IV - WATERSHED CHARACTERISTICS

4-01 General Characteristics. The drainage area above Mathews Canyon Dam comprises about 34 square miles in Lincoln County, Nevada. The longest watercourse in the drainage area extends 10.5 miles above the dam and has an average streambed gradient of 103 feet per mile. Clover Creek which receives the drainage from Mathews Canyon at a point approximately 2 miles downstream (northwest) from the dam, flows northwestward nearly 20 miles to Caliente, where it empties into Meadow Valley Wash. Meadow Valley Wash flows southward to its confluence with the Muddy River near Glendale, 70 miles downstream from Caliente. Downstream from Glendale, the Muddy River flows for a distance of 12 miles to the point where it empties into Lake Mead. Areas downstream of Mathews Canyon Dam are shown on Plate 4-01.

4-02 Topography. The dam's drainage area mainly consists of rolling hills and narrow valleys, with some alluvial wash. The elevations in the drainage area vary from 5,420 feet, msl at the dam to about 7,000 feet, msl at the mountain crest. The project location and topography are shown on Plate 4-02.

4-03 Geology and Soils.

a. Geology. Mathews Canyon Dam lies within the basin and range physiographic province where typically elongated mountain ranges have a strong north-northeast trend. These ranges average approximately 50 miles or more in length with an average width from 5 to 15 miles and vary in height from 1,000 to 5,000 feet. The broad, flat intervening valleys tend to be of equal or greater width than the mountains they separate. Drainage is predominantly internal and many valleys are characterized by flat mud-surfaced playas which are commonly flooded during the rainy season.

Within the Caliente Caldron complex, in which the dam is located, mountains are more irregular than typical basin and range structures and appear almost equi-dimensional. The long mountain ranges and broad valleys west of Meadow Valley Wash retain a strong north-south trend, while east of the wash, the ranges are shorter and their trends are varied. South of Clover Creek, short northeast-trending ranges merge with other ranges trending northwest to form a winding east-west rim along the south border of the Clover Creek drainage basin.

The dam is at the head of a narrow section of Mathews Canyon where bedrock outcrops along both sides of the canyon and underlies the stream bed alluvium at depths of as much as 52 feet. The canyon trends northwestward in a nearly straight course for about 2,000 feet downstream from the dam. The streambed elevation at the dam is about 5,412 feet, msl. The canyon is 300 feet wide from toe to toe of the abutments and about 600 feet wide at elevation 5,483 feet, msl, which is at the crest elevation of the top of dam. The bottomlands forming the reservoir spread out to a maximum width of about one-third of a

mile.

Bedrock at the site is volcanic. Three kinds of fragmental volcanic rock occur below elevation 5,483 feet, msl: pumiceous breccia, andesite agglomerate, and slightly pumiceous breccia, which is the most common rock at the site, is light gray, soft, partly cemented, and composed of many pumice fragments and occasional felsite fragments embedded in a tuff matrix. Most fragments are less than one-inch in diameter; however a few pieces as much as one-foot in diameter occur. In general, the breccia is moderately to sparsely jointed. The andesite agglomerate, which consists of large block of andesite in a matrix of soft tuff, occurs only in irregular lenses. Its outcrops are conspicuously marked by hard reddish-brown andesite blocks as much as 10 feet in diameter. The slightly pumiceous breccia is a light-gray, moderately-hard rock consisting of pumice, rhyolite, small feldspar crystals, and miscellaneous volcanic fragments embedded in well-cemented tuff. It is a much stronger rock than the pumiceous breccia.

b. Seismicity. Within a 100-miles radius of Mathews Canyon Dam are six active and potentially active faults that have the capability of producing an event of sufficient magnitude to affect the dam. Mainstreet-Hurricane, Dry Lake Valley, Coal Valley, and Toroweap-Sevier are active faults located approximately 50, 35, 68, and 70 miles, respectively, from the dam. There is one potentially active fault, the Grand Wash, which is 25 miles from the dam. Seismic events have occurred within the proximity of the dam, but cannot be accurately assigned to any known fault.

c. Soils. The mountainous drainage area is covered with shallow soils and large areas of bare rock. In the canyons, soils are deep. Soils throughout the drainage area are volcanic in origin, and are low in organic content.

4-04 <u>Sediment.</u> There are no sedimentation ranges in the reservoir. The volume and distribution of accumulated sediment are determined by surveys of the appropriate parts (usually the lower elevations) of the reservoir. The original allotted sediment-storage volume of 1,000 acre-foot in the reservoir, was determined from a study of silt accumulation rates in existing reservoirs in the southwest United States. From this study, the silting rate was established at 20 acre-foot per year, or 0.59 acre-foot per square mile per year.

Surveys are conducted after major storms where the water surface has exceeded elevation 5,455 feet, msl or after visual inspection indicates significant sedimentation. The most recent survey, and also the only survey on record, was completed in August 1977. Visual inspection of the reservoir performed just prior to the preparation of the 1978 Review of Hydrology of Mathews Canyon Dam confirmed the adequacy of the original sediment volume estimate. No other surveys have been performed since that time.

Periodic inspection of the dam and reservoir occurs every five years. The latest Periodic Inspection occurred in June 1999. As it was mentioned in paragraph 2-03(d),

during scheduled maintenance times, excess sediment that collects at the approach basin and around the intake tower is excavated and used to create a berm that diverts all sediment flows away from the approach basin and intake tower.

4-05 Climate. The climate of the drainage area is semiarid with hot dry summers and mild, moist winters. Rainless periods of several months during the summer are common. Outside of precipitation, there were never any instrumentation set up for monitoring temperature, snow, or evaporation within the Mathews Canyon Dam basin. Climatological data for temperature, snow, precipitation, and evaporation were collected at the nearby city of Caliente, and are shown on Table 4-1.

a. Temperature. During the summer, days are long and hot, while in the winters, they are short and mild. Records of temperatures in the city of Caliente, which is approximately 20 miles northeast of the Mathews Canyon Dam show temperatures have ranged from 50 to 60 degrees during the winter months and 90 to 110 degrees during the summer months.

b. Precipitation. Precipitation records are available for four selected precipitation stations in or near the drainage area, namely, Mathews Canyon and Pine Canyon Dams, the nearby city of Caliente, and another nearby town, Acoma. The mean annual precipitation ranges from about 10 inches at the dam to 20 inches in the higher mountains. Climatic conditions in the Mathews Canyon basin generally vary with elevation. The months of May and June are somewhat drier than the other months. Precipitation data for the period of record are shown on Table 4-2.

c. Snow. Snow is common during winter storms, especially at higher elevations. According to statements by local residents, the maximum snow accumulation in the mountains probably does not exceed 3 or 4 feet. In the lower valleys, snow never remains on the ground for more than a few days. However, snow data collected at Caliente showed that on February 4, 1989, there was 14 inches of snow, which was the recorded high of the year, as well as the recorded high on record. Snow maps for the area are available through the National Operation Hydrologic Remote Sensing Center (NOHRSC).

d. Evaporation. Available evaporation data is from Caliente, for the period of record beginning in 1956 and ending in 1972. From the available data, average monthly evaporation ranges from ½ to 1 inch. However, maximum records show that during the summer months, evaporation can range from 1 to 5 inches. There has been no collection of evaporation data since 1972.

e. Wind. Within Nevada, the prevailing winds are from the south, southwest, and west. Wind velocities are generally moderate, though in a few places, as around Mount Davidson, there are sometimes fierce winds.

4-06 Storms and Floods.

a. Storms.

(1) Winter Storms. Storm rainfall is usually of low intensity, and its distribution reflects orographic influence. Most precipitation in the drainage area results from general winter storms that are associated with extra tropical cyclones of north Pacific origin. The duration of the most intense, flood-producing rain rarely exceeds 6 hours, although the storm itself may last several days.

(2) Summer Storms. Storms occurring during the summer are of two types: general summer storms and local summer storms. The latter, which are frequent, may result in heavy rain over small areas, but their duration rarely exceeds 3 hours. The general summer storms, which are infrequent, cover comparatively large areas. The duration of these storms may be 24 hours or more. They sometimes include cells of high intensity and short duration rainfall.

b. Floods. Available flood history in the Muddy River Basin dates back to 1905, however, quantitative records are few. Information on floods were collected from historical accounts, records of the Union Pacific Railroad Company, reports by Local, State and Federal agencies, and statements from the local residents. Before the completion of Mathews Canyon Dam, the storms of 1910, 1925, 1938, 1941, and 1946 all generated runoff that resulted in severe property damage near the basin. The storms and floods of 1938 and 1946 were the most significant events on record prior to the construction of Mathews Canyon and Pine Canyon Dams. Brief descriptions of these events are provided in the following paragraphs.

(1) Storm and Flood of 27 February - 3 March 1938. This storm produced large floods over much of southern Nevada, Arizona, southern California, and southern Utah. The flood was the largest general flood of record in the Muddy River Basin. Low rainfall loss rates and unusually heavy rainfall on 2 March caused high rates of runoff, especially in the mountains. At Caliente, the peak discharge on Meadow Valley Wash below Clover Creek was estimated at 15,000 cfs at the mouth of Mathews Canyon. Snowmelt made a significant contribution to runoff during the storm.

(2) Storm and Flood of 27 - 30 October 1946. This general winter storm deposited up to 10 inches of rainfall in the mountains near Clover Creek. Autographic rain gages in the general region, operated by the U.S. Bureau of Reclamation, recorded the severity of rainfall. Isohyets of the total storm precipitation are shown on Plate 4-03. Estimated peak discharges were 700 cfs for Meadow Valley Wash near Panaca, and 3,000 cfs on Muddy River below Glendale. No data was available for the flow at the mouth of Mathews Canyon.

c. Flood Damages. Estimates of damages from floods in Meadow Valley Wash and Lower Muddy River Basins are available for only those floods that have occurred since 1905. However, these estimates are incomplete. Tangible damages estimated at

about $3,000,000 have been reported for the period 1906 to 1955. The principal damage was to the railroad and agricultural property, as mentioned in section 3-02. Since the construction of Mathews Canyon Dam, no significant flood damages have been reported downstream. However, major losses in property and crops in other parts of the state have been reported, such as the damage reported after a storm in 1969 that totaled about $600,000.

4-07 Runoff Characteristics. Streamflow is negligible except immediately after heavy rains or after extensive snowmelt. Climatic conditions are not conducive to perennial flow. However, high-intensity rainfall in combination with the effects of steep gradients result in intense debris-laden floods. Due to the limited size of the drainage area, the greatest peak discharges occur from thunderstorms.

Plate 4-04 graphically shows the monthly mean, maximum and minimum flows at Mathews Canyon Dam for the period of record which began in 1958. Plate 4-05 is a tabulation of this data. The maximum runoff values occur during the winter flood season months of January, February, March, and April.

Plate 4-06 tabulates the annual maximum values for inflow, outflow, and water surface elevation at Mathews Canyon Dam for the period of record. Plate 8-07 is the inflow and outflow discharge frequency curve for Mathews Canyon Dam.

4-08 Water Quality. There is no water quality program at Mathews Canyon Dam. The nearest water quality station, USGS station 09418700, Meadow Valley Wash near Rox, Nevada, was discontinued after 1994. Further information about this station is provided in Section 5-02, Water Quality Stations.

4-09 Channel and Floodway Characteristics. Discharge from the outlet works enters a short open channel that leads to the natural streambed of Mathews Canyon. Discharge from the spillway enters the natural stream about 200 feet below the toe of the dam. This is shown on Photo 4-1. The spillway discharge curve is shown on Plate 4-07. There exists a continuous stage-recording gage downstream from the dam which is housed in a corrugated metal pipe. The discharge rating curve for stream flow at this station is shown on Plate 4-08.

The reaches extending downstream from Mathews Canyon Dam to Lake Mead are predominantly natural streams. Flow from the outlet works is contained in downstream channels. Peak spillway discharges and floods from other drainage areas will overflow the channels of the downstream reaches. The non-damaging channel capacities were evaluated by the Corps of Engineers for their "Report on Survey, Flood Control, Virgin River and Tributaries in Nevada, Arizona and Utah", dated June 20, 1942. The Corps of Engineers' report entitled "Flood Plain Information, Muddy River, Vicinity of Overton, Clark County, Nevada", dated June 1974, identifies overflow areas and profiles of the standard project flood and the intermediate regional flood (100-year frequency flood) for a

7.8 mile reach of the lower Muddy River. The non-damaging channel capacities of the downstream reaches have not been re-evaluated since the survey in 1942. This is because since the completion of the Mathews Canyon Dam project, the most significant flood event observed during the period of record was about a 25-year event, and the economic development at the downstream reaches have not been that rapid or extensive enough to require a new survey. Lincoln County Emergency Management District is the agency responsible for local cooperation and has agreed with the Corps to keep the downstream channels free from man-made encroachment.

4-10 Upstream Structures. No structure that significantly affects runoff exists in the drainage area above Mathews Canyon Dam.

4-11 Downstream Structures. Other existing projects below Mathews Canyon Dam include small dams and weirs constructed for purposes of flood control, erosion control, irrigation and recreation. However, none of these downstream structures significantly affect large floods. Mathews Canyon Dam has an ungated outlet and is self-regulating, which makes coordination of flood releases with other existing projects impossible.

4-12 Economic Data.

a. Population. The dam is in an isolated area located about 20 miles upstream of the City of Caliente, which has a population of approximately 1,160 people (based on Census survey of 1990). The drainage area above Mathews Canyon Dam comprises about 34 square miles in Lincoln County, Nevada, which has a total resident population of approximately 3,837 people. There are also about 1,325 occupied housing units, 58 non-farm establishments (retail trade), and 122 farms within Lincoln County, Nevada.

b. Agriculture. As of 1990, there are 122 farms, which comprise about one percent of the total land within Lincoln County. Agriculture is contained mostly within the general Caliente-Pioche area. Pioche is located approximately 23 miles north of the city of Caliente. These farm lands are locally irrigated, consisting mainly of pasture for cattle feed.

c. Industry. Economic development in the general Caliente-Pioche area consists of scattered areas of irrigated farming land, cattle grazing on privately owned and Public Domain land, mining industries, and some tourist trade in Caliente, which is on U.S. Highway 93. There is also some employment for local road maintenance and construction on the Union Pacific Railroad extending north along Meadow Valley Wash, turning east along Clover Valley, and on into Utah.

d. Flood Damages. Since the completion of the project, the flood damages prevented through fiscal year 1998 are estimated to be $8,000,000. This is a combined benefit from both Mathews Canyon and Pine Canyon Dams and Reservoirs. Because they are an interdependent unit for improvements, a combined economic analysis was

performed. The economic analysis was performed by the Los Angeles District's Economic Section, and the numeric estimate of flood damages prevented was based on their Damage-Discharge curve. The damage reach considered in this analysis were four overflow areas, namely Clover Creek, Caliente, Lower Meadow Valley Wash from Caliente to Muddy River, and Lower Muddy River from Meadow Valley Wash to Lake Mead. The Damage-Discharge curve is shown on Plate 4-09.

Table 4-1. Climatological Data near Mathews Canyon Dam - Caliente

Station Name: CALIENTE
Station ID: 1358

MONTH	TEMPERATURE (EF)[1]			PRECIPITATION (Inches)[2]			SNOW (Inches)[3]			EVAPORATION (Inches)[4]		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	58.57	71.00	40.00	0.37	1.41	0.00	1.79	12.00	0.00	0.00	0.00	0.00
February	64.55	81.00	49.00	0.36	1.90	0.00	1.17	14.00	0.00	0.00	0.00	0.00
March	72.96	90.00	64.00	0.37	1.35	0.00	0.59	8.00	0.00	0.09	1.26	0.00
April	81.24	92.00	69.00	0.32	1.15	0.00	0.07	2.50	0.00	0.32	0.78	0.00
May	89.82	98.00	82.00	0.31	1.48	0.00	0.01	0.50	0.00	0.66	2.55	0.50
June	98.67	109.00	92.00	0.19	0.99	0.00	0.00	0.00	0.00	0.93	5.24	0.48
July	101.84	109.00	98.00	0.35	1.51	0.00	0.00	0.00	0.00	0.87	1.47	0.47
August	98.63	108.00	94.00	0.43	1.70	0.00	0.00	0.00	0.00	1.02	3.19	0.50
September	93.07	106.00	88.00	0.33	1.56	0.00	0.03	2.00	0.00	0.62	0.90	0.36
October	81.04	94.00	77.00	0.39	2.13	0.00	0.06	4.00	0.00	0.42	1.08	0.24
November	68.70	80.00	64.00	0.38	1.80	0.00	0.41	5.00	0.00	0.16	0.54	0.00
December	60.27	71.00	50.00	0.30	2.11	0.00	1.28	11.00	0.00	0.03	0.35	0.00

Table 4-2. Precipitation Data from Mathews and Pine Canyon Dams and Acoma

Month	MATHEWS CANYON DAM[5]			PINE CANYON DAM[5]			ACOMA[6]		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	1.25	5.02	0.00	1.28	5.43	0.00	0.31	0.40	0.00
February	1.90	7.51	0.00	1.81	6.16	0.00	0.31	0.42	0.00
March	1.71	5.98	0.00	1.57	5.68	0.00	0.12	0.20	0.00
April	0.73	4.08	0.00	0.73	3.23	0.00	0.43	0.83	0.00
May	0.68	2.96	0.00	0.77	3.13	0.00	0.01	0.02	0.00
June	0.34	2.59	0.00	0.33	1.44	0.00	0.00	0.00	0.00
July	0.96	6.45	0.00	0.93	6.88	0.00	0.56	0.67	0.00
August	1.13	3.55	0.00	1.07	3.41	0.00	0.27	0.54	0.00
September	0.96	4.72	0.00	0.93	4.42	0.00	0.58	0.67	0.00
October	0.72	3.58	0.00	0.77	3.46	0.00	0.04	0.08	0.00
November	0.98	3.09	0.00	1.03	3.17	0.00	0.00	0.00	0.00
December	0.86	3.64	0.00	0.82	3.88	0.00	0.32	0.62	0.00

1. Period of record for temperature spans 67 years (1931-1997) - Data from NCDC
2. Period of record for precipitation spans 40 years (1958-1997) - Data from NCDC
3. Period of record for snow spans 70 years (1928-1997) - Data from NCDC
4. Available data for evaporation spans only 17 years (1956-1972) - Data from NCDC
5. Period of record for precipitation spans 40 years (1958-1997) - Data from USACE
6. Available data for precipitation in Acoma spans only three years (1949-1951) - Data from NCDC

Photo 4-1. Looking downstream below spillway