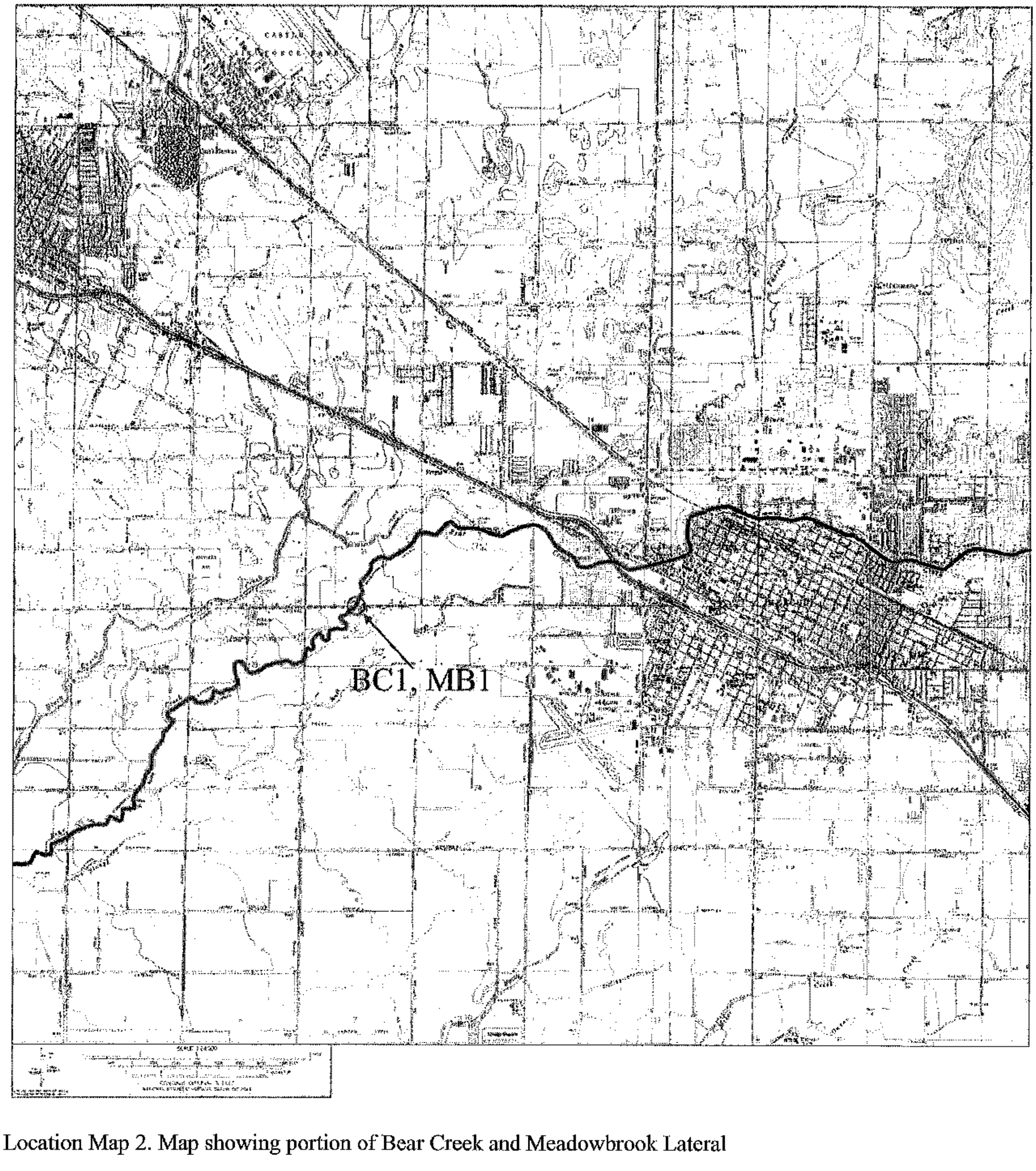
Location Map 1. Map showing portion of Canal Creek, Main Ashe Lateral, and East Ashe Lateral.

Page 70 **of** 75 ***Resource Name or #** MR1

*Recorded by: M.Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

Map Name: Atwater, California, 7.5' USGS Quadrangle ***Date of Map:** 1960 (1987)

Map Name: Merced, California, 7.5' USGS Quadrangle ***Date of Map:** 1961 (1987)



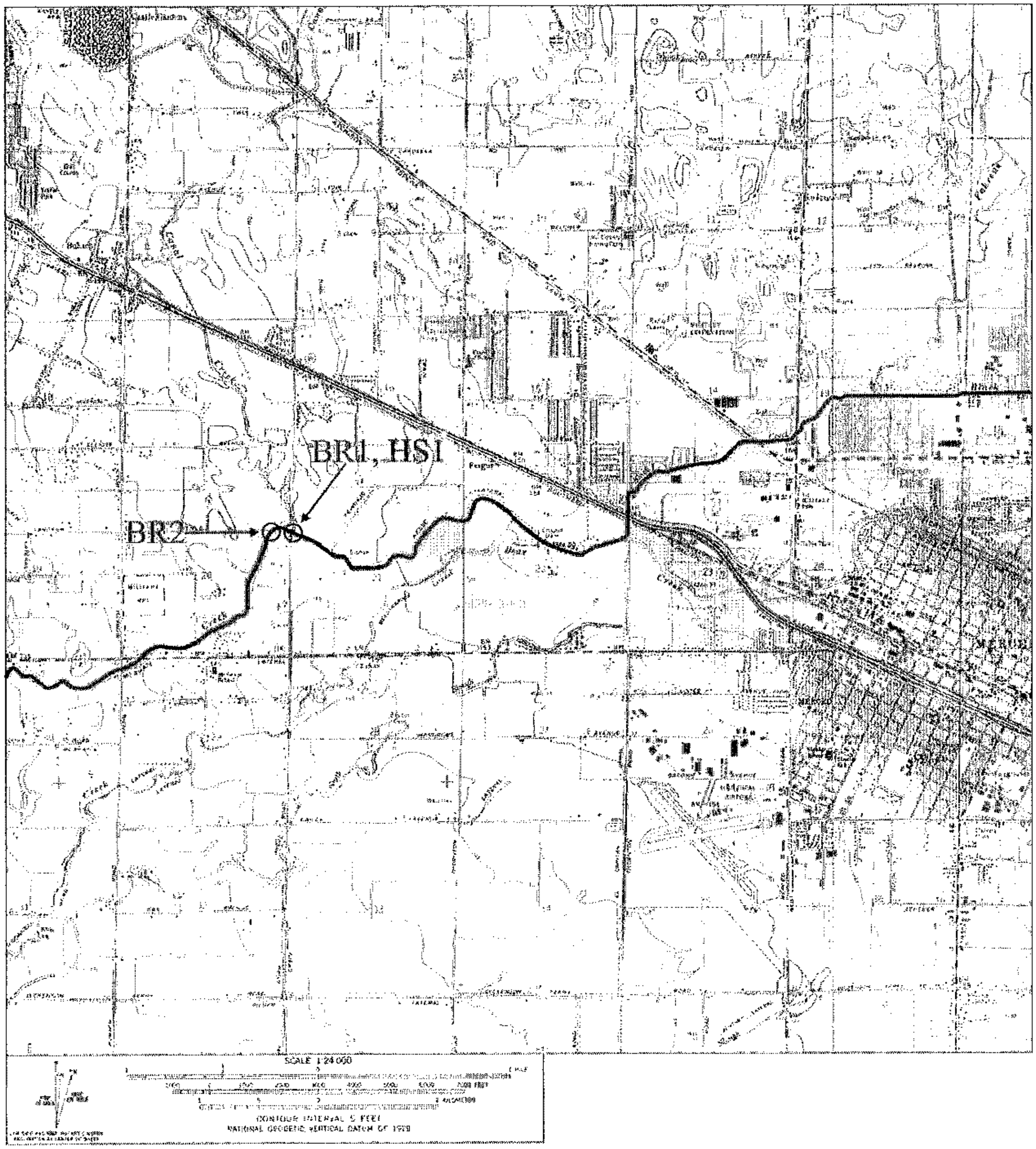
Location Map 2. Map showing portion of Bear Creek and Meadowbrook Lateral

 ***Resource Name or #** MR1

*Recorded by: M.Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

Map Name: Atwater, California, 7.5' USGS Quadrangle ***Date of Map:** 1960 (1987)

Map Name: Merced, California, 7.5' USGS Quadrangle ***Date of Map:** 1961 (1987)



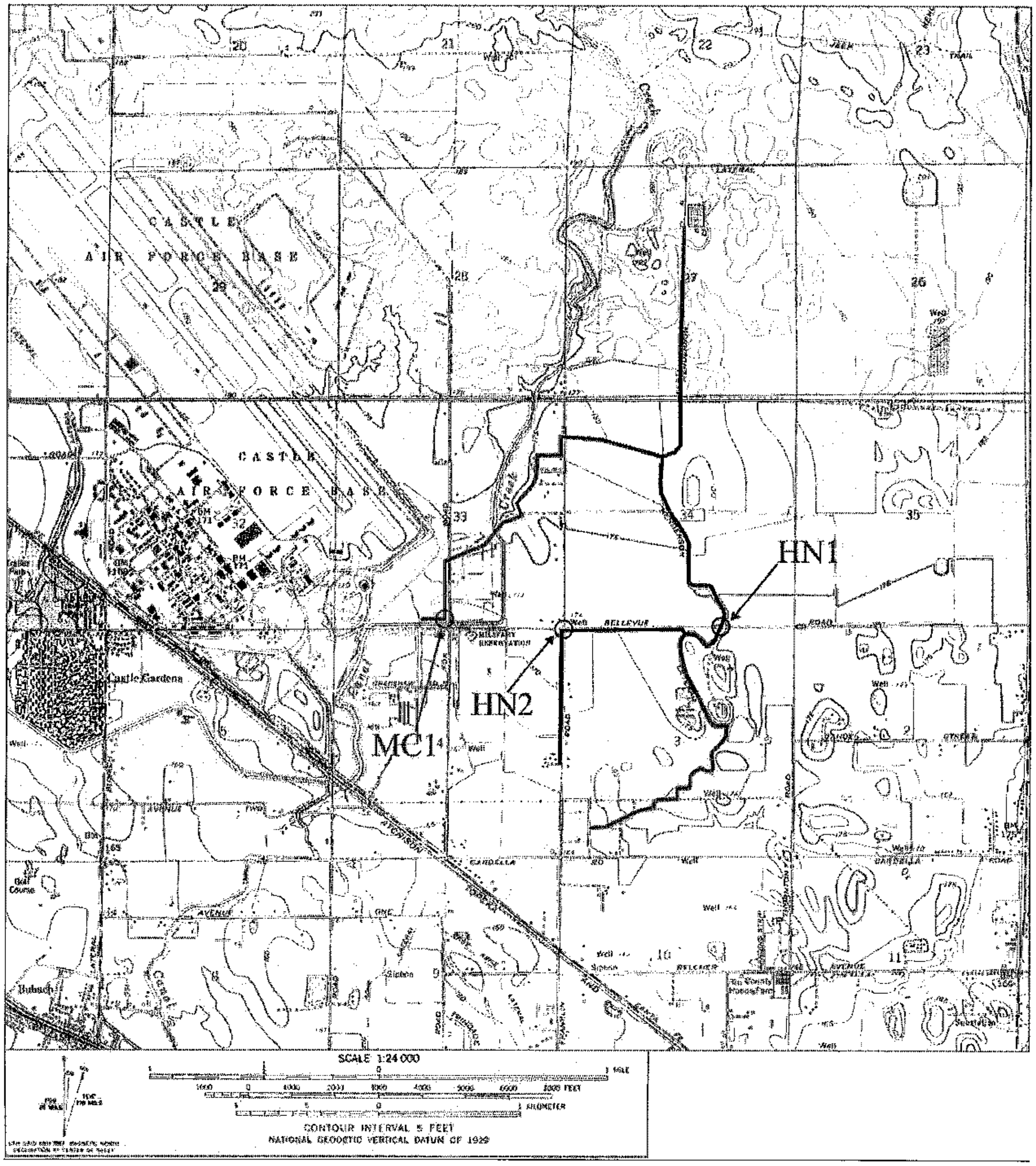
Location Map 3. Map Showing portion of Black Rascal Creek and Hess Lateral.

 ***Resource Name or #** MR1

*Recorded by: M.Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

Map Name: Atwater, California, 7.5' USGS Quadrangle ***Date of Map:** 1960 (1987)

Map Name: Winton, California, 7.5' USGS Quadrangle ***Date of Map:** 1961 (1987)

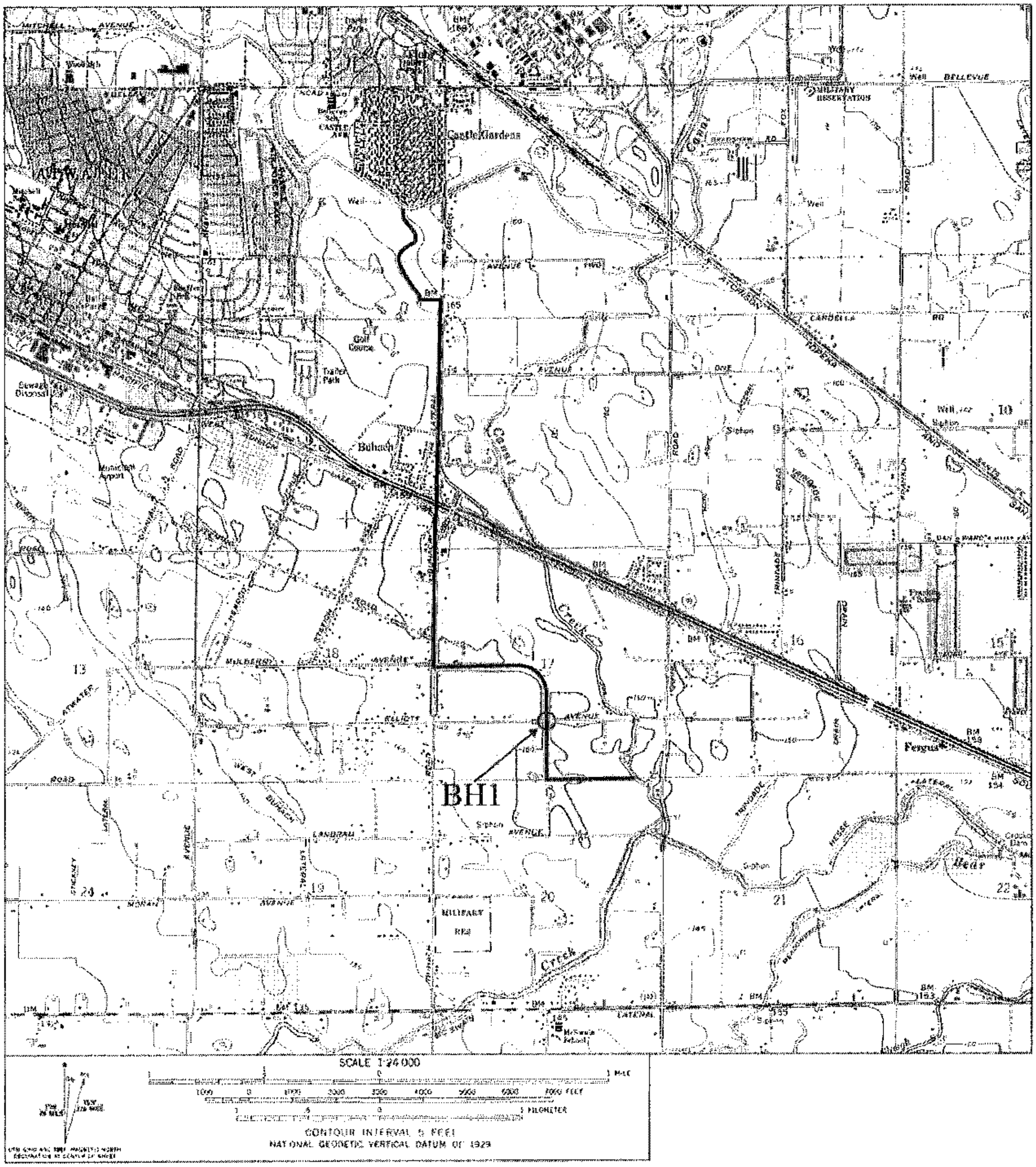


Location Map 4. Map showing portion of Henderson Lateral and Mason-Curtis Lateral.

 ***Resource Name or #** MR1

*Recorded by: M.Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

Map Name: Atwater, California, 7.5' USGS Quadrangle ***Date of Map:** 1960 (1987)



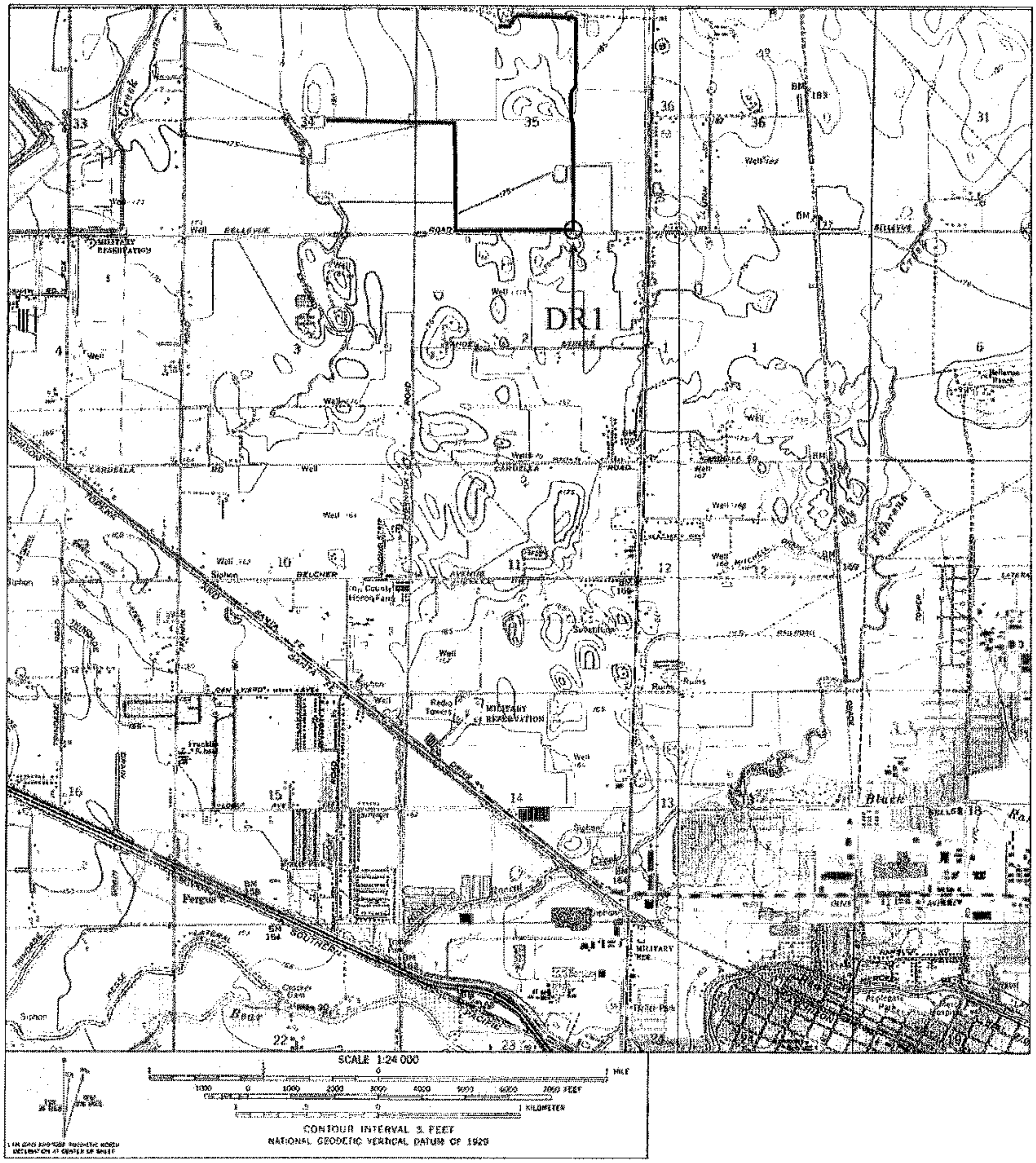
Location Map 5. Map showing location of Buhach Lateral.

 ***Resource Name or #** MR1

*Recorded by: M.Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update

Map Name: Atwater, California, 7.5' USGS Quadrangle ***Date of Map:** 1960 (1987)

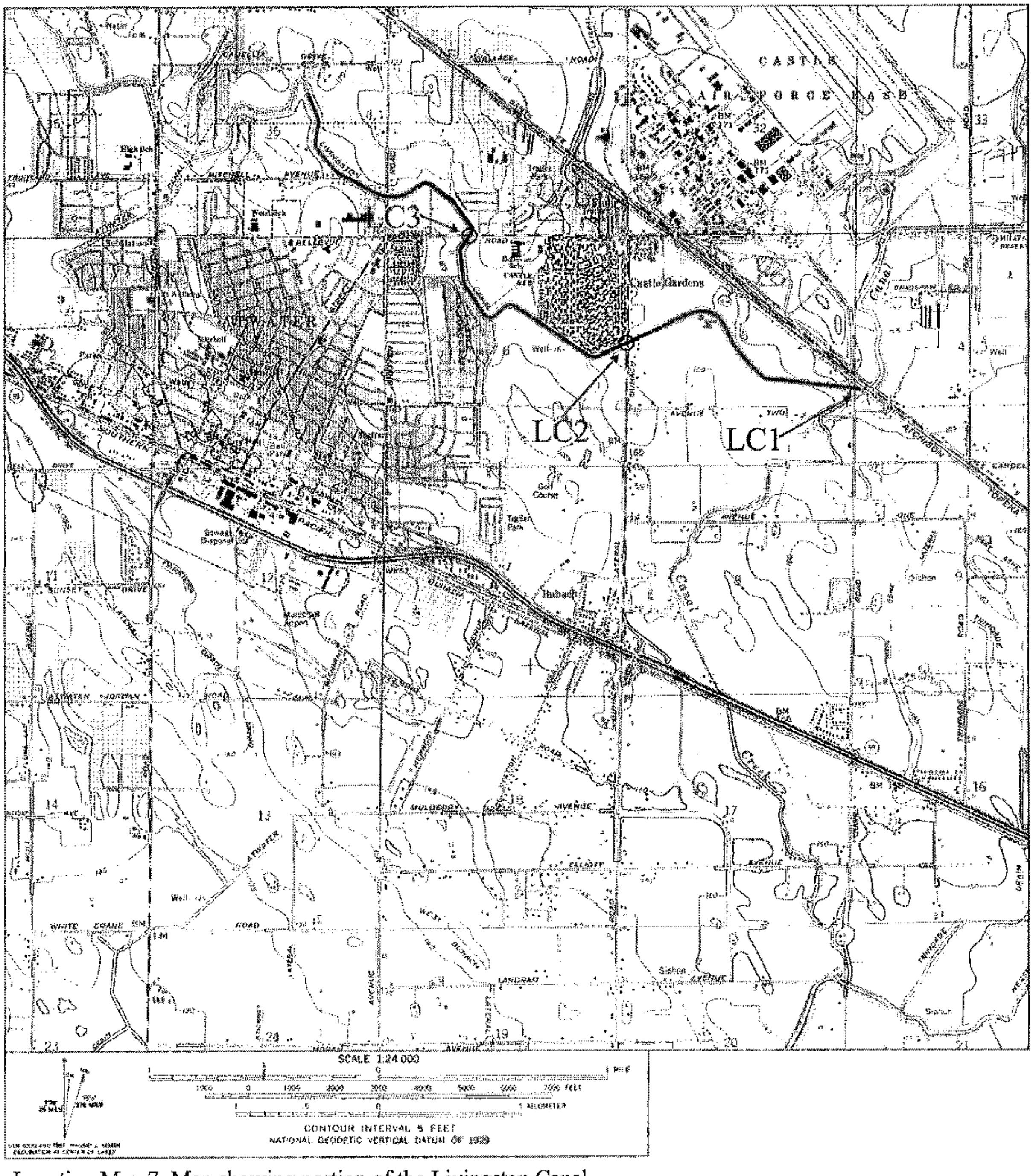
Map Name: Merced, California, 7.5' USGS Quadrangle ***Date of Map:** 1961 (1987)



Location Map 6. Map showing location of the drainage ditch.

Page 75 **of** 75 ***Resource Name or #** MR1

*Recorded by: M.Bunse/S.J. Melvin *Date 12/12/06; 1/22/07 ☒ Continuation ☐ Update



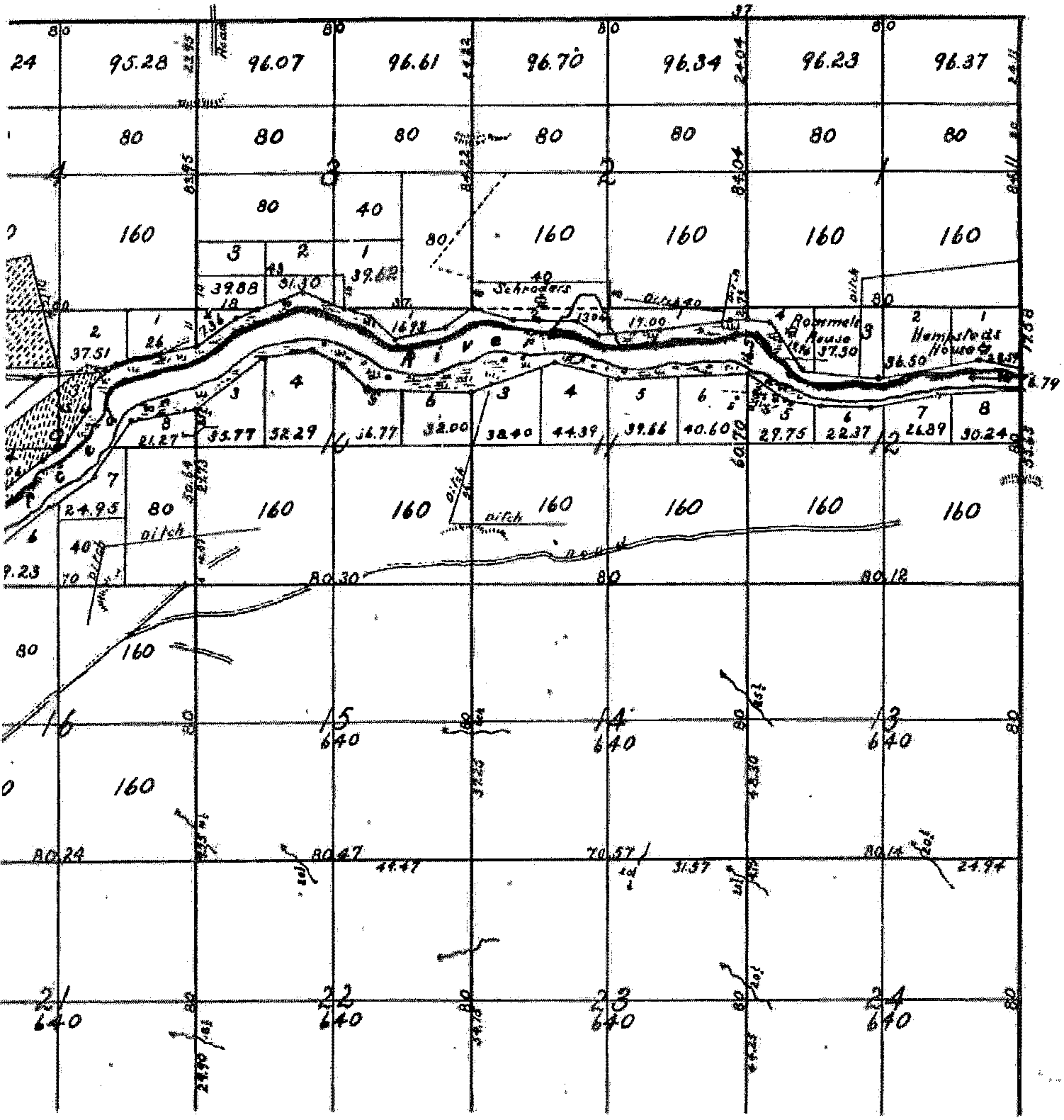
Location Map 7. Map showing portion of the Livingston Canal.

T 5. S. – R. 14 E.

of

MOUNT DIABLO MERIDIAN.

44-327 1853–1855



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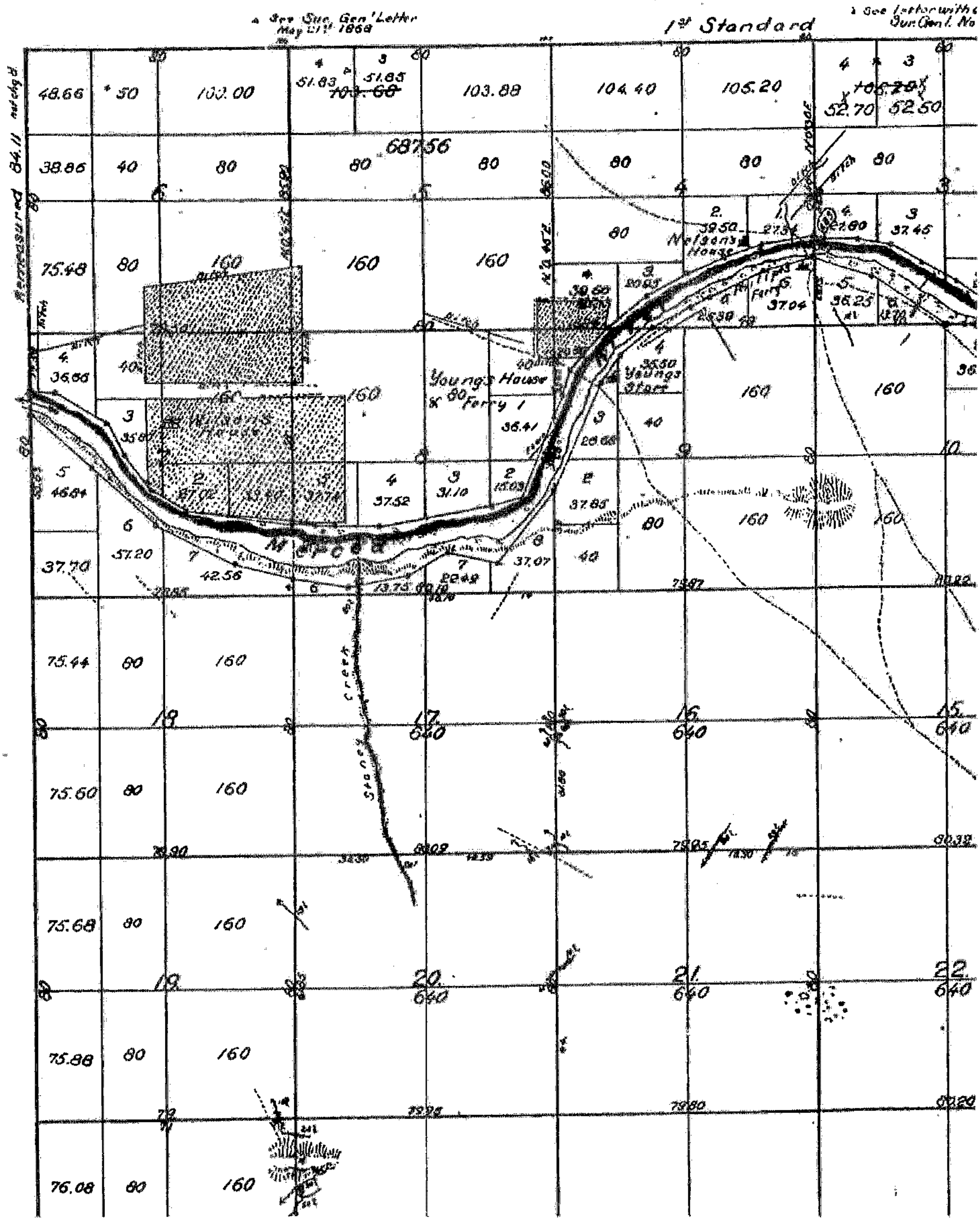
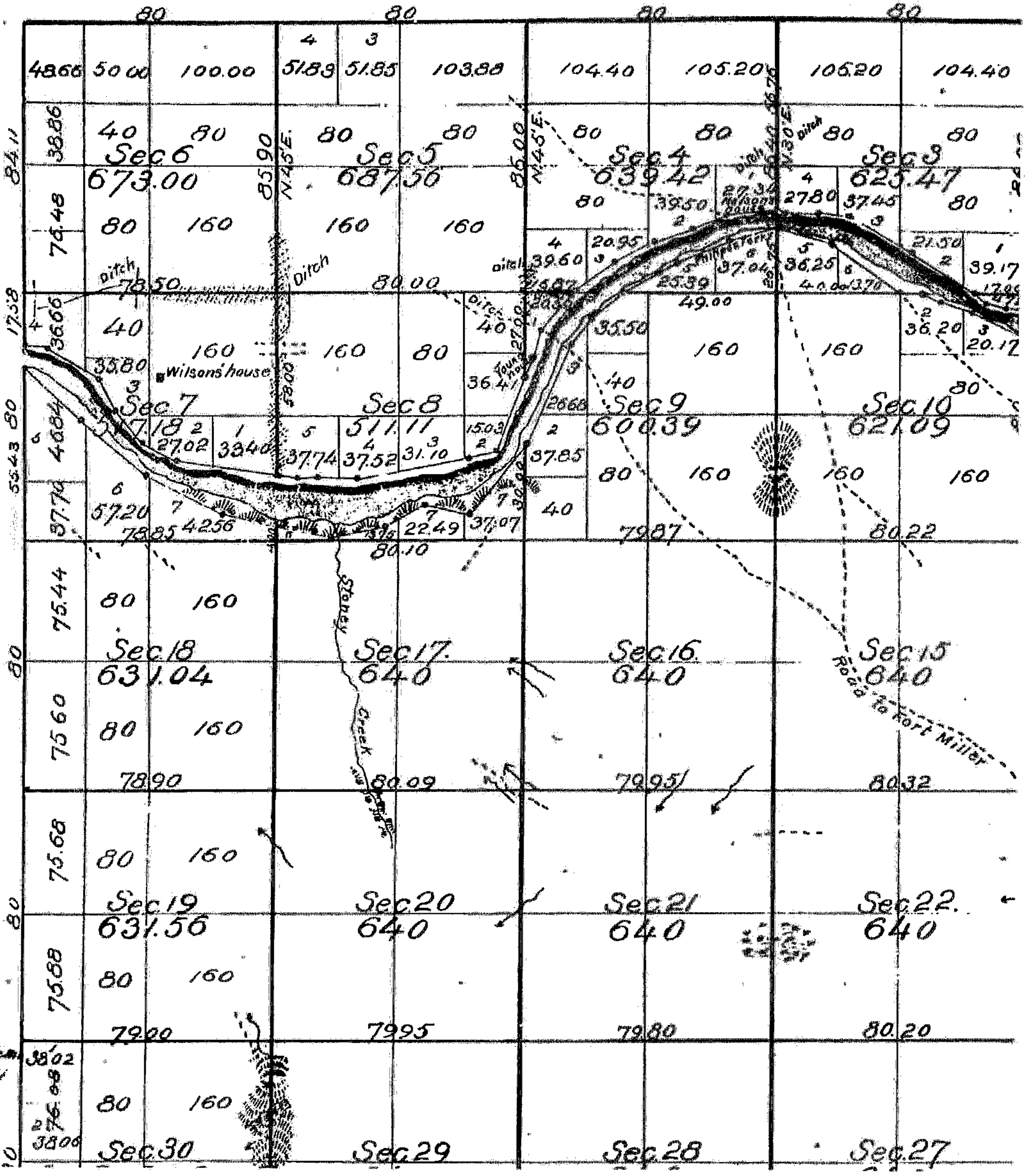
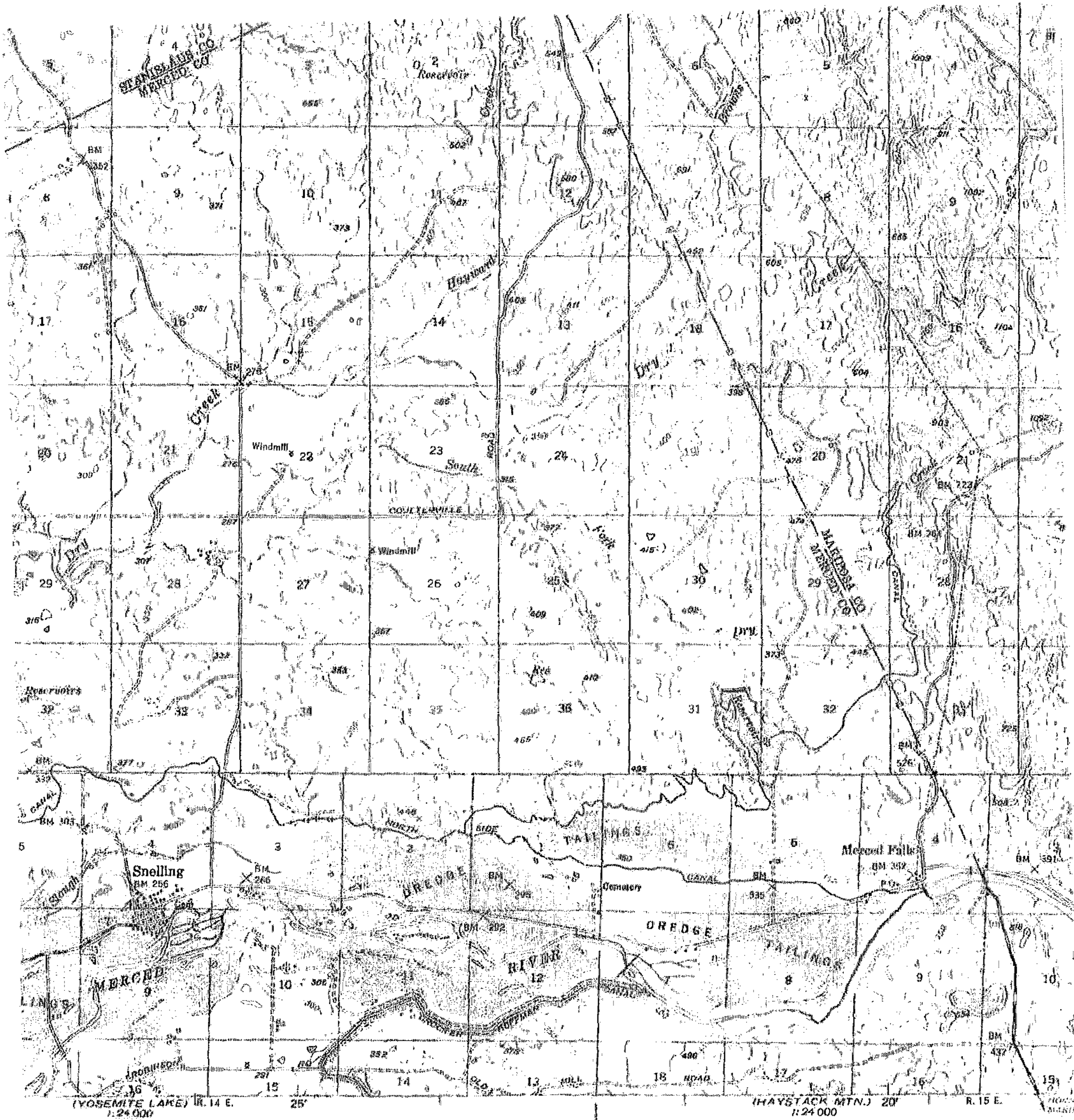


Township No 5 South, Range No 15 East Mount D.

44-329 1853-1878





SCALE 1:62500

1 ½ 0 1 2 3 4 MILES

3000 0 3000 6000 9000 12000 15000 18000 21000 FEET

1 .5 0 1 2 3 4 5 KILOMETERS

TRUE NORTH

MAGNETIC NORTH

17°

APPROXIMATE MEAN DECLINATION, 1954

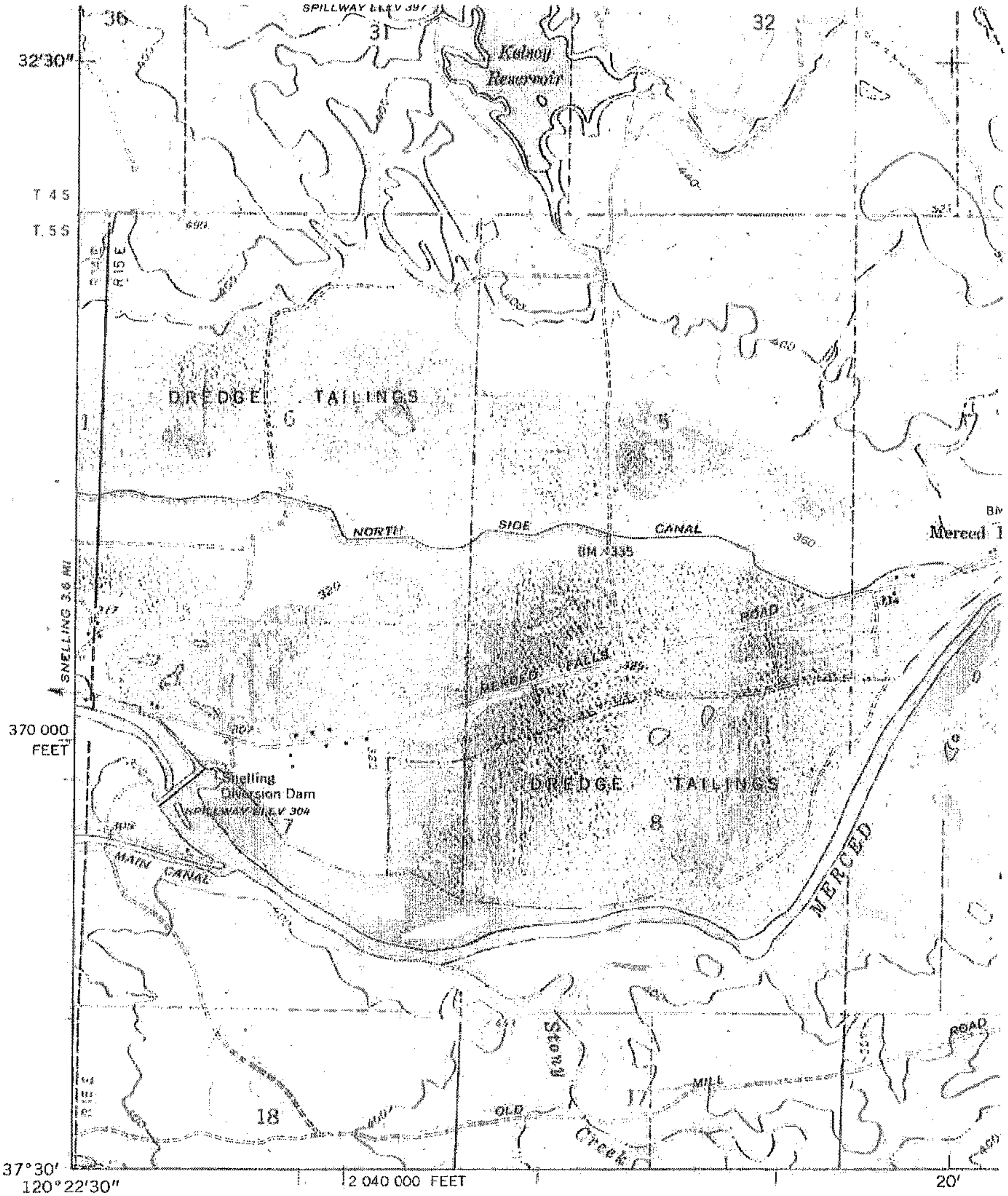
CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL

Merced Falls 15' 1954

CALIF

QUADRANGLE LOCATION

FOR SALE BY U. S. GEOLOGICAL SURVEY, FEDERAL CENTER, DENVER, COLORADO OR WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST



(YOSEMITE LAKE)

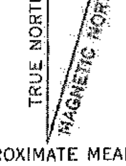
Mapped, edited, and published by the Geological Survey
in cooperation with California Department of Water Resources

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial
photographs taken 1959. Field checked 1962

Polyconic projection. 1927 North American datum
10,000-foot grid based on California coordinate system, zone 3
1000-meter Universal Transverse Mercator grid ticks,
zone 10, shown in blue,

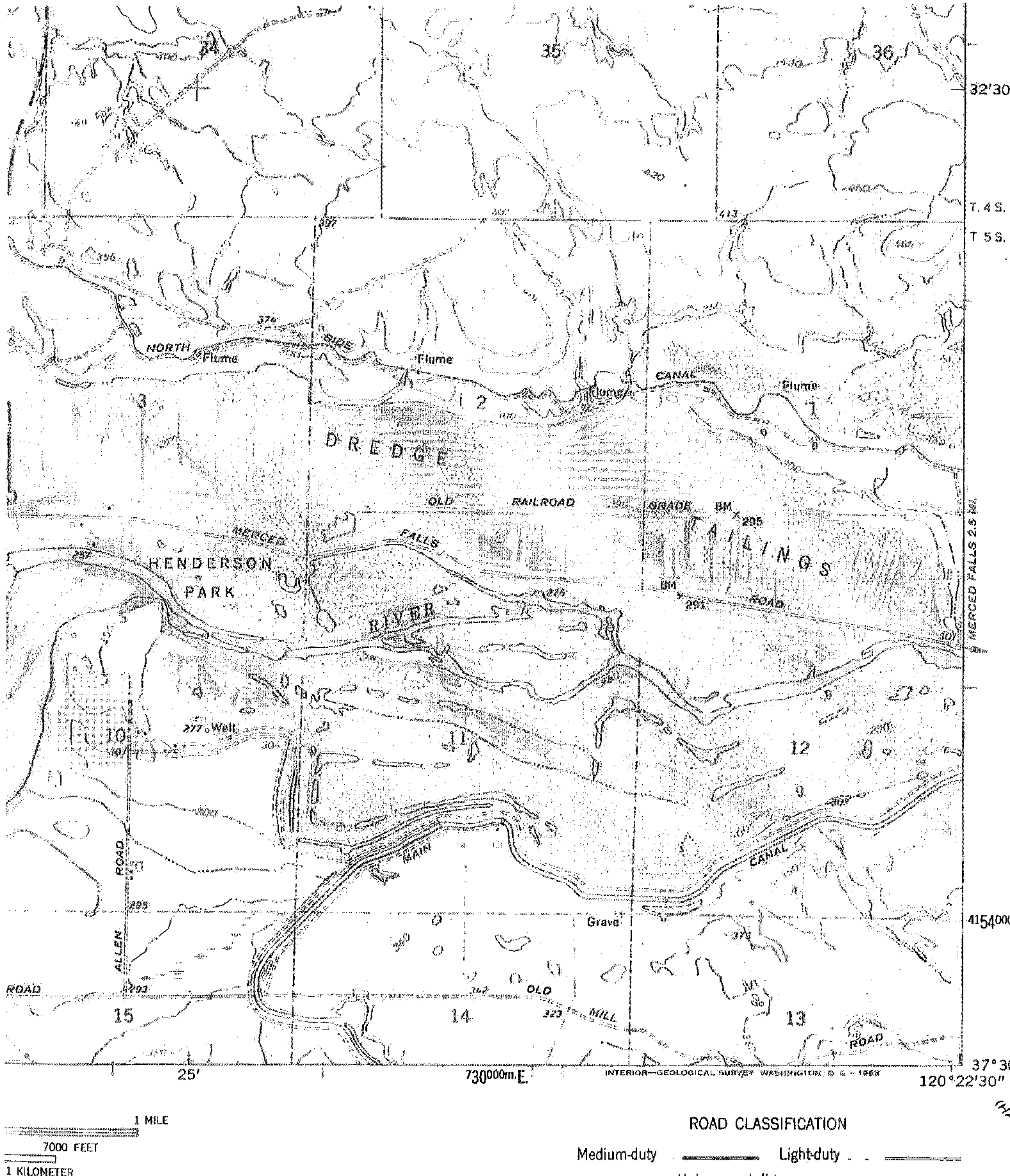
Fine red dashed lines indicate selected fence lines



APPROXIMATE MEAN
DECLINATION, 1962

Merced Falls 7.5' 1962

FO



ROAD CLASSIFICATION

Medium-duty ——— Light-duty ———

Unimproved dirt =========

◯ State Route

QUADRANGLE LOCATION

RDS
ASHINGTON 25, D. C.
ON REQUEST

SNELLING, CALIF.

SW/4 MERCED FALLS 15' QUADRANGLE
N3730—W12022.5/7.5

1962

Appendix D
Department of Parks and Recreation DPR 523

State of California ☐The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary #P-24-001782 UPDATE
HRI #
Trinomial
NRHP Status Code

Other Listings
Review Code Reviewer Date

Page 1 of 1 ***Resource Name or #:** (Assigned by recorder) P-24-001782 Update
P1. Other Identifier: Merced River Ranch Dredging Tailings

***P2. Location:** ☐ **Not for Publication** ☐ **Unrestricted**
***a. County** Merced **and** (P2c, P2e, and P2b or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5' Quad** Snelling **Date** 1962 **T** 5S ; **R** 14E ; NE ¼ **and** NW ¼ **of Sec** 12; MDM **B.M.**
c. Address City Zip
d. UTM: (Give more than one for large and/or linear resources) NAD83 Zone 10N , mE/ mN (See location map)
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, decimal degrees, etc., as appropriate)
To access the south side of the tailings (south of Merced River), take Snelling Road south from the town of Snelling, turn east on Robinson Road, turn north onto the gravel road just before the Main Canal. Do not cross the canal. At the second bridge park and walk north toward the Merced River. To access the north side of the tailings (north of the Merced River), take Merced Falls Road east from the town of Snelling. At the Cuneo Fishing Access parking lot walk south toward the Merced River.

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
The dredge tailings observed are part of a larger expanse of tailings located both north and south of Merced River for approximately 10 miles from the town of Snelling to the Mariposa County border. The previous recordings of the tailings by Kress (2015) and St. Clair (2006) described the dredge tailings as consisting of rounded cobble piles, from 4- to 6-feet in height, running horizontal and diagonal to the Merced River. This is consistent with the findings of this survey, which includes both previous areas recorded. No changes or modifications to the tailings are evident since the time of the previous recording.

***P3b. Resource Attributes:** (List attributes and codes) AH9

***P4. Resources Present:** ☐ Building ☐ Structure ☐ Object ☐Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (view, date, accession #) View north on north side of Merced River

***P6. Date Constructed/Age and Source:** ☐Historic ☐ Prehistoric ☐ Both

***P7. Owner and Address:** California Department of Fish and Game,1416 Ninth Street, Sacramento, California, 95814

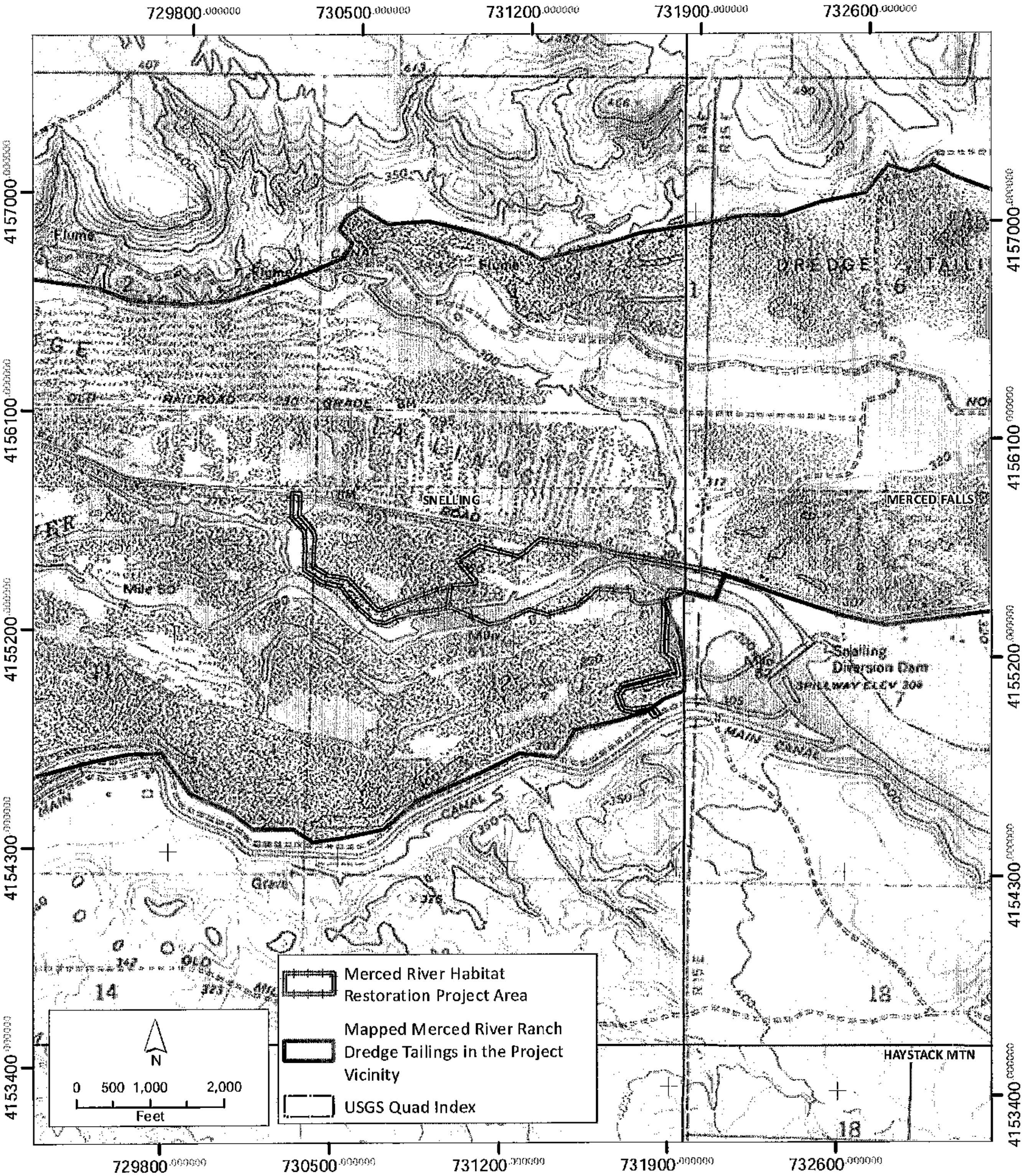
***P8. Recorded by:** (Name, affiliation, and address) Dean Martorana, Horizon Water & Environment, Oakland, CA.

***P9. Date Recorded:** February 2018

***P10. Survey Type:** (Describe) Reconnaissance

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") Cultural Resources Assessment Report, Merced River Habitat Restoration Project #4: Gage 52, Prepared for Merced Irrigation District, 2018.

***Attachments:** ☐NONE ☐Location Map ☐Continuation Sheet ☐Building, Structure, and Object Record



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DREDGE
OLD RAILROAD GRADE
SNELLING ROAD
MERCED FALLS
Mile 50
Snelling Diversion Dam
SPILLWAY ELEV 309
MAIN CANAL
Gravel
HAYSTACK MTN
14
18
13
N
0 500 1,000 2,000
Feet
Merced River Habitat Restoration Project Area
Mapped Merced River Ranch Dredge Tailings in the Project Vicinity
USGS Quad Index

Appendix E
Correspondence with the
State Office of Historic Preservation

From:	Medin, Anmarie@Parks
To:	Janis@horizonh2o.com
Cc:	Schulz, Jeanette@Parks
Subject:	FW: Record on site eligibility - Merced River Ranch Tailings
Date:	Wednesday, July 18, 2018 10:42:05 AM

Janice –
Sorry we can't help you with this request.
Anmarie

From: McDole, Joseph@Parks
Sent: Tuesday, July 17, 2018 4:33 PM
To: Medin, Anmarie@Parks <Anmarie.Medin@parks.ca.gov>
Subject: RE: Record on site eligibility - Merced River Ranch Tailings

Hi Anmarie,
I did not find a previous evaluation for the site.

Sincerely,

Joseph McDole
State Historian II
Information Management Unit
California Office of Historic Preservation
1725 23rd St, Suite 100,
Sacramento CA 95816-7100
www.ohp.parks.ca.gov
916 445-7039 phone
916 445-7053 fax
joseph.mcdole@parks.ca.gov

From: Medin, Anmarie@Parks
Sent: Tuesday, July 17, 2018 1:14 PM
To: McDole, Joseph@Parks <Joseph.McDole@parks.ca.gov>
Subject: FW: Record on site eligibility - Merced River Ranch Tailings

Joseph –
I checked this P-Number in OTIS and there was no entry. Would you be able to help Janice with any other information?
Thanks,
Anmarie

From: Janis Offermann <janis@horizonh2o.com>

Sent: Monday, July 16, 2018 9:54 AM
To: Jeanette.Schultz@parks.ca.gov; Correia, Jay@Parks <Jay.Correia@parks.ca.gov>; Medin, Anmarie@Parks <Anmarie.Medin@parks.ca.gov>
Subject: Record on site eligibility - Merced River Ranch Tailings

Good Morning, Jeanette, AnMarie, and Jay
I apologize for emailing all of you with my question, but I an not sure who I should ask.

We are working on a project along the Merced River that will be reconfiguring mine tailings for salmon spawning. The various overlapping sections of the tailings have been recorded in 2006, 20012, and 2015 (see attached), and most recently by us. It appears that the 2015 recording was for a DWR project, in 2012 they were recorded for a Merced County project, and the 2009 project was for a river restoration project. CDFW apparently owns the property. I don't know the federal nexus for the other projects, but our project is working with the US Bureau of Reclamation (USBR), so perhaps some of the others also had that nexus.

In any case, USBR has asked us whether SHPO has ever concurred with the previous findings that these tailings are not eligible for NRHP listing. Do you have any record of that, or can you point me to who I should contact about it?
Many thanks for any help you can provide

Thanks
janis

Janis Offermann
Cultural Resources Practice Leader
Horizon Water and Environment
400 Capitol Mall, Suite 2500
Sacramento, CA 95814
916.465.8076 – office
530.220.4918 – mobile

Appendix B. Design Approach for MID Merced River Restoration Project

Historically the lower Merced River in the Proposed Action boundary was an anastomosing channel river channel system with diversity of wetland and off channel features (Downs et al. 2011, Stillwater Sciences 2006). Several factors including altered sediment supply and transport, and current land use and property ownership do not allow the creation and maintenance of a dynamic multi-thread channel that once occurred under historical conditions (Stillwater Sciences 2006). Therefore, the Proposed Action approach is to reconfigure the channel and floodplain to optimize habitat function and processes, dramatically altered by intensive mining, which can function under the managed flow regime. This approach was used for two nearby completed Merced River rehabilitation projects, the Merced River Ranch and Henderson Park projects, both funded by the Anadromous Fisheries Restoration Program.

Site description

The Merced River channel within the Proposed Action boundary can generally be characterized into three primary sections – the upper, middle, and lower section - separated by a series of bedrock steps at a bend in the river. The average rived bed slope is 0.0028, which is slightly steeper than the average bed slope of the downstream river corridor through the town of Snelling. This is due to the bedrock outcrop producing a slope break that controls bed elevations.

In the upper section above the bedrock outcrops the channel is uniform and straight with very little variation in the channel topography. The river right bank is confined by Merced Falls Road; south of the road, the right bank is vegetated with a narrow band of trees and shrubs. The river left bank also has a narrow band of vegetation and is bounded to the south by a tailings pile. The Calaveras Trout Farm (private trout farm) and the Merced River Fish Hatchery [A Chinook Salmon hatchery operated by the California Department of Fish and Wildlife (CDFW)] are located south of the tailings. The salmon hatchery receives piped water from Crocker-Huffman Diversion Dam impoundment and water is diverted from the Crocker-Huffman Diversion Dam impoundment to the trout farm via a combination of canals and pipes (Vogel 2007). Bed materials in this area are mostly large cobbles and bedrock, although there is lateral sorting in the channel with finer sediments present near the channel banks. At the very upstream limit there are some gravels in the channel, presumably from CDFW gravel augmentation.

The bedrock exposed middle section is characterized by several river islands and steps in the riverbed profile followed by a narrower channel meander that is adjacent to Merced Falls Road. The channel in this area is very complex with multiple islands and bedrock steps. The overall channel topography slopes to the north in this location, where flow appears to be directed to the river right bank. The river right bank shows signs of erosion adjacent to Merced Falls Road. The river left banks are relatively low relief due to the presence of a large vegetated bar-terrace. Within the terrace there are several high flow side channels adjacent to the main river channel. In the lower most section the channel returns to a uniform state, with little to no variation in the cross sectional or longitudinal profile. Both river left and river right are confined by a narrow band of vegetation and dredger tailings.

The lowest section is roughly 1,000 ft long that transitions from a river island and bedrock step into a long uniform channel that ends at the upstream limit of the Merced River Ranch project. The north channel of the river island does not appear to convey much flow, but there are several small (e.g. 5-10') channels that flow to the south. Adjacent to the northern edge of the river island is a river bed step.

Downstream of the river island both the river bed and cross section topography are very simple, resulting in homogenous hydraulic conditions. The banks have a 20-50' wide riparian corridor before transitioning into tailing piles. At the southern boundary of the middle and lower sections is a culvert that appears to provide drainage from the hatchery.

Overall, the Proposed Action boundary has a relatively high amount of large cobble and bedrock sediment with some gravel. Given the natural occurrence of river islands where channel width is relatively wide, and the presence of riffles embedded within the flow splits, it is hypothesized that more complex geomorphic forms could be created at the Proposed Action boundary and persist into the future depending on future climate, land and water use.

Assumptions for Developing Proposed Action

Basic assumptions that influenced the development of the Proposed Action include:

- Stream flow in the Proposed Action Area is suitable for fall-run Chinook Salmon. Stream flow is partially controlled by Lake McClure, which is the largest reservoir in the watershed, with a capacity to store 1,024,600 acre-ft of water. During most years, flow in the lower Merced River is regulated by releases from New Exchequer Dam, and irrigation diversions both upstream and downstream of Crocker-Huffman Diversion Dam.Existing Land Use: The land is currently the site of a stream gage operated by Merced ID. Recreationists have historically created ad-hoc access sites along the Merced River for rafting purposes. Merced ID is currently constructing a managed, non-motorized boating put-in in the Proposed Action Area to minimize issues with unauthorized ad-hoc access sites, such as erosion, riparian vegetation damage, trash and private property trespassing.
- The current channel is not optimized for adult and juvenile salmonid habitat quality.
- Proposed Action would have multiple benefits and minimal impacts to the stream corridor, riparian vegetation, and any sensitive habitats.

Site Selection

The Proposed Action boundary was chosen as a rehabilitation location on the Merced River due to the following factors:

- *Existing condition*: poor gravel quality and quantity within river, providing little wildlife value or societal benefit; dredge tailings which constrain the river and limit available floodplain habitat, perched floodplain habitat that is currently disconnected from the main river channel due to historic gold mining activities and years of channel incision. The land is currently the site of a stream gage operated by Merced ID. Recreationists have historically created ad-hoc access sites along the Merced River for rafting purposes. Merced ID is currently constructing a managed, non-motorized boating put-in in the Proposed Action Area to minimize issues with unauthorized ad-hoc access sites, such as erosion, riparian vegetation damage, trash and private property trespassing.
- *Potential for enhancement*: suitable gradient and depth; dredge tailings are a source of material for in-channel gravel augmentation.
- *Physical access* to the Proposed Action boundary to allow equipment entrance that would have minimal impacts on the stream corridor, riparian vegetation, any sensitive species habitat, and local community.
- *Consistency with existing planning documents*: The Proposed Action is consistent with the 2030 Merced County General Plan (Merced County 2013). Policy NR-1.19: Merced River Restoration Program Support directs the county to support restoration efforts for the Merced River, consistent with the Merced River Corridor Restoration Plan.

General design description

The Proposed Action will excavate habitat features on the floodplain and use gravel and cobble sediments to rebuild the river bed. The floodplain design would create side channels where possible, and seek to preserve existing high quality biological resources such as wetlands and riparian trees. Once excavated sediments from the floodplain are sorted they would be used to rescale the current river channel geometry to better match the managed flow regime. The river bed would be graded to create mosaic alluvial river mesohabitat units (e.g. riffles, pools and bars) to increase main channel spawning, rearing, and holding habitat, while concurrently raising low-flow water levels to inundate the newly graded floodplain for off channel rearing habitat. The Proposed Action will increase the area of main channel bar edges, which juvenile salmonids use for rearing, particularly during drought years (Beechie et al. 2005). In drought years, when floodplains, side channels, and other off-channel rearing habitats are generally not inundated, juvenile salmonids use main channel bar edges for rearing (Beechie et al. 2005, Sellheim et al. 2015).

Spawning habitat increases are anticipated from rescaling the channel size to the current flow regime, as well as building riffles using appropriately-sized spawning gravels. Rescaling river geometry to better match the managed flow regime is a common enhancement approach in California's regulated rivers. The Proposed Action seeks to instill greater topographic variation in created channel forms beyond a uniform bankfull channel, including riffles, pools and bars. These features would create the hydraulic conditions that vary considerable about average bankfull dimensions that are needed to support geomorphic and ecological processes (Brown et al., 2015; Brown and Pasternack, 2017).

An analysis was completed using the United States Army Corps of Engineers (Corps) HEC-EFM to inform ecologically significant flows during drought years on which to base Proposed Action design criteria. To develop habitat that is inundated for the preferred duration at an expected frequency over the target ecological period, specific flow values during drought years were selected to guide the design based on these datasets. Based on the ecological flow evaluation, design flows were developed to govern the development of habitat design elements.

Design Criteria

Ecological

Chinook Salmon are the most abundant native salmonid within the lower Merced River and are an example of a keystone species (Merz and Moyle 2006). Therefore, management actions that enhance Chinook Salmon health and production would presumably confer benefits to the overall health and production of the lower Merced River.

A major premise of the Proposed Action is that past watershed practices have negatively impacted the diversity and productivity of the Merced River (Freedman et al. 2013); including limiting the quantity and quality of lower Merced River Chinook Salmon spawning and rearing habitat (CDFG 1993; USFWS 1995; USFWS 2001). Furthermore, over-simplification of the main channel, including an over-deepened channel and steep, armored banks, supports potential predators, especially introduced fish species such as striped bass and other predators, that may consume juvenile Chinook Salmon as they rear in, and emigrate from, the Proposed Action Area (Power et al. 1996; Sabal et al. 2016). Within periods of drought, these conditions can be exacerbated due to limited water quantity and quality (Marine and Cech 2004; Merz et al. 2004).

Therefore, increasing the quantity and quality of Chinook Salmon spawning and rearing habitat and reducing the value of potential habitats for invasive predator species, especially during drought periods, may confer benefits to the health and production of Merced River Chinook Salmon (Shrivell 1990; Rahel and Olden 2008). Healthier and more diverse populations are better able to withstand adverse and variable conditions such as those caused by climate change (Lake 2003; Schindler et al. 2010).

Physical habitat models are powerful tools for assessing changes in stream habitat at scales relevant to fish (e.g. Boavida et al. 2012; Koljonen et al. 2013). These models usually combine data on hydromorphological channel structure with habitat suitability indices to obtain the area of the stream habitat suitable (weighted usable area, WUA) for the target organism at a range of discharges. In habitat rehabilitation assessments, habitat models have focused on post-rehabilitation evaluations or comparison of WUAs before versus after rehabilitation (Wheaton et al. 2004; Gard 2009; Korsu et al. 2010).

Depth and velocity tend to be two key aspects know to determine where salmonids set up territories (Table B1). A positive relationship between piscivorous fish abundance and water depth is well documented (Table B1) in the scientific literature, and deep pools are known to facilitate predation (Power et al. 1985; Brown and Moyle 1991; Gelwick et al. 1997). Because depth and velocity within the stream is driven by flow, determining the flow expected for each life stage during drought conditions is paramount to designing habitat that benefits spawning and rearing Chinook Salmon, while reducing habitat that supports potential predators of juvenile salmonids.

Geomorphic

Geomorphic design criteria were developed to promote creation of more sustainable habitat features that are compatible with the current flow regime and sediment augmentation program. These include the reach-average sediment transport regime and geometric criteria associated with self-sustaining alluvial riffle-pools.

Table B1. Depth and velocity suitability criteria for spawning and rearing Chinook Salmon and striped bass, a common invasive predator within the Merced River.

Design flow (cfs	Basis	Min. Depth (ft)	Min. Velocity (ft/s)	Preferred Depth (ft)	Preferred Velocity (ft/s)	Max Depth (ft)	Max Velocity (ft/s)	References
155	Chinook Salmon adult spawning	0.25	0.3	1.5 to 2	1.75 to 2.75	4	5	CFS Unpublished American River; Raleigh et al. 1986; Sommer et al. 2001
450 to 940	Chinook Salmon fry rearing	0.1	0	0.7 to 1.2	0 to 0.4	4.9	2	Raleigh et al. 1986; Allen et al. 1986
450 to 940	Chinook Salmon smolt rearing	0.1	0	0.8 to 1.8	0.2 to 0.79	4.9	2	Allen et al. 1986; Raleigh et al. 1986; Beakes et al. 2012
450 to 940	striped bass habitat	6	0.9	6 to 30	1.64 to 4	30	7	Crance 1984

References

Beakes, M.P., J.W. Moore, N. Retford, R. Brown, J.E. Merz, and S.M. Sogard. 2012. Evaluating statistical approaches to quantifying juvenile Chinook Salmon habitat in a regulated California river. Wiley Online Library DOI: 10.1002/rra.2632

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Downs, P.W., M.S. Singer, B.K. Orr, Z.E. Diggory, and T.C. Church. 2011. Restoring ecological integrity in highly regulated rivers: the role of baseline data and analytical references. Environmental Management 48(4):847-864.

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Gard, M. 2009. Comparison of spawning habitat predictions of PHABSIM and River2D models. International Journal of River Basin Management 7(1):55-71.

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Appendix B. MID Merced River Restoration Basis of Design

Appendix C. MID Merced River Restoration Mitigation and Monitoring Reporting Program

MITIGATION MONITORING AND REPORT PROGRAM:
MERCED IRRIGATION DISTRICT'S MERCED RIVER INSTREAM AND OFF-CHANNEL HABITAT REHABILITATION PROJECT
MITIGATED NEGATIVE DECLARATION

This Mitigation Monitoring and Reporting Program (MMRP) was prepared in accordance with Section 15097 of the California Environmental Quality Act (CEQA) Guidelines. Section 15097 requires that a lead agency establish a program to report on or monitor measures adopted as part of the environmental review process to mitigate or avoid significant effects on the environment. The MMRP for the Merced Irrigation District's Merced River Instream and Off-Channel Habitat Rehabilitation Project is presented here as Table 1.
This MMRP is designed to ensure that the mitigation measures necessary to reduce significant impacts identified in the Merced Irrigation District's Merced River Instream and Off-Channel Habitat Rehabilitation Project Initial Study and Proposed Mitigated Negative Declaration (IS/MND) are implemented. The components of the MMRP Table 1 are listed below:

Mitigation Measures: The mitigation measures are taken verbatim from the Merced Irrigation District's Merced River Instream and Off-Channel Habitat Rehabilitation Project IS/MND. These mitigation measures are referred to in the document as Environmental Commitments (EC's).

Timing/Milestone: Identifies a schedule for conducting each mitigation action.

Responsible Entity: Identifies the entity responsible for implementing specific mitigation measures.

Mitigation Action: Identifies the specific action or actions that must be completed to implement the mitigation measure.

Monitoring and Enforcement Responsibility: Identifies the department/agency, consultant, or other entity responsible for overseeing that mitigation occurs.

Check off Date/Initials: To be filled out when individual mitigation is complete.

MITIGATION MONITORING AND REPORTING PROGRAM: MERCED IRRIGATION DISTRICT'S MERCED RIVER INSTREAM AND OFF-CHANNEL HABITAT REHABILITATION PROJECT					
Mitigation Measure(s)	Timing/ Milestone	Responsible Entity	Mitigation Action	Monitoring and Enforcement Responsibility	Check off Date/Initials
Air Quality					
EC-1: Reduce Dust and Air Quality Impacts Following methods in the Stillwater Sciences (2004) Mercury Assessment, total mercury from sediments will be evaluated to ensure samples are below or within the range of background levels, as defined by Goldfield sediments analyzed for the Western Aggregate Reclamation Plan (0.03 mg/kg to 0.59 mg/kg) (SMGB, 2014). Aqueous raw total mercury will also be tested to ensure that it is below the California Toxics Rule for a drinking water source of 50 ng/L. It is unlikely that excavation and regrading activities may uncover mercury hot spots and or mobilize mercury in the aquatic food web; however, if samples are found with mercury levels above established standards, work will be halted to assess contamination potential. As a further precaution, mercury levels will be measured before, during, and after restoration activities in the Proposed Project area.	Ongoing prior to, during and after restoration activities	Project Applicant/ Contractor	Use qualified QSP and implement measures	Project Applicant/ Contractor	
Biological Resources					
EC-2: Adaptive Construction Approach to Protect Elderberry Plants, Monitor Survival, and Mitigate for Loss Pre-project elderberry plant surveys were conducted to assess impacts to the Valley Elderberry Longhorn Beetle (VELB, *Desmocerus californicus* ssp. *dimorphus*), and	Prior to initiation of restoration activities	Project Applicant/ Contractor	Implement specified mitigation measures	Project Applicant/ Contractor	

surveyors identified 678 elderberry (*Sambucus* spp.) shrubs with stem diameter greater than 1 inch at ground level within the Proposed Action footprint (7). Complete avoidance may be assumed when there is at least a 20-ft (6 m) buffer around the drip line of an elderberry plant (USFWS 2017b). To avoid direct mortality to VELB from crushing by heavy equipment or through destruction of their elderberry shrub habitat during construction, elderberry plants shall be clearly marked prior to construction and intrusion into the prescribed 20-foot buffer zone shall be avoided, as possible. If any mortality of elderberry shrubs occurs, USFWS shall be consulted immediately and appropriate mitigation will be implemented.					
EC-3: Monitor for Fish and Wildlife to Prevent Impacts Pre-construction surveys shall be conducted by qualified wildlife biologists, who shall determine the use of the Proposed Action Area by special status wildlife species. Surveys shall focus on identification of potential American badger (*Taxidea taxus*) dens and other potential wildlife species within the construction footprint and a minimum 500 ft (152.4 m) buffer around the construction footprint. If American badger dens are located within the construction footprint or buffer area, CDFW shall be consulted prior to initiation of construction for further instruction on methods to avoid direct impacts to American badger. Pre-construction surveys shall also determine the use of the Proposed Action construction footprint by San Joaquin kit fox (*Vulpes macrotis mutica*). These surveys shall focus on identification of potential, atypical, active, and natal (USFWS 1999b) kit fox dens. If potential kit fox dens are located within the construction or buffer area, a minimum of five consecutive nights of camera/scent stations and	Ongoing during restoration activities	Project Applicant/ Contractor	Implement specified mitigation measures	Project Applicant/ Contractor	

track stations shall be placed by the den entrances in order to determine if the den is in use by kit fox. If active or natal dens are confirmed, CDFW and USFWS shall be consulted for further instructions on methods to avoid direct impacts to this species. Protocol-level surveys shall also be implemented for other state and federally-listed species including Swainson's hawk (*Buteo swainsoni*), white-tailed kite (*Elanus leucurus*), bald eagle (*Haliaeetus leucocephalus*), yellow-breasted chat (*Icteria virens*), Chinook Salmon, CCV steelhead, and western pond turtle (*Actinemys marmorata*). This includes pre-construction surveys conducted no more than 10 days before Proposed Action implementation by qualified wildlife and fisheries biologists. A minimum no-disturbance buffer of 250 feet around active nests of non-listed bird species; a 500-foot no-disturbance buffer around migratory bird species; and a half mile buffer for nest of listed species and fully protected species (including Swainson's hawk, white-tailed kite and bald eagle) shall be established until breeding season is over or young have fledged. If such a buffer cannot be reasonably accomplished, CDFW shall be consulted. Fish surveys shall be conducted by a qualified biologist and if spawning salmon are observed within the construction footprint, construction shall cease and CDFW and USFWS contacted immediately to determine the appropriate course of action.					
EC-4: Protect and Compensate for Native Trees Native trees, such as Fremont Cottonwood, willows, and alder, with a dbh of 6 in (15.2 cm) or greater shall be protected with 30-ft (9.1-m), 10-ft (3-m), and 10-ft (3-m) buffers, respectively. Native trees shall be marked with flagging if close to the work area to prevent disturbance. To	Prior to initiation of restoration activities	Project Applicant/ Contractor	Implement specified mitigation measures	Project Applicant/ Contractor	

compensate for the removal of riparian shrubs and trees during Proposed Action implementation, the plans shall identify tree and shrub species to be planted, how, where, and when they would be planted, and measures to be taken to ensure a minimum performance criteria of 70% survival of planted trees. Irrigation shall not be used, as the return of inundation to the floodplain is expected to promote survival and growth of native riparian species. The tree plantings shall be based on native tree species compensated for in the following manner: • Oaks having a dbh of 3 – 5 in (7.6 – 12.7 cm) shall be replaced in-kind, at a ratio of 3:1, and planted during the winter dormancy period in the nearest suitable location to the area where they were removed. Oaks with a dbh of greater than 5 in shall be replaced in-kind at a ratio of 5:1. • Riparian trees (i.e., willow, cottonwood, poplar, alder, ash, etc.) and shrubs shall be replaced in-kind within the Proposed Action boundary, at a ratio of 3:1, and planted in the nearest suitable location to the area where they were removed.					
EC-5: Work Outside of Critical Periods for Special Status Species To avoid impacts to special status species, all ground disturbing activities shall be conducted during the period of 15 July through 15 November. No in-stream work would be conducted after 15 October to avoid impacts to spawning Chinook Salmon. Nesting birds and raptors are protected under the MBTA and CDFG Code, and trees and shrubs within the Proposed Action Area likely provide nesting habitat for songbirds and raptors. If construction activities occur during the potential breeding season (February	Prior to initiation of restoration activities	Project Applicant/ Contractor	Implement specified mitigation measures	Project Applicant/ Contractor	

through August) a qualified biologist shall conduct surveys for active nests and/or roosts within a ½ mile radius of the Proposed Action Area no more than 10 days prior to the start of construction. A minimum no disturbance buffer shall be delineated around active nests (size of buffer will depend on species encountered) until the breeding season has ended or until a qualified biologist has determined that the birds have fledged and are no longer reliant upon the nest or parental care for survival.					
EC-6: Monitor for Bats to Prevent Impacts The Proposed Action construction shall occur outside the critical period for bats (after 15 July). Before any ground disturbing activities, a qualified biologist shall survey for the presence of associated habitat types for the bat species of concern. If bats are present, the biologist shall apply a minimum 300 ft (91.4 m) no-disturbance buffer around roosting bats, maternity roosts or winter hibernacula until all young bats have fledged.	Ongoing during restoration activities	Project Applicant/ Contractor	Implement specified mitigation measures	Project Applicant/ Contractor	
Water quality					
EC-7: Monitor Water Quality and Prevent Impacts During in river work, turbidity and total suspended solids shall be monitored with intermittent grab samples from the river, and construction curtailed if turbidity exceeds criteria established by the Regional Water Quality Control Board in its Clean Water Act §401 Water Quality Certification for the Proposed Action. Specifically, sampling shall be performed immediately upstream from the Proposed Action Area and approximately 300 feet downstream of the active work area during construction. Activities shall not cause in surface waters:	Ongoing prior to, during and after restoration activities	Project Applicant/ Contractor	Use qualified QSP and implement measures	Project Applicant/ Contractor	

a) turbidity to exceed 2 NTU's where natural turbidity is less than 2 NTU; b) where natural turbidity is between 1 and 5 NTUs, increases exceeding 1 NTU; c) where natural turbidity is between 5 and 50 NTUs, increase exceeding 20 percent; d) where natural turbidity is between 50 and 100 NTUs, increases exceeding 10 NTUs; e) where natural turbidity is greater than 100 NTUs, increase exceeding 10 percent. Activities shall not cause settleable material to exceed 0.1 ml/L in surface waters as measured in surface waters downstream from the Proposed Action Area. Activities shall not cause pH to be depressed below 6.5 nor raised above 8.5 as measured in surface waters downstream from the Proposed Action Area. The Proposed Action shall not discharge petroleum products into surface water. The Central Valley Water Board shall be notified immediately of any spill of petroleum products. During gravel processing, gravel shall be cleaned prior to placement within the riverbed in a manner that removes any fine-grained sediment (< 6mm size fraction) (fines) that could potentially contain concentrations of mercury. Daily fines samples shall be collected from processed material and analyzed for total mercury. Borrow areas shall be re-graded to ensure the areas do not become potential mercury methylation spots. Fines separated from gravel shall not re-enter the Merced River. New shallow water areas shall have continuous flow and shall not become stagnant. Floodplains shall be re-vegetated to minimize transport of any mercury-containing sediment.					

Sediment fencing shall be used along the river corridor to capture floating materials or sediments mobilized during construction activities, and prevent water quality impacts. Stream bank impacts shall be isolated and minimized to reduce bank sloughing. Banks shall be stabilized with revegetation following Proposed Action activities, as appropriate. A SWPPP shall be developed as part of the BMPs. All pertinent staff shall be trained on and familiarized with these plans. Copies of the plans and appropriate spill prevention equipment referenced in them shall be made available onsite and staff shall be trained in its use. Spill prevention kits shall be in close proximity to construction areas, and workers trained in their proper use.					
EC-8: Use Clean Equipment and Biodegradable Lubricants All equipment shall be clean and use biodegradable lubricants and hydraulic fluids. All equipment working within the stream channel shall be inspected daily for fuel, lubrication, and coolant leaks; and, for leak potentials (e.g. cracked hoses, loose filling caps, stripped drain plugs). Vehicles shall be fueled and lubricated in a designated staging area located outside the stream channel and banks. Clean gravels shall be added to the river using the front-end loaders. Front-end loaders shall be wheeled (rubber tire) to minimize impacts. Construction specifications shall require that any equipment used in or near the river is properly cleaned to prevent any hazardous materials from entering the river, and containment material shall be available onsite in case of an accident. Spill prevention kits shall be located close to construction areas, with workers trained in its use. Contracted construction managers shall regularly monitor construction personnel to ensure environmental	Ongoing during restoration activities	Project Applicant/ Contractor	Implement specified mitigation measures	Project Applicant/ Contractor	

compliance.					
EC-9: Prevent Spread of New Zealand Mudsnails and other Aquatic Invasive Species New Zealand mudsnails (*Potamopyrgus antipodarum*), an introduced species, has been identified in numerous rivers of the Central Valley, including in the Merced River. To minimize the chance that the snails may be transported and spread to other water bodies on equipment, construction specifications shall require that equipment be steam cleaned immediately after the work is completed and before being used in other water bodies. An Invasive Species Risk Assessment and Planning (ISRAP) protocol shall be developed, and all appropriate staff shall be trained as to its purpose and implementation before construction begins. The ISRAP shall be used to prevent the spread of invasive species during Proposed Action construction.	Prior to initiation of restoration activities	Project Applicant/ Contractor	Implement specified mitigation measures	Project Applicant/ Contractor	
Noise					
EC-10: Reduce Impacts from Noise To mitigate noise related impacts, the Proposed Action shall require all contractors to comply with the following operational parameters: • restrict construction activities to time periods between 7:00 am and 5:00 pm when there is the least potential for disturbance; • locate the sorting station away from edge of property and adjacent homes; and • install and maintain sound-reducing equipment and muffled exhaust on all construction equipment.	Ongoing during restoration activities	Project Applicant/ Contractor	Implement specified mitigation measures	Project Applicant/ Contractor	

Cultural resources					
EC-11: Inadvertent Discoveries of Objects of Cultural Significance If any objects of cultural significance are unearthed during the construction process, work shall be halted immediately until a qualified archeologist can assess the significance of the new find. If human remains are unearthed during the construction process, the Proposed Action team shall comply with the California Health and Safety Code Section 7050.5, which states that no further disturbance shall occur until the County Coroner has investigated the situation following the Public Resource Code Section 5097.98.	Ongoing during restoration activities	Project Applicant/ Contractor	Implement specified mitigation measures	Project Applicant/ Contractor	
Recreation					
EC-12. Signs and construction monitor to warn public of construction activity. Signs shall be placed at Merced ID's newly constructed access site, a non-motorized boating put-in located within the Project boundary informing the public about the Project and warning them that potentially dangerous heavy equipment is being operated. A highly visible warning sign shall be placed on the bank approximately 100 feet upstream of instream construction activity, informing any individuals floating down the river about the construction activity and directing them to a safe path to avoid construction activity. In addition, during all instream construction activity, a construction monitor with a radio shall be positioned upstream of the instream construction activity and next to the channel to communicate with the public and with heavy equipment operators to ensure safe passage through the construction area.	Ongoing during restoration activities	Project Applicant/ Contractor	Implement specified mitigation measures	Project Applicant/ Contractor	

Appendix D. MID Merced River Restoration Monitoring Plan

CRAMER FISH SCIENCES
An Employee Owned Consulting Company

MERCED IRRIGATION DISTRICT'S MERCED RIVER INSTREAM AND OFF-CHANNEL REHABILITATION PROJECT

Monitoring Plan

Prepared for:

Merced Irrigation District

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Joseph Merz, PhD

February 2018

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INTRODUCTION

The Merced River Restoration Project No. 4 - Gauge 52 (Project), funded by the USBR and MID, and is designed to provide benefits targeting native salmonids and the ecosystems they inhabit and use, focusing on drought impacts and resiliency to those impacts. The Merced Drought Project was designed using Chinook Salmon (*Oncorhynchus tschawytscha*) as the focal species to provide a sustainable environment for native anadromous fish (salmonids) that are most vulnerable to periods of deficient water supplies.

The Project will improve habitat, including restoring habitat function for key species and lifestages during drought conditions. Benefits to environmental conditions will:

1. Increase available adult and juvenile salmonid habitat
2. Re-establish floodplain and main channel connectivity, especially under low-flow conditions
3. Reduce mined channel features that may attract non-native predators
4. Improve water temperatures
5. Increase natural recruitment of native riparian vegetation.

This Project was designed by a team of restoration ecologists, fisheries biologists, geomorphologists and engineers to address goals of the:

- California Department of Fish and Wildlife Fisheries Restoration Grant Program (Grant No. D1440405) to restore anadromous salmonid habitat impacted by 2014 drought and enhance habitats that showed resiliency.
- NOAA Central Valley Salmon and Steelhead Recovery Plan to implement floodplain and side channel projects that improve river function and increase habitat diversity in the Merced River; and Merced Irrigation District to efficiently increase flow function, decrease salmonid predation by invasive piscivores and restore critical salmonid spawning and rearing habitat previously damaged by historic mechanical dredge mining.

The Project will rehabilitate an estimated 1.7 acres of salmonid spawning habitat, 3.9 acres of seasonally inundated juvenile rearing habitat and over 7 acres of riparian and upland habitat. The studies proposed below will directly measure project effectiveness in terms of habitat quality, adult spawning, juvenile salmon floodplain habitat use, and native and non-native fish communities. This research will provide essential information that will allow MID and state and federal resource agencies to better understand how habitat rehabilitation, coupled with managed flow timing, magnitude, and duration influence habitat quality, predator abundance, and subsequent juvenile salmonid habitat use, growth, and migration. Ultimately, this will inform flow management decisions and directly enhance and inform future restoration efforts in the Merced and other Central Valley rivers facing greater temperature and precipitation fluctuations, including periods of drought.

PHYSICAL CHARACTERISTICS OF PROJECT REACH

To provide context for monitoring activities, physical characteristics of the Project reach are presented. Three hydrogeomorphic zones (HGZ's) of the Project reach were delineated based on local bed slope and base flow depth, velocity and channel width (Figure 1, Table 1). These are important variables that can discriminate channel morphology and usage by aquatic organisms (Rosenfeld et al. 2000, Jowett and Davey 2007, Beakes et al. 2014, Kasprak et al. 2016, Brown and Pasternack 2014& 2017).

A flow of 155 cfs was used to serve as a proxy for base flow; this is a probable flow for the spawning period under drought conditions based on analysis of lower Merced River flow data from 1968-2014 (ESA and CFS, 2018). The bankfull discharge for the study area is approximately 2,000 cfs.

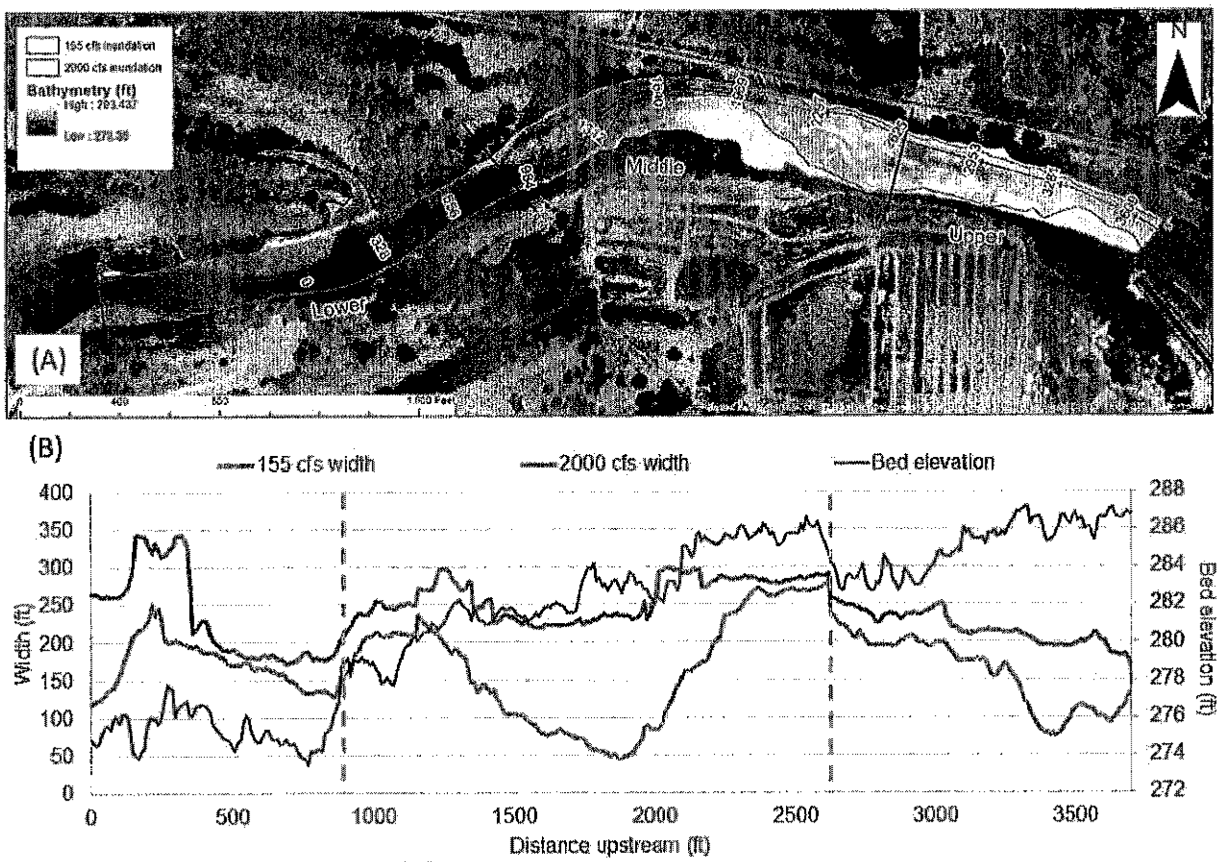

Figure 1. Hydrogeomorphic zones (HGZ) for the Project area showing (A) inundation extent at 155 cfs and bathymetry below 2000 cfs inundation. Longitudinal profile (B) of bed elevation and channel width at 155 and 2000 cfs.

The lower HGZ is characterized as the widest and deepest zone, with relatively low velocity and Froude number. This is due to 1) the lack of gradient and 2) the over-widened channel. The Middle HGZ is characterized by relatively higher velocities and shallower depths. This is due to 1) the curvature of the channel, 2) bedrock in the main channel, and 3) the higher channel gradient. The upper HGZ is has intermediate conditions between the other zones, with moderate velocity and depth. It is similar to the lower zone in terms of gradient but is ~15 feet narrower on average.

Table 1. Physical attributes of each hydrogeomorphic zone. Depth, velocity, Froude number, and width values are averages for each zone and were derived from a 2D numerical flow model at 155 cfs.

HGZ	Length	Gradient	Depth (ft)	Velocity (ft/s)	Froude number	Width (ft)
Lower	870.00	0.003103	4.86	0.17	0.01	171
Middle	1755.00	0.005698	1.36	0.97	0.15	164
Upper	1085.00	0.002765	2.01	0.54	0.07	156

The plots in Figure 2 display velocity versus depth for existing and design conditions at baseflow and bankfull discharge for each HGZ, placing each zone in an ecohydraulic context with hydraulic preferences of adult and juvenile salmon, as well as predatory striped bass (*Morone saxatilis*) and Black Bass (*Micropterus* spp.). These were derived from two-dimensional numerical modeling associated with the design phase (ESA and CFS, 2018) and show how the physical conditions lead to hydraulic conditions that can influence fish habitat and community structure.

For existing conditions the lower HGZ is characterized by low velocities and a wide range of depths at 155 cfs. At 2000 cfs, velocity remains relatively low and depths increase. The middle HGZ is characterized by mostly shallow and high velocity conditions at base flow, and at 2000 cfs channel conditions become deeper and faster, while maintaining the same proportional relationship as at base flow. The upper HGZ is characterized by moderate depths and velocities at base flow, with greater depths and areas of both low and high velocities at 2000 cfs.

Compared to existing conditions, the velocity-depth relationship for design conditions changes drastically for the lower section. Note that much of the hydraulic domain is now outside of the preferred range for predatory bass, as well as the greater density within the adult and juvenile salmon preferred domains. This is not a surprising result considering that design actions in the lower section consist of gravel augmentation and side channel creation. For the middle HGZ there was little work in the channel, so the velocity-depth patterns at 155 cfs do not change appreciably. However, there is a reduction in depths greater than 5 ft, presumably from the side channel features allowing more flow over the floodplain than in the main channel. Visually, the upper HGZ does not change a lot for either flow. Given that channel fill was restricted in this area due to flood level constraints, and there were no floodplain or side channels created, this is expected.

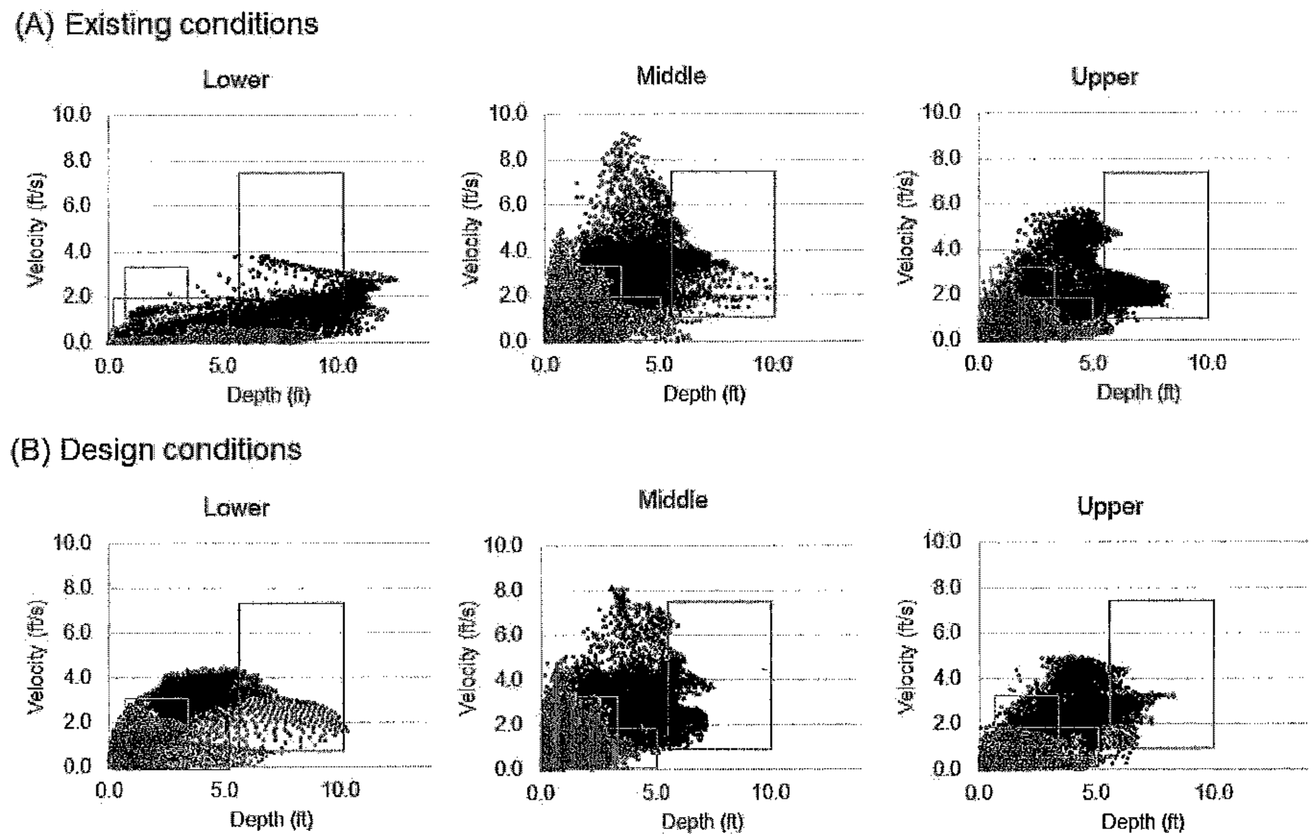

Figure 2. Velocity versus depth plots for the three hydrogeomorphic zones for (A) existing conditions and (b) design conditions. Each point represents a node in the two-dimensional hydraulic model, where grey represents 155 cfs and black represents 2000 cfs. The blue and green boxes indicate approximate hydraulic habitat preference ranges for adult and juvenile salmon, while the red box represents preferences for bass.

ANTICIPATED RESPONSE

During design development, an ecohydraulic modeling approach (sensu Wheaton et al. 2004) was used to determine benefits to juvenile and adult Chinook Salmon (ESA and CFS 2018). A hydrologic analysis for drought conditions identified ecologically relevant flows for the analysis. Drought ecohydology was based on a HEC-EFM analysis on flow to the Merced River below Crocker-Huffman Dam for water years 1968 to 2014. For the spawning period, encompassing 1 October through 31 December, the lowest mean streamflow observed, 155 cfs, was taken as the design flow. To develop design ecohydrology for juvenile rearing, we considered a seasonal 14-day duration of inundation window between 1 February and 15 May, because that is when most juvenile salmon would be present in the Merced River to take advantage of the floodplain inundation (Montgomery et al. 2009, CFS unpublished data). A 14-day minimum pulse that occurs at least every 3 years (average life-expectancy of Central Valley Chinook Salmon) during the Chinook Salmon rearing period is 447 cfs. The 10% recurrence was estimated at 944 cfs and used as an upper limit.

Habitat suitability modeling predicted that, at 155 cfs, there will be a 29% increase in adult spawning habitat. For juvenile rearing habitat, modeling predicted 22 and 32% increases following restoration for 450 and 940 cfs, respectively. In addition to increased juvenile and adult salmon habitat, the design is predicted to eliminate 94.9% of predatory bass habitat.

It is hypothesized that increasing the quantity and quality of Chinook Salmon spawning and rearing habitat and reducing the value of potential habitats for invasive predator species, especially during drought periods, will confer benefits to the health and production of Merced River Chinook Salmon (Shrivell 1990; Rahel and Oden 2008).

MONITORING APPROACH

The Monitoring Plan consists of four monitoring phases to evaluate the success of this Project: pre-project assessment, implementation, effectiveness, and validation. Pre-project monitoring provides baseline conditions used to inform project design, and demonstrates the impaired condition of the project site. Pre-project assessment will be used to evaluate conditions before construction implementation, and will be compared with post-project monitoring data to measure project success, including environmental response and restoration value. Implementation monitoring will help determine if the project was installed per the design standards. Effectiveness monitoring will support determination of project effectiveness in recovering habitat conditions suitable for target species. The final monitoring phase supports determination of whether the project recovers productive habitat for salmonids and riparian vegetation under drought conditions. A range of physical and biological traits will be tracked before and after restoration to assess ecosystem function, and these are described below.

A Before-After-Control-Impact (BACI) study design structure will be used to test the differences between the unrestored and restored sites before and after project implementation (Green 1979, O'Donnell and Galat 2008). This approach is ideal for evaluating the effectiveness of this restoration project because it utilizes a paired series of Control-Impact sites (in this case, "impact" is the restoration treatment), subjected to a series of Before-After replicated measurements, allowing for discrimination between response to restoration and stochastic environmental variability (Bernstein and Zalinski 1983, Stewart-Oaten et al. 1986, Smith 2002).

Sample sites

Sampling sites will be stratified and randomized in the BACI context, and replicate samples will then be collected. Sampling sites will be upstream, within, and downstream of the three restoration project reaches. Figure 3 depicts the general project area, with example locations of sampling sites.

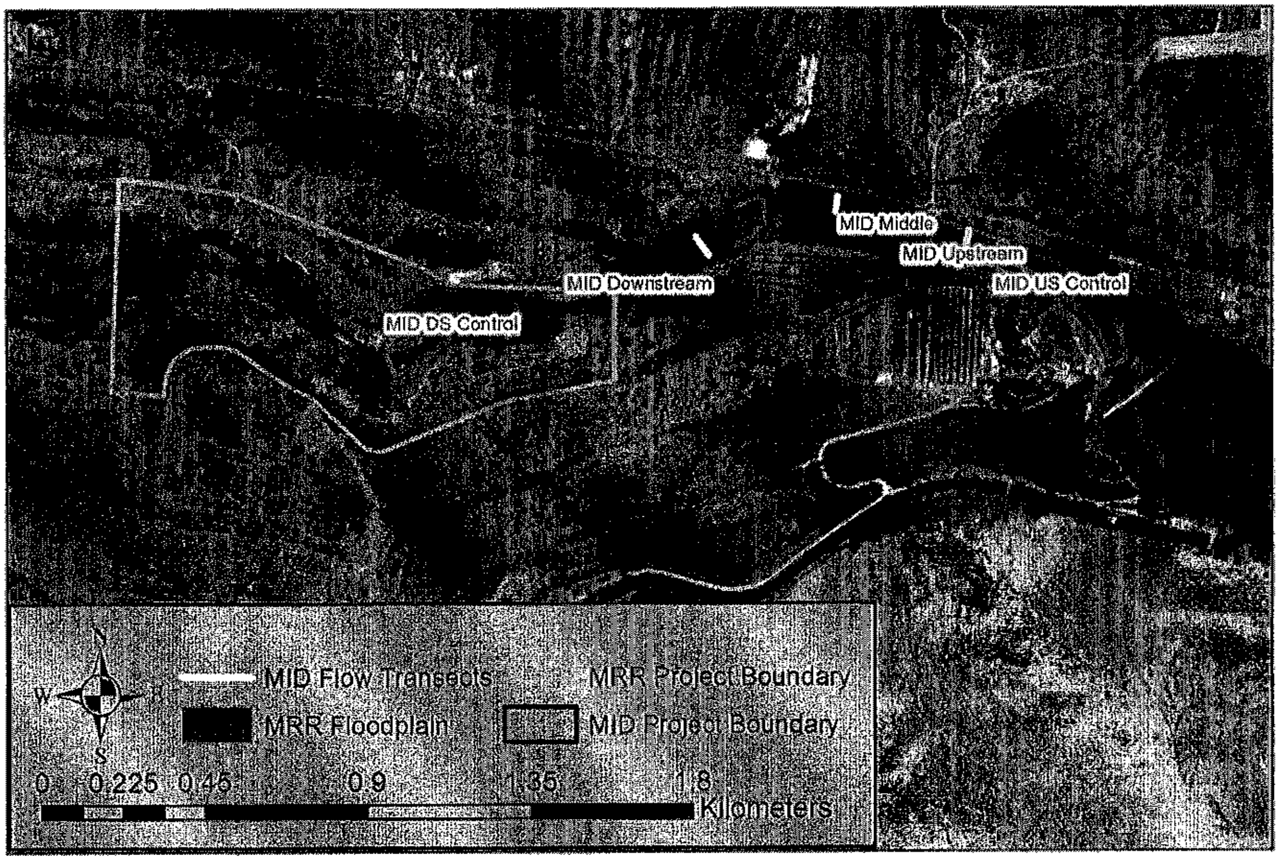

Figure 3. Map of sample locations within the Project Reach and control sites. In addition to unrestored control locations, Merced River Ranch (MRR), a restored reach immediately downstream from the project, will provide a restored control location to compare floodplain and spawning habitat function.

Pre-project monitoring

Pre-project monitoring establishes a baseline from which to measure change following a restoration action. It is a critical component of the other monitoring phases because questions posed by effectiveness and validation monitoring can only be answered if the pre-project condition of the site is documented. Pre-project monitoring is also a component of regulatory compliance because pre-project wildlife and habitat surveys help resource agencies determine whether the project is likely to negatively impact special status plants and animals and what mitigation measures need to be implemented to prevent these impacts. Monitoring efforts to address permitting requirements include special-status plant surveys, fish and wildlife surveys, standardized photo points to document change over time, and water quality measurements during site construction.

Implementation monitoring

Implementation monitoring will determine if the restoration project was built accurately to the design plan, and met the goals of the project design. Generally, this monitoring occurs after construction completion; however, some aspects will be carried out during implementation as a check on design appropriateness (Kershner 1997). Mid-course corrections to implementation can be made as appropriate. In addition to tracking the success of the implementation in terms of physical structure, we will also investigate the hydrological function of the restored side channel and floodplain. The frequency and duration of flooding are among the primary drivers of habitat productivity in terms of accessibility for fish, prey resource production, and habitat maintaining processes leading to increased survival (Hill et al. 1991, Tockner et al. 2000, Zeug et al. 2014). Detailed topographic and bathymetric surveys were conducted during the design process. To determine whether the project was implemented as planned, we will compare bathymetry and topography at the Project site after implementation with the design plans. Below, we describe methods used to collect these data.

Bathymetry and Topography

In-channel and floodplain topographical data support several aspects of habitat restoration, including habitat evaluation, project design and implementation (determining whether a project was *implemented* according to design) as well as long-term monitoring of habitat function and evolution (Wheaton et al. 2004). Furthermore, the data can be used in two-dimensional habitat models to determine whether water depth and velocity are within the range preferred by rearing juvenile salmonids. Bathymetry and topography can help determine relative channel stability and thus are a way of evaluating physical habitat change within a restoration site (Merz et al. 2006).

Topographic and bathymetric surveys are conducted using a total station, real time kinematic global positioning system (RTK GPS) survey unit and a depth sounder to record coordinates (i.e., latitude, longitude, elevation). Point spacing was based on grade-breaks and channel topography instead of a uniform grid (Brasington et al. 2000).

Effectiveness monitoring

Effectiveness monitoring will track physical conditions and biological responses to determine whether the Project effectively enhanced salmonid spawning and rearing habitat. Effectiveness monitoring is complex and requires evaluating the outcomes of multiple objectives relating physical, biological, and biogeochemical factors at work in the river ecosystem (Kondolf and Micheli 1995; Roni et al. 2002, 2008; Wohl et al. 2005). Pre-project monitoring (described above) is an essential part of effectiveness monitoring because it provides a baseline from which to compare post-project conditions. Table 2 outlines questions related to effectiveness monitoring and relevant parameters and monitoring methods.

The hypotheses listed in Table 2 directly address the target objectives for the project. The following methods are for periodic and continuous tracking of those parameters outlined. Below, we describe in greater detail the specific methods used to measure each parameter that will be used to address the effectiveness monitoring questions.

Water level loggers

Water level loggers will be deployed in several locations within the main river channel and the floodplain to measure water depth continuously over time. They will be downloaded regularly and replaced as needed.

Depth and velocity

Specific sites will be selected to perform flow transect measurements to determine localized river discharge. A rope or cable will be secured to the opposing banks perpendicular to the flow approximately 1 – 2 ft (0.3 – 0.6 m) above the water surface. A measuring tape will be attached to the rope or cable using large binder clips at regular intervals. Water velocity and depth are measured, using a flowmeter and a top-setting wading rod, at regularly spaced stations across the entire channel.

Table 2. Effectiveness monitoring hypotheses and parameters.

Hypothesis	Parameter/monitoring method
Side channel and floodplain habitat is inundated for a sufficient duration for juvenile salmonids to utilize it under a range of winter and spring flow conditions, including drought conditions.	Water level loggers, seining
Suitable Chinook Salmon spawning and rearing habitat quantity and quality is enhanced following restoration compared to baseline conditions.	Depth, velocity Water quality (temperature, dissolved oxygen) Photo points
Restoration negatively affects non-native fish species density	Seine surveys, video surveys
Chinook salmon spawning activity will increase following gravel augmentation in the main channel.	Spawning surveys

Discharge (Q) is then calculated using the following formula:

$$Q = \sum (\mathbf{V*D*W \text{ at each station}})$$

where, V= average velocity, D=depth, W=width of station

Flow transect data will be collected under multiple flow conditions before and after implementation to determine whether depth and velocity conditions following restoration are within the preferred range for juvenile salmonid rearing. Depth and velocity data can also be used to validate the results of two dimensional hydraulic modeling of the site.

Water quality

Continuously recording temperature loggers will be deployed in several locations throughout the project site and grab samples of dissolved oxygen will be collected regularly in the main channel and floodplain during fish surveys. These data will be used to determine whether the project was effective at achieving water quality conditions that support adult and juvenile Chinook Salmon.

Photo points

Standardized photo points will be established and periodic aerial drone imagery will be collected throughout the project duration. This imagery will provide a qualitative measure of habitat structural changes, and are required for regulatory compliance. For the photo points, all photographs will be taken at the same height and in the four cardinal directions (i.e., North, South, East and West) at each sampling site with the photo point location recorded using a handheld GPS (Trimble Geo XT 6000 series). Photos will be labeled and stored as part of the ArcGIS spatial database developed during monitoring activities. Qualitative conditions can then be compared using the photo series and change due to restoration activities can be documented. Aerial photographs will also be used to document ecosystem change over time on a larger spatial scale when images are available.

Seining surveys

Seining surveys will be conducted before and after restoration, within the Project footprint in the upper, middle, and lower reaches, and at restored and unrestored control sites (Figure 3), to measure changes in native and non-native fish community composition and restored floodplain habitat utilization by juvenile salmonids. Measuring fish communities directly tests whether the Project met its goals of increasing juvenile salmonid density and reducing invasive predator density, and whether observed densities match modeled predictions of increased habitat capacity.

Seining will be conducted using a 50-foot, ¼" mesh beach seine. Initially, sites will be established at the upper, middle, and lower ends of the project site and at upstream and downstream control sites (Figure 1); however, locations may change depending on accessibility and flow. For fish community surveys, a single seine haul will be performed at each site by hauling the seine in an upstream direction to reduce disturbance of fish, following the general methods of Merz et al. (2016). The seine will be pulled near shore and all fish will be placed into a bucket of clean, cool river water and processed immediately. Fish species and forklength will be collected for all species and weight will be recorded for all juvenile salmon.

Video surveys

Video monitoring surveys will be conducted in upper, middle, and downstream areas (Figure 3) where seining is not possible to assess the presence and relative density of non-native predatory fish in the main channel before and after project implementation. Underwater video cameras (GoPro®) will be affixed to an underwater frame attached to a kayak or small boat, and multiple transects will be recorded throughout the main river channel. A Trimble GeoXT will be used to record the path of the transects. Start time and end time will be recorded for the Trimble GPS unit and for both video cameras. The GPS date/time stamp from the Trimble unit will be linked to the video date/time, allowing a latitude and longitude to be assigned to fish observations.

Spawning surveys

Spawning surveys will be conducted from October-January throughout the project area and control sites to document adult salmon use of the augmented area in the main channel before and after restoration. Surveys will be performed by two crew members, moving in parallel in an upstream direction following the general methods of Zeug et al. 2014. When a redd is observed, the spatial coordinates will be marked using a handheld GPS devices (Trimble GeoXT 2012 6000 Series) and surveyors will record the physical condition of redds, ambient depth and velocity, redd morphology, and the presence or absence of salmon.

Validation monitoring

Juvenile salmonid monitoring

A key goal of this project is the enhancement of juvenile salmonid rearing habitat quantity and quality, subsequent increase in their use of the habitat, and reduced habitat for and abundance of potential fish predators of juvenile salmonids, ultimately culminating in improved health and survival of these fish. Validation monitoring will focus on testing key assumptions about growth and predation and as a consequence this type of monitoring has a research focus (Kershner 1997). To determine whether enhancing off-channel habitat benefited juvenile salmonids, we will specifically test the hypotheses listed in Table 3.

Table 3. Juvenile Salmonid Validation monitoring hypotheses and parameters.

Hypothesis	Parameter/monitoring method
Juvenile Chinook Salmon will have higher site fidelity and longer residence times in restored relative to unrestored reaches of the Merced River.	Recapture of PIT tagged salmon
Floodplain habitats in restored reaches will support higher fish densities compared to unrestored reaches.	Seining surveys
Juveniles that rear in restored habitats have enhanced growth compared to those that rear in unrestored habitats.	Fork length and otolith growth increment measurements from recaptured fish
There will be a higher density and biomass of prey items in the stomach contents of juvenile salmonids in restored vs. unrestored habitats.	Juvenile Chinook Salmon stomach contents analysis

The field experiment described below will be conducted to *validate* the underlying assumptions that enhancing off-channel habitat will result in increased habitat capacity; longer residence times for rearing juvenile salmonids; and improved feeding, growth and health condition. This experiment was designed to directly measure a specific functional ecosystem response to restoration, supporting and informing future restoration efforts.

Juvenile rearing experiment

We will conduct a large-scale mark and recapture experiment that spans the Project site as well as upstream and downstream unrestored control reaches. Specifically, we will inject 8-mm FDX and 12-mm HDX PIT tags into juvenile Chinook Salmon and track their growth and movement throughout the rearing period. Juvenile salmonids will be tagged and re-captured throughout the rearing season during bi-weekly seining efforts (for description of seining methods, see Effectiveness Monitoring section above) within all three restoration reaches and control reaches. We will tag a maximum of 1,000 fish (500 of each tag size) total during seining surveys. Individual length and weight data will be collected from tagged fish prior to release. During seining, previously tagged fish will be identified using a handheld PIT tag reader, and fork length and weight (g) will be measured and recorded, allowing us to estimate growth upon recapture. In general, tagged fish will be released after recovery in the same location in which they were captured. By recapturing marked fish through space and time we will be able to identify what habitat(s) individual fish are occupying in addition to when and how far they moved from the original release location. From a subset of salmon collected late in the season, we will estimate growth rates (daily growth increments) from otoliths, following the methods of Secor et al. (1992). We will also evaluate stomach contents of these fish in the lab.

MANAGEMENT IMPLICATIONS

The information collected through this monitoring effort will help inform flow management decisions. Similar rearing studies to those described in the "Validation Monitoring" section above were conducted during extreme high flow conditions in spring 2017 at two other Merced River restoration projects (CFS, unpublished data). From that study, we learned that restored floodplain habitats can provide productive rearing conditions, healthy growth rates, and support relatively high juvenile salmonid densities, even under flows that are higher than those targeted for the restoration design. This study will augment these results by improving understanding of juvenile salmonid habitat use, outmigration timing, and growth under a range of flow conditions. Ultimately, this information will also help inform spring flow decisions (magnitude, duration, timing of pulses) to better optimize benefits to juvenile salmonids while balancing other water resource needs.

The results of this monitoring effort will also inform future restoration efforts by facilitating a direct evaluation of the impact of a restoration action (i.e., floodplain rearing habitat enhancement) on floodplain utilization, growth benefits, and specific mechanisms that drive these benefits. Floodplain rearing habitat rehabilitation efforts are expensive to implement and, although rearing habitat is generally thought to improve juvenile production, there is little information available about how juvenile salmonids utilize these habitats and what specific features (prey production, cover features) drive productivity and carrying capacity. Developing a better understanding of the links between habitat quality and productivity at multiple life stages will improve the success of recovery efforts (Kershner 1997). This information will be used to direct the design future habitat rehabilitation projects and can be incorporated into existing models to predict rearing capacity of off-channel habitat.

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