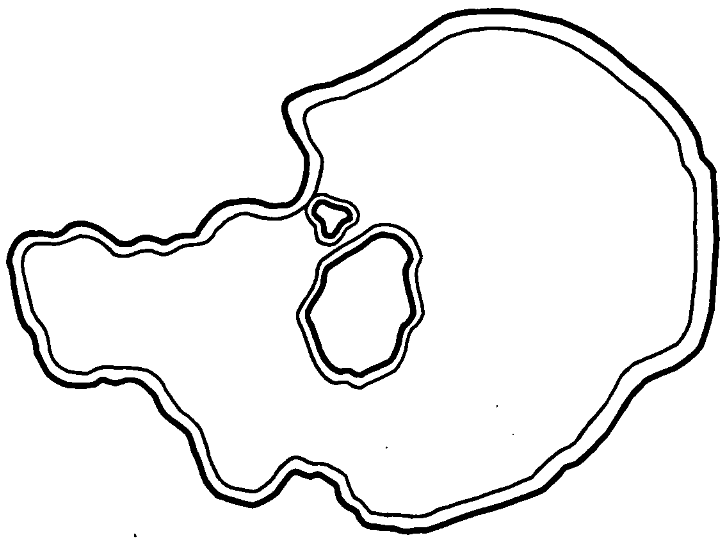
An Auxiliary Report
Prepared for the

# MONO BASIN WATER RIGHTS EIR

## Extent of Riparian Vegetation on Streams Tributary to Mono Lake, 1930-1940



Prepared under the Direction of:

California State Water
Resources Control Board
Division of Water Rights
P.O. Box 2000
Sacramento, CA 95810

Prepared With Funding from:

Los Angeles Department of
Water and Power
Aqueduct Division
P.O. Box 111
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Mono Basin EIR Auxiliary Report No. 1

**An Auxiliary Report**
**Prepared for the**
**Mono Basin Water Rights EIR Project**

This auxiliary report was prepared to support the environmental impact report (EIR) on the amendment of appropriative water rights for water diversions by the City of Los Angeles Department of Water and Power (LADWP) in the Mono Lake Basin. Jones & Stokes Associates is preparing the EIR under the technical direction of the California State Water Resources Control Board (SWRCB). EIR preparation is funded by LADWP.

SWRCB is considering revisions to LADWP's appropriative water rights on four streams tributary to Mono Lake, Lee Vining Creek, Rush Creek, Parker Creek, and Walker Creek. LADWP has diverted water from these creeks since 1941 for power generation and municipal water supply. Since the diversions began, the water level in Mono Lake has fallen by 40 feet.

The Mono Basin water rights EIR examines the environmental effects of maintaining Mono Lake at various elevations and the effects of possible reduced diversions of water from Mono Basin to Owens Valley and the City of Los Angeles. Flows in the four tributary creeks to Mono Lake and water levels in Mono Lake are interrelated. SWRCB's decision on amendments to LADWP's water rights will consider both minimum streamflows to maintain fish populations in good condition and minimum lake levels to protect public trust values.

This report is one of a series of auxiliary reports for the EIR prepared by subcontractors to Jones & Stokes Associates, the EIR consultant, and contractors to LADWP. Information and data presented in these auxiliary reports are used by Jones & Stokes Associates and SWRCB, the EIR lead agency, in describing environmental conditions and conducting the impact analyses for the EIR. Information from these reports used in the EIR is subject to interpretation and integration with other information by Jones & Stokes Associates and SWRCB in preparing the EIR.

The information and conclusions presented in this auxiliary report are solely the responsibility of the author.

Copies of this auxiliary report may be obtained at the cost of reproduction by writing to Jim Canaday, Environmental Specialist, State Water Resources Control Board, Division of Water Rights, P.O. Box 2000, Sacramento, CA 95810.

# Extent of Riparian Vegetation on Streams Tributary To Mono Lake, 1930-1940

## An Assessment Of The Streamside Woodlands And Wetlands, And The Environmental Conditions That Supported Them

A report to
The California State Water Resources Control Board
and
Jones and Stokes, Associates, Sacramento


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A copy of this report has been placed in the Water Resources Center Archives, U.C. Berkeley.

Cite thusly: Stine, Scott, 1991. Extent of riparian vegetation on streams tributary to Mono Lake, 1930-1940: An assessment of the streamside woodlands and wetlands, and the environmental conditions that supported them. Report to the California State Water Resources Control Board, and Jones and Stokes, Associates, Sacramento, 73 pp. plus appendices.

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## Introduction

The purpose of this report is three-fold: 1) to document the composition and extent of the riparian vegetation that existed along portions of Rush, Lee Vining, Parker, and Walker creeks during the decade prior to 1940--the year in which the Los Angeles Department of Water and Power (the DWP) began to export water from the Mono Basin; 2) to describe the climo-hydrologic, geomorphic, and irrigation-related conditions that gave rise to, and supported, that vegetation; and 3) to document the change in both the vegetation and the supporting conditions that occurred due to water operations by the DWP. The report is intended to provide a basis for comparing the nature and distribution of the stream-side vegetation that existed in pre-diversion times with that existing today, and for assessing the feasibility of reestablishing some or all of that vegetation. The main focus is on the riparian vegetation along the stream reaches that have been impacted by DWP's diversions. In some instances this impact has been direct--for instance, the dewatering of the channels (with resultant loss of the riparian stand) on Rush, Parker, Walker, and Lee Vining creeks; and the flooding of tracts of woodland due to the enlargement of Grant Reservoir on Rush Creek. In other cases the impact has been indirect. The diversion-induced lowering of Mono Lake, for instance, has resulted in the lengthening of all of the lake's tributary streams, and the colonization by riparian vegetation of some of these newly created stream reaches.

The period 1930-1940 was selected to represent "pre-diversion" conditions for the following reasons:

--Aerial photographs are available from January, 1930 (the earliest aerials of the Mono Basin), and late June, 1940 (just ~4 months before the DWP began to hold back water from Mono Lake). These photographs permit an accurate assessment of extant conditions.

--Ground photographs and large-scale maps were produced in 1933 as part of the "City of Los Angeles vs. Nina B. Aitken" lawsuit (hereafter called the "Aitken Case"). Several of these maps depict generalized vegetation boundaries, and include detailed topographic contouring that makes it possible to assess the extent to which the streams were incised prior to DWP diversions.

--Long-time residents of the Mono Basin with reliable memories dating to the period 1930-1940 are still living, and are available to illuminate the then-extant conditions.

--Throughout the period, Mono Lake occupied a relatively narrow elevation band (between 6415 and 6421 feet). Under these conditions there was little if any base-level-induced incision or aggradation by the streams.

--The period 1930-1940 includes years of high, low, and normal precipitation, thus providing the basis for assessing a wide range of irrigation and runoff conditions.

The report is divided into the following sections:

1. Sources of Information
2. The Mono Basin Hydroscape Prior To 1930
3. Riparian Vegetation and Supporting Conditions on Rush Creek, 1930-1940
4. Riparian Vegetation and Supporting Conditions on Lee Vining Creek, 1930-1940
5. Riparian Vegetation and Supporting Conditions on Walker and Parker Creeks, 1930-1940
6. Changes in the Riparian Vegetation on Mill, Wilson, and Post Office Creeks, 1930-1940
7. Conclusions
8. Appendix 1
9. Appendix 2

## 1. Sources of Information

A wide variety of different information sources were used in preparing this report. These include the following:

### 1. Aerial photographs

**a**. January, 1930, Fairchild Air Surveys. For several reasons--large scale, low sun angle, and a dearth of leaves on deciduous vegetation--these photographs provide a particularly clear view of riparian and hydrological conditions. They were used as the primary source for mapping vegetation boundaries and former stream courses.

**b**. June 24, 1940, United States Forest Service. These photographs were used to check vegetation maps produced from the 1930 aerials.

**c**. June 24, 1940, United States Forest Service (as above), with annotations by USFS range surveyors on vegetation type and distribution. Reproductions of these photographs were included in Taylor's 1982 report on riparian vegetation. (According to D. Taylor, these photographs no longer exist in the Bishop office of the United States Forest Service, a fact confirmed by Mr. Dick Warren of that office. Mr. Warren also states that any range survey report that was written in conjuntion with the aerial photographic analysis has long been lost).

**d**. August 19, 1954, United States Forest Service. These photographs were used to document the loss of riparian vegetation along Lee Vining Creek.

**e**. August 23, 1963, United States Forest Service(?). Reproductions of these photos are included in Taylor's report on riparian vegetation. They were used here to document the loss of riparian vegetation along Lee Vining Creek.

**f**. September 6, 1968, United States Air Force. These photographs were used to document the loss of riparian vegetation on Lee Vining Creek.

g. May 13, 1972, source unknown. These photographs were used to document the loss of riparian vegetation on Lee Vining Creek.

h. June 15, 1972, source unknown. These false-color infrared photographs were used to document the loss of riparian vegetation on Rush Creek.

i. August 11, 1973, source unknown. These photographs were used to document the loss of riparian vegetation on Rush Creek.

j. October 1, 1982, United States Forest Service. Used as a basis for comparing riparian distribution in 1930 with that in 1982, and to document riparian conditions on Post Office, Mill, and Wilson creeks.

k. July 29, 1986, United States Forest Service. Used for comparing riparian distribution on Parker/Walker creeks in 1930 with that in 1986.

l. August 28, 1987, Los Angeles Department of Water and Power. Used to compare conditions on Rush and Lee Vining creeks in 1987 with that in pre-1941.

## 2. Maps

a. USGS 7.5 min. Lee Vining, California, Provisional Quadrangle (1986, from aerial photographs of August, 1982). Relevant portions of this map were enlarged to 142% original, then used as a base for mapping 1930 riparian and hydrographic conditions.

b. USGS 7.5 min. June Lake, California, Provisional Quadrangle (1986, from aerial photographs of August, 1982). Relevant portions of this map were enlarged to 142% original, then used as a base for mapping 1930 riparian and hydrographic conditions.

**c**. Los Angeles Department of Water and Power maps, produced for the Aitken Case in 1933. These are carefully drawn topographic maps with a contour interval ranging from 2 feet to 10 feet. They were used to define the position of springs and seeps, to document degree of stream incision that existed in pre-diversion times, to define position of irrigation diversions, and, broadly, to check vegetation boundaries. Includes the following Aitken Case exhibits:

*Defendents Exhibit*

F-3. Map showing irrigated areas in Mono Basin from Rush Creek waters made by H.V. Peterson (marked for identification).

*Plaintiff's Exhibits*

77. Map . . . irrigation ditches . . . Lee Vining Creek

78. Map showing Knapp-Waterson property and typical cross sections across Lee Vining Creek and Mattly-Farrington ditch.

**d**. USGS 30 min. Mt Lyell Quadrange (1898-99) showing "Land Classification and Density of Standing Timber". (Plate CXVII from the USGS 21st Annual Report, Part 5.) This map covers the southwestern portion of the Mono Basin. It provides a highly generalized view of vegetation types at the turn of the century, delimits cultivated land, and shows Grant Lake in natural (pre-dam) condition.

## 3. Ground photographs

**a**. Photographs from Elden Vestal, former District Biologist with the California Department of Fish and Game. This collection includes the following exhibits from the Cal Trout vs. State Water Resources Control Board hearing of May, 1990:

**No. 45**. "View generally downstream along lower Rush Creek...7/19/39". This photoghraph shows riparian vegetation associated with the "two channels" of Rush Creek that occur just below the dam. Jeffrey pines occur in the natural (west) channel, and cottonwoods and willows in the east channel.

**No. 46**. "Rush Creek test stream project area, looking northwest from gorge [narrows] ...4/10/47". Jeffrey pines are shown immediately below narrows; the downstream-most jeffrey-pine grove can be seen in the distance.

**No. 47**. This exhibit lacks a label in the Morrison-Foerster exhibit collection. Mr. Marland Chancellor's courtroom notes read thusly: Rush Creek 1 mile above upper bridge". He did not record a photograph date. This photograph illustrates the cottonwoods and willows along both banks of Rush Creek where it impinges against the western canyon wall.

**No. 48.** "Test stream, Mono Co. Calif. ...Anglers fishing the meadow section of Rush Creek... 5/2/48." This photo pictures the main stream and distributary in the meadows reach. Graminoid (grass-like) vegetation with occasional willows and cottonwoods are evident.

**No. 49**. "Rush Creek Test Stream... Section 1/2 mile above upper bridge... 5/2/48". Graminoid vegetation types with occasional willows and cottonwoods are evident. Graminoid vegetation covers the stream banks (including the gently sloping channel walls), providing channel stability. This photograph was used to check the degree of post-1948 stream incision.

**No. 50**. "Rush Creek Test Stream... Downstream weir and fish trap... 4/10/47. Flow est. 20 cfs." This photograph shows tall willows and graminoid vegetation.

**No. 51**. "Delta section of Rush Creek from below lower bridge looking toward Mono Lake... 2/21/47. Flow of 152 cfs...". Graminoid vegetation covers the stream banks (including the gently sloping channel walls), providing stability.

**No. 56**. This exhibit is a photocopy of 3 small photographs in the Morrison and Foerster exhibit collection. The lowermost of the three is relevant and is labeled thusly: "Rush Creek ... View upstream from old US 395 hwy bridge near Cain Ranch ... 7/19/39." It shows a few small jeffrey pines in the reach immediately above the old highway, as well as some willows and cottonwoods. Riparain vegetation in this reach is generally sparse and close to the stream.

**b.** Photographs from the Aitkin Case exhibits:

**No. 3b**. Confluence of Walker and Rush Creeks, looking south from above Walker. This early 1930s photograph shows cottonwoods at the mouth of Walker Creek; cottonwoods and jeffrey pines can be seen along Rush Creek. The deciduous trees are without leaves.

**No. 3c**. Rush Creek on Clover property. This photo from the early 1930s shows willows and cottonwoods (without leaves) on the banks of the stream.

**No. 3d**. Panoramic view northward toward the Rush Creek bottomlands, from the triangulation point at the narrows. This photograph from the early 1930s shows the springs, seeps, and marshlands that existed along the western side of the bottomlands immediately below the narrows; also pictured is the jeffrey-pine grove immediately below the narrows.

**No. 3e**. View obliquely downward from hill, looking toward the Rush Creek bottomlands. This photo from the early 1930s shows anastomosing channels, cress beds, ponded water, willows, and cottonwoods.

**No. 3f**. This photograph was taken from immediately below Photo 3e above.

**No. 3g**. Rush Creek near stream mouth. This photograph from the early 1930s shows sparce willows on graminoid meadows, with cress beds in the stream.

**No. 3h**. This photograph was taken from the same location as photo 3e, except at stream level.

c. Photographs from W.L.Huber (engineer, So. Sierra Power) 1931-32

Huber file #205 (in Water Resource Archives) consists of photographs. Photos 11191 and 92, dated 9/17/32, show Rush Creek at the weir below old Highway 395. There is little flow in the stream--"water all in ditches". Riparian vegetation is conspicuously absent. Photograph 10959, dated 7/4/31, shows the weir near the mouth of Lee Vining Creek. This photo shows dense riparian vegetation.

## 4. Conversations with long-time residents of the Mono Basin:

a. Mr. Don Banta (619) 647-6627.

11/6/90. Phoned Mr. Banta, who says that there was no lumbering on lower Lee Vining Creek in his time. He knew of Leroy Vining's milling exploits, which he believes were centered just a few hundred yards upstream from the county road crossing. He knows of no logging activities that took place on Rush Creek.

11/16/90. I spent time with Mr. Banta in the field. He mentioned that in the 1930s and '40s the Horse Creek Embayment, near the Dondero ranch house, used to be characterized by a copious spring. It is now gone.

**b.** Mr. Wallace McPherson (619) 932-7730.

11/5/90. Mr. McPherson says that Mill Creek is named for a quartz mill rather than a sawmill. During his time in the basin, the only sawmill on Lee Vining Creek was located near the confluence of Lee Vining and Gibbs creeks. There was also a mill in "Sawmill Canyon" (between the Mono Basin-age moraines), and one northeast of Wilson Butte. He remembers no mills on Rush Creek below Grant Reservoir. He remembers aspen on Lee Vining Creek, and few on Rush Creek. Regarding jeffrey pines, he says that there were scattered individuals on Lee Vining Creek, but very few below Highway 395 on Rush Creek.

3/9/91. Mr. McPherson says that aspens ocurred along both the upper and lower portions of the right flank of Lee Vining Creek, but not in the middle reaches.

**c.** Mr. Wayne McAfee (206) 457-1639

11/6/90. Mr. McAfee says that from 1925 (his earliest recollection) to ~1940, flow from Walker and Parker creeks reached Rush Creek only in the wet years. Most of the time the water was spread onto the Farrington and Cain ranches. He says that pines, willows, and "buckbrush" (presumably buffaloberry--Shepherdia argentea) were the common vegetation types along Parker and Walker creeks. The portions of the streams immediately above old Highway 395 were meadow, as now.

**d.** Mr. Wes Johnson (619) 648-7454

5/6/91. Mr. Johnson, who has been a game warden in the eastern Sierra for the California Department of Fish and Game since 1947, states that riparian degredation in the bottomlands of Rush Creek began in the early 1970s. The vegetation remained lush until that time.

## 5. Conversations with Mono Basin scientists:

**a.** Mr. Elden Vestal (707) 224-3543.

**Re. Rush Creek**:

11/5/90. According to Mr. Vestal, jeffrey pines on Rush Creek occurred intermittantly from Grant Dam downstream to the narrows. There was a grove just below the narrows on the east side of the stream, then a stretch with no pines. The lowest grove was near the ford. Logging on Rush Creek did occur under the Forest Service, which hired a lumber company out of Bishop. This was around 1940. The company took the largest of the trees, up to 3.5 - 4 feet in diameter, between the dam and Highway 395. Aspens occurred only sparsely on Rush Creek, and only above the highway. They were abundant on the former (now submerged) reach of Rush Creek above Grant Reservoir. Springs along the west side of Rush Creek issued from several levels.

11/12/90. Mr. Vestal says that the "excellent gravels" he refers to in his deposition ranged in size from 1/8 inch to 3 inches. He described the springs areas along the Rush Creek bottomlands thusly: Along the east side, the main "issue" was around the downstream end of the big wash. The water issued "from just above a white layer [silt] in the layer-cake-like sediments". On the west side, they extended for 1/4 to 1/2 mile downstream, but not to the ford. He also mentioned the springs that issued upstream of the narrows. Vestal says that Claude James, the DWP hydrographer, established the gaging station at the ford "because he believed that it would get everything" (in other words, he, like Vestal and Lee, believed that all of the seepage occurred above that point).

3/6/91. Mr. Vestal says that the highly productive cress beds to which he refers in his narratives occurred in the small rills that drained the springs and seeps. Both large and small trout migrated up these rills and fed. The length of channel that composed the riparian system of the bottomlands far exceeded that of today. Cress beds were also found at the mouth of Walker Creek, and trout were able to migrate a short distance up Walker Creek (due to seepage flow) to feed.

**Re. Lee Vining Creek**:

11/5/90 Mr. Vestal says that there was "a good distribution" of jeffrey pines mixed with cottonwoods and lodgepole pines, from Highway 395 downstream to opposite town. Jeffrey pines and cottonwoods continued on both sides of the stream to just above the county road. There were no jeffrey pines below the county road (contrast this with today). There were definitely more aspens on Lee Vining Creek than on Rush. He remembers no logging on Lee Vining Creek. Note that Vestal now says that Water Birch (rather than Creek Alder, as he said in his narrative) was a common constituent of the riparian vegetation along Rush and Lee Vining creeks.

**Re. Parker and Walker creeks:**

11/5/90 According to Mr. Vestal, during his tenure there was sometimes flow at the mouths of Parker and Walker just before irrigation diversions began (i.e. in the springtime).

**b.** Dr. Dean Taylor (408) 459-9100. Biosystems Inc., Santa Cruz, CA.
11/12/90 Phoned Dr. Taylor regarding the annotated 1940 aerial photographs. He says that they were (but no longer are) available in the Bishop office of the United States Forest Service. There may have been a range survey report that went along with these, but he never saw it. Dr. Taylor reiterates that aspens rarely reproduce by seed, and so take a long time to become established. He believes that aspen groves would be a sign of long-persistant (as opposed to irrigation induced) seepage and springs. I asked him if he used the H.V. Peterson maps of 1933 in his reconstruction of riparian vegetation in the Mono Basin. He answered that he did not.

**c.** Prof. Duncan Patten (602) 965-2975. Arizona State Univ.,Tempe
4/22/91 According to Professor Patten, aspens occurred along the west wall of Rush Creek above the Parker-Rush confluence. This grove stood "about 10 feet above the stream." Aspens also grew (and continue to grow) at the mouth of Walker Creek.

**d.** Dr. Stacy Li (916) 652-7449. Aquatic Systems Research, Loomis, CA
2/1/91 According to Dr. Li, gravels such as those described by Vestal along the bottomlands of Rush Creek now occur along only 20-30% of the reach; those that persist are largely cemented to the point of immobility.

**e.** Mr. Kurt Weingartner, Los Angeles Department of Water and Power (213) 481-6529.
4/11/91. Mr. Weingartner reports the peak daily flows for 1938, '67, and '69 as follows:

**Lee Vining Creek** 2.5 miles above ranger station
1938-highest daily average = 503.4 cfs on June 9
1967-highest daily average = 520 cfs on July 4. Note that most of this was diverted into Grant Lake, and so never saw lower Lee Vining Creek. Releases down the stream at the point of diversion peaked out on July 5 at 288 cfs.
1969-highest daily average = 418 cfs on June 4

**Rush Creek** at dam site above Grant Lake Reservoir
1938-highest daily average = 711 cfs on June 28
1967-highest daily average = 992 cfs on July 14
1969-highest daily average = 508 cfs on June 16

**Rush Creek** Release at Mono Gate No. 1 (+ spill)
1938-unknown (KW will call if info from highway crossing is available)
1967-240 release at MG No. 1 (+ 988 spill) on July 4 =1228 cfs
1969-340 cfs steady release through much of May-August

## 6. Notes, court transcripts, narratives, and publications on the Mono Basin

**a.** Mr. Charles H. Lee, consulting hydrologist, Los Angeles Department of Water and Power, 1930s. Available at the Water Resources Center Archives, U.C. Berkeley. This collection includes estimates of vegetation acreages, as well as field notes from which the following are excerpted:

From notes of 3/23/34:
5:10 pm. Drove up along Rush Creek bottoms and wherever saw creek noted [water] cress along margins. In low bottoms 11/2 mi above lake grassy meadow some places 1000 ft wide and springs and seepages all along margin and cut meander channels. These channels discharge into creek. These seepages and springs enter from both sides of the bottoms [emph added]. This swampy meadow about 1/2 mile above ford crossing.
5:30 pm. Mouth of Walker Creek at Rush Creek 100 ft. above granite dyke [the granite dyke is "the narrows" of modern parlance]. Cress along margins of Walker and Rush Creeks and seepages entering at level 6 ins. to 1 ft. above stream level. Big seepage flow into Rush Creek within first 150 ft above Walker from both sides appreciably increasing flow [of Rush Creek] . . . Total flow at dyke 6-8 s.f.

From notes of 4/21/34:
Noted benches to east of Rush Creek just above ford south of Lower Clover. Volcanic Rock in places. Creek channel cuts in against it for several hundred feet above ford. . . Cress in stream channel, but no indications of strong seepage from east . . .

**b.** Mr. S.T. Harding, consulting hydrologist, State of California. This file includes personal and field notes from trips to the Mono Basin beginning in the 1920s. Available at the Water Resources Center Archives, U.C. Berkeley. Harding's notes from 1922, and his manuscript of 1962, provide valuable information on irrigation acreages.

**c.** Mr. Elden Vestal, District Biologist for the California Department of Fish and Game in the late 1930s through early 1950s. In preparation for the Cal Trout hearings of May, 1990, Mr. Vestal provided narratives, from which the following items are excerpted:

Vestal re. Rush Creek:

"From Grant Lake damsite downstream to the Gorge [narrows] [between the period 1939-1942], streamside and bank cover consisted principally of willows, creek alder [EV now calls this water birch--see personal communication], black cottonwoods, lodgepole pine, and jeffrey pine. Three-toothed sage[brush], some bitterbrush, rabbit brush, and wild rose 'filled in'. Jeffrey and lodgepole pines were somewhat clustered at intervals--the lowermost cluster of jeffrey pines being located just below the gorge [narrows] (see Vestal photograph of April 10, 1947) [note that in conversation Mr. Vestal said that there was a small grove of jeffrey pines farther downstream along the left side of the stream, just above the ford. This is corroborated on aerial and ground photographs]. Some jeffrey pines exceeded three feet in diameter (indicating very old trees), while a few lodgepoles exceeded 20 inches in diameter. Through well over sixty percent (est.) of the reach from the dam to near the mouth at Mono Lake there was excellent streamside bank cover. Willows and cottonwoods were particularly dense from old U.S. Highway 395 downstream to below the gorge [narrows] and through the meadows section downstream to about 1/4 mile above the mouth in the Rush Creek delta at Mono Lake (see Vestal photographs in "Rush Creek Test Stream Reports" for 1947 and 1954 to the Department of Fish and Game). In all those sections, pines, cottonwoods, and willows were clustered and were well developed from many years of growth, there was good stream shade and shelter. Roots of willows and cottonwoods extending from the stream banks provided a great deal of instream riparian cover at more normal stream flows; these flows are inferred to be pre-project flows, ranging from the natural winter minimum up through maximum during Spring runoff and grading through the average inseason of the summer through fall. Few quaking aspen extended along Rush Creek below Grant Lake, the principal concentrations being above the Grant Lake inlet and streamside to Silver Lake.

The Grant Lake inlet delta [supported] aspen, cottonwoods, and lodgepole pines [that] were all destroyed by chain saws and bulldozers, piled and burned by the City of L.A. clearance crews, largely in the summer and fall of 1940. Similarly, I believe the logging of the largest and easy-to-get jeffrey and lodgepole pines below Grant Lake was done by the Inyo Lumber Company in the period 1940-1942. The remaining riparian heavy cover was gradually destroyed by desiccation from decreasing releases and Rush Creek flows right up to (and following) my departure from the area in late 1950.

When I first saw Rush Creek on April 30, 1938 . . . [c]lustered jeffrey pines and the more extensive streamside cottonwoods, willows, and sagebrush dominated the riparian cover above and below the highway [old 395]. I was struck by the excellence of well-sorted gravels. Moderate to coarse gravel and rubble with scattered boulders, comprised the common stream bottom type, providing abundant stream habitat for good food production and spawning.

. . . [In Oct. 1940 the Rush Creek delta] was well-watered, although not as extensively as would occur at the normally higher flows of spring. Many ducks (spoonbills), some coots, and a few geese were seen. . . .[I]n addition to fishing, duck hunting each year brought many hunters to Rush Creek Ranch to hunt from blinds in the broad delta."

. . . Vestal notes that on Feb. 21, 1947, there was a gain of about 18 cfs to Rush Creek between the narrows and "a station just above the upper bridge, apparently from springs and seeps in the upper Meadows reach".

"An important food-producing feature of lower Rush Creek in the springs area of the upper Meadows reach were the water cress beds. These were swampy growths which produced large numbers of scuds [small, freshwater amphipods, Hyallela azteca] and other stream-bottom foods (chiefly aquatic insects). As the spring seepages declined over the years with declining releases and flows below Grant Lake, these important food-producing areas declined also."

"With the rapid to moderate gradient at normal range of flows, the normal velocity range sorted the glacial gravels and rubble to create a stepped character to the stream. This resulted, in turn, in the creation of many short riffles, pools, and runs with considerable white water. Such a condition enormously enhanced stream habitat in terms of food production, instream shelter, and spawning. This was commonly observed in the reach below Grant Lake dam to and just below old US Highway 395.

## Vestal re. Lee Vining Creek

. . . In the reach below the Ranger Station, riparian cover consisted of lodgepole pine, jeffrey pine, aspen and willows. There were good pools and riffles in the more gradual sections and the appearance was one of an excellent trout stream. As the gradient steepened, the stream bottom was characterized by boulders, rubble, less but "pocketed" gravels and fewer riffles and runs. There were shorter and deeper pools. Near the Ranger Station grasses and moss covered the stream banks in places. From just above US 395 to opposite Lee Vining, as the reach steepened the bottom was mostly boulders and heavy rubble. There were many small, deeper pools in the rapid, plunging stream, some $1^1/2$ to more than 3 feet deep. There was abundant white water. Riparian cover was dominated by black cottonwoods, jeffrey pine, wild rose thickets, and both sage and bitterbrush. The streamside complex was good for shelter and shade. Opposite [?? presumably the town of Lee Vining] the stream gradient lessened; there were many relatively small but good pools and small patches of gravels suitable for spawning. Toward Mono Lake, the stream became more gradual and open and appeared to be a better and more productive stream."

In 1954 Mr. Vestal published "Creel Returns from Rush Creek Test Stream...1947-1951. Relevant excerpts include the following:

... Since 1947 the City of Los Angeles has released no water into Rush Creek from Grant Lake dam during the entire trout season [May-Oct. incl]. As a result, the test stream at the upstream barrier [the lower end of the narrows] was completely dry by late August in 1948 and by mid-July in 1949, and the entire summer flow has been supplied by the springs just below this barrier. Without water to replenish water tables in the valley floor, these springs have declined steadily [despite the fact that this is a wetter period then 1924-34, when the decline was much less]; the minimum flow in the test stream [measured at the ford] has fallen from 24 cfs in 1947 to 12 cfs in 1948, 13 cfs in 1949, and 2 cfs in 1950 and '51. Mean flow during the 1951 season was only 2.5 cfs.

In preparation for the Cal Trout mandate hearings of May, 1990, Mr. Vestal provided deposition testimony on Jan. 11, 1990, excerpts and references from which follow:

pg 32 Water persisted in Parker and Walker creeks below the DWP diversion "early in the year".

pg 65 Vestal refers to "superior habitat" on Rush Creek below the gorge [narrows] . "The [vegetation] cover was more dense. The gravels were well-sorted and spread out. The stream was meandering... Foods came in from the springs...

pg 68 "I don't recall any extensive braiding [on Lee Vining Creek] but it was fairly well concentrated, but there was some braiding ... throughout ... the delta of Lee Vining Creek.

pg 74 "... very extensive aspen groves [existed at] ... the inlet portion of [Grant] lake. The aspen were bulldozed over, staked, and burned and cleared out before the City could fill Grant Lake with water."

pg 77 Mr. Vestal describes a photograph showing vegetation along Rush Creek.

pg 95 The springs immediately above Walker and Parker confluence with Rush Creek were smaller than those below the gorge [narrows].

pg 106-108 Mr. Vestal describes stream width and gravels at four stations in the test stretch on Feb. 21, 1947. Sta. 1 (100 yds below the narrows)--width 25 feet, gravels excellent; Sta. 2 (0.7 mi. below the narrows)--width 20 ft, excellent gravels, willows and cottonwoods predominated; Sta 3 (the ford); average width 30 ft; Sta. 4 (120 yds above the then-stream mouth)--average width 40 ft, "stream was slightly murky at this point." Mr. Vestal says (pers comm 12 Nov 90) that his "excellent gravels" ranged from 1/8 inch to 3 inches.

pg. 169 Mr. Vestal describes the erosion that he saw upon his return to Rush Creek in 1986, following a 35-year absence. "The incision was at least 30 ft deep, wide channel, and the stream was a mixture of heavy gravel and rubble and boulders."

pg 171 Vestal describes the loss of vegetation on Rush Creek that occurred during his 35-year absence.

pg 177 In 1951, at the time he left the basin, Mr. Vestal saw "the rusty red of jeffrey Pines below Highway 395 looking down Rush Creek where drying had caused plants--and some cottonwoods had withered and died also."

pg 178 Mr. Vestal describes vegetation along the Grant Reservoir-to-Highway 395 section of Rush Creek. He says that the jeffrey pines were logged off by a DWP contractor.

pg 226 Mr. Vestal discusses waterfowl and ponds.

pg 227-28 and 232-33 Vestal discusses ponds at the mouth of Rush Creek. He believes that these were meanders that were modified by dams, diking, and ditching.

pg 233-35 Ditto

pg 243 Mr Vestal recommends that the "state compendium" on the Pacific Flyway be obtained from Mr. Dan Conley of the Department of Fish and Game in Sacramento. This will have Mono Basin numbers for other years, and may provide insights to the locations of marshes.

pg 245-46 Mr. Vestal gives a description of the vegetation along the 3.2-mile test stretch of Rush Creek from the gorge [narrows] on down. "It was a sinuous stream for the most part on down for the length of the 3.2 miles. The stream was bordered more than half of its length by dense willows, this was actually described as a jungle. Anglers reported it as a jungle, and so did our men report it as a jungle trying to get through the dense willows... Then they broke out, there were places where anglers could have access to the meanders of the stream. And most of these areas where there were open places between the riparian cover were grassy meadow area. This was in this upper portion of about a mile, is where the springs area issued... It was a very grazable meadow, but at the same time in the early years it was swampy and there were watercress beds in there. The issues came out and meandered out through this... Then the stream meandered on... and the situation as far as willows and cottonwoods continued on down. There were cottonwoods of various ages and sizes with open areas intermittently and right on down to the vicinity of the upper bridge. There was an open area there." (Note that Vestal refers to the bottomlands--from below the narrows to ~the ford--as the "meadows area".)

pg 250 Vestal gives a description of where the springs areas were, but refers to a map that was pesent at the deposition. On 11/12/90 I called Mr. Vestal to get this clarified. See personal communication notes.

pg 252 "The stream bottom throughout this reach of 3.2 miles had some fabulous gravels... and they were graded, well out in the typical section of the stream, and it was very productive."

pg 267-268 Mr. Vestal describes the stretch of stream between Grant Reservoir and Highway 395. "... Coming down from Grant Lake the stream was relatively more respected [sic restricted]... There were more pools... there was relatively more drop-off, even some cascades in there at the time... Then it went down [to] what we call the bend, -- ...As it got down toward the plain of Pumice Valley it had a tendency to spread out, it was less confined within a canyon type of terrain, and got more so as it approached Highway 395, and so did the openness in the stream and the gravel, and the productivity increased from... a few hundred yards below Grant Lake right on down to the highway, old Highway 395."

pg 270 "...one of the last things I remember before I left the area was above and below 395 and down that far the rusty colored jeffrey pines that were just dead. And there were many... black cottonwoods dead."

pg 271-73. Mr. Vestal describes the "plant beds" in old Grant Reservoir in the '30s:

"There were very extensive [underwater] plant beds [on the east side of the lake--indicates on photos]. [They were located on] generally the east side of Grant Lake in the shallows... [H]ere is where more often than not was a great concentration of chubs of various sizes and several fish, the dominant population of browns, large browns. ...Grant Lake under those conditions was a relatively warmer lake, shallower and relatively a warmer lake. [Describes temperatures]." Q. "Do you know if those plant beds are still there?" A. "...Because of the change, the lake then was... eutrophic water, and it was very productive, partly due to the plant bed and partly due to certainly temperatures and so on. But the lake changed as it deepened, it enlarged and deepened and cooler, and the habitat of the lake became generally more favorable because of that and the increased plankton production for rainbow...".

pg 285 Q. "Did you see any evidence that [Rush] Creek had been harmed by high flows in the past?" A. "No... there was no evidence that I can recall that the stream had been harmed by, for example, the upward range of 1200 second feet... Nothing of a catastrophic nature. Certainly at 1200 second feet in Rush Creek there were velocities that would move bottom materials, but the stream from Grant Lake down to the lower limit of the riparian cover was protected and contained, its integrity was preserved because of the intense growths of willows and cottonwoods and riparian growth."

d. Mr. Russell Rawson, Water and Land Use Engineer for the Los Angeles Department of Water and Power from 1966-present. As part of the Cal Trout hearings of May, 1990, Mr. Rawson presented testimony regarding irrigation diversions from Rush, Lee Vining, Parker, and Walker Creeks. His transcript includes a description of the DWP's Lee Vining conduit (including the siphons and sand traps), the geography and history of irrigation diversions from the streams that supply the conduit, and the geography and history of irrigation diversions from Rush Creek. Rawson's transcript is partiularly valuable when used with the exhibits that were placed into evidence during his testimony.

e. Dr. G.M. Kondolf, reports. Dr. Kondolf's work include unpublished reports to Beak Consultants, Sacramento. One of these, "Historical channel stability analysis for Rush Creek . . ." documents the changes in stream position that occurred between 1930 and 1986. My reconstructions differ from those of Kondolf, but only in minor and insignificant ways.

Kondolf, G.M., 1988. Historical channel stability analysis for the Rush Creek Instream Flow Study. Unpublished report to BEAK Consultants, Sacramento (September 15, 1988), 17 pp. plus appendices.

____________, 1988. Hydrologic studies for the Rush Creek Instream Flow Study. Unpublished report to BEAK Consultants, Sacramento (October 29, 1988), 24 pp.

f. J.C. Stromberg and D.T. Patten papers. Two papers by Ms. Stromberg and Prof. Patten concern the reestablishement of riparian vegetation on Rush Creek. The authors report on the relationship between streamflow and growth of remnant riparian vegetation. In their analysis they assume that past flows measured near the Grant Dam are applicable to the entire stream, an assumption of questionable validity given the massive irrigation diversions, and the irrigation-induced springflow, that occurred downstream of the dam. The studies nevertheless provide a valuable basis for further work.

Stromberg, J.C., and D.T. Patten, 1990. Riparian vegetation instream flow requirements: A case study from a diverted stream in the eastern Sierra Nevada, California. Environmental Management v. 14 (2), pp. 185-194.

______________________, 1989. Early recovery of an eastern Sierra Nevada riparian system after 40 years of stream diversions. Pp. 399-404 in Proceedings of the California Riparian Systems Conference, September 22-24, 1988, Davis, California.

g. Mr. P.T. Vorster master's thesis. Mr. Vorster's thesis on the Mono Basin provides information on flow- and irrigation- measurement stations, on evapotranspiration rates, and on elements of the historical geography.

Vorster, P.T., 1985. A water balance forecast model for Mono Lake, California. Master's thesis from California State University, Hayward, published by the USDA Forest Service Region 5 as Earth Resources Monograph #10, 350 pp.

h. Bulletin 1 of the California State Water Resources Board (1951). This compendium provides estimates of runoff in the Mono Basin for years prior to the installation of permanent recording stations on the streams.

i. Dr. D.W. Taylor report. This report contains invaluable analysis of factors affecting riparian distribution along the eastern Sierra Nevada. It, in combination with other sources, was used to compile the species lists provided here.

Taylor, D.W., 1982. Eastern Sierra riparian vegetation: Ecological effects of stream diversions. Report to the Inyo National Forest, April, 1982, 56 pp.

## 7. Irrigation records

This report utilizes the following irrigation records (included herein as Appendix 2):

A-ditch at intake, 1920-1970 (in acre feet). (DWP)

B-ditch at intake, 1920-1968 (in acre feet). (DWP)

C-ditch at intake, 1920-1935 (in acre feet). (DWP)

Rush Creek annual diversions, 1923-1931 (in acre feet). (Southern Sierra Power Co.)

## 8. Streamflow Records

This report utilizes the following DWP streamflow records (included herein as Appendix 2):

Rush Creek at North Line [= the ford], 1934-38, 1951-67 (in cfs).

Rush Creek at highway [395], 1922-1947 (in cfs).

Grant Lake Reservoir spill, 1947-1989 (in acre feet).

Mono Gate #1, 1941-1989 (in acre feet).

Lee Vining Creek at county road, April 1934 to May 1969 (in cfs).

Parker Creek back of Cain Ranch, 1934-1962 (in cfs).

Additional flow records are reported above in narratives and reports by Vestal and Lee, and in conversations with Weingartner.

## 2. The Mono Basin Hydroscape Prior To 1940-- A Brief History Of Irrigation

### A. Introduction

It is important to understand that hydrographic conditions in the Mono Basin during the decade preceeding diversions by the DWP were not natural. For decades, water had been diverted for agriculture, milling, and mining. Agricultural diversions, in particular, were important in creating the hydrographic conditions that existed when the DWP began to operate its system in 1940.

Irrigation in the Mono Basin began during the 1860's. Water was diverted from many of the basin's streams using a system of ditches. Application of water was typically restricted to the growing season, between May (occasionally April) and September (occasionally October), though some ditches (including "Indian", "Farmers", and some unnamed canals on Walker Creek) carried water throughout some years. During the early decades of this century large amounts of water were diverted from Mono Basin streams, a factor that is relevant to an understanding of the riparian vegetation for three reasons: 1) diversion of water deprived some stream reaches of much (and at times all) surface water; 2) irrigation diversions appear to have contributed substantially to springflow along the Rush Creek bottomlands and elsewhere, thus affecting the nature and extent of the vegetation; 3) the irrigation ditches fostered their own strands of "streamside" vegetation, thus increasing the riparian acreage in the Mono Basin. Each of the important irrigation ditches is discussed below.

### B. Irrigation from Rush Creek

Three main irrigation channels and several minor ones, constructed early in the 20th century, diverged from Rush Creek (Figure 1). The uppermost of the main diversions, "C-ditch" (aka "main west canal"), headed at the site of the present-day Grant Dam (the present dam stands ~400 m NNE of the1930 dam

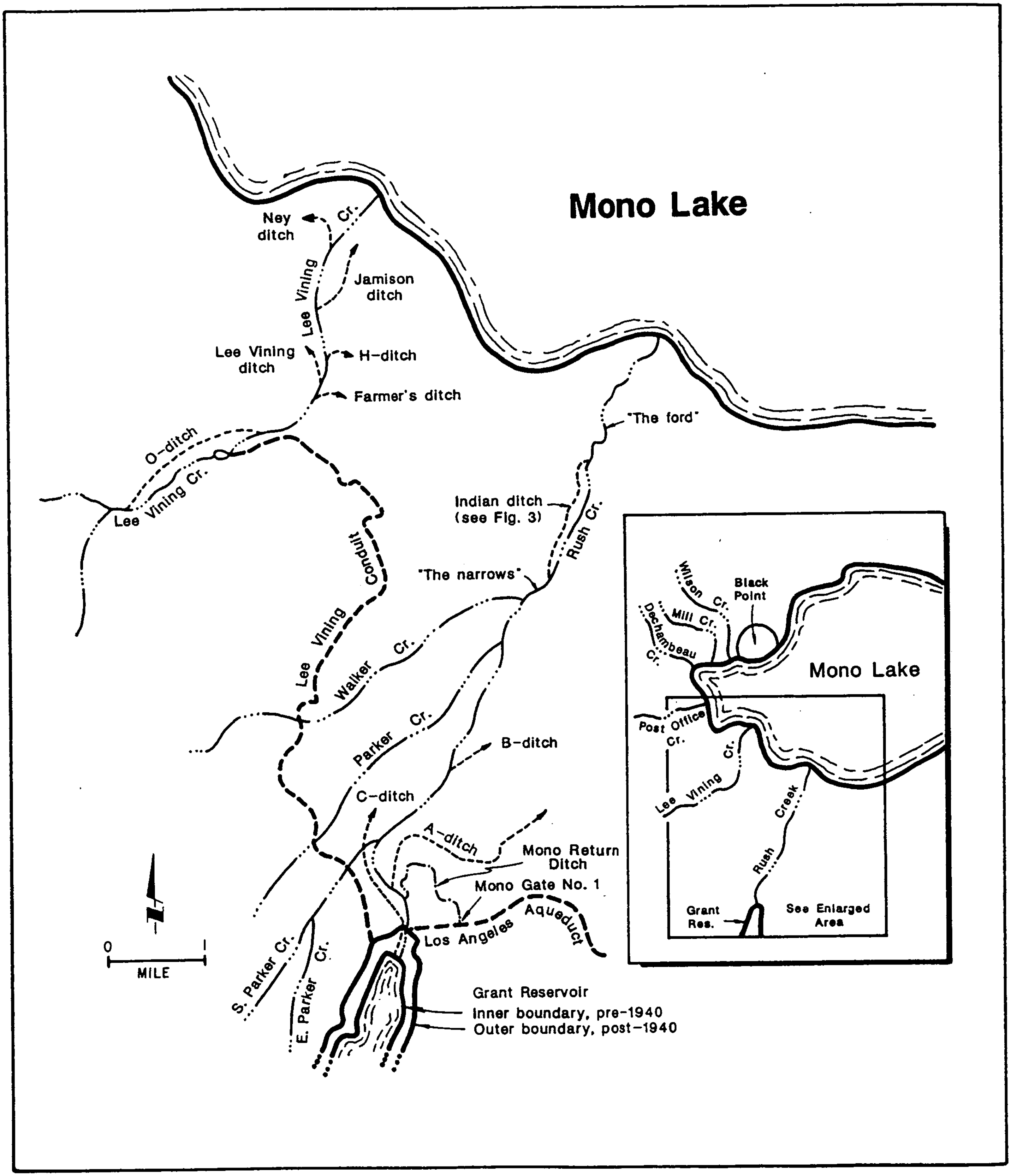


Figure 1. Hydrographic Index Map

site). C-ditch flowed northwest, watering the permeable alluvial deposits on the Parker and Walker alluvial fans. (C-ditch served to supplement the water already being applied to these lands from Parker and Walker creeks). Diversions on C-ditch amounted to between 2100 and 7700 acre feet per year, and averaged 4500 acre feet per year (1920-1935), according to the "LADWP records" (recorded by Cain Irrigation Company). Use of C-ditch ceased in 1935, when the DWP began work on the new Grant Dam.

"A-ditch" (aka "main east canal") was the largest of the diversions, conveying 7430 to 40,440 af/yr between 1920 and 1940 (average =18,920 af/yr). To deliver water from Grant Lake to A-ditch irrigators used a ~1000-foot-long natural declivity cut into the Tahoe-age moraine below the old dam site. (This "A-ditch declivity" lies east of, and parallels, the main channel of Rush Creek.) After entering A-ditch the water flowed eastward onto the highly permeable deltaic gravels in the Pumice Valley area between Aeolian Buttes and Rush Creek. A-ditch operated until 1970, though there was a drastic reduction in diversions (to a yearly average of only 3370 af--thus, an ~80% cutback) after 1947.

"B-ditch" (aka "lower east canal") also flowed eastward. It bifurcated from Rush Creek just above old Highway 395, and irrigated the central part of Pumice Valley. Between 1920 and 1940 it conveyed between 3390 and 14,575 af/yr (average =7305 af/yr). B-ditch continued to operate until 1967, though there was a marked reduction in diversions (to an average of 2125 af/yr--thus, a ~70% cutback) after 1947.

All of the areas irrigated by the 3 main Rush Creek ditches are characterized by highly permeable substrates. In order to be effective, water had to be applied in large quantities (up to 45 feet/acre in the Pumice Valley area). This water percolated through the sediments, and was responsible for the springs that emanated from the margins of the Rush Creek bottomlands (see below).

One minor irrigation channel on Rush Creek--"Indian ditch" (see Figure 3a for location)--is noteworthy. It diverged westward from Rush Creek at a point approximately 2000 feet downstream from "the narrows" (see Figure 1 for location), and flowed roughly parallel to the main stream along the western margin of the Rush Creek bottomlands. It provided water to the area that is known today as "the lower meadows", maintaining it as a morass throughout the year. Use of Indian ditch was halted shortly after 1940.

## C. Irrigation from Lee Vining Creek

Six main irrigation canals, and several minor ones, conveyed water from the main stem of Lee Vining Creek. These include the following (see Figure 1):

"O-ditch" was the highest of the diversion canals. It headed at an elevation of ~7320 feet, and irrigated tracts of meadow upstream of the Forest Service Compound. Unlike most of the canals, O-ditch remains in operation today.

"Lee Vining ditch" (aka Curry ditch) diverged from the left bank of Lee Vining Creek immediately above Highway 395. It was used as a water supply for the town of Lee Vining, and to irrigate lands in the vicinity of town. Diversions to Lee Vining Ditch persisted until 1959.

"Mattly-Farrington ditch" (aka "Farmer's ditch") transferred water from a small dam below the Forest Service Compound to the piedmont lands north of Walker Creek. Use of Farmer's ditch was halted during the drought of 1947-1951; it was reactived in 1952 and '53. It has not operated since.

"Ney ditch" (aka Mattly-Ney ditch) diverged westward at 6540 feet, carrying water to the southern part of the Western Embayment. Like Farmer's ditch, the Ney ditch was abandoned after 1952.

"H-ditch" tapped Lee Vining Creek at elevation 6830 feet. It conveyed water to "Roger's ditch", which irrigated lands near the present-day airport, and to the "Cremasco-Mattly ditch", which irrigated i) the Mattly lands high

(~6800 feet) in the Horse Creek Embayment; and ii) the Cremasco lands low in that same embayment. This latter transfer employed, in part, the natural channel of Horse Creek.[1] It may have been responsible for the large spring that issued from low in the Horse Creek Embayment near the Dondero ranch.

"Jamison ditch" diverged eastward at 6610 feet, carrying water to the shorelands lying up to 0.5 miles southeast of the mouth of Lee Vining Creek. It seems likely that use of Jamison Ditch ceased shortly after 1940.

Among the minor ditches that diverged from the main channel of Lee Vioning Creek was a small, unnamed canal that headed at ~6480 feet. It carried water to lands immediately northwest of the Lee Vining Creek mouth.

## D. Irrigation from Walker and Parker Creeks

As early as the 1860s, water from Walker, Parker, South Parker, East Parker, and Bohler creeks (Figure 1) were being diverted over their respective alluvial fans to improve the quality and prolong the growing season of pasture. By the late 1890s an extensive system of ditches permitted irrigation of somewhat over 2200 acres of permeable fan surface.

Beginning around 1915 irrigation of the Parker/Walker lands was supplemented by Rush Creek water delivered by C-ditch (see above). This supplementation continued until 1935. On the Walker/Parker lands, as in Pumice Valley, some of the irrigation water moved through the permeable sediments adjacent to Rush Creek, reappearing as springs and seeps along the margins of the Rush Creek bottomlands, and at the canyon mouths of Parker and Walker creeks.

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[1] Horse Creek is incorrectly called "Gibbs Creek" , or "Gibbs Canyon Creek" on some old land-use maps. Note that Gibbs Creek is actually a tributary of Lee Vining Creek that joins the main stream above the Forest Service Compound (Figure 1). A portion of Gibbs Creek is diverted into Horse Creek at an elevation of 8500 feet, to supplement the irrigation of the Horse Meadows area.

It is worth noting that, by 1930, many of the irrigation ditches of the Mono Basin (as well as the artificially-watered natural declivities that were used to convey water to the ditches) had been colonized by a strand of riparian vegetation. Disuse of many of the ditches has resulted in the loss of much of that vegetation.

# 3. RIPARIAN VEGETATION AND SUPPORTING CONDITIONS ON RUSH CREEK, 1930-1940

## A. Climo-hydrologic Context

An understanding of the "climo-hydrologic" conditions (including climate, groundwater, runoff, springflow, streamflow, and irrigation practices) that characterized the Rush Creek drainage from immediately above Grant Reservoir to Mono Lake between 1930 and 1940 is an essential first step in accounting for the nature and extent of the riparian vegetation that existed during those years. These factors are discussed in turn.

***Climate, 1930-1940.*** In January of 1930, at the time the Fairchild aerial photographs were taken, the Mono Basin, like much of the western United States, was experiencing a severe drought (the "Dust Bowl" drought). The previous 32 months had been characterized by low precipitation and runoff (based on estimates made by the California State Water Resources Board in their Bulletin 1, runoff in the Mono Basin was 75% of normal in 1927-28, and 58% of normal in 1928-29). The drought continued through 1934. Estimates of Mono Basin runoff from Bulletin 1 are given in Table 1 below (figures are percent of the annual average for the period 1895-1947--note that this average is close to that of the "modern period" of 1937-1983):

**Table 1. Mono Basin Runoff, Water Years 1929-30 to 1939-40**
Figures for each year expressed as a percentage of average annual runoff for the period 1895-1947

| | |
|---|---|
| 1929-30 | 61% |
| 1930-31 | 44 |
| 1931-32 | 97 |
| 1932-33 | 66 |
| 1933-34 | 49 |
| 1934-35 | 91 |
| 1935-36 | 104 |
| 1936-37 | 91 |
| 1937-38 | 159 |
| 1938-39 | 64 |
| 1939-40 | 104 |

***Irrigation, 1930-1940.*** Irrigation diversions from the three main Rush Creek ditches during the period 1930-1940 are given below in Table 2 (diversions on A- and B-ditches are expressed as a percentage of the 1920-1940 annual mean; diversions on C-ditch are expressed as a percentage of the 1920-1935 annual mean). In comparing these numbers with the runoff figures given above, it becomes clear that application of irrigation water was particularly high in dry years, and low in wet years.

**Table 2. Irrigation from Rush Creek, 1930-1940**
Figures for each ditch expressed as a percentage of its average annual release for the period 1920-1940 (1920-1935 on C-ditch)

| | A-ditch | B-ditch | C-ditch |
|---|---|---|---|
| 1930-31 | 111% | 93% | 82% |
| 1931-32 | 62% | 68% | 122% |
| 1932-33 | 133% | 156% | 171% |
| 1933-34 | 122% | 112% | 159% |
| 1934-35 | 82% | 67% | 105% (diversions cease) |
| 1935-36 | 118% | 127% | |
| 1936-37 | 56% | 81% | |
| 1937-38 | 61% | 51% | |
| 1938-39 | 39% | 46% | |
| 1939-40 | 69% | 97% | |

***Hydrologic conditions, 1930-1940.*** The factors of climate, runoff, and irrigation discussed above worked in tandem to create the distribution of surface, sub-surface, and spring water that existed along Rush Creek between 1930 and 1940. Because of the ongoing drought, and the normally sparse winter runoff, flow in Rush Creek, as well as in Mono Lake's other feeder streams, was low when the Fairchild aerial photographs were taken in January, 1930. Neither Parker nor Walker Creek was delivering surface water to Rush Creek, and Rush Creek itself was dry between B-ditch (immediately above old Highway 395) and a point about 300 feet upstream from the Rush-Walker confluence. At that point springs issued from both margins of the Rush Creek canyon floor, providing Rush Creek with surface flow.

These springs represent the upstream-most expression of a seep system that extended intermittently ~1.4 miles downstream along the right margin of the canyon bottom, and somewhat farther downstream along the canyon's left margin. The Aitken Case map of 1931-33 delineates some of these springs of the Rush Creek bottomlands. The map shows a spring area at elevation 6640 feet on the east side of Rush Creek ~0.2 mile above its confluence with Walker Creek, and seepage areas along the west side of the channel at, and within ~0.4 mile below, the narrows. These latter springs issued from two different levels--the upper between 6620 and 6635 feet, and the lower at ~6570 feet. Elden Vestal (pers. comm.) confirms that during the late 1930s and early 1940s the west-side springs of the Rush Creek bottomlands occurred at 2 levels. According to Vestal, the biggest springs on east side of Rush Creek issued from "around the downstream end of the big wash" (in the SE $^{1}/_{4}$ of the NE $^{1}/_{4}$ of section 26 in T1N R26E).

Another early description of the springs of the Rush Creek bottomlands is found in the notes of C.H. Lee. On March 23, 1934, he visited Rush Creek near the Rush/Walker confluence:

> 5:30 pm. Mouth of Walker Creek at Rush Cr. 100 ft. above granite dyke [the granite dyke is "the narrows" of modern parlance]. Cress along margins of Walker and Rush creeks and seepages entering at level 6 ins. to 1 ft. above stream level. Big seepage flow into Rush Creek within first 150 ft above Walker <u>from both sides</u> [emph. added], appreciably increasing flow [of Rush Creek]... Total flow at dyke 6-8 s.f.

Lee also noted that while Walker Creek itself was dry, seepage occurred along the margins of the lower reaches of its channel.

Earlier that afternoon, Lee described the meadows area ~0.5 mile above the ford. There he found

> grassy meadow some places 1000 ft wide and springs and seepages all along margin and cut meander channels. These channels discharge into creek. These seepages and springs <u>enter from both sides of the bottoms</u> [emph added].

The downstream limit of the spring system cannot be delineated precisely. Lee's notes of 4/21/34, however, suggest that in streamcuts immediately above the ford (in the area where volcanics from the 600-year-old

Mono Craters eruption first appear in the walls of the stream cuts), springflow along the eastern bank of Rush Creek was at most minor:

> Noted benches to east of Rush Creek just above ford south of Lower Clover. Volcanic Rock in places. Creek channel cuts in against it for several hundred feet above ford . . . Cress in stream channel, but no indications of strong seepage from east . . .

Locations of the individual springs along the Rush Creek bottomlands coincided with aquitards composed of fine, relatively impermeable lake-bottom silts and clayey silts that are interbedded within the permeable outwash gravels of the late Pleistocene Rush Creek delta. These relatively impermeable layers, the lowest of which lies ~20-30 feet above stream level along much of lower Rush Creek, perch groundwater moving streamward from adjacent lands. Lee's account suggests that silts and clays may have cropped out along the channel floor of Rush Creek, and that springs may have issued from underneath the stream. He quoted "JEJ" (presumably Jones, who made streamflow measurements in the area) to the effect that he (JEJ) had

> ... found clay at certain points in the bed of Rush Creek below the granite dyke [the narrows] with water issuing through openings therein as springs in the bottom of deeper pools in the creek channel.

It is clear that the existence of the spring system depended on the natural and artificial application of water onto areas adjacent to the Rush Creek bottomlands. Springs along the west side of the bottomlands were supplied naturally by Parker, Walker, and Bohler creeks, and artificially by C-ditch. The source of the springs along the east side of the bottomlands was A- and B-ditches. As discussed below, disuse of A-, B-, and C-ditches, and the diversion by DWP of most of Parker and Walker creeks, has deprived the springs of the bulk of their supply, resulting in their near or complete extinguishment.

The amount of water that the spring system contributed to Rush Creek at the time the first aerial photographs of the basin were taken in 1930 is of major importance in appreciating the distribution of the riparian vegetation that existed in that year. Gaging-station data indicates that in January of 1930 flow along Rush Creek at Highway 395 was zero. It is clear from the photographs that flow remained zero downstream to the upper end of the spring system, above the confluence with Walker Creek. Over the next ~4 miles the amount of water in Rush Creek increased substantially, with 35-40 cfs being measured at the ford. None of this gain of 35-40 cfs was supplied by surface flow from Walker or Parker creeks (or from other tributaries, for that matter). The entire gain is thus reasonably attributed to the springs and seeps along the margins of the Rush Creek canyon bottom, and to seepage at the mouths of the Parker and Walker creek canyons.

The spring-related gain demonstrated for January of 1930 is not an aberration. Synthesis of flow records from throughout the remainder of the Dust-Bowl drought, set out below in Tables 3 and 4, provides a range of these gains. Table 3 gives the highest mean-monthly flows, and the lowest mean-monthly flows, recorded at Highway 395 during the period 1930-1934.

**Table 3**. Highest and lowest mean-monthly flows at Hwy 395 crossing on Rush Creek, 1930-34

| | Highest mean monthly | Lowest mean monthly |
|---|---|---|
| 1930-31 | 43 cfs (Nov '30) | 0 cfs (Jan-Mar '31) |
| 1931-32 | 60 cfs (Mar '32) | 0 cfs (Sep-Dec '31, Jan-Feb '32) |
| 1932-33 | 125 cfs (Jul '32) | 0 cfs (Aug-Sep '32) |
| 1933-34 | 2.5 cfs (Apr '33) | 0 cfs (May-Dec 33) |

The flow measured at the ford during each of the months given in Table 3, together with the gain that occurred between Highway 395 and the ford, is provided in Table 4 (only the highest and lowest gain is given for the "zero months" listed in Table 3).

It is evident from Table 4 that during the latter years of the Dust-Bowl drought the gain between Highway 395 and the ford ranged from a high of 52 cfs (in January, 1932) to a low of 18 cfs (in June of 1933). The springs themselves clearly had the effect of keeping Rush Creek, from above its

Table 4. Gain between Hwy 395 and the ford for months of highest flow and zero flow,1930-34

| | HIGH-FLOW MONTHS (in cfs) | | | ZERO-FLOW MONTHS (in cfs) |
|---|---|---|---|---|
| | Flow at Ford | | gain between 395 & ford | Flow at Ford (= gain between 395 & ford) |
| 1930-31 | (Nov '30) | 75 | 32 | 45, 34 cfs (Jan and Mar '31) |
| 1931-32 | (Mar '32) | 82 | 22 | 39, 52 cfs (Sep '31 and Jan '32) |
| 1932-33 | (Jul '32) | 159 | 34 | 33, 36 cfs (Aug and Sep '32) |
| 1933-34 | (Apr '33) | 24 | 21.5 | 18, 37 cfs (Jun and Nov '33) |

confluence with Walker Creek to its mouth, wetted during even the driest and most irrigation-intensive months of the drought.

(The contribution of surface flow from Parker and Walker creeks to these gains was likely zero in most months of the Dust Bowl, and almost certainly remained below 20% of the gain in all months of that drought. Geomorphological evidence suggests that on rare occasions a small amount of return flow from the lands watered by B-ditch reached Rush Creek. This water flowed down a small ravine on the east side of Rush, and entered the creek ~500 feet upstream of the Rush/Parker confluence. Addition of water to Rush Creek by this route was at most a minor factor--and in all but a few weeks a non-factor--in contributing to the spring-induced gains.)

***Conclusions.*** Irrigation diversions, and the irrigation-induced spring system, exerted both direct and indirect impacts on the hydrology of Rush Creek during the period 1930-1940. Among these impacts are the following:

*--Dewatering of the stream between B-ditch and the narrows.* Flow records indicate that during the 60-month period 1930-1935, the Rush Creek channel at Highway 395 was dry during 28 of the months. This includes periods of up to 9 months when the channel was continuously dry.

*--Decrease in the overall amount of water moving through Rush Creek.* Even in that portion of the Rush Creek system that was fed by the irrigation-induced springs, the total amount of water moving through the stream was lower than would have been the case under natural conditions. This overall decrease in flow resulted from evapotranspiration losses on the irrigated lands, and from

subsurface transport of irrigation waters away from the stream drainage.

*--Change in the seasonality of flow.* Irrigation diversions served to decrease the amount of water that, under natural conditions, would have moved through the Rush Creek bottomlands during the spring and summer seasons. During the fall and winter, in contrast, flows through the bottomlands were kept higher than the natural level due to the input of water from springs.

## B. Rush Creek Geomorphic Conditions, 1930-1940

***Background.*** By influencing the distribution of both surface- and groundwater, and by imposing topographic constraints, the geomorphology of the Mono tributaries played a major role in determining the nature and extent of the riparian vegetation. The most important geomorphological considerations in this regard include the form, position, gradient, and depth of the channel; distribution of sediment types and bedrock; and the morphology (including both width and topography) of the floodplain. These factors exerted a strong control on the following conditions:

*--Depth and configuration of the groundwater table.* Along alluvial stream systems such as those tributary to Mono Lake, the width of the floodplain is a prime determinant of groundwater availablility (and thus of riparian distribution). In broad valley-bottoms such as that characterizing Rush Creek below the narrows, the water table may, under some circumstances, stand close to the ground surface for a considerable distance to either side of the stream. In contrast, where the floodplain is narrow, as in the bottom of a constricted canyon, the area of high water table may be limited to a thin strip along the stream margin. The degree to which a stream has incised its floodplain can likewise influence the level of the water table. Even in broad valley-bottoms, stream incision can result in a drop in the water table, perhaps to levels that prohibit maintenance, or recolonization, of riparian woodlands and wet meadows.

--*Potential depth of incision.* Exposure of a bedrock sill such as "the narrows" on Rush Creek can act as a local constraint on erosion, defining the upstream-most point to which headward incision can propogate on the reach below the sill, and the lowest level to which incision can occur on the reach above the sill. Incision can also be inhibited by the presence of large cobbles and boulders on the floor of a channel.

--*Frequency of flooding.* The width, depth, and gradient of a channel, together with a channel-roughness factor, determine the amount of water per unit time that can pass through the channel before flooding occurs. Alteration of any these parameters, due to incision, aggradation, lateral erosion, meander cut-off, or avulsion (the abrupt abandonment of an existing channel) can thus result in changes in the frequency of flood events. This in turn determines the frequency with which water-borne seeds are dispersed (thus exerting some influence on the establishment of next-generation riparian vegetation), and the frequency of overbank silt-dispersing events (thus influencing the water-retaining capacity of the bottomland soils--see below).

--*Water-retaining capacity of the substrate.* The ability of a soil to retain water depends in part on the coarseness/fineness of the parent sediment. On alluvial bottomlands such as those found along the streams of the Mono Basin, it is not uncommon to find a wide range of sediment types, from fine overbank silts in some places, to sands, gravels, cobbles or, locally, boulders in others. The distribution of these sediment types, with their various water-retaining capacities, creates a mosaic of water availability that influences the distribution of vegetation. In general, silt-sized sediment not only retains moisture longer than coarser-grained materials, but also promotes moisture availability by drawing groundwater to the surface through capillary action.

***Conditions from Grant Dam to the narrows, 1930-1940.*** By 1930 the mile-long stretch of Rush Creek immediately below Grant Reservoir had been artificially modified to function as a supply channel for A and C ditches. This reach seems to have been generally devoid of channel-bottom or channel-side obstructions, and was apparently capable of conveying large amounts of water without overflowing. It was obliterated and replaced with the "Mono Gate No. 1" when the new Grant Dam was constructed in 1939-40. With the exception of this alteration, the geomorphological changes that occurred between 1940 and the present day along the reach from Grant Dam to the narrows appear on aerial photographs to have been few and minor. The description that follows takes this apparent lack of change into account, drawing on information from the period 1930-40, as well as on modern-day records.

Below the engineered reach (or, in present-day terms, below Grant Dam) Rush Creek flows through a relatively deep, ~mile-long defile cut into the Tahoe-age terminal moraine. This narrow, steep-walled reach (which parallels the "A-ditch defile") is characterized by a bed of large glacial boulders that, by inhibiting incision, has kept the stream at a relatively high gradient (to >70/1000).

Rush Creek debouches from this minor canyon onto a relatively open (~500-foot-wide) floodplain at elevation ~7020 feet, then flows ~1.4 miles to Highway 395 through a relatively straight channel (with occasional overflow channels) of generally decreasing gradient (from ~47/1000 at the upper end, to ~22/1000 at the lower). This channel represents a shallow cut into the late Pleistocene Rush Creek delta. Incision of the delta in early Holocene time winnowed much of the fine outwash gravel that was present, leaving behind the lag of large cobbles and boulders that today dominates the bed of the channel. Pockets of gravel persist locally; they become more abundant near Highway 395.

The concave-upward profile of the stream above Highway 395 gives way to a similar profile between Highway 395 and the narrows (with gradients ranging from 80/1000 immediately below the highway, to 40/1000 immediately above the narrows). This reach below Highway 395 is characterized by a single, relatively straight, cobble/boulder channel with pockets of gravel. It differs from the reach above the highway in that it forms a deep canyon in the late Pleistocene Rush Creek delta, and flows across a relatively narrow floodplain along the floor of that canyon.

***Conditions from the narrows to Mono Lake, 1930-1940.*** The narrows consists of a localized outcrop of erosionally resistant quartzite and quartz monzonite. Rush Creek has cut a narrow, near-vertical-walled gorge through this material, probably by exploiting a rock joint. The stream cascades through the gorge across large boulders quarried from the outcrop.

Immediately below the narrows, at elevation 6600 feet, the valley of Rush Creek flares into a broad bottomland with a width of up to 1300 feet. Unlike the stream reaches above the narrows, which are essentially erosional in character, this bottomland is depositional--that is, it is composed of alluvial fill deposited by the stream as part of the Rush Creek delta during late Holocene high stands of Mono Lake. (Volcanic sediments from recent eruptions of the Mono Craters also contribute in a minor but important way to the deposits of this reach--see below). Geomorphic conditions along Rush Creek below the narrows have changed dramatically since 1940. The description that follows is therefore based on pre-1940 historical sources, and on field observations of the remnant channel.

During the 1930s Rush Creek crossed the bottomlands along a sinuous path that, over much of its length, consisted of more than one channel (Figure 2). Channel gradient ranged from moderate (20 to 30/1000 immediately below the narrows) to remarkably low (<6/1000 between the ford and the county road). Aerial and ground photographs clearly show that dense riparian vegetation lined the banks along most of the reach, binding the sediments that composed the channel walls. Riverine landforms (bar-and-swale topography, cut-off meanders, oxbow lakes, etc.) suggestive of lateral migration over time, were common on the bottomlands.

Remnants of the channel used by Rush Creek between 1930 and 1940

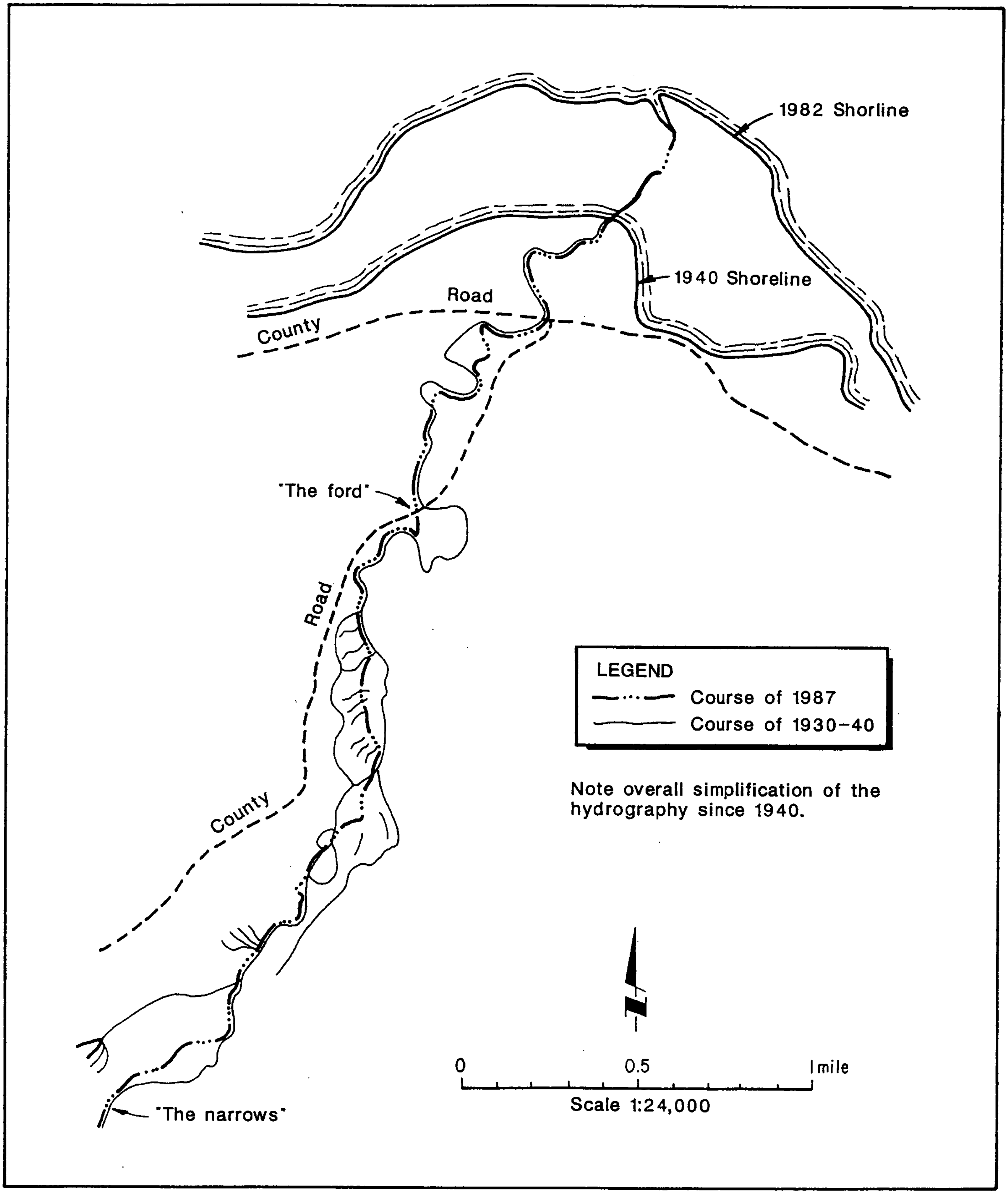


Figure 2. Rush Creek Below the Narrows, 1930 and 1987

persist at several sites along the bottomlands (as explained below, catastrophic floods in 1967-69 and 1980, combined with a drop in lake level, forced Rush Creek to incise and change its course; this explains the presistence of these remnants). These abandoned segments allow the channel of 1930-40 to be characterized with fair precision. That channel varied in width from approximately 21 feet to approximately 30 feet. Near-vertical to steeply sloping channel walls approximately 4 feet high met a near-flat to broadly concave channel floor which, in many areas, was covered with gravels in the sub-inch to 3-inch range (Vestal's description of the gravels that lined the Rush Creek channel floor in the late 1930s and 1940s proves to be an accurate depiction of those that persist on the floor of the abandoned channel--see below). The channel was cut directly into the surface of the botomlands, which served as the floodplain, taking the overflow during times of high water.

Low gradients and shallow, narrow channels combined to make flooding common, as indicated by natural levees, and the numerous layers of overbank silt that are visible today in the walls of the stream-cuts. During times of high runoff the floodwaters spread laterally across the bottomlands, then flowed slowly lakeward through a system of low-gradient channels that crossed the meadows and riparian woodland. By laterally spreading the floodwaters rather than concentrating them, this system minimized the velocity (and thus the competence and incision) of the stream, even during times of highest runoff (e.g. in 1938, when flows are believed to have reached an average daily peak in excess of 700 cfs).

Large portions of the bottomlands had the character of a morass. Water from the irrigation-fed springs and seeps that lined the margins of the bottomlands flowed to Rush Creek through a system of small rills that, according to Vestal, were large enough to accomodate trout. Thousands of feet of rills, supporting water cress, fed the main stream.[1] These rills, together

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[1] According to Vestal, these cress-filled rills contributed substantially to the Rush Creek fishery, by providing food, cover, a fry-rearing area, and a source of temperate water.

with the oxbow and swale depressions, low surface gradient, and high water table, made standing water common, even during times of low runoff.

Overbank silts deposited during floods constituted the most areally extensive sediment type on the Rush Creek bottomlands. Bars of gravel and sand (typically levees from an abandoned or laterally-shifted channel) protruded through the silts in various places, forming islands of relatively permeable substrate. The silts of the bottomlands remained saturated even during periods of low precipitation and streamflow (e.g. see aerial photographs of January, 1930). The islands of coarser sediments formed a drier soil environment, due both to their topographic prominence (resulting in a greater depth-to-groundwater), and their greater permeability.

Vestal's notes from the late 1930s, together with his more recent narratives, indicate that the floor of Rush Creek from the narrows to the ford was composed mainly of "excellent [spawning] gravels" ranging in size from $^{1}/_{8}$ inch to 3 inches. Immediately downstream from the ford the stream abutted outcrops of easily erodible, easily transportable volcanic ejecta from the Mono Craters eruption of 600 years ago. Erosion from these outcrops introduced large angular boulders of pumice into the system, creating a more bouldery channel floor than that existing above the ford.

## C. Rush Creek Riparian Vegetation, 1930-1940

The Fairchild aerial photographs show that in January of 1930 wet meadow, riparian woodland, and sagebrush scrub covered the banks and bottomlands of Rush Creek from Grant Dam to approximately 1000 feet upstream of the stream mouth. Species composition, density, and width of the strand varied substantially from site to site.

The dominant vegetation types were determined with fair surety from the aerial photographs of 1930 and 1940. Confirmation was obtained from ground photographs, from written sources, from personal communciation with individuals who then resided in the area, and from field inspection. These same secondary sources were tapped for information concerning understory species.

The most important species included the following *(note that the purpose here, and in discussions of the vegetation that existed on the other creeks, is not to produce an exhaustive list of species, but to provide botanists with the names of indicator species that will key them to the habitat type):*

i. Salix sp. Willows reaching arboreal dimensions were common on the floodplain of Rush Creek, forming pure stands or, more commonly, occuring as co-dominants with cottonwoods. These tree-like willows may well have been S. lasiandra, S. exigua, S. laevigata, and S. lasiolepis, though the willows are not readily distinguishable to species on aerial or ground photographs. Smaller species, including S. exigua, (and perhaps S. geyeriana and S. lutea, = S. rigida?) were common on and adjacent to the floodplain. The buffaloberry (Shepherdia argentea) sometimes occurred in association with the willows; it could not be differentiated from willows on the available aerial photographs.

ii. Populus trichocarpa. The black cottonwood was the most abundant arboreal species along Rush Creek, dominating the floodplain. It occurred in pure stands, though more commonly it was found in association with the willows (see above).

iii. Pinus sp. Two species of pines (P. jeffreyi and P. contorta) occurred along Rush Creek. Compared to the willows and cottonwoods, neither was common; indeed, the lodgepole was rare downstream from Grant Dam.

iv. Populus tremuloides. While abundant along Rush Creek above Grant Reservoir, quaking aspen was uncommon below the Grant Dam, occuring in just 3 small groves. These groves occurred on slopes adjacent to, and above, the stream, where groundwater issued as seeps.

Understory vegetation could not be identified to the species level on ground or aerial photographs. Examination of written records, and conversations with observers, yield the following list of understory species that occurred commonly on Rush Creek (there are unquestionably others):

Shepherdia argentea (sometimes occuring as a dominant)
Betula occidentalis
Rosa woodsii
Carex sp. (including but not limited to C. praegracilis, C. rostrata, C. nebrascensis, and C. lauginosa)
Juncus sp. (including but not limited to J. balticus)
Artemisia tridentata
Purshia tridentata
Chrysothamnus nauseosus
Typha latifolia
"Cress" (presumably water cress, Nasturtium officinale)
Species of the Poaceae, including but not limited to Deschampsia caespitosa, D. elongata, Poa pratensis, and Elymus triticoides)

Figure 3 shows the distribution and density of the dominant vegetation assemblages that existed along Rush Creek in 1930-1940. Assemblage boundaries were drawn from the 1930 and 1940 aerial photographs onto enlarged (to 142% original, =1:16,900) copies of the United States Geological Survey's Lee Vining and June Lake 7.5 minute Quadranges (provisional 1986 editions, scale 1:24,000). A particular vegetation assemblage had to measure >200 feet in its smallest dimension to qualify as a mappable unit (exceptions were made where the vegetation boundaries were exceptionally well defined, and where the different vegetation types could be confirmed from ground photographs). In several places along Rush Creek the riparian strand composed a band narrower than 200 feet (this occured along the eastern wall of the Rush Creek bottomlands, where seepage supported a thin strip of vegetation, and at many sites upstream of the narrows, where floodplain width was minimal). Acreages of the vegetation assemblages were derived by tracing the polygon boundaries with a digital planimeter. In nearly all cases the acreages derived here closely matched those derived by C.H. Lee in the early 1930s (see below).

The mapping units used on Rush Creek include the following:

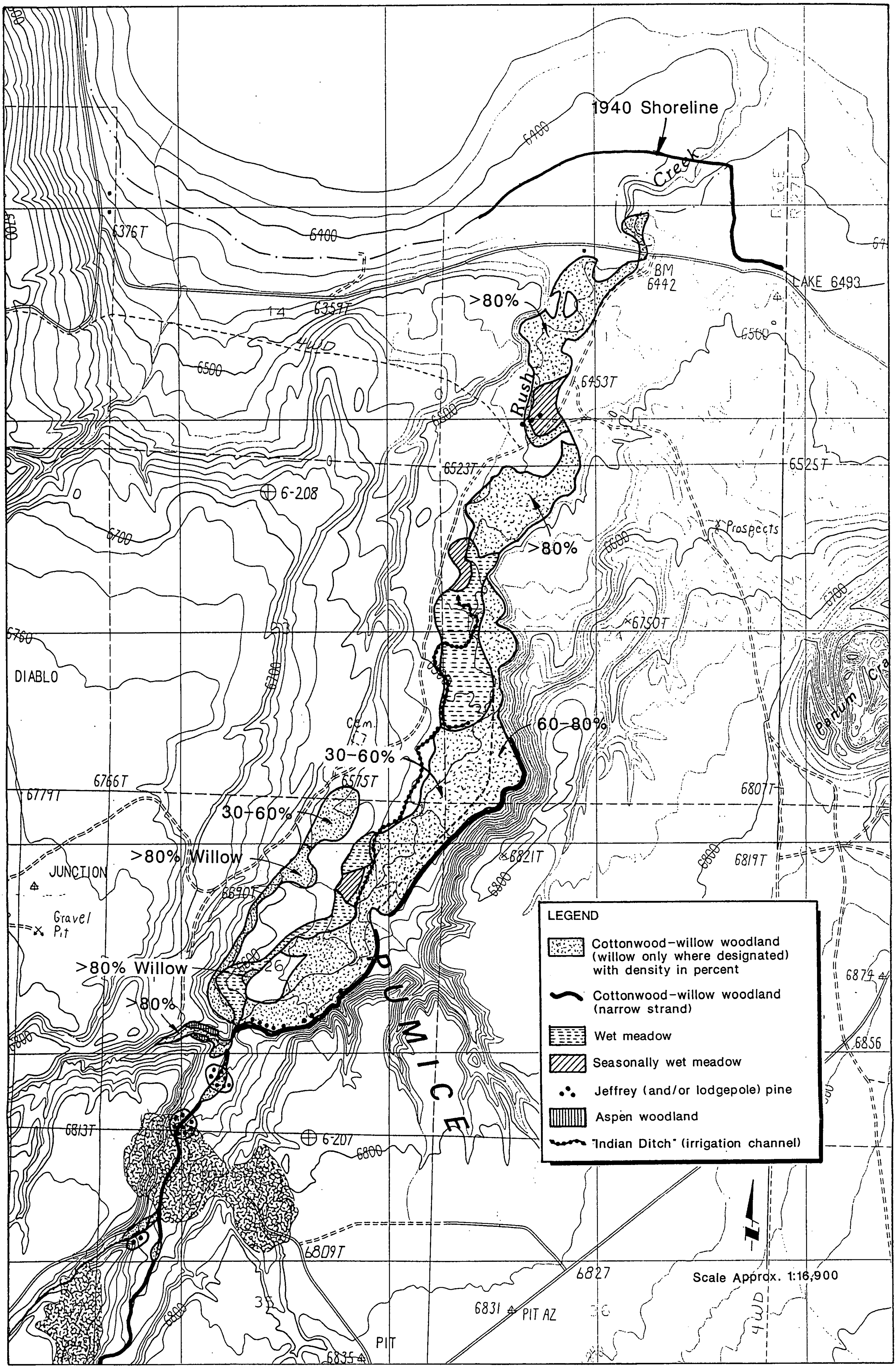


Figure 3a. Riparian Vegetation on Rush Creek 1930-1940
(See also Figures 3b and 3c)

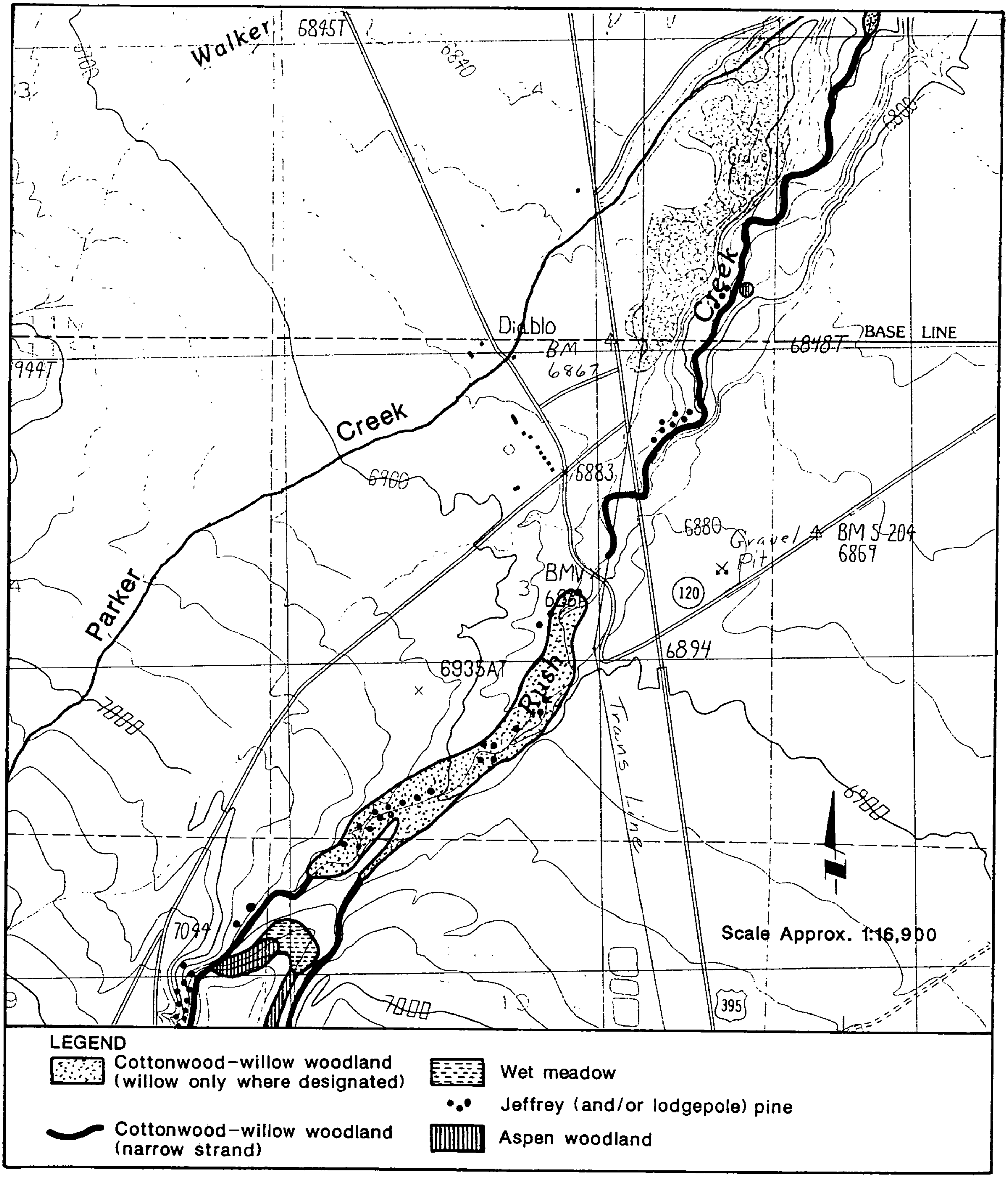


Figure 3b. Riparian Vegetation on Rush Creek 1930-1940
(See also Figures 3a and 3c)

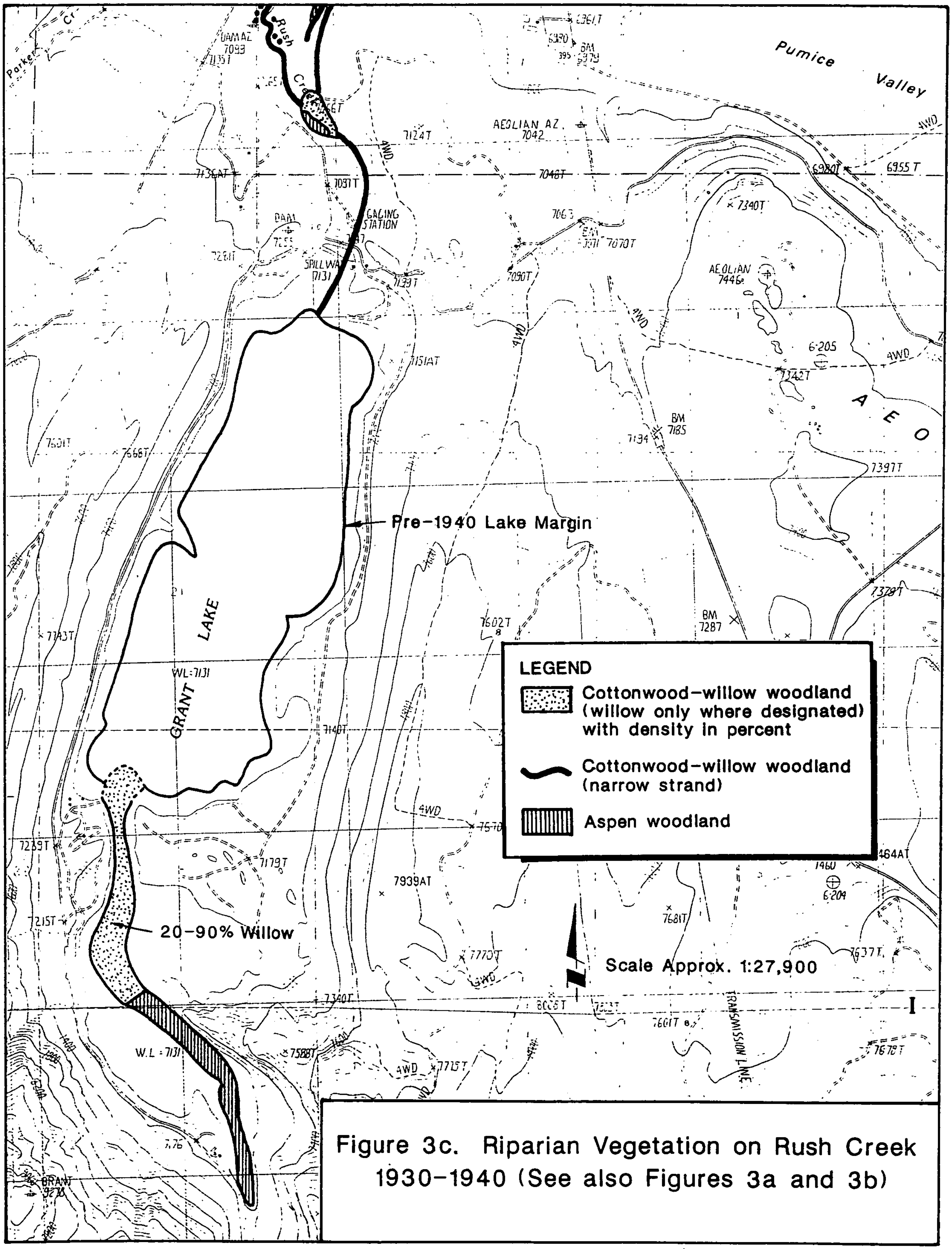


Figure 3c. Riparian Vegetation on Rush Creek 1930-1940 (See also Figures 3a and 3b)

i. *Wet meadow* (total 65 acres in the Rush Creek system below Grant Lake). This unit owed its existence to sedimentary and geomorphic conditions that favored a high water table, in combination with year-round flow of seeps and springs. It was typically characterized by graminoid vegetation (grasses,sedges, rushes), though scattered willows occasionally composed up to ~30% of the cover (when woody vegetation composed greater than 30% of the cover, a designation other than "wet meadow" was applied, even if the ground itself suggested "wet meadow"). Wet meadow was common in the Rush Creek bottomlands below the narrows (particularly on the west side of the stream), where it covered a total of ~62 acres. A considerable portion of this--the ~38-acre meadow that stood ~0.5 miles above the ford--was maintained at least in part by direct irrigation from "Indian Ditch". In the absence of Indian Ditch this particular meadow may have been "seasonally-wet meadow".

ii. *Seasonally wet meadow* (total 16 acres in the Rush Creek system below Grant Lake). This unit included areas that were wetted by overbank flows (from either the main stream or one of its tributaries) during the high-runoff season. This type of meadow dried seasonally. On aerial photographs, at least, the vegetation appears similar to that of the wet meadow, though there may well have been real differences. Seasonally-wet meadow was restricted to the flanks of the Rush Creek bottomlands, in areas that were unaffected by either direct irrigation or springflow.

iii. *Willowlands* (total 17 acres in the Rush Creek system below Grant Lake). This unit includes only the arbuscular (shrub-like) willows; the tree-sized willows appear to have occurred mainly in association with cottonwoods in the "cottonwood-willow woodland" (see below). (Buffaloberry was mapped with the willows, since it could not be differentiated on air photographs.) The willows seem to have been the earliest woody colonizers in the riparian zone, appearing on lands newly created by lateral planation and by retreat of the Mono shoreline. In general, willowlands occurred in two main settings: on recently disturbed lands (including the banks of the stream), and along moderately to steeply sloping lands fed by seeps and springs. For mapping purposes the 17 acres of willowland was divided into 2 density catagories: 60-80% cover (total ~7 acres), and >80% cover (total ~10 acres).

iv. *Cottonwood and willow woodland* (total 256 acres in the Rush Creek system below Grant Lake). The association of cottonwoods, and willows of both arboreal and arbuscular types, was the most widespread of the riparian units on Rush Creek. It occurred immediately adjacent to the stream, as well as on floodplain areas characterized by a high water table. On and near the bottomlands it covered a total of ~208 acres; an additional 48 acres occurred in 2 broad patches above Old Highway 395. For mapping purposes this 256 acres was divided into 3 density catagories: 30-60% cover (total = 122 acres), 60-80% cover (total 72 acres), and >80% cover (total 62 acres). The character of the cottonwood- willow woodland is well illustrated in Aitken Case exhibits 3c, 3e, 3f, and 3h.

v. *Pines.* Fewer than 100 medium to large jeffrey pines (and a handful of lodgepoles) occurred along Rush Creek below Grant Reservoir. These are mapped as dots on Figure 3. The pines were most abundant above the narrows, where they occurred in small congregations (in many cases too small to be called groves). They were restricted to the fringes of the riparian woodland, where the land was seldom flooded, but were the water table would have been moderately high. No attempt was made to derive an acreage of pines on Rush Creek.

vi. *Aspens* (total ~10 acres in the Rush Creek system below Grant Lake). As noted above, only 3 groves of aspens were identified from aerial and ground photographs of Rush Creek (I was able to identify the smallest of these only after conferring with Prof. Duncan Patten). Conversations with Elden Vestal confirm that aspens were indeed rare along Rush Creek below Grant Reservoir. They occurred on slopes in areas of naturally occuring springs and/or seeps.

vii. *Sagebrush scrublands.* The lands of low water table that lay adjacent to the wetter areas in the Rush Creek system were covered by brushy species, most notably Big Sagebrush (Artemisia tridentata) Scrub occurred not only upslope of the riparian/wetland vegetation, but amongst it, on the islands of coarse sediment in the bottomlands.

The total acreage given here for aspen, cottonwood-willow woodland, and willowlands (283 acres) does not include the thin riparian strand that lined the east wall of the Rush Creek bottomlands below the narrows, or that which occurred along Rush Creek itself above the narrows. While it is difficult to express these thin strips in areal terms, a 50-foot-wide swath extending over a distance of four miles may be used as reasonable dimensions. This would reduce to an area of approximately 25 acres, for a total riparian area on Rush Creek below Grant Lake of 308 acres.[1] Over long stretches of the stream between Highway 395 and the narrows, this strand is said to have been "jungle-like" in density.

## D. Changes in the Rush Creek Riparian System After 1940--An Overview

***Climo-hydrologic setting, and geomorphic changes***. In November of 1940 the DWP began impounding water behind the newly enlarged Grant Dam, thus holding back water from Rush Creek. Actual diversion of water from the Mono Basin began the following April. Due to high runoff, however, DWP diversions from the basin remained generally low through 1946, and periods when no water was released down Rush Creek were few and short-lived (annual runoff from the Mono Sierra between 1941 and 1946 averaged 115% of the 1937-1983 mean, according to Vorster.) The period between 1941 and 1946 saw well-above-normal irrigation diversions on A and B ditches. It is therefore not surprising that Vestal reports high springflows in the Rush Creek bottomlands during this period. Despite the commencement of DWP

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[1] C.H. Lee estimated from J.V. Peterson's generalized vegetation maps that the willow, cottonwood, and aspen on Rush Creek covered approximately 467 acres. Exactly what portion of Rush Creek Lee considered in his calculation is not known, though it seems likely that he included acreages along stretches of Rush Creek above Grant Reservoir. As described below, that area supported extensive stands of riparian woodland, some 90 acres of which were destroyed when the reservoir was enlarged in 1939-40.

operations, then, Rush Creek remained well-watered through 1946.

The following five years (1947-1951) were characterized by lower than normal runoff (according to Vorster, annual runoff from the Mono Sierra was 75-76% of the 1937-1983 annual mean in 4 of these years, and 98% of the annual mean in one year). Between 1948 and 1951 the DWP diverted virtually all of the Rush Creek flow, as well as all the flow from Walker and Parker creeks (see below) into its aqueduct; irrigation diversions from Rush Creek were cut to zero, and diversions onto the Walker and Parker creek lands were greatly reduced, thus substantially diminishing the supply of water to the spring system of the bottomlands. Gradually, springflow began to wane: Vestal reports that the minimum flow of Rush Creek at the ford had dropped to 12 cfs by 1948, and to just 2 cfs by 1950 and '51. Mean streamflow at the ford in 1951 was only 2.5 cfs. Operation of "Indian Ditch" had ceased by this time (it is not operative at the time of, or after, the aerial photographs of August 1954 were taken).

Flow records indicate that between 1952 and 1959 releases from Mono Gate No. 1 were highly variable, ranging from an annual high of 68,000 acre feet to an annual low of zero. Irrigation releases to A and B ditches likewise varied markedly, though they remained above 50% of normal in all but one year. Following a four-year period of dewatering in the late 1940s and early 1950s, then, Rush Creek was rewatered, albeit in a highly variable regime, between 1952 and 1959.

The years 1960 to 1965 saw almost no release of water to Rush Creek from Grant Reservoir. Equally as significant were the cutbacks in irrigation releases on A- and B-ditches--these averaged only ~23% of the long-term normal on B-ditch, and less than 3% on A-ditch, over this 6-year period. The year 1966 brought moderate releases to both Rush Creek and the irrigation ditches.

During the period 1940-1966, the surface elevation of Mono Lake dropped nearly 30 vertical feet--from 6417 feet to 6389 feet--in response to DWP's diversions. This drop in lake level is of tremendous importance in understanding the geomorphological modification of Rush Creek below the narrows that occurred in the spring and summer of 1967, when floods on that stream reached monumental proportions. In July alone of that year over 53,000 acre feet of water spilled and/or was released from Grant Reservoir--an average flow over the month of nearly 900 cfs. The flood washed out the stream gauge at the ford, making it impossible to determine precisely the peak discharge, but observers report that at times during this month flows on Rush Creek exceeded 1500 cfs. Had Mono Lake stood at its 1940 (or even 1950) level at the time of this deluge, geomorphological modification of the Rush Creek bottomlands would probably have been only minor: As in previous floods, the stream would have overflowed its banks and covered the entire valley bottom with shallow water. But regression of the lake had exposed a previously submerged topographic nickpoint on the Rush Creek delta that instigated incision of the stream--first at the stream mouth, then progressively headward to the narrows. This incision, in turn, forced other changes: Suddenly the channel was deeper and its gradient was steeper--in both cases permitting greater amounts and velocities of flow. With excess energy suddenly imparted to the system, the stream cut off several large meanders and in places avulsed, straightening (and thus further steepening) the channel. High (but not monumental) flows again occurred on Rush Creek in 1969, though it seems probable that, with the lake occupying nearly the same elevation it did in 1967, further incision was slight.

These flood years were followed in 1970 by the inception of the DWP's "second barrel" of the Owens Valley-to-Los Angeles Aqueduct, which permitted the agency to increase its export of water from the Mono Basin. Thereafter, the DWP was forced to release substantial amounts of water from Mono Gate No. 1 to Rush Creek only during periods of highest runoff. Releases were less than 1% of the long-term normal in 7 of the 9 years between 1971-79, and only in one year of that period did releases exceed 50% of normal. Operation of the second barrel had the additional effect of bringing an end to irrigation diversions on A and B ditches. The spring system along the east wall of the bottomlands likely ceased flowing shortly after 1970, while the system on the west side, fed only by the irrigation of Cain Ranch lands, was likely greatly diminished.

Mono Lake responded to these increased diversions by increasing its rate of decline. By 1980 the lake surface had fallen to a level 16 feet below that of 1967-69. High releases and spill from Grant Reservoir during the spring and summer of that year forced renewed incision of the stream. The high flows of 1982, '83, and '86 widened this newly-deepened channel.

Today Rush Creek below the narrows flows through a single channel that is deeper (by ~2-7 feet immediately below the narrows, by 15 feet at the county road crossing, and by ~30 feet at its mouth), steeper (by ~10% near the narrows to ~60% near the ford), wider (by ~15 to ~35 feet) and straighter, than the channel of 1930-1940. Today's channel is far larger in cross-sectional area than the pre-1940 channel, with the result that far higher streamflows are now required to flood the bottomlands. Deprived of access to its former floodplain, the stream is in the process of carving a new floodplain adjacent to the channel. No silts have yet accumulated on the cobbles and boulders of the new floodplain, leaving some species of riparian vegetation without an appropriate seedbed. The lack of silt deposition is perhaps because of the high gradient of the floodplain, and the torrential nature of the floods that cross it.[1]

The incision of Rush Creek below the narrows resulted in the removal of much of Vestal's "excellent gravel". The present-day bed is dominated by large cobbles along at least 80% of the narrows-to-ford reach (Stacy Li, pers. comm). Flushing of the gravels probably occurred due to winnowing during the incision events of 1967 and 1980. Through a mechanism that is not completely clear,

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[1] The lack of silts may also be due to another important change in the flood regime of Rush Creek: Formerly, floods subsided slowly, permitting a gradual buildup of sediment. In contrast, since the DWP began their operations, the high flows have not been allowed to subside slowly, but rather have been terminated abruptly (literally "turned off"), providing little opportunity for deposition.

much of the gravel that does persist has become immobile due to cementation, apparently with iron or manganese oxide.

Springflow along the margins of the bottomlands, previously made copious by irrigation, is now meager and restricted to a few localities immediately below the narrows along the west valley wall. This factor, together with the channel incision, has caused a marked drop of the water table in all but a few small areas of the Rush Creek bottomland. As a result, most of the bottomland, which was previously morass even at low stream flows, is today dry even during times of substantial stream flow.

The mouth of the stream now lies ~0.6 miles north of its 1940 position due to lake recession. This new reach is deeply entrenched into highly porous volcanic and deltaic sediments. Its floodplain is relatively narrow, and is bounded by high-standing erosional terraces that mark the stream levels of 1967-69 and 1980.

Upstream of the bottomlands, the geomorphology of Rush Creek has changed relatively little since 1940, in large part because the nickpoint induced by the recession of Mono Lake cannot be translated beyond the bedrock constriction at the narrows. This, and the fact that the channel bed in many areas above the narrows is dominated by large, transport-resistant cobbles and boulders, has prevented appreciable incision by the stream. Lateral migration of the channel above the narrows has occurred, but is appreciable at just 2 sites: Immediately above and below the crossing of old Highway 395, where the channel was modified by gravel extraction and/or gravel dumping during the construction of the highway and/or B-ditch; and immediately above the narrows, where gravel quarrying seems to have destablized the western bank of the stream, causing some channel filling. In both cases, these changes in the stream were undoubtedly exacerbated by the degradation of the riparian vegetation.

***Changes in riparian vegetation.*** The Dust Bowl drought of the 1920s and '30s, while severe, seems to have had little if any degragdation of the riparian vegetation along Rush Creek. Irrigation-induced flows from springs and seeps, as well as periodic stream releases, apparently were sufficient to maintain a high water table and favorable growing conditions, as evidenced by accounts from early observers, and by photographs from the early and mid-1930s showing generally healthy-appearing vegetation. (Some local destruction of the riparian stand had occurred prior to 1930 immediately above and below Highway 395, due perhaps to the construction of the highway and B-ditch--see below).

Similar evidence, in combination with written and spoken accounts from observers, indicates that in general the riparian vegetation thrived during the well-watered years through 1947. Exceptions to this rule occurred due to logging; between 1940 and 1942 the largest of the old-growth jeffrey and lodgepole pines between Grant Reservoir and Highway 395 were logged by DWP or Forest Service contractors (Vestal notes and testimony).

Shortly after the near-total halt of stream releases in 1948, the riparian vegetation on Rush Creek above the narrows began to show signs of desiccation. Upon his departure from the Mono Basin in 1951, Vestal noted that many of the cottonwoods below Highway 395 had died, and that dying jeffrey pines were turning a "rusty red". It seems reasonable to assume that riparian loss after 1951 was greatest and most rapid during the times of similarly low stream releases (e.g. 1960-65); degradation may have slowed, if not ceased, during times of moderate releases (e.g. 1952-59).

In general, riparian degradation along Rush Creek below the narrows occurred more slowly than it did on the higher reaches of the stream. Aerial photographs from the 1950s and '60s show that dense vegetation persisted in the bottomlands thoughout this period, a conclusion corroborated by Mr. Wes Johnson (personal communication). Apparently the watertable along most of the bottomlands remained high enough to support the vegetation. Only the lands formerly irrigated by Indian Ditch, which were dry by 1954, were adversely affected during this period by the DWP's operations.

Wholesale modification of the bottomland vegetation came only after the stream incision of 1967. By the early 1970s the incision-induced drop in the water table, together with the cessation of irrigation releases on A and B ditches and a lack of stream releases, had resulted in the desiccation of much of the cottonwood-willow woodlands (Wes Johnson, personal communication). By 1980, when I began work in the Mono Basin, little living phreatophytic vegetation remained along the bottomlands. (Throughout the period between 1940 and 1980 grazing animals had access to lands along Rush Creek. The stock undoubtedly influenced the timing and degree of vegetation change, at least locally.)

During the past decade, several years of high precipitation and runoff ( i.e. 1980, '82, '83, '84, and '86), in combination with court-mandated flows, have kept water in Rush Creek for prolonged periods. Stromberg and Patten document the rebound of riparian vegetation that has occurred in some areas since that time. Recolonization of large areas of the bottomlands, however, is occurring only very slowly, if at all, and there seems to be little evidence of recolonization by the once-dense cottonwoods. Riparian vegetation has yet to establish itself along most of the reach below the county road.

## E. The Enlargement of Grant Reservoir and its Impact on the Riparian Vegetation of Rush Creek, 1930-1940

Enlargement of Grant Reservoir in 1939-40 (from a surface area of ~700 acres at capacity to ~1100 acres) resulted in two notable and direct changes in riparian vegetation. Prior to 1940, Rush Creek entered the reservoir through a narrow canyon cut into recessional moraines of late Tioga age. The lower 1.5 miles of this canyon was inundated when the reservoir was filled, resulting in the loss of ~50 acres of aspen woodland (interspersed with cottonwoods and lodgepole pines), and ~40 acres of undifferentiated wet meadow and cottonwood-willowland. (These areas were logged and burned by the DWP in the summer and fall of 1940, prior to inundation.)

The ~0.75-mile-long irrigation supply channel that served as the spillway for the old dam was in places densely lined with willows and aspens. Replacement of the old dam as part of the reservoir enlargement resulted in the obliteration of most of this channel, and the loss of the vegetation (assuming a total width for the riparian corridor of 50 feet, this translates to a loss of ~4.5 acres of vegetation).

# 4. RIPARIAN VEGETATION AND SUPPORTING CONDITIONS ON LEE VINING CREEK, 1930-1940

## A. Climo-hydrologic Context

The climatic history discussed above for Rush Creek applies equally to Lee Vining Creek. The hydrology of the Lee Vining drainage during the period 1930-1940, however, differs significantly from that of Rush, and so is discussed in detail.

Between 1930 and 1940, large amounts of water were taken from Lee Vining Creek for irrigation and hydroelectric generation. But the available historical sources indicate that a substantial portion of Lee Vining Creek water remained undiverted. When the Fairchild aerial photographs were taken in January of 1930, Lee Vining Creek flowed all the way to the lake. The Aitken Case maps of the early 1930s likewise show a stream stretching to the lake. Even at the height of the irrigation season in the last (and second driest) of the Dust Bowl years, the stream never dewatered. Only 6 times during the 68 months between April of 1934 (when the Lee Vining flow record begins) and November of 1940 (when DWP began operations) did the mean monthly flow at the county road crossing of Lee Vining Creek drop below 12 cfs. In almost half of those 68 months flow exceeded 30 cfs, and in one quarter of the months flow was in excess of 60 cfs. The impression is of a stream well-watered throughout the period 1930-40.

Irrigation return flow, while an important element of Rush Creek hydrology, played a relatively minor role on Lee Vining Creek. Most of the irrigation water was diverted away from the creek's drainage, so that any resultant runoff or seepage fed areas other than the stream. There were three exceptions to this rule: Irrigation water from the Lee Vining ditch that was applied to the lands adjacent to town occasionally ran off into Lee Vining Creek through a cut near the present-day sewage ponds. A portion of the water applied to these same lands undoubtedly seeped through the alluvial and lacustrine sediments of the late Pleistocene Lee Vining Creek delta, and reappeared in the walls of Lee Vining Canyon below town. It seems likely that this represented a relatively small contribution to the natural seepage that occured along the canyon walls. (The presence on these seepage areas of quaking aspen--a tree that, because of its reliance on vegetative reproduction, colonizes and expands its distribution only slowly, suggests that seepage had been present here for hundreds if not thousands of years. These aspens, and the seeps that feed them, persist today despite the cessation in 1959 of irrigation from Lee Vining ditch.)

A second exception was found to the east of the stream, where small amounts of surface water from lands irrigated by Rogers ditch occasionally reached Lee Vining Creek. The groundwater contribution from this source, if it existed at all, was insignificant.

Groundwater was of greater significance in the final exception. This involved water utilized at the Forest Service compound, as well as irrigation water applied from O-ditch to the lands upstream from the compound. Surface and sub-surface flow from these sources supplied a small (but in post-diversion years significant--see below) amount of water to the stream reach above, and immediately below, Highway 395.

## B. Lee Vining Creek Geomorphic Conditions, 1930-1940

Exhibit 33, prepared for the Aitken Case, provides an accurate record of the course that Lee Vining Creek followed in 1933 (Figure 4). Any differences that exist between that course and the ones pictured on the 1930 and 1940 aerial photographs are slight.

From the present-day site of the DWP's diversion facility on Lee Vining Creek, the stream followed a meandering, ~mile-long path of gentle gradient (~26/1000) across alluvial fill within the valley formed by the Tioga-age lateral moraines. This is hereafter called the "Forest Service Reach".

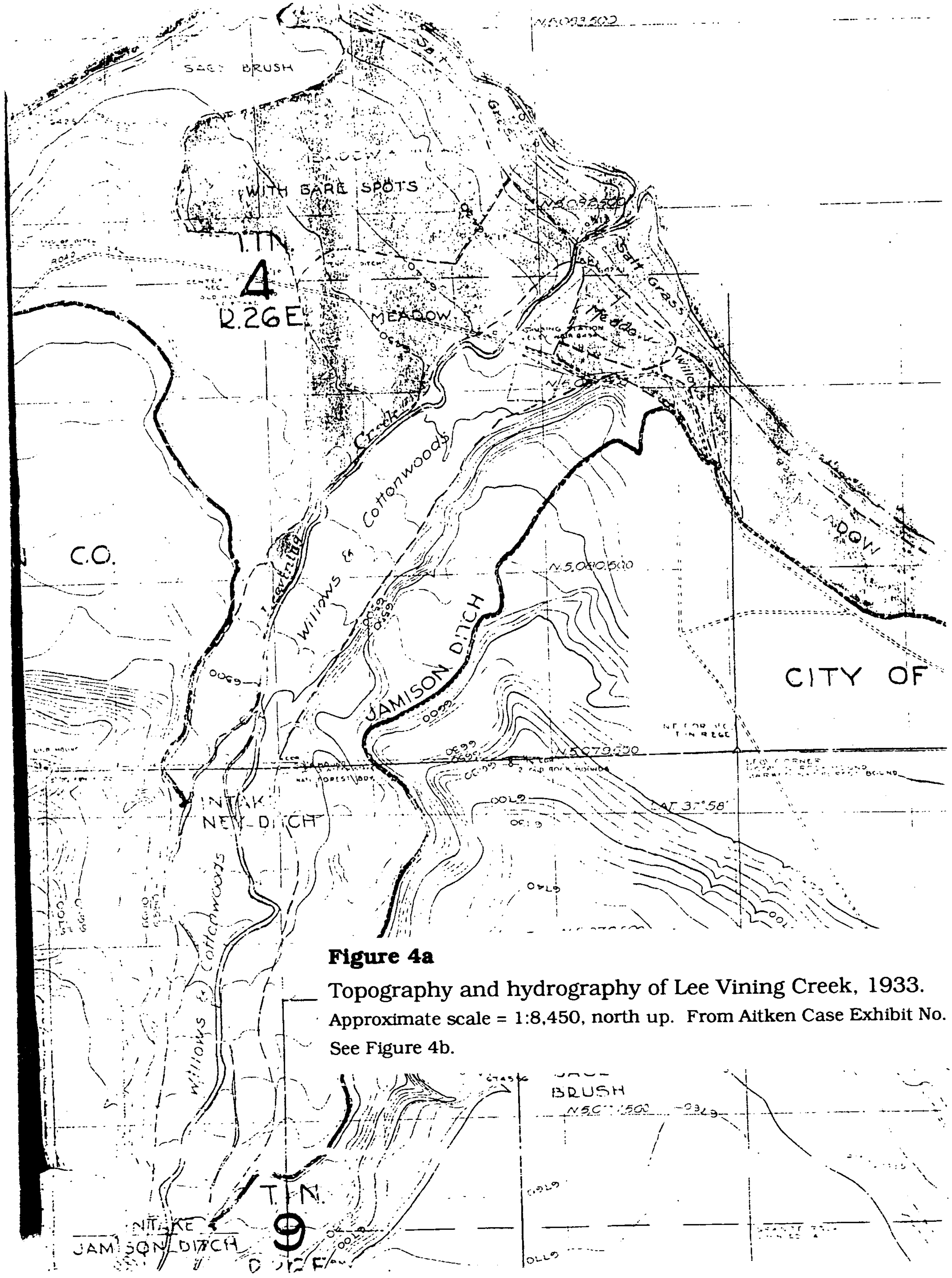


**Figure 4a**

Topography and hydrography of Lee Vining Creek, 1933.

Approximate scale = 1:8,450, north up. From Aitken Case Exhibit No. 77

See Figure 4b.

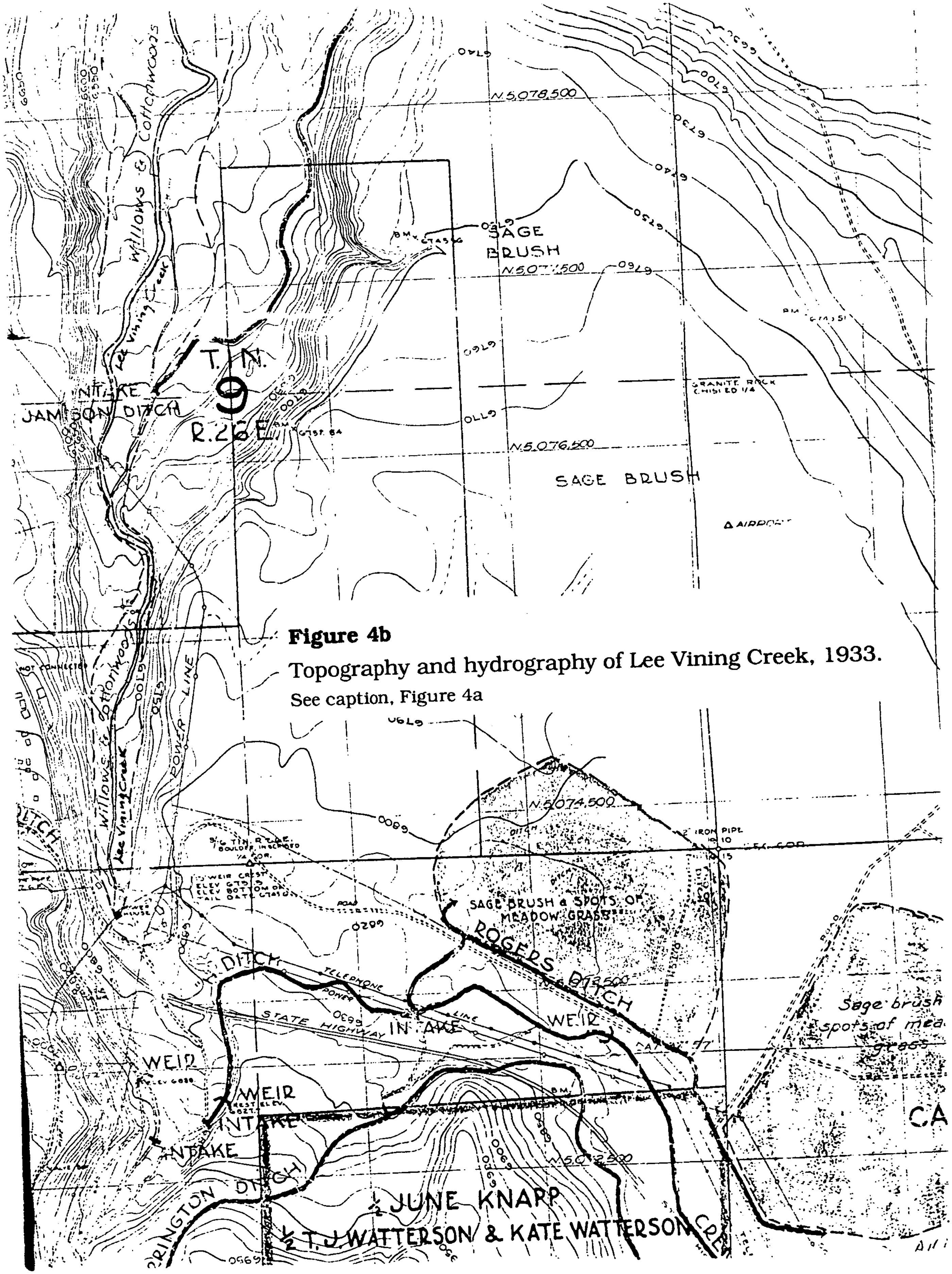


**Figure 4b**

Topography and hydrography of Lee Vining Creek, 1933.

See caption, Figure 4a

Beyond the Tioga-age terminal moraines the stream cascaded down a steep (in places >100/1000), bouldery, 7000-foot-long reach cut into glacial till of pre-Tioga (likely Tahoe) age. One overflow channel in this reach (hereafter called the "moraine reach") carried water ~2000 feet before rejoining the main stream. The overflow channel was effectively cut off from the system when the new segment of Highway 120 was built in the early 1970s.

At the approximate location of Highway 395 (elevation ~6800 feet) the stream entered a canyon that was cut into the late Pleistocene Lee Vining Creek delta. From this point to the county road, a distance of 1.8 miles, it flowed through this "delta canyon" at a generally decreasing gradient (from ~80/1000 near the canyon head, to ~30/1000 near the canyon mouth). Fine gravels were largely winnowed when this canyon was cut in early Holocene time, leaving behind the lag of cobbles and boulders that dominated the channel floor in 1930-40. True braiding was rare along this delta-canyon reach during the decade prior to DWP's operations, though numerous overflow channels existed.

At times during the late Holocene, rises in lake level caused aggradation along the delta-canyon reach. The stream in 1930-40 had incised these aggraded deposits, and was in some areas laterally constrained by the resultant islands of sediment (interfluves), even during times of high runoff. Along most portions of the reach, however, the stream was incised only a few feet (based on the Aitken Case maps), and it readily overflowed when runoff was high, spreading overbank sands and silts onto the floodplain.

At the county road (elevation ~6440 feet), Lee Vining Creek debouched from its delta canyon, flowing ~500 feet to the lake over Holocene-age deltaic deposits. These deposits were composed of sediments winnowed from the canyon, and were therefore finer (typically cobbles and gravels) than those that composed the canyon floor.

### C. Lee Vining Creek Riparian Vegetation, 1930-1940

Quaking aspen, while rare on Rush Creek below Grant Lake, was a commonly occuring species along the flanks of the upper reaches of Lee Vining Creek's delta canyon; one small grove also occurred along the right flank of the delta canyon near its mouth. The occurence and maintenance of this species on Lee Vining Creek was apparently related more to natural seepage from the deltaic sediments composing the canyon walls than to flow of the stream itself. The aspen distribution along Lee Vining Creek seems to have changed little since 1940, and therefore is not dealt with further here.[1] Instead, concern is with the floodplain vegetation which, on Lee Vining Creek, was synonymous with the riparian corridor.

A list of the dominant and sub-dominant species that composed the riparian corridor on Lee Vining Creek below DWP's diversion would bear a high degree of similarity to the list provided above for Rush Creek. Exceptions include the near or total absence of silver buffaloberry, and the presence of dogwood (Cornus stolonifera) and white fir (Abies concolor), on Lee Vining Creek. This latter species was rare below the morainal reach of the stream.

The vegetation assemblages that existed along Lee Vining Creek below what would become DWP's point of diversion are mapped on Figure 5. Production of the map involved the same procedure described above for Rush Creek. The mapping units used on Lee Vining Creek include the following:

i. *Seasonally-wet meadow* (total ~32 acres). One patch of meadow, located west of Lee Vining Creek near the stream mouth, was watered by a small unnamed irrigation ditch. The land appears to be dry on the aerial photographs of January, 1930, but wet on those of June, 1940. Maintenance of this meadow was dependent on irrigation; it has reverted to sagebrush.

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[1] Range-survey annotations on the 1940 aerial photographs show a small area of aspen along the mid-reaches of the right wall of Lee Vining Creek's delta canyon. I cannot find any field evidence of former aspens in that area, and the 1930 aerial photographs show no such grove. I conclude ttherefore hat this grove did not exist.

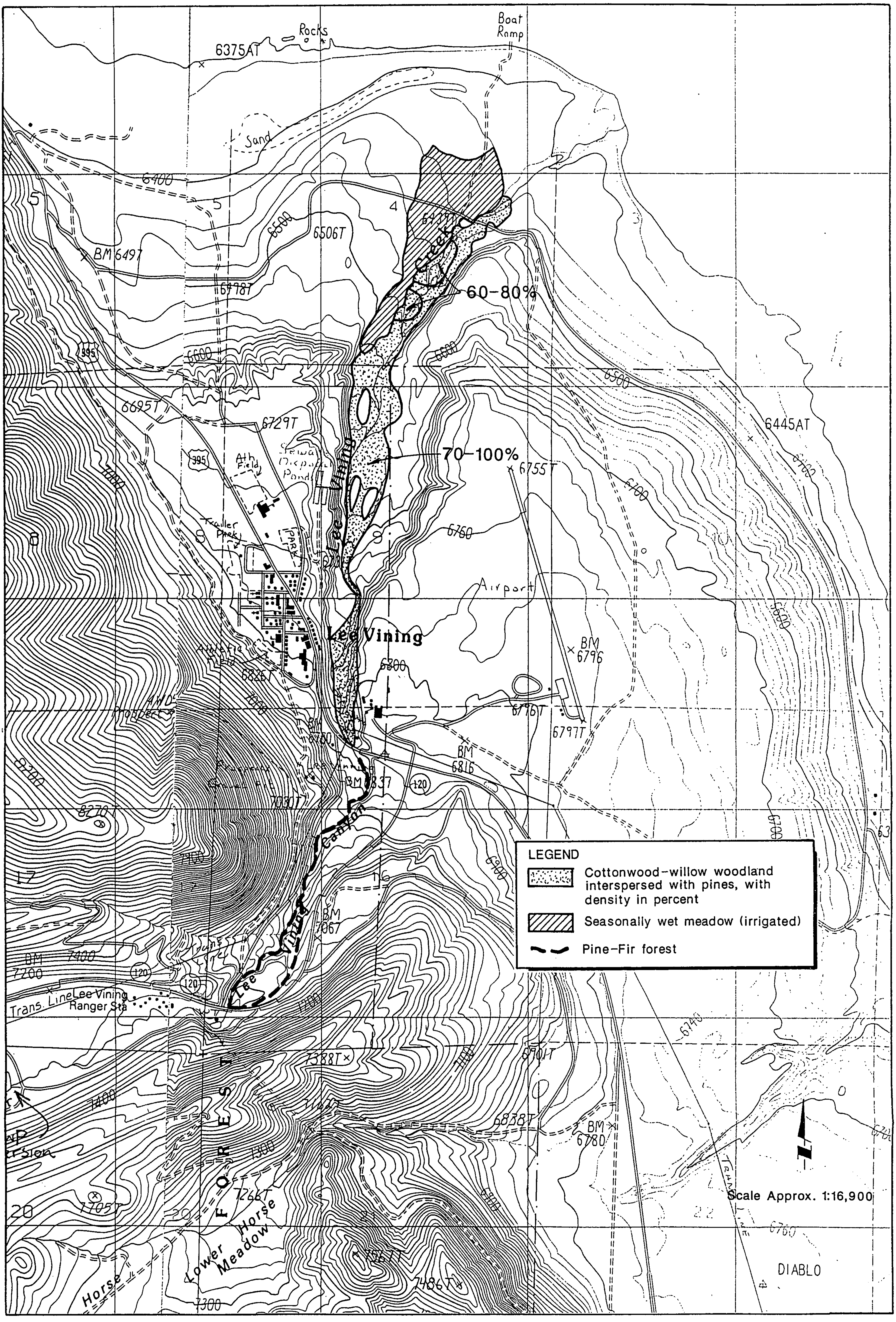


Figure 5. Riparian Vegetation Along Lower Lee Vining Creek 1930–1940

ii. *Cottonwood and willow woodland* (total ~84 acres). The most extensive of the vegetation types mapped on Lee Vining Creek is cottonwood and willow woodland. This association covered nearly the entire floodplain of the delta-canyon reach of Lee Vining Creek, at densities of between 60 and 100%. For mapping purposes two overlapping density classifications--60-80%, and 70-100%-- were employed. This assemblage was interspersed with jeffrey (and very occasional lodgepole) pines. The pines were particularly abundant in the uppermost fifth of the delta-canyon reach--the steepest and narrowest portion of the reach. (Note that C.H. Lee, based on H.V. Peterson's delineation of vegetation boundaries on the Aitken Case maps, derived a total of 85 acres of deciduous woodland for Lee Vining Creek.)

iii. *Pine-Fir woodland* (total ~32 acres). A narrow but dense band of white fir and jeffrey (occasionally lodgepole) pine interspersed with aspens, cottonwoods, and various understory shrubs, dominated the moraine reach of Lee Vining Creek. In general the deciduous trees and shrubs became more common near the lower end of the reach, where the valley was flatter and less constricted than at higher elevations. Pine-fir woodland lined the main stem of the stream, as well as the ~2000-foot-long avulsion channel near the head of the reach. This assemblage appears to have changed little since 1930-40 (see below), though Taylor noted that, as of 1982, the vegetation had not reached equilibrium with the reduced streamflows resulting from DWP diversions.

iv. *Sagebrush scrubland.* In the absence of seepage or irrigation, lands standing above the riparian corridor along Lee Vining Creek were dominated by sagebrush scrub. This included lands adjacent to the floodplain, as well as the interfluves. Four small patches of scrubland, totaling ~14 acres, stood amongst the riparian strand along the delta-canyon reach of the stream.

## D. Changes in the Lee Vining Creek Riparian System After 1940--An Overview

Because of high runoff, DWP's water-export operations did not markedly change the flow regime of Lee Vining Creek until 1947. Between April of that year and February of 1952, the average monthly flow at the county road crossing fell to 1.1 cfs--less than 2.5% of what it had been during the previous (and first) 13 years of record. The cutbacks rapidly desiccated the riparian vegetation of the delta-canyon reach. Sometime prior to 1954 (rumors say 1951) the riparian vegetation along the middle portions of that reach was dry enough to be consumed by fire. By 1963 nearly all of the woodland of the delta-canyon reach that had survived the fire was dead. Only in the uppermost fifth of the reach did it survive (see below).

Surprisingly, the catastrophic flood of 1967 that so changed the geomorphology of Rush Creek was not felt on Lee Vining Creek. Even though Grant Reservoir was full and spilling, the DWP continued to divert Lee Vining water to it by way of the conduit. The amount of water that spilled into Lee Vining Creek at the DWP diversion was minor.

During the high runoff year of 1969, in contrast, the DWP did release large amounts of water down Lee Vining Creek. This release, coupled with the lake regression of the previous decades, caused the stream to incise. Incision was greatest (up to ~7 feet) in the lower ~3000 feet of the channel, where the sediments that composed the bed were relatively fine and erodible. Above the county road, in the delta-canyon reach, the boulders of the channel floor restricted incision.

The flood of 1969 induced other, more significant, geomorphic changes along the delta-canyon reach of Lee Vining Creek. With the riparian vegetation now dead and no longer binding the fine overbank sediments that composed the former forest floor on the floodplain, the torrent scoured and removed the fine sediments, exposing the underlying cobbles and gravels. (The fine overbank sediments that covered surfaces above the level of this flood persist today.) The absence of ground-binding vegetation also permitted the stream to erode laterally and avulse: Approximately 2700 feet upstream from the county road crossing (elevation ~6500 feet), the stream cut and occupied a new channel along the right wall of the delta canyon, abandoning its former course along the left wall.[1] The high runoff of 1980, '82, and '83 forced another ~10 feet of incision in the lower reaches of the Lee Vining Creek, and further widened the channel floor.

In the uppermost section of the delta-canyon reach of Lee Vining Creek, as well as along the moraine reach, the riparian vegetation has persisted despite DWP's diversions. The reason for this persistence might lie in the fact that since 1947 residual flow from within and above the Forest Service reach has continued to water Lee Vining Creek down to, and somewhat below, Highway 395. This residual flow is composed of seasonal flow from Log Cabin Creek, return flow and groundwater seepage from water used at the Forest Service compound, and return flow and seepage from O-ditch irrigation.

With this possibility in mind, it is of interest to consider another vegetation change that occurred in post-diversion time along Lee Vining Creek. For approximately 2500 feet below Highway 395 (thus, in the upper 2500 feet of the delta-canyon reach) the riparian vegetation was slow to desiccate in response to the DWP's diversions. In August of 1954, a time when the riparian stand along the rest of the delta canyon was dead or dying, this portion of the strand persisted. On aerial photographs taken in August of 1963 even this persistent strip seems to be dying; with few exceptions, only trees in the

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[1] The importance of a lack of vegetation in accounting for the modification of Lee Vining Creek during the flood of 1969 is made clear by comparing the runoff characteristics of that year with those of another flood year--1938. In June of 1938 flow at the gaging station above the Forest Service compound averaged ~300 cfs; average daily flows during that month reached as high as 503 cfs (on June 9). It is evident from the 1940 aerial photographs that this flood, though severe, had no appreciable impact on the geomorphology of Lee Vining Creek. Clearly, with vegetation binding the channel walls and the floodplain, the system was capable of withstanding such high flows.

The highest average monthly flow recorded in 1969 was virtually the same as in 1938--311 cfs--and the average daily flows were substantially lower than those of 1938, peaking at 418 cfs (on June 4). Nevertheless, the 1969 flood wreaked havoc on the now-denuded stream, stripping the woodland soils of the floodplain, widening the channels, and forcing the above-noted avulsion. (Note that these changes occurred upstream of the reach that was affected by incision; the geomorphic alterations in the delta-canyon reach were thus not caused by the drop in lake level.)

upper ~500 feet of the reach support leaves. By October of 1982, in contrast, this entire strip had recovered, and by August of 1986, the vegetation along this stretch was approaching pre-1941 densities. It seems plausible that the increase in diversions on O-ditch that began around 1965 (to ~160% of the 1947-1964 amount) may have played a role in this riparian recovery.

The persistence of the vegetation in the upper portions of the delta canyon reach, and throughout the morainal reach of Lee Vining Creek, together with the coarseness of the sediments that compose the channel bed over these portions of the stream, prevented any notable geomorphic change during the floods of 1969 and the early and mid-1980s.

Due to the artificially induced drop of Mono Lake, Lee Vining Creek is currently ~1900 feet longer than it was in 1940. A few cottonwoods, and, near the stream mouth, a stand of willows densely interspersed with introduced species of vegetation (primarily Melilotus alba), have colonized this new reach. The newly colonized ground constitutes ~5 acres.

## 5. RIPARIAN VEGETATION AND SUPPORTING CONDITIONS ON WALKER AND PARKER CREEKS, 1930-1940

### A. Geomorphic and Climo-hydrologic Context

Under natural conditions Walker, Parker, South Parker, and East Parker[1] creeks come off the bedrock Sierra into canyons created by lateral moraines, then flow through cuts in the fanglomerate of the Sierran piedmont. At times of normal runoff the piedmont reaches may constitute single channels; during floods, the creeks spill into distributary channels near the fan heads.

The piedmont reaches of the main- and distributary channels are steepest (40-50/1000) and most deeply entrenched (~10 feet) near the heads of the fans. The channels gradually flatten (to ~15/1000) and became shallower (~3 feet) as they approach the distal margin of the fans (near the site of old Highway 395 on Parker Creek, and near present-day 395 on Walker).[2] There they enter minor canyons cut into alluvial and lacustrine sediments of the late Pleistocene Rush Creek delta, and flow to Rush Creek through these "delta-canyons".

Between 1930 and 1940 the surface hydrology of the piedmont reaches of Walker and greater Parker creeks was dominated by the irrigation system. Between April and September of each year much of the streamflow was diverted into ditches and spread onto the alluvial fans. A portion of this spread water was lost to ET; another fraction made its way back into the stream channels as return flow; the remainder percolated eastward as groundwater, reappearing as springs along the western margin of the Rush Creek bottomlands, and immediately above the mouths of Parker and Walker creeks.

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[1] South Parker and East Parker are the informal but widely used names given to the small perennial streams that flow northeastward between Parker Creek and Grant Lake.

[2] The 1953 USGS Mono Craters Quadrangle incorrectly shows Parker Creek entering Rush Creek just south of Cain Ranch. The stream actually enters Rush Creek 1.4 miles farther north.

While portions of the piedmont reaches were at times dry during the Dust Bowl drought, these times were likely of brief duration. The available records (restricted to Parker Creek, and beginning in April of 1934) indicate that, even late in the irrigation season during the last of the Dust-Bowl years, flow (albeit as little as 0.8 cfs) remained in the Parker Creek channel behind Cain Ranch. Even during these dry times, the water table in the vicinity of the natural channels was undoubtedly kept high by the application of irrigation water.

Following the Dust Bowl drought, at least a small amount of water seems to have remained in the channels of the piedmont reaches throughout the year. A comparison of Parker Creek flows recorded above the point of irrigation with those recorded behind Cain Ranch indicates that despite the diversion of as much 95% of the Parker water for irrigation, monthly flow behind Cain Ranch dropped below 1 cfs only 2 times between 1935 and 1940. While no measurements are available for Walker Creek, one might infer that, like Parker, its piedmont reach seldom if ever dewatered between 1935 and 1940.

The reaches of the streams below the piedmont are characterized by course deltaic gravels. It may well be that these delta-canyon reaches lost considerable water to percolation as they flowed to Rush Creek. This, in combination with the irrigation diversions, would account for McAfee's contention that between 1925 and 1940 Parker and Walker creeks reached all the way to Rush Creek only in the wettest years.

### B. Parker and Walker Creek Riparian Vegetation, 1930-1940

The aerial photographs of 1930 show narrow strands of riparian vegetation along the piedmont and delta-canyon reaches of the main- and distributary channels of Walker and greater Parker creeks. In comparing the 1930 photographs with those from the 1980s, it is clear that, in all but a few small areas, the extent and distribution of the dominant arboreal and arbuscular vegetation has changed little since DWP began exporting water from the Mono Basin. With little change to document, no maps of the 1930 vegetation were produced. The areas of change are discussed below.

## C. Changes in the Walker/Parker Creek Riparian System After 1940--An Overview

***Climo-hydrologic changes.*** Judging from the record of Parker Creek flow behind Cain Ranch, operation of the Parker/Walker irrigation system changed little during the first 7 years of DWP's export from the Mono Basin. Beginning in 1948, however, DWP began to divert nearly all of the Parker/Walker flow (including any would-be irrigation water) into the Lee Vining-to-Grant Reservoir conduit (hereafter called the Lee Vining conduit). As a result, flow on Parker Creek behind Cain Ranch (and presumably on Walker Creek as well) dropped to zero. It remained zero until the spring of 1952, when high runoff and renewed irrigation diversions resulted in Walker/Parker water bypassing the Lee Vining conduit. In most of the years that followed, some water was released for irrigation between May and early October, though the bulk of the Walker/Parker water (50-60% in the average year) was diverted to Los Angeles by way of Grant Reservoir. (A small portion of this reduction in flow was made up for by the release of Lee Vining Creek water onto Parker/Walker lands from siphon valves and sand traps along the Lee Vining conduit.) In wet years large amounts of water bypassed the Lee Vining conduit and filled the natural channels all the way to Rush Creek.

***Changes in riparian vegetation.*** As noted above, comparison of aerial photographs from 1930 and 1986/87 reveals changes in the riparian vegetation on the Walker/Parker Creek lands at only a few locations. Indeed, over most areas of the Walker and Parker creek fans, the arboreal and arbuscular riparian vegetation pictured on the 1930 photographs can be accounted for, tree-for-tree and bush-for-bush, on the 1986/87 photographs. The only change of any consequence lying along the piedmont reaches of these streams occured as a result of the construction of DWP's diversion pond on Walker Creek. Vegetation was destroyed not only by the excavation of the pond, but by the dumping of the spoils on a ~4000 square-foot site lying ~200 feet SE of the pond (this resulted in the loss of ~1-2 acres of riparian vegetation).

Along the delta-canyon reaches of both Walker and Parker creeks, changes in riparian vegetation since 1940 have been of greater consequence. Perhaps because of the permeable nature of the deltaic sediments, and the consequent tendency of the streams to wither as they cross these lands, DWP's water diversions have had a severe impact on the riparian strand at these localities. The dense corridor of willows that grew along Parker Creek between old Highway 395 and Rush Creek in 1930 has been lost to desiccation along at least 80% of the reach. Desiccation has destroyed the willow strand along most of the upper ~50% of Walker Creek's delta canyon. Cottonwoods, willows, aspens, and jeffrey pines persist in the lower ~1000 feet of the Parker Creek channel, and in the lower 2500 feet of Walker Creek. In both cases these woodlands appear to be supported by springs and seeps emanating from low in the canyon walls.

It is important to note that the riparian vegetation that persists on large areas of the Parker/Walker piedmont may not represent a steady-state condition. Obviously the water table, bouyed by irrigation releases, has remained high enough to support the existing vegetation. But while it is clear that little vegetation has been lost since 1930, it also appears that little has been gained, suggesting that recruitment might not be taking place under present-day conditions. It may be that overbank events are not occurring often enough to disperse seeds in adequate numbers or, alternatively, that grazing may be supressing seedlings. In either case, one might predict the eventual loss of the existing vegetation with no replacement. The status of recruitment requires more investigation.

## 6. Changes in the Riparian Vegetation at the Mouths of Mill, Wilson, and Post Office Creeks, 1940-1982

### A. Changes in Post Office Creek

The DWP's diversions did not directly affect Mill, Wilson, or Post Office creeks (Figure 1). Nevertheless, by forcing the lake to fall, those diversions had the effect of lengthening the streams, thus creating actual and potential riparian habitat. The informally named Post Office Creek (along the western shore of Mono Lake in Section 31 of T2N R26E) has been lengthened by approximately 1050 feet. It has not encountered an appreciable nickpoint, and so has not incised. The stream now supports a dense stand of willows and other riparian vegetation, ~24 acres of which grows on lands uncovered by the artificially-induced drop in lake level. The riparian vegetation has not grown to the lake shore. It is thus true that the riparian acreage can be expected to increase (by perhaps an additional 25%) if the lake remains at its present position; it is also true that if the lake were to rise as much as 6-8 feet above its present elevation, little riparian vegetation at this site would be destroyed.

### B. Changes in Wilson Creek

Wilson Creek, formerly a small, ephemeral stream, today carries water that has been diverted from Mill Creek by Southern California Edison for the purpose of hydroelectric generation at a power plant immediately north of the mouth of Lundy Canyon. It also carries a smaller, though still significant, amount of Virginia Creek water diverted by irrigation interests.[1] These diversions have increased the flow of Wilson Creek by perhaps one to two orders of magnitude. Flows today are determined by the amount of water diverted from Mill and Virginia creeks, and by the intensity and distribution of irrigation on the ranch lands northwest of Mono Lake.[2] Since the lake began

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1 Under natural conditions Virginia Creek is a stream of the Bridgeport Basin, a tectonic depression immediately north of the Mono Basin.

2 Mill and Virginia creek water supplied to the Dechambeau Ranch by way of Wilson Creek drains eastward through an unnamed channel that feeds the Dechambeau Hot Ponds, immediately north and east of Black Point (Figure 1).

to fall in 1947 Wilson Creek has lengthened by ~2100 feet. In the area of the newly-relicted shorelands, the stream has incised its delta by as much as 8 feet. At a few sites along the walls of this incised channel willows have become established. These sites total perhaps 2 acres in area. (The willows and other types of marsh vegetation that have colonized the newly-uncovered spring sites around Wilson Creek and elsewhere will be documented in my report to the California State Water Resources Control Board on the wetlands of the Mono shorelands.)

### C. Changes in Mill Creek

Mill Creek has been artificially diminished in size due to the above noted hydroelectric and irrigation diversions (note that these activities are unrelated to operations by the DWP). Presently Mill Creek carries water only in years of abnormally high runoff. The stream is now ~2200 feet longer than it was when Mono Lake began to fall in 1947. It has carved and incised 2 channels. Only a small amount of riparian vegetation has thus far colonized these channels, presumably because of the inconsistency and short-lived nature of stream releases.

## 7. Conclusions

A variety of different sources--maps, aerial and ground photographs, historical accounts, field notes, and conversations with long-time observers--have been used to document the distribution and density of riparian and other streamside vegetation that existed along Mono Lake's tributaries during the decade prior to the commencement of DWP's operations in 1940. In pursuing this work, emphasis has been placed not only on the vegetation itself, but on the geomorphic and hydrologic conditions that supported it. An understanding of these other elements of the riparian system is of the utmost importance in explaining the vegetation changes of the past half-century.

Prior to 1940, lands along Rush, Lee Vining, Parker, and Walker creeks supported dense stands of streamside vegetation. The vegetation was not in a "natural" state, but rather reflected a decades-long history of modification due to flow manipulation and grazing. In two important ways--construction of irrigation canals that supported woody phreatophytes, and the irrigation-induced augmentation of seeps and springs that made adjoining lands unnaturally wet--land use in pre-DWP times increased riparian abundance.

By 1930 the areas of high watertable adjacent to Rush and Lee Vining creeks supported over 450 acres of deciduous woodland (dominated by willows, cottonwoods, and aspens), and over 110 acres of wet- or seasonally-wet meadow. As of the early 1980s, operation of the DWP system had led to the loss of over 90% of this floodplain vegetation. In some cases the losses are directly attributable to DWP's operation, e.g. the inundation of vegetation that accompanied the enlargement of Grant Reservoir, the dewatering of the streams and consequent desiccation of the plants, and the discontinuation of most irrigation diversions with consequent loss of seeps and springs. In other cases the loss of riparian vegetation was indirect. For instance, the incision of Rush Creek that resulted from the diversion-induced regression of Mono Lake caused a drop in the water table, thereby contributing to drier soil conditions.

Equally as instructive are the DWP-controlled streams and stream reaches which, at least from an aerial photographic point of view, have experienced only minor vegetation changes. This is true of the piedmont lands on Walker and Parker creeks, as well as the moraine reach of Lee Vining Creek. The lack of change, however, may in itself be telling: Taylor's caution concerning possible vegetation-hydrology disequilibrium on Lee Vining Creek above and immediately below Highway 395 may also be applicable to Walker/Parker lands, where a lack of reproduction may ultimately lead to the demise of the riparian stand.

Where it has occurred, alteration of the riparian system has resulted from a complex interplay of factors. As in the above example, a DWP-induced geomorphic change (i.e. incision of Rush Creek due to the drop of the lake) has led to a vegetation change (due to a drop in the water table). In other cases cause and effect are reversed: On Lee Vining Creek, a DWP-induced vegetation change (e.g. the loss of riparian vegetation due to the dewatering of the stream) has led to geomorphic change (channel avulsion and stripping of the woodland soils). These examples serve to illustrate the interdependency of elements of the riparian system, and to stress that any initial impact to the system need not be limited to the vegetation itself.

The hydrological and geomorphological impacts to the system, though perhaps less obvious than the destruction of the vegetation, could have greater long-term consequences for restoration efforts. While it may be possible to reestablish vegetation readily and rapidly on areas where geomorphic and hydrologic conditions remain favorable to riparian species (e.g. above the Rush Creek narrows, and within close proximity to the stream at several sites below the narrows), it could prove extremely difficult and slow to restore the previously existing soils, spring systems, morasses, rill networks, and fluvial conditions (including channel gradient and depth, and frequency and magnitude of floods) that supported the vegetation in pre-export times.

Finally, it is stressed that future efforts to restore riparian vegetation on long stretches of Rush and Lee Vining creeks (and on Mono Lake's other tributary streams as well) will be inextricably linked to lake level. Should Mono Lake drop below its historical low stand (6372 feet), stream incision will begin anew, with consequences for all elements of the riparian systems on these streams.

# Appendix 1

Irrigation records

B DITCH AT INTAKE ACRE-FEET RUNOFF YEARS 1920-21 TO 1966-67 ID - BADS2

| | | | | | | | APR-SEP | % | | | | | | | OCT-MAR | % | | % | REL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | APR | MAY | JUN | JUL | AUG | SEP | TOTAL | NORM | OCT | NOV | DEC | JAN | FEB | MAR | TOTAL | NORM | TOTAL | NORM | POS |
| MEAN | 344 | 1060 | 1120 | 1044 | 818 | 486 | 4871 | | 138 | 12 | 2 | 1 | 12 | 46 | 212 | | 5083 | | |
| CFS | 6 | 17 | 19 | 17 | 13 | 8 | 13 | | 2 | 0 | 0 | 0 | 0 | 1 | 1 | | 7 | | |
| MAX. | 1904 | 2886 | 2951 | 3528 | 3052 | 2215 | 14484 | | 704 | 220 | 88 | 49 | 525 | 1920 | 2805 | | 14574 | | |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | |
| 1924-25 | 851 | 656 | 1136 | 793 | 762 | 894 | 5092 | 105 | 213 | 0 | 0 | 0 | 0 | 122 | 335 | 158 | 5427 | 107 | 23 |
| 1923-24 | 1070 | 1918 | 1378 | 1311 | 843 | 325 | 6845 | 141 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6845 | 135 | 15 |
| 1922-23 | 0 | 509 | 2227 | 2481 | 1919 | 357 | 7493 | 154 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7493 | 147 | 9 |
| 1921-22 | 238 | 1459 | 1784 | 1971 | 1714 | 555 | 7721 | 158 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7721 | 152 | 8 |
| 1920-21 | 478 | 1260 | 1683 | 1595 | 1500 | 413 | 6929 | 142 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6929 | 136 | 13 |
| 1919-20 | | | | | | | | | | | | 0 | 0 | 0 | | | | | |

LOS ANGELES DEPARTMENT OF WATER AND POWER | AQUEDUCT DIVISION | HYDROLOGY SECTION

A DITCH AT INTAKE ACRE-FEET

RUNOFF YEARS 1920-21 TO 1971-72

ID - AAOC2

| YEAR | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 688 | 2123 | 2443 | 2221 | 1915 | 1105 | 10496 | | 348 | 25 | 14 | 7 | 25 | 95 | 514 | | 11010 | | |
| CFS | 12 | 35 | 41 | 36 | 31 | 19 | 29 | | 6 | 0 | 0 | 0 | 0 | 2 | 1 | | 15 | | |
| MAX. | 4017 | 7718 | 7857 | 8980 | 8440 | 5641 | 39250 | | 3654 | 712 | 364 | 189 | 1009 | 3304 | 4666 | | 40441 | | |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | |
| 1972-73 | 0 | | | | | | | | | | | | | | | | | | |
| 1971-72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1970-71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1969-70 | 0 | 436 | 1364 | 1398 | 1136 | 857 | 5191 | 49 | 264 | 0 | 0 | 0 | 0 | 0 | 264 | 51 | 5455 | 50 | 36 |
| 1968-69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1967-68 | 73 | 1886 | 1940 | 1588 | 936 | 867 | 7290 | 69 | 792 | 1 | 0 | 0 | 0 | 0 | 793 | 154 | 8083 | 73 | 31 |
| 1966-67 | 0 | 0 | 206 | 289 | 196 | 0 | 691 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 691 | 6 | 39 |
| 1965-66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1964-65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1963-64 | 0 | 0 | 0 | 67 | 0 | 0 | 67 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 1 | 41 |
| 1962-63 | 1505 | 0 | 0 | 0 | 0 | 0 | 1505 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1505 | 14 | 38 |
| 1961-62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 221 | 221 | 43 | 221 | 2 | 40 |
| 1960-61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1959-60 | 0 | 1795 | 1321 | 7 | 55 | 0 | 3178 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3178 | 29 | 37 |
| 1958-59 | 0 | 1361 | 2264 | 3136 | 3214 | 2144 | 12119 | 115 | 464 | 0 | 0 | 0 | 0 | 0 | 464 | 90 | 12583 | 114 | 23 |
| 1957-58 | 0 | 0 | 2098 | 2751 | 1686 | 38 | 6573 | 63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6573 | 60 | 35 |
| 1956-57 | 0 | 1969 | 2824 | 4010 | 3889 | 2829 | 15521 | 148 | 731 | 0 | 0 | 0 | 0 | 0 | 731 | 142 | 16252 | 148 | 14 |
| 1955-56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1954-55 | 376 | 2099 | 2473 | 2339 | 0 | 0 | 7287 | 69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7287 | 66 | 33 |
| 1953-54 | 527 | 1619 | 1302 | 2323 | 875 | 145 | 6791 | 65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6791 | 62 | 34 |
| 1952-53 | 0 | 583 | 2237 | 1382 | 2545 | 922 | 7669 | 73 | 542 | 38 | 0 | 0 | 0 | 0 | 580 | 113 | 8249 | 75 | 30 |
| 1951-52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1950-51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1949-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1948-49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 1947-48 | 1669 | 4519 | 2529 | 3820 | 896 | 1397 | 14830 | 141 | 216 | 0 | 0 | 0 | 0 | 0 | 216 | 42 | 15046 | 137 | 18 |
| 1946-47 | 0 | 4121 | 1300 | 4459 | 4782 | 2744 | 17406 | 166 | 468 | 0 | 0 | 0 | 0 | 0 | 468 | 91 | 17874 | 162 | 12 |
| 1945-46 | 34 | 4109 | 4391 | 2840 | 2916 | 1549 | 15839 | 151 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15839 | 144 | 16 |
| 1944-45 | 0 | 2970 | 3647 | 1628 | 2146 | 326 | 10717 | 102 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10717 | 97 | 27 |
| 1943-44 | 696 | 4595 | 4690 | 1881 | 684 | 1861 | 14407 | 137 | 270 | 0 | 0 | 0 | 0 | 0 | 270 | 53 | 14677 | 133 | 20 |
| 1942-43 | 2122 | 3873 | 4202 | 1821 | 1435 | 1128 | 14581 | 139 | 118 | 0 | 0 | 0 | 0 | 0 | 118 | 23 | 14699 | 134 | 19 |
| 1941-42 | 1330 | 3872 | 4117 | 1403 | 236 | 659 | 11617 | 111 | 757 | 0 | 0 | 0 | 0 | 0 | 757 | 147 | 12374 | 112 | 24 |
| 1940-41 | 3797 | 4459 | 4186 | 1209 | 1542 | 534 | 15727 | 150 | 0 | 117 | 74 | 0 | 0 | 0 | 191 | 37 | 15918 | 145 | 15 |
| 1939-40 | 788 | 2920 | 2162 | 1381 | 604 | 498 | 8353 | 80 | 353 | 0 | 0 | 0 | 1009 | 3304 | 4666 | 908 | 13019 | 118 | 22 |
| 1938-39 | 0 | 0 | 2017 | 2816 | 1057 | 710 | 6600 | 63 | 603 | 228 | 0 | 0 | 0 | 0 | 831 | 162 | 7431 | 67 | 32 |
| 1937-38 | 48 | 1785 | 3262 | 3043 | 2207 | 742 | 11087 | 106 | 415 | 0 | 0 | 0 | 0 | 0 | 415 | 81 | 11502 | 104 | 26 |
| 1936-37 | 167 | 1822 | 3738 | 1955 | 849 | 801 | 9332 | 89 | 409 | 137 | 281 | 189 | 102 | 89 | 1207 | 235 | 10539 | 96 | 28 |
| 1935-36 | 0 | 2335 | 5425 | 2457 | 5919 | 3913 | 20049 | 191 | 728 | 712 | 364 | 164 | 185 | 147 | 2300 | 448 | 22349 | 203 | 7 |
| 1934-35 | 4017 | 2732 | 2139 | 2409 | 1746 | 1356 | 14399 | 137 | 1051 | 0 | 0 | 0 | 0 | 0 | 1051 | 204 | 15450 | 140 | 17 |
| 1933-34 | 687 | 2766 | 2932 | 4484 | 4589 | 3920 | 19378 | 185 | 3654 | 0 | 0 | 0 | 0 | 137 | 3791 | 738 | 23169 | 210 | 6 |
| 1932-33 | 517 | 3943 | 5272 | 2607 | 4897 | 5641 | 22877 | 218 | 2301 | 0 | 0 | 0 | 0 | 0 | 2301 | 448 | 25178 | 229 | 4 |
| 1931-32 | 862 | 2184 | 2106 | 2243 | 1850 | 1578 | 10823 | 103 | 885 | 0 | 0 | 0 | 0 | 0 | 885 | 172 | 11708 | 106 | 25 |
| 1930-31 | 2141 | 2914 | 4966 | 4018 | 3919 | 1886 | 19844 | 189 | 1142 | 63 | 0 | 0 | 0 | 0 | 1205 | 234 | 21049 | 191 | 8 |

LOS ANGELES DEPARTMENT OF WATER AND POWER

AQUEDUCT DIVISION

HYDROLOGY SECTION

A DITCH AT INTAKE ACRE-FEET

RUNOFF YEARS 1920-21 TO 1971-72

ID - AAOC2

| YEAR | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 688 | 2123 | 2443 | 2221 | 1915 | 1105 | 10496 | | 348 | 25 | 14 | 7 | 25 | 95 | 514 | | 11010 | | |
| CFS | 12 | 35 | 41 | 36 | 31 | 19 | 29 | | 6 | 0 | 0 | 0 | 0 | 2 | 1 | | 15 | | |
| MAX. | 4017 | 7718 | 7857 | 8980 | 8440 | 5641 | 39250 | | 3654 | 712 | 364 | 189 | 1009 | 3304 | 4666 | | 40441 | | |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | |
| 1929-30 | 412 | 3900 | 4487 | 4115 | 3907 | 756 | 17577 | 167 | 947 | 0 | 0 | 0 | 0 | 0 | 947 | 184 | 18524 | 168 | 11 |
| 1928-29 | 3321 | 7281 | 5658 | 5584 | 4484 | 1131 | 27459 | 262 | 461 | 0 | 0 | 0 | 0 | 0 | 461 | 90 | 27920 | 254 | 2 |
| 1927-28 | 728 | 7718 | 7857 | 8980 | 8440 | 5527 | 39250 | 374 | 279 | 0 | 0 | 0 | 0 | 912 | 1191 | 232 | 40441 | 367 | 1 |
| 1926-27 | 2587 | 6023 | 6314 | 4706 | 4241 | 1764 | 25635 | 244 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25635 | 233 | 3 |
| 1925-26 | 2213 | 5310 | 4251 | 7270 | 5085 | 293 | 24422 | 233 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24422 | 222 | 5 |
| 1924-25 | 1209 | 2039 | 2284 | 1394 | 1052 | 781 | 8759 | 83 | 262 | 0 | 0 | 0 | 0 | 67 | 329 | 64 | 9088 | 83 | 29 |
| 1923-24 | 2979 | 4413 | 3851 | 3819 | 3644 | 2070 | 20776 | 198 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20776 | 189 | 9 |
| 1922-23 | 0 | 1535 | 5135 | 6643 | 5157 | 1133 | 19603 | 187 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19603 | 178 | 10 |
| 1921-22 | 201 | 1857 | 2440 | 3535 | 3429 | 2520 | 13982 | 133 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13982 | 127 | 21 |
| 1920-21 | 761 | 2677 | 3624 | 3707 | 3357 | 2459 | 16585 | 158 | 0 | 0 | 0 | 0 | 0 | 73 | 73 | 14 | 16658 | 151 | 13 |
| 1919-20 | | | | | | | | | | | | 0 | 0 | 0 | | | | | |

| | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 344 | 1060 | 1120 | 1044 | 818 | 486 | 4871 | | 138 | 12 | 2 | 1 | 12 | 46 | 212 | | 5083 |
| CFS | 6 | 17 | 19 | 17 | 13 | 8 | 13 | | 2 | 0 | 0 | 0 | 0 | 1 | 1 | | 7 |
| MAX. | 1904 | 2886 | 2951 | 3528 | 3052 | 2215 | 14484 | | 704 | 220 | 88 | 49 | 525 | 1920 | 2805 | | 14574 |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |

| YEAR | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1967-68 | 0 | 207 | 215 | | | | | | | | | | | | | | | | |
| 1966-67 | 0 | 106 | 308 | 292 | 257 | 221 | 1184 | 24 | 34 | 0 | 0 | 0 | 0 | 0 | 34 | 16 | 1218 | 24 | 38 |
| 1965-66 | 0 | 48 | 292 | 420 | 609 | 471 | 1840 | 38 | 107 | 0 | 0 | 0 | 0 | 0 | 107 | 51 | 1947 | 38 | 34 |
| 1964-65 | 0 | 155 | 229 | 281 | 307 | 298 | 1270 | 26 | 66 | 0 | 0 | 0 | 0 | 0 | 66 | 31 | 1336 | 26 | 37 |
| 1963-64 | 0 | 62 | 303 | 432 | 403 | 295 | 1495 | 31 | 241 | 26 | 0 | 0 | 0 | 0 | 267 | 126 | 1762 | 35 | 35 |
| 1962-63 | 0 | 54 | 340 | 997 | 316 | 0 | 1707 | 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1707 | 34 | 36 |
| 1961-62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 |
| 1960-61 | 0 | 98 | 192 | 37 | 0 | 0 | 327 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 327 | 6 | 39 |
| 1959-60 | 0 | 746 | 941 | 1033 | 866 | 110 | 3696 | 76 | 68 | 0 | 0 | 0 | 0 | 0 | 68 | 32 | 3764 | 74 | 29 |
| 1958-59 | 0 | 631 | 1238 | 1547 | 1491 | 1100 | 6007 | 123 | 281 | 0 | 0 | 0 | 0 | 0 | 281 | 133 | 6288 | 124 | 19 |
| 1957-58 | 0 | 249 | 1552 | 1527 | 1520 | 274 | 5122 | 105 | 51 | 0 | 0 | 0 | 0 | 0 | 51 | 24 | 5173 | 102 | 24 |
| 1956-57 | 0 | 1501 | 1054 | 1388 | 1383 | 1051 | 6377 | 131 | 107 | 0 | 0 | 0 | 0 | 0 | 107 | 51 | 6484 | 128 | 18 |
| 1955-56 | 0 | 15 | 36 | 0 | 0 | 0 | 51 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 51 | 1 | 42 |
| 1954-55 | 113 | 1276 | 1232 | 1192 | 163 | 106 | 4082 | 84 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4082 | 80 | 28 |
| 1953-54 | 158 | 600 | 513 | 1254 | 636 | 78 | 3239 | 66 | 43 | 0 | 0 | 0 | 0 | 0 | 43 | 20 | 3282 | 65 | 33 |
| 1952-53 | 0 | 586 | 985 | 970 | 906 | 269 | 3716 | 76 | 561 | 64 | 0 | 0 | 0 | 0 | 625 | 295 | 4341 | 85 | 27 |
| 1951-52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 |
| 1950-51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 |
| 1949-50 | 0 | 59 | 0 | 0 | 0 | 0 | 59 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 59 | 1 | 41 |
| 1948-49 | 0 | 86 | 67 | 66 | 0 | 0 | 219 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 219 | 4 | 40 |
| 1947-48 | 586 | 1006 | 476 | 791 | 111 | 429 | 3399 | 70 | 37 | 18 | 4 | 0 | 0 | 0 | 59 | 28 | 3458 | 68 | 31 |
| 1946-47 | 0 | 1896 | 371 | 1892 | 1958 | 1127 | 7244 | 149 | 240 | 0 | 0 | 0 | 0 | 0 | 240 | 113 | 7484 | 147 | 10 |
| 1945-46 | 35 | 2136 | 2108 | 2120 | 1184 | 1285 | 8868 | 182 | 605 | 0 | 0 | 0 | 0 | 0 | 605 | 286 | 9473 | 186 | 3 |
| 1944-45 | 0 | 2032 | 2397 | 1357 | 429 | 426 | 6641 | 136 | 242 | 0 | 0 | 0 | 0 | 0 | 242 | 114 | 6883 | 135 | 14 |
| 1943-44 | 205 | 1875 | 1989 | 701 | 278 | 594 | 5642 | 116 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5642 | 111 | 22 |
| 1942-43 | 909 | 2016 | 1954 | 234 | 749 | 48 | 5910 | 121 | 5 | 0 | 0 | 0 | 0 | 0 | 5 | 2 | 5915 | 116 | 20 |
| 1941-42 | 945 | 2345 | 1968 | 746 | 543 | 136 | 6683 | 137 | 62 | 0 | 0 | 0 | 0 | 0 | 62 | 29 | 6745 | 133 | 17 |
| 1940-41 | 1904 | 2206 | 2042 | 1144 | 599 | 370 | 8265 | 170 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8265 | 163 | 6 |
| 1939-40 | 570 | 1418 | 752 | 445 | 647 | 482 | 4314 | 89 | 360 | 0 | 0 | 0 | 525 | 1920 | 2805 | 1325 | 7119 | 140 | 11 |
| 1938-39 | 0 | 143 | 1385 | 406 | 663 | 507 | 3104 | 64 | 259 | 27 | 0 | 0 | 0 | 0 | 286 | 135 | 3390 | 67 | 32 |
| 1937-38 | 0 | 834 | 1279 | 1038 | 572 | 0 | 3723 | 76 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3723 | 73 | 30 |
| 1936-37 | 59 | 1511 | 1609 | 1083 | 821 | 743 | 5826 | 120 | 76 | 0 | 0 | 0 | 0 | 0 | 76 | 36 | 5902 | 116 | 21 |
| 1935-36 | 0 | 2063 | 1958 | 1719 | 1378 | 1415 | 8533 | 175 | 270 | 220 | 88 | 49 | 48 | 58 | 733 | 346 | 9266 | 182 | 4 |
| 1934-35 | 1432 | 941 | 586 | 801 | 502 | 329 | 4591 | 94 | 197 | 67 | 11 | 0 | 0 | 0 | 275 | 130 | 4866 | 96 | 26 |
| 1933-34 | 978 | 1190 | 1549 | 1687 | 1254 | 856 | | | 657 | | | | | | | | | | |
| 1932-33 | 420 | 1574 | 1921 | 2220 | 2357 | 2203 | 10695 | 220 | 704 | 0 | 0 | 0 | 0 | 0 | 704 | 333 | 11399 | 224 | 2 |
| 1931-32 | 547 | 1310 | 839 | 715 | 662 | 489 | 4562 | 94 | 293 | 95 | 0 | 0 | 0 | 0 | 388 | 183 | 4950 | 97 | 25 |
| 1930-31 | 1126 | 1065 | 1627 | 1246 | 1137 | 375 | 6576 | 135 | 197 | 39 | 0 | 0 | 0 | 0 | 236 | 111 | 6812 | 134 | 16 |
| 1929-30 | 216 | 2180 | 1694 | 1362 | 1476 | 414 | 7342 | 151 | 452 | 0 | 0 | 0 | 0 | 0 | 452 | 213 | 7794 | 153 | 7 |
| 1928-29 | 679 | 2016 | 1405 | 1226 | 1092 | 2215 | 8633 | 177 | 497 | 0 | 0 | 0 | 0 | 0 | 497 | 235 | 9130 | 180 | 5 |
| 1927-28 | 373 | 2886 | 2951 | 3528 | 3052 | 1694 | 14484 | 297 | 90 | 0 | 0 | 0 | 0 | 0 | 90 | 43 | 14574 | 287 | 1 |
| 1926-27 | 1689 | 1977 | 1797 | 1028 | 795 | 198 | 7484 | 154 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7484 | 147 | 10 |
| 1925-26 | 1228 | 1235 | 909 | 2636 | 1029 | 54 | 7091 | 146 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7091 | 140 | 12 |

LOS ANGELES DEPARTMENT OF WATER AND POWER

AQUEDUCT DIVISION

HYDROLOGY S

C DITCH AT INTAKE ACRE-FEET

RUNOFF YEARS 1920-21 TO 1934-35

ID - CA

| | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 445 | 984 | 977 | 963 | 698 | 382 | 4450 | 49 | 0 | 0 | 0 | 0 | 0 | 49 | 4499 |
| CFS | 7 | 16 | 16 | 16 | 11 | 6 | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| MAX. | 1323 | 1570 | 1476 | 2036 | 1754 | 1720 | 7713 | 413 | 0 | 0 | 0 | 0 | 0 | 413 | 7713 |
| MIN. | 0 | 0 | 351 | 177 | 203 | 0 | 2113 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2113 |

| YEAR | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1935-36 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | |
| 1934-35 | 1323 | 1040 | 535 | 591 | 795 | 428 | 4712 | 106 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4712 | 105 | 7 |
| 1933-34 | 67 | 1240 | 1085 | 1360 | 1389 | 1130 | | | 880 | 0 | 0 | 0 | 0 | 0 | | | | | |
| 1932-33 | 247 | 1382 | 1401 | 1209 | 1754 | 1720 | 7713 | 173 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7713 | 171 | 1 |
| 1931-32 | 612 | 1493 | 873 | 751 | 704 | 633 | 5066 | 114 | 413 | 0 | 0 | 0 | 0 | 0 | 413 | 840 | 5479 | 122 | 3 |
| 1930-31 | 543 | 1052 | 789 | 492 | 525 | 301 | 3702 | 83 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3702 | 82 | 9 |
| 1929-30 | | 611 | 686 | 620 | 544 | 31 | | | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| 1928-29 | 296 | 861 | 363 | 177 | 203 | 213 | 2113 | 47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2113 | 47 | 13 |
| 1927-28 | 64 | 1021 | 985 | 1258 | 1115 | 650 | 5093 | 114 | 27 | 0 | 0 | 0 | 0 | 0 | 27 | 55 | 5120 | 114 | 5 |
| 1926-27 | 378 | 927 | 867 | 540 | 326 | 154 | 3192 | 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3192 | 71 | 11 |
| 1925-26 | 840 | 1570 | 1174 | 1934 | 737 | 0 | 6255 | 141 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6255 | 139 | 2 |
| 1924-25 | 649 | 1072 | 1055 | 649 | 564 | 601 | 4590 | 103 | 199 | 0 | 0 | 0 | 0 | 0 | 199 | 405 | 4789 | 106 | 6 |
| 1923-24 | 331 | 1435 | 1476 | 1238 | 624 | 129 | 5233 | 118 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5233 | 116 | 4 |
| 1922-23 | 0 | 138 | 1440 | 2036 | 652 | 52 | 4318 | 97 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4318 | 96 | 8 |
| 1921-22 | 0 | 0 | 1394 | 1294 | 753 | 88 | 3529 | 79 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3529 | 78 | 10 |
| 1920-21 | 499 | 805 | 351 | 350 | 328 | 0 | 2333 | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2333 | 52 | 12 |
| 1919-20 | | | | | | | | | | | | | | | | | | | |

C DITCH AT INTAKE ACRE-FEET

| | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 41 | 1 | 0 | 0 | 0 | 0 | 42 | | 8 | 110 | 183 | 166 | 143 | 86 | 696 | | 739 | | |
| CFS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 2 | 3 | 3 | 2 | 1 | 2 | | 1 | | |
| MAX. | 164 | 28 | 0 | 0 | 0 | 0 | 164 | | 89 | 351 | 400 | 345 | 325 | 268 | 1201 | | 1252 | | |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | |

| YEAR | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989-90 | 56 | 0 | 0 | | | | | | | | | | | | | | | | |
| 1988-89 | 58 | 0 | 0 | 0 | 0 | 0 | 58 | 137 | 0 | 85 | 143 | 169 | 119 | 143 | 659 | 95 | 717 | 97 | 32 |
| 1987-88 | 26 | 0 | 0 | 0 | 0 | 0 | 26 | 61 | 0 | 45 | 103 | 98 | 79 | 67 | 392 | 56 | 418 | 57 | 49 |
| 1986-87 | 35 | 0 | 0 | 0 | 0 | 0 | 35 | 83 | 41 | 68 | 60 | 57 | 68 | 63 | 357 | 51 | 392 | 53 | 50 |
| 1985-86 | 22 | 0 | 0 | 0 | 0 | 0 | 22 | 52 | 0 | 44 | 131 | 118 | 106 | 71 | 470 | 68 | 492 | 67 | 44 |
| 1984-85 | 59 | 0 | 0 | 0 | 0 | 0 | 59 | 139 | 26 | 77 | 112 | 96 | 70 | 93 | 474 | 68 | 533 | 72 | 42 |
| 1983-84 | 74 | 0 | 0 | 0 | 0 | 0 | 74 | 174 | 20 | 151 | 142 | 161 | 106 | 104 | 684 | 98 | 758 | 103 | 27 |
| 1982-83 | 53 | 0 | 0 | 0 | 0 | 0 | 53 | 125 | 0 | 40 | 158 | 227 | 176 | 96 | 697 | 100 | 750 | 102 | 28 |
| 1981-82 | 102 | 0 | 0 | 0 | 0 | 0 | 102 | 241 | 0 | 48 | 194 | 201 | 200 | 75 | 718 | 103 | 820 | 111 | 23 |
| 1980-81 | 77 | 0 | 0 | 0 | 0 | 0 | 77 | 182 | 0 | 175 | 241 | 221 | 195 | 109 | 941 | 135 | 1018 | 138 | 9 |
| 1979-80 | 69 | 0 | 0 | 0 | 0 | 0 | 69 | 163 | 1 | 119 | 244 | 243 | 182 | 130 | 919 | 132 | 988 | 134 | 14 |
| 1978-79 | 92 | 2 | 0 | 0 | 0 | 0 | 94 | 222 | 0 | 49 | 184 | 263 | 223 | 122 | 841 | 121 | 935 | 127 | 17 |
| 1977-78 | 61 | 0 | 0 | 0 | 0 | 0 | 61 | 144 | 0 | 51 | 189 | 201 | 161 | 100 | 702 | 101 | 763 | 103 | 26 |
| 1976-77 | 50 | 0 | 0 | 0 | 0 | 0 | 50 | 118 | 0 | 90 | 153 | 144 | 156 | 135 | 678 | 97 | 728 | 99 | 31 |
| 1975-76 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 139 | 153 | 161 | 147 | 141 | 741 | 106 | 741 | 100 | 30 |
| 1974-75 | 45 | 0 | 0 | 0 | 0 | 0 | 45 | 106 | 0 | 55 | 220 | 221 | 144 | 140 | 780 | 112 | 825 | 112 | 22 |
| 1973-74 | 94 | 0 | 0 | 0 | 0 | 0 | 94 | 222 | 9 | 186 | 192 | 217 | 190 | 106 | 900 | 129 | 994 | 135 | 12 |
| 1972-73 | 34 | 0 | 0 | 0 | 0 | 0 | 34 | 80 | 0 | 84 | 146 | 150 | 147 | 115 | 642 | 92 | 676 | 92 | 34 |
| 1971-72 | 7 | 0 | 0 | 0 | 0 | 0 | 7 | 17 | 0 | 117 | 216 | 220 | 134 | 103 | 790 | 113 | 797 | 108 | 24 |
| 1970-71 | 22 | 0 | 0 | 0 | 0 | 0 | 22 | 52 | 9 | 18 | 202 | 225 | 110 | 68 | 632 | 91 | 654 | 89 | 35 |
| 1969-70 | 105 | 0 | 0 | 0 | 0 | 0 | 105 | 248 | 1 | 213 | 231 | 207 | 157 | 79 | 888 | 128 | 993 | 134 | 13 |
| 1968-69 | 50 | 0 | 0 | 0 | 0 | 0 | 50 | 118 | 0 | 12 | 158 | 262 | 239 | 204 | 875 | 126 | 925 | 125 | 19 |
| 1967-68 | 77 | 0 | 0 | 0 | 0 | 0 | 77 | 182 | 44 | 150 | 195 | 199 | 250 | 234 | 1072 | 154 | 1149 | 156 | 3 |
| 1966-67 | 93 | 0 | 0 | 0 | 0 | 0 | 93 | 219 | 0 | 56 | 196 | 229 | 219 | 211 | 911 | 131 | 1004 | 136 | 11 |
| 1965-66 | 71 | 28 | 0 | 0 | 0 | 0 | 99 | 233 | 0 | 49 | 205 | 221 | 269 | 268 | 1012 | 145 | 1111 | 150 | 5 |
| 1964-65 | 86 | 2 | 0 | 0 | 0 | 0 | 88 | 207 | 0 | 27 | 96 | 89 | 155 | 93 | 460 | 66 | 548 | 74 | 41 |
| 1963-64 | 66 | 0 | 0 | 0 | 0 | 0 | 66 | 156 | 0 | 43 | 99 | 187 | 117 | 101 | 547 | 79 | 613 | 83 | 36 |
| 1962-63 | 74 | 9 | 0 | 0 | 0 | 0 | 83 | 196 | 0 | 86 | 112 | 38 | 145 | 110 | 491 | 71 | 574 | 78 | 37 |
| 1961-62 | 17 | 0 | 0 | 0 | 0 | 0 | 17 | 40 | 0 | 34 | 148 | 121 | 35 | 80 | 418 | 60 | 435 | 59 | 48 |
| 1960-61 | 164 | 0 | 0 | 0 | 0 | 0 | 164 | 387 | 0 | 66 | 56 | 99 | 83 | 38 | 342 | 49 | 506 | 69 | 43 |
| 1959-60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 94 | 81 | 88 | 75 | 370 | 53 | 370 | 50 | 51 |
| 1958-59 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 116 | 95 | 46 | 257 | 37 | 257 | 35 | 53 |
| 1957-58 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 165 | 114 | 149 | 45 | 473 | 68 | 473 | 64 | 45 |
| 1956-57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 245 | 176 | 143 | 5 | 572 | 82 | 572 | 77 | 38 |
| 1955-56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 91 | 269 | 288 | 121 | 23 | 792 | 114 | 792 | 107 | 25 |
| 1954-55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 121 | 79 | 59 | 37 | 307 | 44 | 307 | 42 | 52 |
| 1953-54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 206 | 121 | 99 | 77 | 26 | 563 | 81 | 563 | 76 | 39 |
| 1952-53 | 36 | 0 | 0 | 0 | 0 | 0 | 36 | 85 | 89 | 154 | 211 | 212 | 135 | 27 | 828 | 119 | 864 | 117 | 21 |
| 1951-52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 221 | 334 | 50 | 193 | 99 | 897 | 129 | 897 | 121 | 20 |
| 1950-51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 74 | 0 | 0 | 0 | 74 | 11 | 74 | 10 | 54 |
| 1949-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 151 | 291 | 0 | 0 | 0 | 442 | 63 | 442 | 60 | 46 |
| 1948-49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 182 | 0 | 188 | 70 | 440 | 63 | 440 | 60 | 47 |
| 1947-48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 55 |

LOS ANGELES DEPARTMENT OF WATER AND POWER | AQUEDUCT DIVISION | HYDROLOGY SECTION

O DITCH 1/4 MILE BELOW INTAKE ACRE-FEET | HYDROGRAPHIC YEARS 1934-35 TO 1988-89 | ID - OAIL2

| | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 41 | 1 | 0 | 0 | 0 | 0 | 42 | 8 | 110 | 183 | 166 | 143 | 86 | 696 | 739 |
| CFS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 3 | 2 | 1 | 2 | 1 |
| MAX. | 164 | 28 | 0 | 0 | 0 | 0 | 164 | 89 | 351 | 400 | 345 | 325 | 268 | 1201 | 1252 |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| YEAR | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1946-47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 258 | 310 | 105 | 23 | 7 | 703 | 101 | 703 | 95 | 33 |
| 1945-46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 281 | 238 | 213 | 186 | 95 | 1013 | 146 | 1013 | 137 | 10 |
| 1944-45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 242 | 361 | 218 | 325 | 55 | 1201 | 173 | 1201 | 163 | 2 |
| 1943-44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 123 | 272 | 167 | 141 | 40 | 743 | 107 | 743 | 101 | 29 |
| 1942-43 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 57 | 320 | 237 | 213 | 286 | 0 | 1113 | 160 | 1115 | 151 | 4 |
| 1941-42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 205 | 272 | 191 | 164 | 102 | 934 | 134 | 934 | 126 | 18 |
| 1940-41 | 11 | 2 | 0 | 0 | 0 | 0 | 13 | 31 | 1 | 175 | 302 | 213 | 234 | 21 | 946 | 136 | 959 | 130 | 16 |
| 1939-40 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 9 | 84 | 351 | 96 | 325 | 74 | 46 | 976 | 140 | 980 | 133 | 15 |
| 1938-39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 239 | 400 | 345 | 40 | 61 | 1085 | 156 | 1085 | 147 | 7 |
| 1937-38 | 14 | 0 | 0 | 0 | 0 | 0 | 14 | 33 | 0 | 43 | 129 | 246 | 120 | 0 | 538 | 77 | 552 | 75 | 40 |
| 1936-37 | 137 | 0 | 0 | 0 | 0 | 0 | 137 | 323 | 0 | 183 | 199 | 236 | 298 | 199 | 1115 | 160 | 1252 | 170 | 1 |
| 1935-36 | 143 | 0 | 0 | 0 | 0 | 0 | 143 | 337 | 8 | 243 | 290 | 218 | 109 | 68 | 936 | 134 | 1079 | 146 | 8 |
| 1934-35 | 134 | 26 | 0 | 0 | 0 | 0 | 160 | 377 | 0 | 145 | 180 | 171 | 239 | 201 | 936 | 134 | 1096 | 148 | 6 |
| 1933-34 | | | | 0 | 0 | | | | 79 | 187 | 172 | 128 | 104 | 84 | | | | | |

# Appendix 2

Streamflow records

LOS ANGELES DEPARTMENT OF WATER AND POWER · AQUEDUCT DIVISION · HYDROLOGY SECTION

MONO GATE #1 RETURN ACRE-FEET

RUNOFF YEARS 1941-42 TO 1987-88

ID - MUUA2

| | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 2533 | 3657 | 4316 | 4637 | 2796 | 1435 | 19373 | 837 | 959 | 1452 | 1693 | 1572 | 2394 | 8926 | 28299 |
| CFS | 43 | 59 | 73 | 75 | 45 | 24 | 53 | 14 | 16 | 24 | 28 | 28 | 39 | 25 | 39 |
| MAX. | 18129 | 20658 | 21135 | 20400 | 18199 | 11980 | 99196 | 10754 | 12715 | 15188 | 16620 | 15376 | 18032 | 74911 | 174107 |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| YEAR | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988-89 | 1140 | 1187 | 1149 | 1172 | 1188 | 1150 | | | 1197 | 1160 | 1199 | | | | | | | | |
| 1987-88 | 1167 | 1197 | 1192 | 1219 | 1207 | 2137 | 8119 | 42 | 1091 | 1136 | 1196 | 1169 | 1139 | 1169 | 6900 | 77 | 15019 | 55 | 23 |
| 1986-87 | 18129 | 20658 | 20838 | 20400 | 3038 | 1131 | 84194 | 435 | 1179 | 1150 | 1235 | 1189 | 1033 | 1184 | 6970 | 78 | 91164 | 322 | 5 |
| 1985-86 | 1160 | 1209 | 1148 | 1205 | 1188 | 1130 | 7040 | 36 | 1235 | 1132 | 1168 | 1168 | 1055 | 11647 | 17405 | 195 | 24445 | 86 | 16 |
| 1984-85 | 3762 | 1582 | 1473 | 1414 | 1476 | 1418 | 11125 | 57 | 1474 | 1008 | 1567 | 4393 | 1071 | 1168 | 10681 | 120 | 21806 | 77 | 18 |
| 1983-84 | 17334 | 11676 | 21135 | 18872 | 18199 | 11980 | 99196 | 512 | 10754 | 12715 | 15188 | 16620 | 10215 | 9419 | 74911 | 839 | 174107 | 615 | 1 |
| 1982-83 | 0 | 0 | 5988 | 12740 | 608 | 0 | 19336 | 100 | 0 | 0 | 9610 | 6695 | 15376 | 18032 | 49713 | 557 | 69049 | 244 | 7 |
| 1981-82 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 1980-81 | 11462 | 9749 | 2598 | 10493 | 3376 | 179 | 37857 | 195 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37857 | 134 | 14 |
| 1979-80 | 0 | 0 | 0 | 0 | 0 | 26 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 1430 | 1430 | 16 | 1456 | 5 | 31 |
| 1978-79 | 0 | 0 | 6547 | 6131 | 2467 | 0 | 15145 | 78 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15145 | 54 | 22 |
| 1977-78 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 1976-77 | 0 | 15 | 30 | 31 | 31 | 30 | 137 | 1 | 7 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 144 | 1 | 33 |
| 1975-76 | 0 | 5 | 30 | 31 | 31 | 18 | 115 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 115 | 0 | 34 |
| 1974-75 | 0 | 34 | 60 | 61 | 61 | 10 | 226 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 226 | 1 | 32 |
| 1973-74 | 0 | 0 | 4262 | 0 | 18 | 13 | 4293 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4293 | 15 | 27 |
| 1972-73 | 0 | 0 | 9 | 31 | 31 | 0 | 71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 71 | 0 | 36 |
| 1971-72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 1970-71 | 897 | 738 | 730 | 520 | 419 | 0 | 3304 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3304 | 12 | 29 |
| 1969-70 | 17066 | 18472 | 18674 | 20366 | 11734 | 4711 | 91023 | 470 | 1597 | 1676 | 952 | 7795 | 6456 | 6145 | 24621 | 276 | 115644 | 409 | 2 |
| 1968-69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3205 | 12290 | 15495 | 174 | 15495 | 55 | 21 |
| 1967-68 | 9943 | 14588 | 14454 | 14888 | 14769 | 11935 | 80577 | 416 | 7862 | 9412 | 8415 | 5543 | 1482 | 502 | 33216 | 372 | 113793 | 402 | 3 |
| 1966-67 | 0 | 988 | 936 | 615 | 436 | 0 | 2975 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2975 | 11 | 30 |
| 1965-66 | 0 | 0 | 0 | 0 | 111 | 0 | 111 | 1 | 0 | 811 | 5581 | 5782 | 5706 | 3878 | 21758 | 244 | 21869 | 77 | 17 |
| 1964-65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 1963-64 | 0 | 0 | 0 | 83 | 0 | 0 | 83 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 35 |
| 1962-63 | 0 | 0 | 502 | 3378 | 0 | 0 | 3880 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3880 | 14 | 28 |
| 1961-62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 1960-61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 1959-60 | 3921 | 1644 | 1872 | 690 | 994 | 0 | 9121 | 47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9121 | 32 | 26 |
| 1958-59 | 4873 | 11948 | 11583 | 11810 | 4560 | 2735 | 47509 | 245 | 454 | 0 | 0 | 0 | 0 | 5891 | 6345 | 71 | 53854 | 190 | 11 |
| 1957-58 | 883 | 60 | 4467 | 4536 | 3445 | 169 | 13560 | 70 | 0 | 530 | 3257 | 3255 | 2932 | 3098 | 13072 | 146 | 26632 | 94 | 15 |
| 1956-57 | 0 | 4090 | 4090 | 6383 | 7174 | 4003 | 25740 | 133 | 1200 | 3888 | 4243 | 4197 | 3812 | 4320 | 21660 | 243 | 47400 | 167 | 12 |
| 1955-56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 1954-55 | 520 | 4169 | 4298 | 2922 | 0 | 0 | 11909 | 61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11909 | 42 | 25 |
| 1953-54 | 980 | 2017 | 2053 | 4443 | 2003 | 536 | 12032 | 62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12032 | 43 | 24 |
| 1952-53 | 20 | 7620 | 11687 | 12065 | 8325 | 1920 | 41637 | 215 | 3622 | 5355 | 3457 | 3876 | 4082 | 5917 | 26309 | 295 | 67946 | 240 | 8 |
| 1951-52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 1950-51 | 0 | 0 | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 37 |
| 1949-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 38 |
| 1948-49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 1947-48 | 2915 | 5225 | 3510 | 4057 | 1106 | 1606 | 18419 | 95 | 123 | 0 | 0 | 0 | 0 | 0 | 123 | 1 | 18542 | 66 | 19 |
| 1946-47 | 5770 | 6455 | 6068 | 7192 | 7069 | 4283 | 36837 | 190 | 2520 | 5295 | 7254 | 7254 | 6996 | 10327 | 39646 | 444 | 76483 | 270 | 6 |

MONO GATE #1 RETURN ACRE-FEET RUNOFF YEARS 1941-42 TO 1988-89 ID - MUUA2

| YEAR | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 2504 | 3606 | 4250 | 4564 | 2763 | 1429 | 19115 | | 864 | 963 | 1446 | 1683 | 1562 | 2369 | 8887 | | 28002 | | |
| CFS | 42 | 59 | 71 | 74 | 45 | 24 | 53 | | 14 | 16 | 24 | 27 | 28 | 39 | 25 | | 39 | | |
| MAX. | 18129 | 20658 | 21135 | 20400 | 18199 | 11980 | 99196 | | 10754 | 12715 | 15188 | 16620 | 15376 | 18032 | 74911 | | 174107 | | |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | |
| 1946-47 | 5770 | 6455 | 6068 | 7192 | 7069 | 4283 | 36837 | 193 | 2520 | 5295 | 7254 | 7254 | 6996 | 10327 | 39646 | 446 | 76483 | 273 | 6 |
| 1945-46 | 2650 | 13855 | 14418 | 15279 | 14938 | 6478 | 67618 | 354 | 4727 | 976 | 5106 | 6024 | 5219 | 5901 | 27953 | 315 | 95571 | 341 | 4 |
| 1944-45 | 0 | 5123 | 6024 | 3181 | 2714 | 1024 | 18066 | 95 | 418 | 0 | 0 | 0 | 0 | 0 | 418 | 5 | 18484 | 66 | 20 |
| 1943-44 | 3502 | 11563 | 11854 | 12352 | 11200 | 3875 | 54346 | 284 | 359 | 0 | 0 | 0 | 0 | 0 | 359 | 4 | 54705 | 195 | 10 |
| 1942-43 | 8870 | 8777 | 8955 | 9391 | 5743 | 4626 | 46362 | 243 | 694 | 0 | 0 | 4605 | 3637 | 3088 | 12024 | 135 | 58386 | 209 | 9 |
| 1941-42 | 3207 | 8424 | 11349 | 11137 | 2953 | 1454 | 38524 | 202 | 952 | 0 | 0 | 0 | 446 | 7107 | 8505 | 96 | 47029 | 168 | 13 |
| 1940-41 | | | | | | | | | | | | 0 | 0 | 0 | | | | | |

LOS ANGELES DEPARTMENT OF WATER AND POWER

AQUEDUCT DIVISION

HYDROLOGY SECTION

ID - GURD2

GRANT LAKE RESERVOIR SPILL ACRE-FEET

HYDROGRAPHIC YEARS 1941-42 TO 1988-89

| | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 433 | 273 | 73 | 63 | 0 | 19 | 860 | 87 | 134 | 48 | 1114 | 753 | 534 | 2668 | 3528 |
| CFS | 7 | 5 | 1 | 1 | 0 | 0 | 2 | 1 | 2 | 1 | 18 | 12 | 9 | 7 | 5 |
| MAX. | 13244 | 11395 | 3507 | 2979 | 0 | 912 | 31125 | 4161 | 4897 | 2123 | 38180 | 13240 | 10601 | 43143 | 43143 |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| YEAR | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989-90 | 0 | 0 | 0 | | | | | | | | | | | | | | | | |
| 1988-89 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1987-88 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1986-87 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1985-86 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1984-85 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 13 |
| 1983-84 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3172 | 13240 | 8263 | 24675 | 925 | 24675 | 699 | 3 |
| 1982-83 | 13244 | 11395 | 3507 | 2979 | 0 | 0 | 31125 | 3619 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 31125 | 882 | 2 |
| 1981-82 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 10592 | 10601 | 21253 | 797 | 21253 | 602 | 4 |
| 1980-81 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1979-80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 426 | 3822 | 0 | 4248 | 159 | 4248 | 120 | 8 |
| 1978-79 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1977-78 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1976-77 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1975-76 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1974-75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1973-74 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1972-73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1971-72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1970-71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1969-70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1968-69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1967-68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1966-67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 161 | 38180 | 4802 | 0 | 43143 | 1617 | 43143 | 1223 | 1 |
| 1965-66 | 7509 | 1692 | 0 | 0 | 0 | 0 | 9201 | 1070 | 0 | 1519 | 0 | 0 | 0 | 0 | 1519 | 57 | 10720 | 304 | 6 |
| 1964-65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2078 | 6763 | 8841 | 331 | 8841 | 251 | 7 |
| 1963-64 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1962-63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3399 | 298 | 0 | 3697 | 139 | 3697 | 105 | 9 |
| 1961-62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1960-61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1959-60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1958-59 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1957-58 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1956-57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1955-56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1718 | 799 | 0 | 2517 | 94 | 2517 | 71 | 10 |
| 1954-55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1953-54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1952-53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1951-52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4161 | 4897 | 2123 | 6512 | 492 | 0 | 18185 | 682 | 18185 | 515 | 5 |
| 1950-51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1949-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1948-49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 |
| 1947-48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |

RUSH CREEK AT HIGHWAY ACRE-FEET RUNOFF YEARS 1922-23 TO 1946-47 ID - RHHQ2

| YEAR | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 2425 | 2525 | 3329 | 4363 | 2277 | 1409 | 16328 | | 1775 | 1639 | 1934 | 2192 | 2011 | 2696 | 12246 | | 28574 | | |
| CFS | 41 | 41 | 56 | 71 | 37 | 24 | 45 | | 29 | 28 | 31 | 36 | 36 | 44 | 34 | | 39 | | |
| MAX. | 8399 | 10350 | 12095 | 21900 | 13293 | 7269 | 73306 | | 6178 | 5432 | 7717 | 7878 | 7303 | 10506 | 40546 | | 103552 | | |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 4 | | 1109 | | |
| 1947-48 | 729 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | | | | | | | | |
| 1946-47 | 5737 | 1010 | 4541 | 1143 | 548 | 493 | 13472 | 83 | 1710 | 5432 | 7717 | 7878 | 7303 | 10506 | 40546 | 331 | 54018 | 189 | 3 |
| 1945-46 | 2624 | 8193 | 8188 | 10613 | 10939 | 3598 | 44155 | 270 | 4085 | 1014 | 5300 | 6199 | 5499 | 6173 | 28270 | 231 | 72425 | 253 | 2 |
| 1944-45 | 0 | 214 | 0 | 0 | 0 | 0 | 214 | 1 | 0 | 0 | 0 | 0 | 0 | 895 | 895 | 7 | 1109 | 4 | 21 |
| 1943-44 | 3020 | 5203 | 5241 | 9769 | 10039 | 1312 | 34584 | 212 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 34588 | 121 | 9 |
| 1942-43 | 6158 | 3967 | 3612 | 7949 | 4039 | 4097 | 29822 | 183 | 675 | 0 | 0 | 4876 | 4875 | 3840 | 14266 | 116 | 44088 | 154 | 6 |
| 1941-42 | 3092 | | | | | | | | | | | | 202 | 7133 | | | | | |
| 1940-41 | 607 | 2824 | 2693 | 3086 | 1163 | 464 | 10837 | 66 | 912 | 213 | 638 | 0 | 0 | 0 | 1763 | 14 | 12600 | 44 | 14 |
| 1939-40 | 4683 | 485 | 724 | 146 | 526 | 311 | 6875 | 42 | 897 | 1407 | 298 | 203 | 2620 | 1199 | 6624 | 54 | 13499 | 47 | 13 |
| 1938-39 | 8399 | 10350 | 12095 | 21900 | 13293 | 7269 | 73306 | 449 | 6178 | 4712 | 6919 | 3734 | 3221 | 5482 | 30246 | 247 | 103552 | 362 | 1 |
| 1937-38 | 2622 | 6107 | 7611 | 3324 | 1591 | 4099 | 25354 | 155 | 3023 | 2573 | 3107 | 3212 | 3182 | 5896 | 20993 | 171 | 46347 | 162 | 5 |
| 1936-37 | 3388 | 2603 | 966 | 4974 | 4488 | 5536 | 21955 | 134 | 2977 | 42 | 1730 | 2317 | 2889 | 3521 | 13476 | 110 | 35431 | 124 | 8 |
| 1935-36 | 2759 | 2206 | 5094 | 5554 | 411 | 15 | 16039 | 98 | 2550 | 3134 | 4704 | 4154 | 3115 | 4369 | 22026 | 180 | 38065 | 133 | 7 |
| 1934-35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 997 | 2113 | 4332 | 7442 | 61 | 7442 | 26 | 16 |
| 1933-34 | 149 | 0 | 0 | 0 | 0 | 0 | 149 | | 0 | 0 | 0 | | | | | | | | |
| 1932-33 | 2612 | 18 | 18 | 7483 | 0 | 0 | 10131 | 62 | 2324 | 3874 | 1396 | 375 | 200 | 203 | 8372 | 68 | 18503 | 65 | 12 |
| 1931-32 | 36 | 12 | 101 | 123 | 43 | 0 | 315 | 2 | 0 | 0 | 0 | 0 | 0 | 3603 | 3603 | 29 | 3918 | 14 | 19 |
| 1930-31 | 333 | 68 | 387 | 61 | 37 | 6 | 892 | 5 | 1580 | 2594 | 61 | 0 | 0 | 0 | 4235 | 35 | 5127 | 18 | 18 |
| 1929-30 | 1089 | 117 | 125 | 141 | 86 | 36 | 1594 | 10 | 972 | 54 | 61 | 0 | 0 | 295 | 1382 | 11 | 2976 | 10 | 20 |
| 1928-29 | 1059 | 344 | 190 | 166 | 31 | 119 | 1909 | 12 | 117 | 3903 | 2023 | 978 | 100 | 92 | 7213 | 59 | 9122 | 32 | 15 |
| 1927-28 | 3029 | 1224 | 256 | 1869 | 209 | 119 | 6706 | 41 | 2306 | 506 | 849 | 4150 | 3618 | 3824 | 15253 | 125 | 21959 | 77 | 11 |
| 1926-27 | 357 | 326 | 95 | 68 | 61 | 60 | | | 2158 | 2452 | | 805 | 811 | 4587 | | | | | |
| 1925-26 | 6 | 12 | 149 | 271 | 0 | 3291 | | | 3874 | 2291 | 4126 | | | | | | | | |
| 1924-25 | 36 | 25 | 12 | 0 | 0 | 0 | 73 | 0 | 1525 | 726 | 1045 | 1679 | 178 | 25 | 5178 | 42 | 5251 | 18 | 17 |
| 1923-24 | 179 | 3689 | 6902 | 4058 | 215 | 428 | 15471 | 95 | 2675 | 1636 | 1463 | 1605 | 288 | 43 | 7710 | 63 | 23181 | 81 | 10 |
| 1922-23 | 2553 | 4372 | 11151 | 9260 | 154 | 1690 | 29180 | 179 | 2767 | 2594 | 3296 | 3665 | 3038 | 2318 | 17678 | 144 | 46858 | 164 | 4 |
| 1921-22 | | | | | | | | | | | | 2871 | 2366 | 3333 | | | | | |

CITY OF LOS ANGELES
DEPARTMENT OF WATER AND POWER
Division of Hydrography

Station RUSH CREEK - HIGHWAY

Quantities expressed in SECOND feet.

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Mean Sec. Ft. | Acre Feet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1933-34 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 1934-35 | 0.0 | 0.0 | 0.0 | 16.22 | 38.05 | 70.48 | 46.37 | 35.88 | 85.62 | 90.34 | 6.69 | 0.25 | 32.4 | 234[illegible]1 |
| 1935-36 | 41.48 | 52.69 | 76.53 | 67.58 | 54.18 | 71.08 | 56.96 | 42.36 | 16.24 | 80.91 | 73.01 | 93.06 | 60.6 | 43951 |
| 1936-37 | 48.43 | 0.70 | 28.14 | 37.69 | 52.04 | 57.27 | 44.08 | 99.35 | 127.94 | 57.04 | 25.88 | 68.90 | 53.6 | 38830 |
| 1937-38 | 49.18 | 43.25 | 50.55 | 52.25 | 57.30 | 95.91 | 141.18 | 168.37 | 203.31 | 356.26 | 216.25 | 122.19 | 130.3 | 94299 |
| 1938-39 | 100.50 | 79.20 | 112.56 | 60.74 | 58.01 | 89.18 | 78.71 | 7.89 | 12.17 | 2.37 | 8.56 | 5.23 | 51.3 | 37121 |
| 1939-40 | 14.59 | 23.65 | 4.85 | 3.30 | 45.57 | 19.50 | 10.20 | 45.94 | 45.26 | 50.20 | 18.93 | 7.80 | 24.1 | 17461 |
| 1940-41 | 14.84 | 3.56 | 10.38 | 0.0 | 0.0 | 0.0 | 51.97 | STATION ABANDONED | | | | | | |
| 1941-42 | | | | | 3.63 | 116.03 | 103.51 | 64.53 | 61.73 | 129.30 | 65.70 | 68.87 | | |
| 1942-43 | 10.98 | 0.0 | 0.0 | 79.31 | 87.80 | 62.46 | 50.77 | 84.64 | 88.10 | 158.91 | 163.30 | 22.05 | 67.5 | 48850 |
| 1943-44 | 0.07 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.48 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 21[illegible] |
| 1944-45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.56 | 44.12 | 133.28 | 137.63 | 172.64 | 177.95 | 60.49 | 62.2 | 45051 |
| 1945-46 | 66.45 | 17.05 | 86.21 | 100.84 | 99.03 | 100.41 | 96.44 | 16.44 | 76.32 | 18.6 | 8.9 | 8.3 | 57.7 | 41741 |
| 1946-47 | 27.81 | 91.31 | 125.53 | 128.1 | 131.5 | 170.9 | 12.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 57.0 | 41275 |
| 1947-48 | 0.0 | 0.0 | 0.0 | 0.0 | STATION ABANDONED JAN. 26, 1948 | | | | | | | | | |

Code 16000 1M 1-51 P.O. 24438

Sheet ______ of ______ Sheets

CITY OF LOS ANGELES
DEPARTMENT OF WATER AND POWER
Division of Hydrography

Station RUSH CREEK - NORTH LINE (COUNTY ROAD)

Quantities expressed in SECOND- feet.

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Mean Sec. Ft. | Acre Feet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1933-34 | | | | | | | 20.5 | 21.3 | 24.8 | 21.6 | 23.6 | 26.1 | | |
| 1934-35 | 29.7 | 27.7 | 24.0 | 31.6 | 58.7 | 89.9 | 70.5 | 55.8 | 124.2 | 115.2 | 38.3 | 36.0 | 58.4 | 42271 |
| 1935-36 | 87.3 | 91.4 | 95.3 | 108.4 | 99.9 | 117.4 | 93.9 | 79.1 | 58.5 | 150.1 | 127.2 | 139.4 | 104.1 | 75551 |
| 1936-37 | 96.3 | 36.8 | 67.5 | 74.0 | 95.2 | 93.9 | 82.8 | 129.7 | 176.7 | 106.2 | 65.2 | 105.6 | 94.1 | 63096 |
| 1937-38 | 82.2 | 77.6 | 86.8 | 87.0 | 96.5 | 143.5 | 215.0 | 247.2 | | | | | | |

CODE 18000 2M 4-53 P.O. 33532

Sheet ______ of ______ Sheets

CITY OF LOS ANGELES
DEPARTMENT OF WATER AND POWER
HYDROLOGY SECTION

STATION RUSH CREEK - NORTH LINE (COUNTY ROAD)

QUANTITIES EXPRESSED IN SECOND FEET

| YEAR | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | JULY | AUG. | SEPT. | MEAN SEC. FT. | ACRE FEET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1951-52 | | | | | | | | 192.6 | 195.3 | 318.9 | 117.6 | 17.3 | | |
| 1952-53 | 43.8 | 92.7 | 61.7 | 66.8 | 74.5 | 98.0 | 13.8 | 7.2 | 10.6 | 11.0 | 9.4 | 7.2 | [illegible] | 29854 |
| 1953-54 | 8.7 | 8.5 | 7.5 | 7.0 | 7.3 | 6.5 | 5.2 | 5.9 | 10.8 | 13.1 | 8.6 | 6.8 | 8.0 | 5784 |
| 1954-55 | 7.2 | 7.6 | 7.8 | 6.9 | 7.7 | 6.7 | 7.1 | 6.4 | 4.7 | 3.9 | 3.7 | 4.0 | 6.1 | 4442 |
| 1955-56 | 4.3 | 4.3 | 6.5 | 4.6 | 4.2 | 4.2 | 4.1 | 6.7 | 20.6 | 90.5 | 70.9 | 19.6 | 20.2 | 14669 |
| 1956-57 | 11.5 | 74.3 | 69.2 | 70.3 | 70.7 | 74.4 | 24.9 | 13.9 | 30.5 | 25.8 | 17.7 | 10.9 | 41.0 | 29674 |
| 1957-58 | 11.2 | 16.4 | 56.1 | 56.1 | 58.0 | 58.1 | 92.2 | 182.1 | 194.2 | 185.7 | 59.6 | 28.9 | [illegible] | 60393 |
| 1958-59 | 21.1 | 14.6 | 13.4 | 12.2 | 11.5 | 91.0 | 68.6 | 11.3 | 12.4 | 14.8 | 11.7 | 10.3 | 24.5 | 17732 |
| 1959-60 | 11.6 | 11.2 | 9.9 | 9.9 | 10.9 | 11.0 | 9.2 | 8.5 | 6.1 | 4.5 | 3.7 | 3.6 | 8.3 | 6047 |
| 1960-61 | 4.8 | 4.9 | 4.6 | 4.9 | 4.1 | 2.9 | 2.9 | 3.2 | 2.8 | 1.8 | 1.0 | 0.8 | 3.2 | 2325 |
| 1961-62 | 0.9 | 1.3 | 1.8 | 1.4 | 2.0 | 2.8 | 3.5 | 2.8 | 3.6 | 10.0 | 5.1 | 0.3 | 3.0 | 2143 |
| 1962-63 | 0.9 | 1.7 | 1.2 | 1.5 | 2.4 | 0.8 | 0.7 | 0.6 | 0.5 | 60.9 | 14.8 | 2.7 | 7.5 | 5430 |
| 1963-64 | 1.2 | 1.0 | 1.7 | 1.2 | 1.0 | 1.0 | 0.3 | 0.2 | 0.1 | 0 | 0.1 | 0.1 | 0.7 | 481 |
| 1964-65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11.8 | 45.3 | 114.8 | [illegible] | 10339 |
| 1965-66 | 117.7 | 33.7 | 75.9 | 84.3 | 92.0 | 56.1 | 1.8 | 33.8 | 8.1 | 1.5 | 4.0 | 4.2 | [illegible] | 30905 |

SHEET OF SHEETS Register Installed 4-8-52

CITY OF LOS ANGELES
DEPARTMENT OF WATER AND POWER
HYDROLOGY SECTION

STATION RUSH CREEK - NORTH LINE (COUNTY ROAD)

QUANTITIES EXPRESSED IN SECOND FEET

| YEAR | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | JULY | AUG. | SEPT. | MEAN SEC. FT. | ACRE F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1966-67 | 4.0 | 2.0 | 3.5 | 3.3 | 0.3 | 0.5 | 173.8 | 235.2 | 228.5 | DISCONTINUED 7-3-67 | | | | |

SHEET ________ OF ________ SHEETS

| | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 1528 | 1888 | 2009 | 2657 | 1721 | 1708 | 11511 | | 1474 | 1100 | 1589 | 1631 | 1611 | 2126 | 9531 | | 21042 | | |
| CFS | 26 | 31 | 34 | 43 | 28 | 29 | 32 | | 24 | 18 | 26 | 27 | 29 | 35 | 26 | | 29 | | |
| MAX. | 5588 | 11196 | 11557 | 12415 | 7818 | 8296 | 45042 | | 7235 | 4617 | 5339 | 5348 | 5358 | 8820 | 34535 | | 74765 | | |
| MIN. | 0 | 0 | 0 | 0 | 5 | 4 | 49 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 49 | | |

| YEAR | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1967-68 | 10344 | 14463 | 13598 | | | | | | | | | | | | | | | | |
| 1966-67 | 105 | 2081 | 482 | 92 | 248 | 252 | 3260 | 28 | 247 | 121 | 213 | 204 | 16 | 29 | 830 | 9 | 4090 | 19 | 11 |
| 1965-66 | 0 | 0 | 0 | 726 | 2782 | 6831 | 10339 | 90 | 7235 | 2004 | 4666 | 5185 | 5108 | 3447 | 27645 | 290 | 37984 | 181 | 4 |
| 1964-65 | 20 | 13 | 7 | 0 | 5 | 4 | 49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 49 | 0 | 16 |
| 1963-64 | 44 | 36 | 31 | 3747 | 909 | 163 | 4930 | 43 | 72 | 61 | 104 | 73 | 59 | 63 | 432 | 5 | 5362 | 25 | 10 |
| 1962-63 | 206 | 171 | 214 | 616 | 312 | 15 | 1534 | 13 | 56 | 98 | 73 | 91 | 132 | 50 | 500 | 5 | 2034 | 10 | 14 |
| 1961-62 | 174 | 197 | 166 | 111 | 60 | 45 | 753 | 7 | 58 | 78 | 108 | 86 | 109 | 170 | 609 | 6 | 1362 | 6 | 15 |
| 1960-61 | 545 | 524 | 361 | 276 | 229 | 211 | 2146 | 19 | 296 | 289 | 282 | 302 | 227 | 176 | 1572 | 16 | 3718 | 18 | 12 |
| 1959-60 | 4082 | 695 | 739 | 912 | 722 | 614 | 7764 | 67 | 712 | 665 | 608 | 609 | 628 | 679 | 3901 | 41 | 11665 | 55 | 7 |
| 1958-59 | 5486 | 11196 | 11557 | 11415 | 3667 | 1721 | 45042 | 391 | 1294 | 869 | 825 | 749 | 640 | 5595 | 9972 | 105 | 55014 | 261 | 3 |
| 1957-58 | 1480 | 852 | 1816 | 1585 | 1087 | 650 | 7470 | 65 | 689 | 973 | 3452 | 3449 | 3218 | 3572 | 15353 | 161 | 22823 | 108 | 6 |
| 1956-57 | 245 | 413 | 1226 | 5564 | 4357 | 1165 | 12970 | 113 | 705 | 4424 | 4252 | 4324 | 3925 | 4574 | 22204 | 233 | 35174 | 167 | 5 |
| 1955-56 | 422 | 396 | 281 | 240 | 229 | 239 | 1807 | 16 | 261 | 257 | 401 | 283 | 240 | 257 | 1699 | 18 | 3506 | 17 | 13 |
| 1954-55 | 309 | 362 | 640 | 804 | 527 | 403 | 3045 | 26 | 445 | 453 | 479 | 421 | 427 | 410 | 2635 | 28 | 5680 | 27 | 9 |
| 1953-54 | 819 | 441 | 630 | 675 | 575 | 430 | 3570 | 31 | 535 | 508 | 464 | 429 | 404 | 399 | 2739 | 29 | 6309 | 30 | 8 |
| 1952-53 | 3806 | 11844 | 11620 | 19689 | 7232 | 1059 | | | 2696 | 5517 | 3796 | 4109 | 4139 | 6027 | | | | | |
| NO DATA FOR YEARS 1939-40 THROUGH 1951-52 | | | | | | | | | | | | | | | | | | | |
| 1938-39 | 12776 | 15193 | | | | | | | | | | | | | | | | | |
| 1937-38 | 4924 | 7974 | 10509 | 6530 | 4009 | 6284 | 40230 | 349 | 5053 | 4617 | 5339 | 5348 | 5358 | 8820 | 34535 | 362 | 74765 | 355 | 1 |
| 1936-37 | 5588 | 4861 | 3481 | 9225 | 7818 | 8296 | 39269 | 341 | 5921 | 2187 | 4150 | 4549 | 5286 | 5773 | 27866 | 292 | 67135 | 319 | 2 |
| 1935-36 | | | | | | | | | 5369 | 5435 | 5856 | 6662 | 5744 | 7216 | | | | | |

RUSH CREEK AT COUNTY ROAD ACRE-FEET RUNOFF YEARS 1934-35 TO 1934-35 ID - RVH02

| | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 1220 | 1312 | 1474 | 1325 | 1452 | 1551 | 8334 | 1824 | 1649 | 1473 | 1944 | 3261 | 5528 | 15679 | 24013 |
| CFS | 21 | 21 | 25 | 22 | 24 | 26 | 23 | 30 | 28 | 24 | 32 | 59 | 90 | 43 | 33 |
| MAX. | 1220 | 1312 | 1474 | 1325 | 1452 | 1551 | 8334 | 1824 | 1649 | 1473 | 1944 | 3261 | 5528 | 15679 | 24013 |
| MIN. | 1220 | 1312 | 1474 | 1325 | 1452 | 1551 | 8334 | 1824 | 1649 | 1473 | 1944 | 3261 | 5528 | 15679 | 24013 |

| YEAR | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1935-36 | 4195 | 3431 | 7390 | 7081 | 2355 | 2140 | | | | | | | | | | | | | |
| 1934-35 | 1220 | 1312 | 1474 | 1325 | 1452 | 1551 | 8334 | 100 | 1824 | 1649 | 1473 | 1944 | 3261 | 5528 | 15679 | 100 | 24013 | 100 | 1 |

CITY OF LOS ANGELES
DEPARTMENT OF WATER AND POWER
HYDROLOGY SECTION

STATION LEE VINING CREEK - MONO LAKE (COUNTY ROAD)

QUANTITIES EXPRESSED IN Second FEET

| YEAR | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | JULY | AUG. | SEPT. | MEAN SEC. FT. | ACRE FEET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1933-34 | | | | | | | 32.62 | 24.36 | 17.08 | 4.36 | 0.47 | 2.04 | | |
| 1934-35 | 16.37 | 24.39 | 25.04 | 23.76 | 21.32 | 25.00 | 25.91 | 65.09 | 172.34 | 71.4 | 46.2 | 25.1 | 45.2 | 32704 |
| 1935-36 | 32.4 | 22.0 | 19.2 | 20.3 | 19.2 | 29.9 | 46.6 | 93.0 | 152.0 | 106.3 | 52.8 | 31.3 | 52.1 | 37835 |
| 1936-37 | 17.6 | 16.9 | 22.6 | 42.8 | 45.7 | 37.4 | 32.1 | 98.4 | 166.4 | 73.0 | 21.6 | 12.1 | 48.8 | 35333 |
| 1937-[illegible] | 16.4 | 13.4 | 29.6 | 25.8 | 34.8 | 52.1 | 65.2 | 123.2 | 296.3 | 217.7 | 87.6 | 61.5 | 85.5 | 61858 |
| 1938-39 | 43.3 | 52.3 | 26.4 | 12.0 | 14.8 | 17.0 | 27.2 | 31.1 | 29.2 | 9.6 | 10.4 | 5.1 | 23.2 | 16793 |
| 1939-40 | 10.2 | 16.2 | 20.5 | 25.3 | 17.4 | 16.6 | 26.9 | 108.9 | 166.3 | 49.0 | 27.5 | 22.4 | 42.2 | 30648 |
| 1940-41 | 25.0 | 26.7 | 13.7 | 7.9 | 5.8 | 5.6 | 14.1 | 78.7 | 183.1 | 129.1 | 5.0 | 2.5 | 41.6 | 30093 |
| 1941-42 | 11.8 | 24.2 | NR | NR | NR | NR | 80.7 | 61.1 | 180.2 | 167.6 | 47.2 | 10.3 | (48.7) | (35262) |
| 1942-43 | 2.5 | 12.3 | 46.7 | 61.4 | NR | 28.8 | 61.8 | 127.2 | 155.5 | 140.3 | 49.4 | 18.2 | (59.1) | (42801) |
| 1943-44 | 2.2 | 4.5 | 12.0 | 56.4 | 28.0 | NR | 23.9 | 44.9 | 29.1 | 15.4 | 4.9 | 7.0 | (19.0) | (13799) |
| 1944-45 | 0 | 0 | 0 | 0 | 0 | 0 | 2.8 | 88.0 | 172.0 | 163.7 | 66.2 | 22.5 | (43.0) | (31113) |
| 1945-46 | 21.8 | 29.5 | 31.5 | 16.6 | 0 | 45.3 | 47.2 | 10.7 | 85.4 | 33.1 | 6.9 | 3.0 | (22.4) | (16211) |
| 1946-47 | 8.9 | 30.9 | 40.5 | 47.3 | 43.0 | 23.7 | 3.0 | 1.2 | 0.6 | 0.3 | 0.2 | 0.2 | 16.5 | 11950 |
| 1947-48 | 0.2 | 1.2 | 1.2 | 2.1 | 1.7 | 1.3 | 1.1 | 0.7 | 0.3 | 0.2 | 0.2 | 0 | 0.8 | 512 |

CITY OF LOS ANGELES
DEPARTMENT OF WATER AND POWER
HYDROLOGY SECTION

STATION LEE VINING CREEK - MONO LAKE (COUNTY ROAD)

QUANTITIES EXPRESSED IN SECOND FEET

| YEAR | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | JULY | AUG. | SEPT. | MEAN SEC. FT. | ACRE FEET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1948-49 | 0 | 0.60 | 0.45 | 0.20 | 0.30 | 2.23 | 1.77 | 0.65 | 0.18 | 0 | 0 | 0 | 0.53 | 385 |
| 1949-50 | 0 | 0.33 | 0.50 | 0 | 0 | 0.11 | 0.71 | 0.56 | 0.45 | 0.05 | 0 | 7.63 | 0.85 | 617 |
| 1950-51 | 1.51 | 5.87 | 5.81 | 5.30 | 3.16 | 1.77 | 0.31 | 3.65 | 3.84 | 0.14 | 0 | 0 | 2.61 | 1820 |
| 1951-52 | 0 | 0 | 0 | 0 | 0.99 | 23.53 | 43.77 | 140.34 | 209.10 | 190.89 | 71.16 | 6.42 | 57.41 | 41673 |
| 1952-53 | 27.03 | 23.37 | 28.87 | 46.8 | 35.3 | 25.1 | 4.1 | 1.3 | 0.9 | 0.6 | 0 | 0 | 16.1 | 11618 |
| 1953-54 | 0 | 0 | 0.9 | 1.8 | 1.8 | 1.6 | 1.6 | 0.4 | 0.1 | 0 | 0 | 0 | 0.72 | 522 |
| 1954-55 | 0 | 0 | 0 | 0.35 | 0.36 | 0.14 | 0.15 | 0.29 | 0.83 | 20.16 | 0.43 | 0 | 1.92 | 139[illegible] |
| 1955-56 | 0 | 0.61 | 5.35 | 1.26 | 1.16 | 0.82 | 2.45 | 40.15 | 27.65 | 74.11 | 31.27 | 0.54 | 12.55 | 9100 |
| 1956-57 | 0.40 | 59.59 | 42.46 | 26.75 | 28.51 | 31.65 | 5.40 | 1.06 | 12.66 | 0 | 0 | 0 | 17.26 | 12495 |
| 1957-58 | 0 | 3.84 | 23.39 | 21.53 | 38.23 | 32.04 | 34.35 | 127.98 | 196.25 | 146.50 | 0.78 | 0 | 52.12 | 377[illegible] |
| 1958-59 | 0 | 0 | 0 | 0 | 0 | 34.46 | 27.56 | 0.10 | 0.57 | 0 | 0 | 0 | 5.25 | 3799 |
| 1959-60 | 0.18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 | 11 |
| 1960-61 | 0 | 0.11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 6 |
| 1961-62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| 1962-63 | 0 | 0 | 0 | 0.27 | 0.32 | 0 | 0 | 0 | 10.20 | 0 | 0 | 0 | 0.89 | [illegible] |

11[illegible]

SHEETS

CITY OF LOS ANGELES
## DEPARTMENT OF WATER AND POWER
HYDROLOGY SECTION

STATION LEE VINING CREEK - MONO LAKE

QUANTITIES EXPRESSED IN SECOND - FEET

| YEAR | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | JULY | AUG. | SEPT. | MEAN SEC. FT. | ACRE FEET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1963-64 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1964-65 | 0 | 0 | 1.6 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0.1 | 0 | 0 | 0.2 | 115 |
| 1965-66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1966-67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37.1 | 85.8 | 0.44 | 0 | 10.4 | 7512 |
| 1967-68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1968-69 | 0 | 0 | 0 | 0 | 0 | 11 | 54 | 218 | | RECORD DISCONTINUED STA. DESTROYED BY HIGH WATER | | | | |

1104

LEE VINING CREEK SPILL AT INTAKE ACRE-FEET HYDROGRAPHIC YEARS 1941-42 TO 1988-89 ID - LJMM2

| | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 434 | 373 | 445 | 551 | 439 | 505 | 2747 | | 702 | 1531 | 2682 | 2581 | 1052 | 472 | 9019 | | 11766 |
| CFS | 7 | 6 | 7 | 9 | 8 | 8 | 8 | | 12 | 25 | 45 | 42 | 17 | 8 | 25 | | 16 |
| MAX. | 6136 | 4080 | 3336 | 3949 | 2870 | 3836 | 16428 | | 6561 | 13296 | 18769 | 15217 | 10647 | 5159 | 53851 | | 65007 |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |

| YEAR | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989-90 | 290 | 301 | 863 | | | | | | | | | | | | | | | | |
| 1988-89 | 238 | 261 | 275 | 277 | 250 | 251 | 1552 | 57 | 250 | 294 | 334 | 306 | 306 | 267 | 1757 | 19 | 3309 | 28 | 22 |
| 1987-88 | 559 | 289 | 217 | 212 | 197 | 207 | 1681 | 61 | 219 | 213 | 220 | 233 | 235 | 227 | 1347 | 15 | 3028 | 26 | 23 |
| 1986-87 | 630 | 618 | 644 | 625 | 609 | 679 | 3805 | 139 | 638 | 672 | 636 | 663 | 634 | 631 | 3874 | 43 | 7679 | 65 | 19 |
| 1985-86 | 0 | 0 | 0 | 0 | 0 | 19 | 19 | 1 | 0 | 804 | 5352 | 4141 | 392 | 617 | 11306 | 125 | 11325 | 96 | 15 |
| 1984-85 | 16 | 0 | 0 | 0 | 0 | 7 | 23 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 25 | 0 | 39 |
| 1983-84 | 3569 | 447 | 2 | 0 | 0 | 0 | 4018 | 146 | 0 | 57 | 40 | 1628 | 1456 | 720 | 3901 | 43 | 7919 | 67 | 18 |
| 1982-83 | 6136 | 2163 | 83 | 1320 | 1454 | 0 | 11156 | 406 | 30 | 4467 | 18331 | 15217 | 10647 | 5159 | 53851 | 597 | 65007 | 553 | 1 |
| 1981-82 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 1353 | 6043 | 2839 | 1954 | 12213 | 135 | 12213 | 104 | 14 |
| 1980-81 | 0 | 0 | 0 | 3 | 4 | 0 | 7 | 0 | 0 | 41 | 9 | 0 | 27 | 7 | 84 | 1 | 91 | 1 | 37 |
| 1979-80 | 22 | 0 | 0 | 0 | 0 | 0 | 22 | 1 | 1281 | 4442 | 834 | 3870 | 4667 | 544 | 15638 | 173 | 15660 | 133 | 12 |
| 1978-79 | 0 | 0 | 0 | 10 | 0 | 0 | 10 | 0 | 0 | 77 | 126 | 0 | 0 | 129 | 332 | 4 | 342 | 3 | 30 |
| 1977-78 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 41 | 3073 | 4060 | 0 | 0 | 7174 | 80 | 7174 | 61 | 20 |
| 1976-77 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 46 |
| 1975-76 | 0 | 13 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 42 |
| 1974-75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 276 | 0 | 0 | 0 | 305 | 3 | 305 | 3 | 31 |
| 1973-74 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 182 | 266 | 5 | 4 | 0 | 457 | 5 | 457 | 4 | 29 |
| 1972-73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 819 | 0 | 0 | 0 | 857 | 10 | 857 | 7 | 25 |
| 1971-72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 0 | 137 | 12 | 170 | 2 | 170 | 1 | 35 |
| 1970-71 | 0 | 0 | 4 | 4 | 0 | 0 | 8 | 0 | 0 | 1 | 108 | 0 | 9 | 0 | 118 | 1 | 126 | 1 | 36 |
| 1969-70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 226 | 0 | 0 | 0 | 247 | 3 | 247 | 2 | 34 |
| 1968-69 | 0 | 0 | 44 | 0 | 0 | 1265 | 1309 | 48 | 4156 | 13296 | 18769 | 12282 | 176 | 0 | 48679 | 540 | 49988 | 425 | 4 |
| 1967-68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 45 |
| 1966-67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2640 | 7565 | 41 | 0 | 10246 | 114 | 10246 | 87 | 16 |
| 1965-66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 46 |
| 1964-65 | 0 | 0 | 127 | 0 | 0 | 0 | 127 | 5 | 0 | 35 | 28 | 63 | 0 | 0 | 126 | 1 | 253 | 2 | 33 |
| 1963-64 | 5 | 1 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 44 |
| 1962-63 | 8 | 0 | 0 | 1 | 2 | 0 | 11 | 0 | 0 | 18 | 773 | 7 | 0 | 0 | 798 | 9 | 809 | 7 | 26 |
| 1961-62 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 14 | 0 | 16 | 0 | 40 |
| 1960-61 | 0 | 30 | 0 | 0 | 0 | 0 | 30 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 31 | 0 | 38 |
| 1959-60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 10 | 2 | 0 | 0 | 15 | 0 | 15 | 0 | 41 |
| 1958-59 | 0 | 0 | 0 | 0 | 0 | 2552 | 2552 | 93 | 1879 | 0 | 99 | 0 | 0 | 9 | 1987 | 22 | 4539 | 39 | 21 |
| 1957-58 | 0 | 242 | 1686 | 1535 | 2259 | 2323 | 8045 | 293 | 2379 | 8509 | 11750 | 9334 | 19 | 0 | 31991 | 355 | 40036 | 340 | 6 |
| 1956-57 | 0 | 4080 | 3070 | 2803 | 1674 | 2208 | 13835 | 504 | 247 | 0 | 1098 | 0 | 0 | 0 | 1345 | 15 | 15180 | 129 | 13 |
| 1955-56 | 0 | 12 | 425 | 30 | 17 | 0 | 484 | 18 | 71 | 252 | 1328 | 5036 | 2384 | 0 | 9071 | 101 | 9555 | 81 | 17 |
| 1954-55 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 152 | 105 | 0 | 0 | 257 | 3 | 258 | 2 | 32 |
| 1953-54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 9 | 0 | 9 | 0 | 43 |
| 1952-53 | 1912 | 1593 | 2267 | 3562 | 2412 | 1995 | 13741 | 500 | 174 | 274 | 520 | 792 | 247 | 0 | 2007 | 22 | 15748 | 134 | 11 |
| 1951-52 | 9 | 1 | 7 | 0 | 251 | 1657 | 1925 | 70 | 2646 | 9233 | 12936 | 12639 | 6002 | 653 | 44109 | 489 | 46034 | 391 | 5 |
| 1950-51 | 4 | 75 | 0 | 98 | 2 | 0 | 179 | 7 | 0 | 335 | 421 | 0 | 0 | 0 | 756 | 8 | 935 | 8 | 24 |
| 1949-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 635 | 635 | 7 | 635 | 5 | 28 |
| 1948-49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 46 |
| 1947-48 | 498 | 38 | 32 | 135 | 46 | 0 | 749 | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 749 | 6 | 27 |

LEE VINING CREEK SPILL AT INTAKE ACRE-FEET

HYDROGRAPHIC YEARS 1941-42 TO 1988-89

ID - LJMM2

| | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 434 | 373 | 445 | 551 | 439 | 505 | 2747 | | 702 | 1531 | 2682 | 2581 | 1052 | 472 | 9019 | | 11766 |
| CFS | 7 | 6 | 7 | 9 | 8 | 8 | 8 | | 12 | 25 | 45 | 42 | 17 | 8 | 25 | | 16 |
| MAX. | 6136 | 4080 | 3336 | 3949 | 2870 | 3836 | 16428 | | 6561 | 13296 | 18769 | 15217 | 10647 | 5159 | 53851 | | 65007 |
| MIN. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |

| YEAR | OCT | NOV | DEC | JAN | FEB | MAR | OCT-MAR TOTAL | % NORM | APR | MAY | JUN | JUL | AUG | SEP | APR-SEP TOTAL | % NORM | TOTAL | % NORM | REL POS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1946-47 | 1347 | 2233 | 3130 | 3265 | 2870 | 1962 | 14807 | 539 | 889 | 1162 | 1293 | 1327 | 1014 | 904 | 6579 | 73 | 21386 | 182 | 10 |
| 1945-46 | 2354 | 2370 | 2412 | 2741 | 2715 | 3836 | 16428 | 598 | 4205 | 1644 | 6881 | 1661 | 1361 | 1289 | 17041 | 189 | 33469 | 284 | 8 |
| 1944-45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1912 | 6619 | 11008 | 11240 | 5240 | 3082 | 39101 | 434 | 39101 | 332 | 7 |
| 1943-44 | 956 | 298 | 674 | 3483 | 1702 | 1394 | 8507 | 310 | 1599 | 4659 | 2983 | 2182 | 1930 | 942 | 14295 | 158 | 22802 | 194 | 9 |
| 1942-43 | 982 | 980 | 2916 | 3949 | 2557 | 2140 | 13524 | 492 | 4566 | 9800 | 11790 | 10687 | 5119 | 2529 | 44491 | 493 | 58015 | 493 | 3 |
| 1941-42 | 1587 | 2136 | 3336 | 2418 | 2033 | 1749 | 13259 | 483 | 6561 | 6210 | 12244 | 12793 | 5595 | 2342 | 45745 | 507 | 59004 | 501 | 2 |
| 1940-41 | | | | | | | | | | | | | | 1079 | | | | | |



11

CITY OF LOS ANGELES
DEPARTMENT OF WATER AND POWER
Division of Hydrography

Station PARKER CREEK - BACK OF CAIN RANCH

Quantities expressed in SECOND feet.

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Mean Sec. Ft. | Acre Feet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1933-34 | | | | | | | 1.54 | 2.77 | 2.39 | 1.54 | 1.26 | 0.79 | | |
| 1934-35 | 3.49 | 2.82 | 2.08 | 2.36 | 2.09 | 2.32 | 5.31 | 2.42 | 6.08 | 1.63 | 0.96 | 0.94 | 2.7 | 1956 |
| 1935-36 | 3.13 | 2.52 | 1.73 | 2.04 | 2.01 | 3.45 | 4.06 | 1.57 | 2.19 | 7.34 | 7.46 | 4.57 | 3.5 | 2552 |
| 1936-37 | 2.80 | 2.72 | 1.92 | 1.99 | 2.46 | 3.76 | 3.71 | 4.31 | 4.36 | 9.10 | 5.79 | 5.27 | 4.0 | 2915 |
| 1937-38 | 3.06 | 2.49 | 6.70 | 2.26 | 2.15 | 3.40 | 9.42 | 18.72 | 25.71 | 28.54 | 21.65 | 12.95 | 11.5 | 8313 |
| 1938-39 | 8.94 | 6.32 | 4.65 | 4.00 | 2.75 | 4.53 | 5.12 | 1.30 | 2.11 | 1.38 | 3.33 | 2.85 | 3.9 | 2858 |
| 1939-40 | 5.12 | 3.93 | 2.97 | 2.90 | 3.00 | 2.85 | 1.60 | 3.99 | 6.77 | 4.68 | 10.68 | 3.41 | 4.3 | 3147 |
| 1940-41 | 2.79 | 2.78 | 2.51 | 2.34 | 2.69 | 4.12 | 4.93 | 2.28 | 2.83 | 21.62 | 4.98 | 1.81 | 4.7 | 3381 |
| 1941-42 | 4.67 | 6.08 | 5.36 | 4.95 | 4.64 | 4.74 | 5.97 | 0.65 | 1.57 | 32.80 | 22.23 | 9.16 | 8.6 | 6234 |
| 1942-43 | 5.34 | 4.35 | 3.80 | 3.77 | 3.88 | 5.49 | 9.73 | 2.13 | 1.57 | 28.23 | 30.74 | 4.20 | 8.7 | 6284 |
| 1943-44 | 4.53 | 1.34 | 0.80 | 0.91 | 1.04 | 1.13 | 1.93 | 1.70 | 1.85 | 3.38 | 3.65 | 4.16 | 2.2 | 1601 |
| 1944-45 | 4.00 | 3.78 | 2.52 | 3.08 | 7.23 | 4.73 | 4.93 | 4.36 | 10.48 | 15.81 | 12.08 | 9.04 | 6.8 | 4946 |
| 1945-46 | 7.80 | 6.84 | 4.79 | 3.15 | 2.38 | 4.95 | 8.75 | 5.32 | 8.17 | 5.46 | 17.13 | 7.61 | 6.9 | 4985 |
| 1946-47 | 8.76 | 6.10 | 6.39 | 3.80 | 4.87 | 5.65 | 2.37 | 3.35 | 2.98 | 0.75 | 1.27 | 3.94 | 4.2 | 3027 |
| 1947-48 | 4.01 | 3.96 | 2.41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.9 | [illegible] |

2032 6J00 2M 4-53 P.O. 33562

Sheet ........ of ________ Sheets

CITY OF LOS ANGELES
# DEPARTMENT OF WATER AND POWER
## HYDROLOGY SECTION

STATION PARKER CREEK - BACK OF CAIN RANCH

QUANTITIES EXPRESSED IN SECOND - FEET

| YEAR | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | JULY | AUG. | SEPT. | MEAN SEC. FT. | ACRE FEET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1948-49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1949-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1950-51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1951-52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1952-53 | 3.68 | 5.02 | 4.29 | 4.66 | 4.64 | 4.67 | 0.06 | 3.00 | 7.49 | 16.74 | 16.05 | 6.31 | 4.16 | 3012 |
| 1953-54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.92 | 1.22 | 2.33 | 0.01 | 2.65 | [illegible] |
| 1954-55 | 0.89 | 0 | 0 | 0 | 0 | 0 | 0 | 0.13 | 1.47 | 2.25 | 2.09 | 0.94 | 0.58 | 413 |
| 1955-56 | 1.11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.37 | 0.43 | 0.12 | 0.11 | 0.34 | 243 |
| 1956-57 | 3.69 | 0.92 | 0 | 0 | 0 | 0 | 0 | 0.96 | 3.16 | 9.36 | 6.08 | 4.37 | 2.10 | [illegible] |
| 1957-58 | 1.98 | 0 | 0 | 0 | 0 | 0 | 0 | 2.99 | 7.62 | 4.23 | 1.57 | 2.10 | 1.87 | 1350 |
| 1958-59 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.17 | 122 |
| 1959-60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1960-61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1961-62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1962-63 | | | | DISCONTINUED | | | | | | | | | | |

SHEET ____ OF ____ SHEETS