Nevada State Water Plan
PART 1 — BACKGROUND AND RESOURCE ASSESSMENT

Section 4
Water Resources Background

Introduction

An understanding of the state's water resources is a necessary component to the planning and management process. It is the intent of this section to provide the reader with an overview of Nevada's surface water and groundwater resources.

Topography

The topography of Nevada and the surrounding areas makes for a unique and diversified climate. Nearly all of Nevada is in the Basin and Range Province of the Intermountain Plateaus, a rugged elevated area between the Rocky Mountains and the Pacific mountain system. The topography of the Basin and Range province is characterized by isolated, long and narrow, roughly north-south trending, parallel mountain ranges and broad, intervening valleys as shown in Figure 4-1.

Internal drainage is a significant feature of the hydrology of much of Nevada. About 84 percent of the State is within the Great Basin in which drainage is to low areas in enclosed basins rather than to the sea.

Hydrographic Areas

The topography and related geology of the State has resulted in complex surface and ground water systems, complicating the management of these resources. In the 1960s, the Nevada State Engineer's Office and the U.S. Geological Survey (USGS) recognized the need for a systematic identification of the valleys or hydrographic areas throughout Nevada. Such a system was needed in the study, research, development, management and administration of the water resources, both ground-water and surface water. A hydrographic areas map was subsequently developed in 1968 by the USGS and the State Engineer's Office. This was the first known effort to identify completely and systematically the hydrographic regions and areas of the Nevada. While the 1968 map has undergone some minor revisions, it continues to provide the basis for water planning, management and administration. The current hydrographic area map delineates 256 hydrographic areas within 14 major hydrographic regions and basins (Figure 4-2, Table 4-1). Of the 14 hydrographic regions and basins, only the Snake River Basin and the Colorado River Basin drain to the sea.

Figure 4-1 - shaded relief map

Figure 4-2 - Hydrographic Regions and Basins

Table 4-1. List of Hydrographic Areas

1. NORTHWEST REGION
1. Pueblo Valley
2. Continental Lake Valley
3. Gridley Lake Valley
4. Virgin Valley
5. Sage Hen Valley
6. Guano Valley
7. Swan Lake Valley
8. Massacre Lake Valley
9. Long Valley
10. Macy Flat
11. Coleman Valley
12. Mosquito Valley
13. Warner Valley
14. Surprise Valley
15. Boulder Valley
16. Duck Lake Valley

2. BLACK ROCK DESERT REGION
17. Pilgrim Flat
18. Painter Flat
19. Dry Valley
20. Sano Valley
21. Smoke Creek Desert
22. San Emidio Desert
23. Granite Basin
24. Hualapai Flat
25. High Rock Lake Valley
26. Mud Meadow
27. Summit Lake Valley
28. Black Rock Desert
29. Pine Forest Valley
30. Kings River Valley
    (A) Rio King Subarea
    (B) Sod House Subarea
31. Desert Valley
32. Silver State Valley
33. Quinn River Valley
    (A) Orovada Subarea
    (B) McDermitt Subarea

3. SNAKE RIVER BASIN
34. Little Owyhee River Area
35. South Fork Owyhee River Area
36. Independence Valley
37. Owyhee River Area
38. Bruneau River Area
39. Jarbidge River Area
40. Salmon Falls Creek Area
41. Goose Creek Area

4. HUMBOLDT RIVER BASIN
42. Marys River Area
43. Starr Valley Area
44. North Fork Area
45. Lamoille Valley
46. South Fork Area
47. Huntington Valley
48. Dixie Creek - Tenmile Creek Area
49. Elko Segment
50. Susie Creek Area
51. Maggie Creek Area
52. Marys Creek Area
53. Pine Valley
54. Crescent Valley
55. Carico Lake Valley
56. Upper Reese River Valley
57. Antelope Valley
58. Middle Reese River Valley
59. Lower Reese River Valley
60. Whirlwind Valley
61. Boulder Flat
62. Rock Creek Valley
63. Willow Creek Valley
64. Clovers Area
65. Pumpernickel Valley
66. Kelly Creek Area
67. Little Humboldt Valley
68. Hardscrabble Area
69. Paradise Valley
70. Winnemucca Segment
71. Grass Valley
72. Imlay Area
73. Lovelock Valley
    (A) Oreana Subarea
74. White Plains

5. WEST CENTRAL REGION
75. Bradys Hot Springs Area
76. Fernley Area
77. Fireball Valley
78. Granite Springs Valley
79. Kumiva Valley

6. TRUCKEE RIVER BASIN
80. Winnemucca Lake Valley
81. Pyramid Lake Valley
82. Dodge Flat
83. Tracy Segment
84. Warm Springs Valley
85. Spanish Springs Valley
86. Sun Valley
87. Truckee Meadows
88. Pleasant Valley
89. Washoe Valley
90. Lake Tahoe Basin
91. Truckee Canyon Segment

7. WESTERN REGION
92. Lemmon Valley
    (A) Western Part
    (B) Eastern Part
93. Antelope Valley
94. Bedell Flat
95. Dry Valley
96. Newcomb Lake Valley
97. Honey Lake Valley
98. Skedaddle Creek Valley
99. Red Rock Valley
100. Cold Spring Valley
    (A) Long Valley

8. CARSON RIVER BASIN
101. Carson Desert
    (A) Packard Valley
102. Churchill Valley
103. Dayton Valley
104. Eagle Valley
105. Carson Valley

9. WALKER RIVER BASIN
106. Antelope Valley
107. Smith Valley
108. Mason Valley
109. East Walker Area
110. Walker Lake Valley
    (A) Schurz Subarea
    (B) Lake Subarea
    (C) Whisky Flat - Hawthorne Subarea

10. CENTRAL REGION
111. Alkali Valley (Mineral)
    (A) Northern Part
    (B) Southern Part
112. Mono Valley
113. Huntoon Valley
114. Teels Marsh Valley
115. Adobe Valley
116. Queen Valley
117. Fish Lake Valley
118. Columbus Salt Marsh Valley
119. Rhodes Salt Marsh Valley
120. Garfield Flat
121. Soda Spring Valley
    (A) Eastern Part
    (B) Western Part
122. Gabbs Valley
123. Rawhide Flats
124. Fairview Valley
125. Stingaree Valley
126. Cowkick Valley
127. Eastgate Valley Area
128. Dixie Valley
129. Buena Vista Valley
130. Pleasant Valley
131. Buffalo Valley
132. Jersey Valley
133. Edwards Creek Valley
134. Smith Creek Valley
135. Ione Valley
136. Monte Cristo Valley
137. Big Smoky Valley
    (A) Tonopah Flat
    (B) Northern Part
138. Grass Valley
139. Kobeh Valley
140. Monitor Valley
    (A) Northern Part
    (B) Southern Part
141. Ralston Valley
142. Alkali Spring Valley (Esmeralda)
143. Clayton Valley
144. Lida Valley
145. Stonewall Flat
146. Sarcobatus Flat
147. Gold Flat
148. Cactus Flat
149. Stone Cabin Flat
150. Little Fish Lake Valley
151. Antelope Valley (Eureka & Nye)
152. Stevens Basin
153. Diamond Valley
154. Newark Valley
155. Little Smoky Valley
    (A) Northern Part
    (B) Central Part
    (C) Southern Part
156. Hot Creek Valley
157. Kawich Valley
158. Emigrant Valley
    (A) Groom Lake Valley
    (B) Papoose Lake Valley
159. Yucca Flat
160. Frenchman Flat
161. Indian Springs Valley
162. Pahrump Valley
163. Mesquite Valley (Sandy Valley)
164. Ivanpah Valley
    (A) Northern Part
    (B) Southern Part
165. Jean Lake Valley
166. Hidden Valley (South)
167. Eldorado Valley
168. Three Lakes Valley (Northern Part)
169. Tikapoo Valley (Tickaboo Valley)
    (A) Northern Part
    (B) Southern Part
170. Penoyer Valley (Sand Spring Valley)
171. Coal Valley
172. Garden Valley
173. Railroad Valley
    (A) Southern Part
    (B) Northern Part
174. Jakes Valley
175. Long Valley
176. Ruby Valley
177. Clover Valley
178. Butte Valley
    (A) Northern Part (Round Valley)
    (B) Southern Part
179. Steptoe Valley
180. Cave Valley
181. Dry Lake Valley
182. Delamar Valley
183. Lake Valley
184. Spring Valley
185. Tippett Valley
186. Antelope Valley (White Pine & Elko)
    (A) Southern Part
    (B) Northern Part
187. Goshute Valley
188. Independence Valley (Pequop Valley)

11. GREAT SALT LAKE BASIN
189. Thousand Springs Valley
    (A) Herrill Siding - Brush Creek Area
    (B) Toano - Rock Spring Area
    (C) Montello - Crittenden Creek Area (Montello Valley)
190. Grouse Creek Valley
191. Pilot Creek Valley
192. Great Salt Lake Desert
193. Deep Creek Valley
194. Pleasant Valley
195. Snake Valley
196. Hamlin Valley

12. ESCALANTE DESERT
197. Escalante Desert

13. COLORADO RIVER BASIN
198. Dry Valley
199. Rose Valley
200. Eagle Valley
201. Spring Valley
202. Patterson Valley
203. Panaca Valley
204. Clover Valley
205. Lower Meadow Valley Wash
206. Kane Springs Valley
207. White River Valley
208. Pahroc Valley
209. Pahranagat Valley
210. Coyote Spring Valley
211. Three Lakes Valley (Southern Part)
212. Las Vegas Valley
213. Colorado Valley
214. Piute Valley
215. Black Mountains Area
216. Garnet Valley (Dry Lake Valley)
217. Hidden Valley (North)
218. California Wash
219. Muddy River Springs Area (Upper Moapa Valley)
220. Lower Moapa Valley
221. Tule Desert
222. Virgin River Valley
223. Gold Butte Area
224. Greasewood Basin

14. DEATH VALLEY BASIN
225. Mercury Valley
226. Rock Valley
227. Fortymile Canyon
    (A) Jackass Flats
    (B) Buckboard Mesa
228. Oasis Valley
229. Crater Flat
230. Amargosa Desert
231. Grapevine Canyon
232. Oriental Wash

Climate

The climate of Nevada is characterized as semi-arid to arid with precipitation and climate varying widely throughout the State. With temperatures that fall below -40°F in the northeast, and rise over 120°F in the south, and precipitation that ranges from only three to four inches in Southern Nevada to over 40 inches (and over 300 inches of snowfall) in the Carson Range portion of the Sierra Nevada Mountains, Nevada is truly a land of constrasts. Three basic geographical characteristics are responsible for Nevada's unusual and diverse climate:

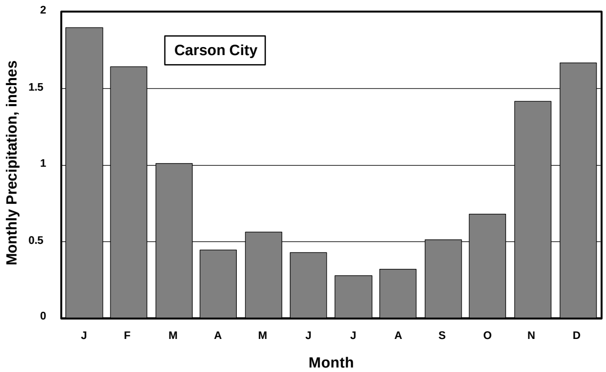
Latitude: Nevada spans approximately seven degrees of latitude, or about 500 miles, from the north boundary to the southern tip of the State. As a result, average temperatures are 15° to 20°F cooler in the north than the south.

Elevation: The Basin and Range Province, with its wide elevation fluctuations from the valley floors to the mountain tops, is another factor responsible for our diverse climate. Elevations vary from under 1,000 feet to over 13,000 feet above sea level, with the higher elevations generally experiencing lower temperatures and more precipitation.

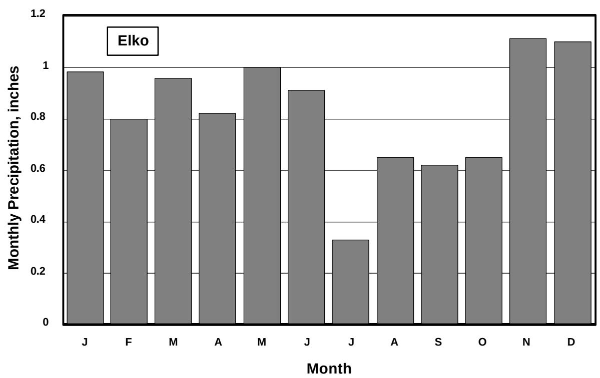
Continentality: Continentality is the most important factor affecting Nevada's climate. The continental effect results from the continuous barrier of the Pacific mountain system to the west. Moisture laden winds traveling east from the Pacific Ocean are forced to rise, cool and drop precipitation as the Pacific mountain system is encountered. The resulting winds entering Nevada are much drier and provide reduced precipitation. This rainshadow effect is the primary reason for Nevada's dry climate.

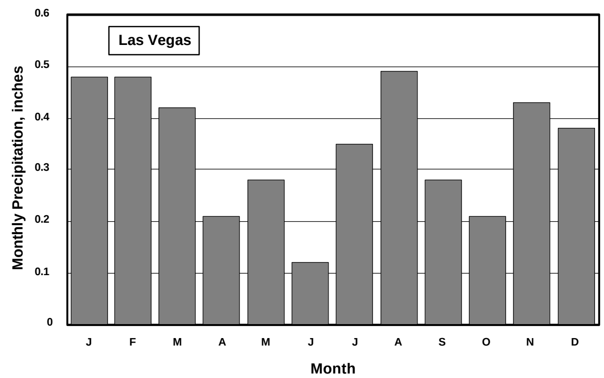
Figure 4-3 shows the spatial variability of precipitation in Nevada. With total precipitation averaging approximately nine inches per year, Nevada is the most arid state in the nation. Monthly and annual fluctuations in precipitation can be significant. Figure 4-4 displays monthly and annual precipitation variations for three selected precipitation measurement sites in Nevada. Of the total annual precipitation falling in Nevada, approximately 10 percent results in stream runoff and groundwater recharge (*Water for Nevada, Nevada's Water Resources - Report No. 3,* State Engineer's Office, October 1971). The remaining 90 percent is lost through evaporation and transpiration. Like precipitation, evaporation is also widely variable. Average lake surface evaporation rates range from less than 36 inches per year in the west to over 80 inches per year in the south (Figure 4-5).

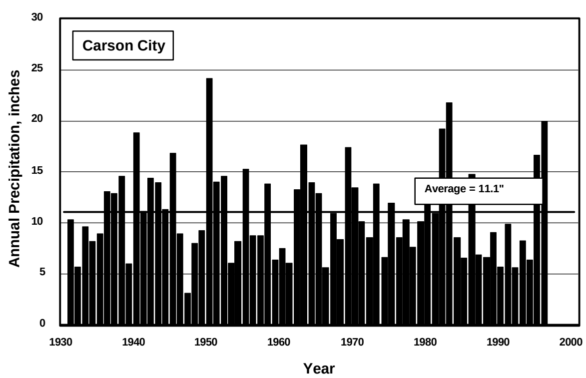
Figure 4-3 Precipitation



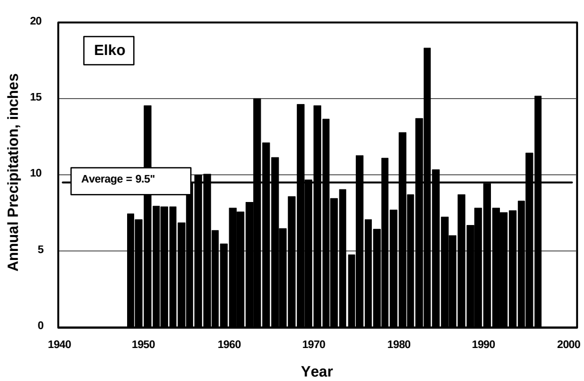
Monthly Variations: Precipitation in Nevada varies from month to month with most moisture falling in the winter. During the warmer and drier summer periods, the precipitation that does occur is the result of convective summer thunderstorms which can produce brief, but intense rainfall.







Annual Variations: The average of annual precipitation is commonly used as an indicator of the amount of precipitation that could be expected in a given year. However, annual variations in precipitation are significant and "average" years are rarely experienced.



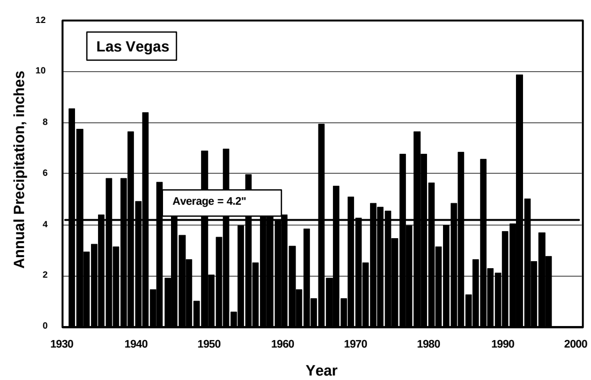


Fig. 4-4. Precipitation Variability for 3 Selected Sites

Figure 4-5 Evaporation

Surface Water

Surface water is a limited and precious resource in Nevada providing about 70 percent of the total water supply used in the state. Spring and summer snowmelt supplies most of the streamflow in Nevada. However, isolated summer convective storms probably cause a majority of the streamflow in southern Nevada's low altitude basins.

Throughout the State, surface water flows can vary widely from year to year and from month to month, with maximum discharges generally in May and June as a result of snowmelt in the mountains. With the exception of the Humboldt Basin, most of the surface waters in Nevada's rivers are the result of snowmelt occurring in other states such as California, Wyoming, Colorado, and Utah.

Flows in the upper reaches of the larger rivers (Carson, Humboldt, Truckee, Walker) typically increase as one moves downstream. The larger rivers typically follow the flow pattern of a gaining stream in the well-watered mountain reaches and a losing stream in the lower-altitude reaches. Reductions in flow occur due to irrigation, public use, infiltration, and evapotranspiration.

Major Rivers, Lakes and Reservoirs

Nevada can claim very few large rivers and streams compared to other states. With the exception of the Colorado River, Nevada's perennial rivers are small by nationwide standards. Rivers in the Snake River Basin and Colorado River Basin regions flow into the ocean, with the remaining streams systems discharging into terminal sinks and lakes with no outflow to the sea. The major river systems in Nevada are the Colorado, Walker, Carson, Truckee, and Humboldt (Figure 4-6). Table 4-2 summarizes the main lakes and reservoirs within these river systems and in Nevada.

The **Carson River** flows from the eastern slopes of the Sierra Nevada in California and terminates in the Carson Sink. Waters of the Carson River are used predominately for agriculture from Carson Valley down to the Fallon area. Only a few regulating storage reservoirs exist in the basin, with Lahontan Reservoir being the largest. Lahontan Reservoir is used to store water from the Carson River, and water diverted from the Truckee River by Derby Dam and conveyed to Lahontan Reservoir via the Truckee Canal. Water released from Lahontan Reservoir is used predominately for agriculture, and wildlife purposes.

The **Colorado River** is the largest river in Nevada, flowing through Wyoming, Colorado, Utah, New Mexico, Arizona, California and Nevada. Along its 1,400 mile course to the Gulf of Mexico, the Colorado River Basin drains an area of about 240,000 square miles or about one-twelfth the area of the contiguous United States. The Colorado River and tributaries in Nevada provide a majority of the drinking water supply to the Las Vegas area, hydroelectric power and recreation opportunities at Lake Mead and Lake Mohave, and water for agricultural purposes.

Figure 4-6 Major rivers, lakes, reservoirs

Table 4-2. Major Lakes and Reservoirs of Nevada and Portions of California

Hydrographic Region	Lake/Reservoir	Surface Area, acres	Active Storage Capacity, acre-feet	Total Storage Capacity, acre-feet
Carson River	Lahontan Reservoir	14,600	317,000	317,000
Colorado River	Lake Mead	158,000	26,200,000	29,700,000
	Lake Mohave	28,000	1,810,000	1,820,000
Humboldt River	Pitt-Taylor Reservoir, Lower	2,570	22,200	22,200
	Pitt-Taylor Reservoir, Upper	2,070	24,200	24,200
	Rye Patch Reservoir	12,400	194,300	194,300
	South Fork Reservoir	1,650	41,000	41,000
Snake River	Wild Horse Reservoir	2,830	73,500	73,500
Truckee River	Big and Little Washoe Lakes	5,800	14,000	38,000
	Boca Reservoir	980	40,870	41,110
	Donner Lake	800	9,500	Not reported
	Independence Lake	700	17,500	Not reported
	Lake Tahoe	124,000	744,600	125,000,000
	Martis Creek Lake	770	20,400	21,200
	Prosser Creek Reservoir	750	28,640	29,840
	Pyramid Lake[1]	111,400 (as of 9/30/96)	not applicable	21,760,000 (as of 9/30/96)
	Stampede Reservoir	3,440	221,860	226,500
Walker River	Bridgeport Reservoir	2,914	40,500	40,500
	Topaz Lake	2,410	61,000	126,000
	Walker Lake[1]	33,500 (as of 9/30/96)	not applicable	2,153,000 (as of 9/30/96)
	Weber Reservoir	950	13,000	13,000

[1]Pyramid and Walker lakes are natural terminal lakes with no outlet.

The **Humboldt River** is the longest river contained wholly within the State. The Humboldt River originates in the Ruby, East Humboldt, Independence and Jarbidge Mountains and flows westward to terminate in the Humboldt Sink. A majority of the Humboldt River system water is used for agriculture. There are only a few flow regulating reservoirs in the basin, the largest (Rye Patch Reservoir) being near the end of the system. As a result, late season irrigation water shortages are commonplace throughout much of the area above Rye Patch Reservoir.

The **Truckee River** originates at the northern end of Lake Tahoe in California and terminates at Pyramid Lake. Along its course, water is utilized to meet a variety of needs, such as municipal and industrial, agriculture, hydroelectric power, and wildlife. A portion of the Truckee River flow is diverted at Derby Dam and is conveyed via the Truckee Canal to Lahontan Reservoir in the Carson River Basin. With numerous upstream reservoirs, mostly in California, the Truckee River is one of the most regulated river systems in Nevada.

The **Walker River**, with its headwaters in California, flows into Nevada and terminates at Walker Lake. Most of the flow of the Walker River system originates in California and is used predominately for agricultural purposes in Nevada and California. The two largest reservoirs on the system (Topaz Lake located in Nevada and California, Bridgeport Reservoir located wholly in California) are owned and operated by the Walker River Irrigation District and are predominately used to supply irrigation water to district members.

Streamflow Forecasts and Data Collection

The collection and analysis of snowpack and streamflow data are essential for proper management and planning of our surface water resources. A better understanding of each basin's surface water system is made possible through snow depth and streamflow measurements.

Snowpack Measurments and Streamflow Forecasts. Natural Resources Conservation Service (NRCS) operates a series of snow depth measurement stations through the western United States, including Nevada. Utilizing the data collected at these stations, NRCS and National Weather Service hydrologists develop streamflow and water supply forecasts for the major surface water systems. These forecasts are used to guide water management and emergency management decisions.

Gaging Stations. The USGS is the principal Federal agency which collects surface water data in Nevada. The USGS began collecting streamflow data in 1889 with the establishment of a gaging station on the Truckee River near the Nevada-California state line. During the next six years, additional gaging stations were established in the Humboldt, Carson, Walker and Truckee basins. As of 1996, the USGS surface water quantity monitoring network consists of water discharge measurements for 170 gaging stations on streams, canals and drains, 99 peak flow stations and miscellaneous sites, and five springs; and water levels and contents for 22 lakes and reservoirs. The general objective of the stream-gaging program is to provide information on, or to develop estimates of, flow characteristics at any point on any stream.

Other entities collect streamflow data for regional purposes. For example, the Clark County Regional Flood Control District operates a network of meteorologic and water depth monitoring stations as part of the District's Flood Threat Recognition Program..

Streamflow Characteristics. Most of the streamflow in Nevada is the result of runoff from melting snow. Runoff patterns in Nevada vary greatly both seasonally and geographically, and are mainly determined by precipitation patterns (location and timing) and other climate patterns, such as temperature. Other factors such as surface geology, vegetation, and land use affect the amount of runoff entering the rivers and streams. Streamflows are further affected by human-induced influences such as diversions and reservoir operations.

Table 4-3 summarizes some basic streamflow characteristics for selected USGS gaging stations throughout Nevada (see Figure 4-7 for station locations). As shown, average annual flows vary widely from river to river. Within a given river system, flows fluctuate year to year in response to changes in precipitation amounts. Some of these annual variations can be dramatic. For instance, at the "Walker River near Wabuska, NV" gaging station, the highest flows for a year exceeded the lowest annual flows by over 50 times. Figure 4-8 depict monthly and annual streamflow variations for the Colorado, Humboldt and Truckee rivers.

Water Yields and Committed Resources

The estimated average annual yield from Nevada's surface water systems is approximately 3.2 million acre-feet per year (Table 4-4). Generally, Nevada's surface water sources, such as lakes, streams and springs, have been fully appropriated and used for many years. In some instances, water may be available from these sources during high water years, however storage facilities would be required to capture the surplus flows for later use.

Most priority rights for surface water in Nevada were established in the 1800s. Rights to use water for irrigation date back to the 1850s in streams draining the Sierra Nevada Mountains and to the 1870s and 1880s in the Humboldt River Basin.

Droughts and Floods

Nevada is a land of extremes, with droughts and floods common in our highly variable climate. Years of average streamflows are rarely experienced. Periods of high flows followed by low flows are more the norm in Nevada.

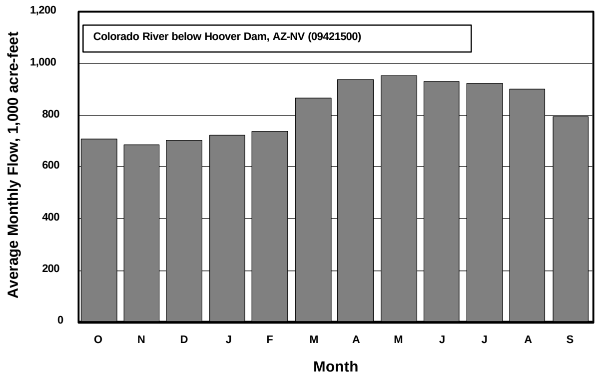
Droughts. Years of below average flows in rivers are not uncommon and many water users are prepared to cope with one year of low streamflows by resorting to supplemental sources such as reservoirs and groundwater. For most of Nevada's water users, who depend mostly upon surface water, problems can begin to occur when below average flows are experienced for two or more consecutive years. Over time, reservoir and groundwater levels tend to decline due to increased uses and these supplemental sources may become depleted. Droughts can also create quality problems for both surface water and groundwater sources. The decreased flows experienced during a drought tend to result in diminished quality for the remaining water.

Table 4-3. Summary of Streamflow Data for Selected Gaging Stations

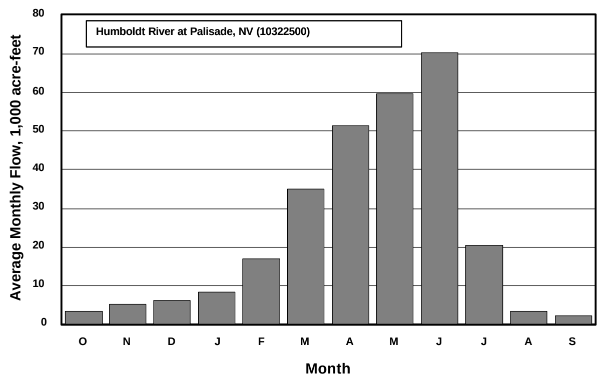
Hydrographic Region	Gaging Station Name (Number)	Period of Record	Annual Streamflow Statistics, acre-feet		
			Average Annual	Lowest Annual	Highest Annual
Carson River	East Fork Carson River near Gardnerville, NV (10309000)	1890-1997	278,800	66,300	655,200
	West Fork Carson River at Woodfords, CA (10310000)	1901-97	81,000	18,900	210, 000
	Carson River near Carson City, NV (10311000)	1940-97	298,700	42,400	826,800
	Carson River near Ft. Churchill, NV (10312000)	1911-97	272,900	26,300	804,400
Colorado River	Virgin River at Littlefield, AZ (09415000)	1930-97	175,600	72,400	504,600
	Muddy River near Glendale, NV (09419000)	1913-97	30,600	23,500	35,900
	Colorado River below Hoover Dam, AZ-NV (09421500)	1935-97	10,050,000	5,556,000	22,150,000
Humboldt River	Humboldt River at Palisade, NV (10322500)	1903-97	288,800	25,200	1,336,000
	Humboldt River near Imlay, NV (10333000)	1935-97	201,000	18,800	1,460,000
Snake River	Owyhee River above China Diversion Dam near Owyhee, NV (13176000)	1939-84	107,600	33,500	230,800
Truckee River	Truckee River at Farad, CA (10346000)	1909-97	554,500	133,200	1,769,000
	Truckee River at Reno, NV (10348000)	1907-96	492,500	76,700	1,701,000
	Truckee River below Derby Dam near Wadsworth, NV (10351600)	1918-97	289,100	4,500	1,759,000
Walker River	East Walker River near Bridgeport, CA (10293000)	1922-97	105,800	27,100	320,700
	West Walker near Coleville, CA (10296500)	1903-97	202,100	53,900	484,300
	Walker River near Wabuska, NV (10301500)	1902-97	123,300	9,300	602,300

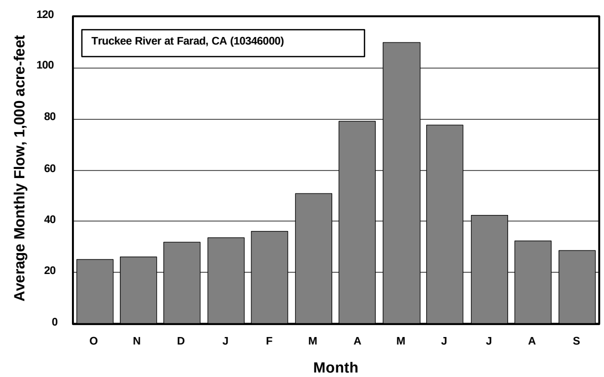
Note: Some years of data may be missing within each period of record.
Source: U.S. Geological Survey

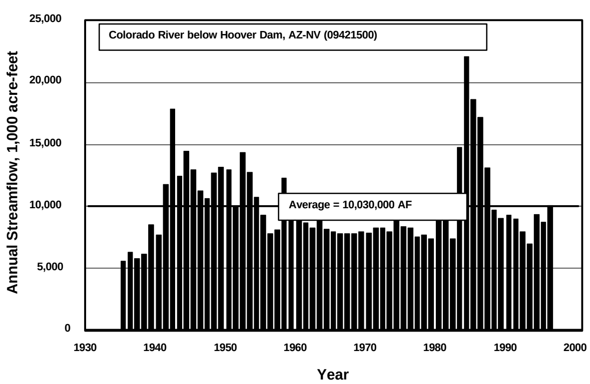
Figure 4-7 selected gaging stations



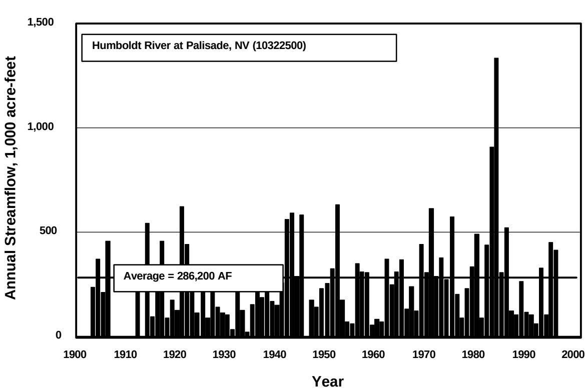
Monthly Variations: Streamflows in Nevada vary from month to month with most flow occurring from March through June as a result of snowmelt. Colorado River flows fluctuate much less from one month to the next due to the regulating effect of reservoirs on the system.







Annual Variations: Streamflows vary from year to year in response to annual variations in precipitation amounts upstream of the gaging stations



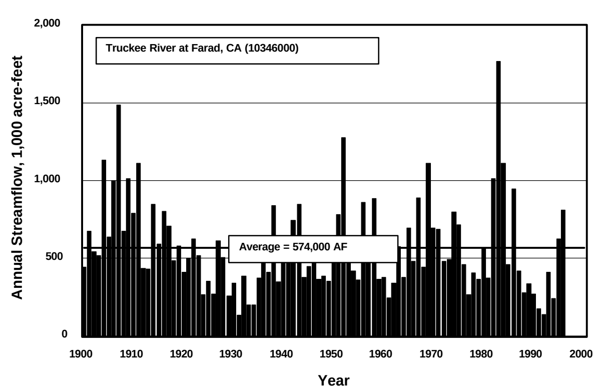


Fig. 4-8. Streamflow Variability for 3 Selected Sites

Table 4-4.

Summary of Surface Water Runoff and Flows (excluding Colorado River)

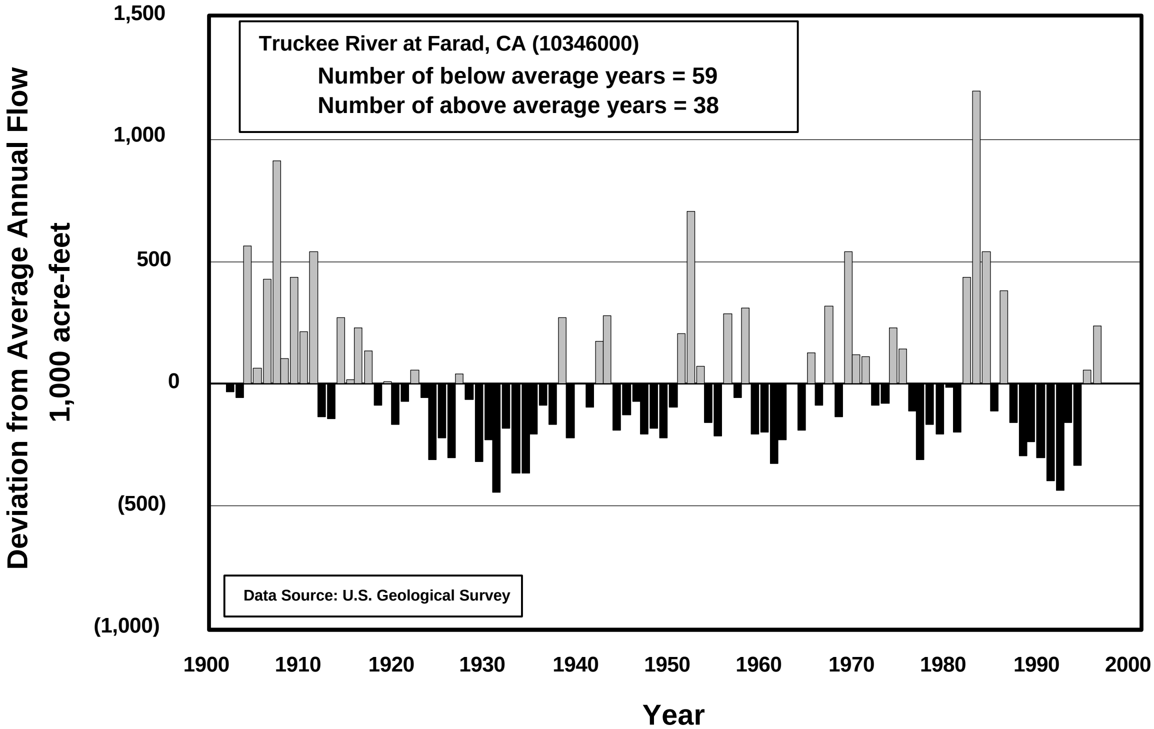
Description	Acre-feet per year
Average Annual Surface Runoff	
From Watersheds within Nevada	1,900,000
Inflow from Other States	1,300,000
Total	3,200,000
Average Annual Surface Outflow to Other States	700,000

Source: “Water for Nevada, Report No. 3", State Engineer’s Office, 1971

Drought periods (consecutive years with streamflows much less than average) are frequent in Nevada. In many cases, Nevada’s river systems experience more “below average water years” than “above average water years” (Figure 4-9). The most significant documented droughts of the 20th century were during 1928-37, 1953-55, 1959-62, 1976-77 and 1987-94, with the 1928-37 period possibly the most severe and longest of this century in northern Nevada.

Floods. Even though Nevada is the driest state with an average annual precipitation of nine inches, floods are common and have occurred in all parts of the state. The effects of floods in Nevada have increased steadily as population and development have increase since the mid-1900s. Development has encroached upon natural floodplains, including alluvial fans, and thereby increasing flood damage risks.

On the Truckee, Carson, and Walker rivers in west-central Nevada, the most severe floods have resulted from winter rains on snow in the Sierra Nevada Mountains. In the large drainages in southern Nevada, and small drainages and alluvial fans throughout Nevada, flash floods resulting from intense rainfall over relatively small areas are the most common. Flooding from these intense rainstorms is typically sudden and life threatening. Flooding along the Humboldt, Truckee, Carson, and Walker rivers in northern Nevada is generally not as sudden and more time is available to prepare for the flooding. However, these floods are usually longer with longer periods of flood inundation. Table 4-5 summarizes the major flood events that have occurred this century in Nevada.



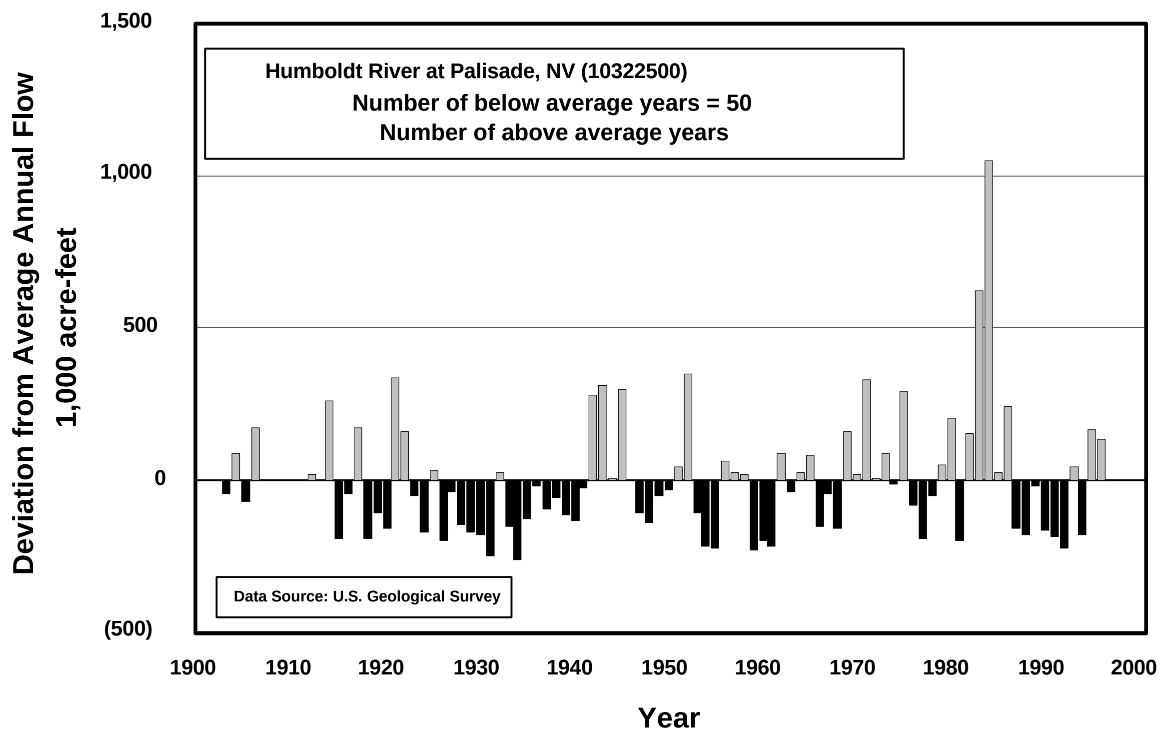


Fig. 4-9. Examples of Annual Deviations from Average Annual Flows

Table 4-5. Summary of Major Floods in Nevada, 1907-97

Date	Area Affected	Recurrence Interval (years)	Remarks
Mar. 1907	Sierra Nevada drainages	Unknown	May rank with 1950 and 1955 floods in Carson Valley and along Truckee River
Feb. 1910	Upper Humboldt River basin	>100	Similar to hydrologic conditions during Feb. 1962 flood.
Nov.-Dec. 1950	Sierra Nevada drainages	50	Not as severe as Dec. 1955 flood in Carson River drainage.
Dec. 1955	Sierra Nevada drainages	40 to 100	Most severe flood from upper Carson River drainage downstream to Carson City
Feb. 1962	Humboldt River drainage	>50 in upper Humboldt	Rapid thawing and light rain on snowpack
Feb. 1963	Sierra Nevada drainages	50	Severe in Carson and Truckee River drainages
Dec. 1964	Sierra Nevada drainages	20	
Sept. 14, 1974	Eldorado Canyon (dry tributary to the Colorado River, 50 miles southeast of Las Vegas)	>100	9 lives lost
July 1975	Las Vegas Valley	Unknown	2 lives lost
Aug. 1981	Moapa Valley and vicinity	Unknown	Severe damage to agriculture and highways.
Mar.-June 1983	Statewide except south	<10 to 50	Greatest snowmelt floods known (except in Humboldt River basin - see Apr.-June 1984).
July 1983	Las Vegas Valley, Muddy River	Unknown	
Apr.-June 1984	Centered in Humboldt River drainage	>100 along middle and lower Humboldt River	Greatest snowmelt floods known in Humboldt River basin.
July-Sept. 1984	Las Vegas Valley	Unknown	5 lives lost
Feb. 1986	Sierra Nevada drainages	10 to 50	Greatest discharge in main rivers since 1963
Jan. 1997	Sierra Nevada drainages	50 to >100	Heavy rainfall on snowpack

Source: National Water Summary 1988-89 - Floods and Droughts: Nevada, U.S. Geological Survey, Carson City, Nevada.; January 1997 Flooding in Northern Nevada - Was This a “100-Year Flood”?, U.S.G.S. Fact Sheet FS-077-97, U.S. Geological Survey, Carson City, Nevada, May 1997.

Water Quality

Nevada's surface water quality is regulated by the Nevada Division of Environmental Protection (NDEP) and the State Environmental Commission (SEC). The quality of surface water in Nevada varies greatly from location to location and from month to month with changes in flows. Tables 4-6 and 4-7 shows average total dissolved solids concentrations at a number of surface water monitoring sites throughout Nevada. In planning, both water quantity and quality need to be considered concurrently as both are interrelated. In general, constituent concentrations vary with changes in streamflow. Similarly, lake water quality is impacted by water levels in the State's terminal lakes. Figure 4-10 shows how total dissolved solids concentrations have increased in Walker and Pyramid lakes as the volume of water has decreased

Table 4-6. Comparison of Streamflow and Dissolved-Solids Concentrations at Selected USGS Water-Quality Sites

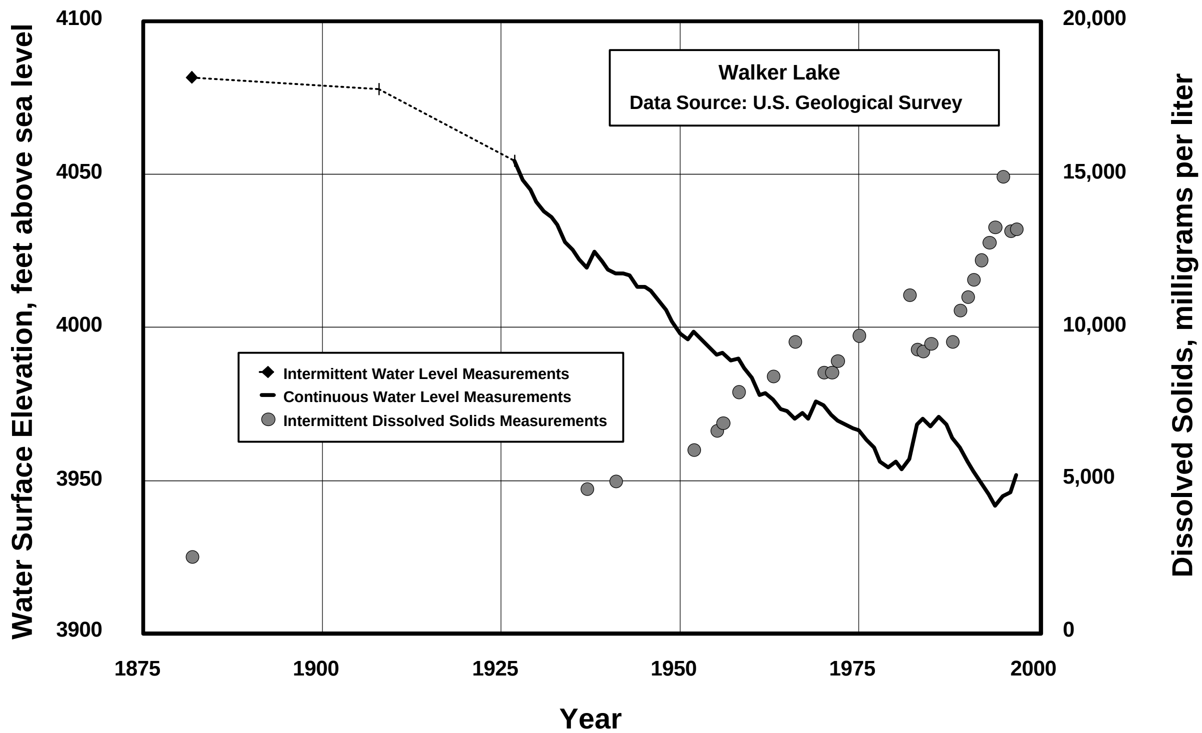
U.S.G.S. Water Quality Station	Mean Concentration of Dissolved Solids, milligrams per liter	Mean Discharge, cubic feet per second
Virgin River at Littlefield, AZ (09415000)	1,990	243
Colorado River below Hoover Dam, AZ-NV (09521500)	697	13,840
Steptoe Creek near Ely, NV (10244950)	180	7.0
South Twin River near Round Mountain, NV (10249300)	86	6.6
Carson River near Carson City, NV (10311000)	199	405
Humboldt River near Carlin, NV (10321000)	301	375

Source: Water Resources Data, Nevada, Water Year 1996, U.S. Geological Survey Water Data Report NV-96-1

Table 4-7. Comparison of Streamflow and Dissolved-Solids Concentrations at Selected NDEP Water-Quality Sites

NDEP Water Quality Station	Mean Concentration of Dissolved Solids, milligrams per liter	Mean Discharge, cubic feet per second
Truckee River at Tracy, NV	160	780
Walker River at Snyder Lane	200	180

Source: Nevada Division of Environmental Protection files, U.S. Geological Survey data, and Nevada Division of Water Planning files



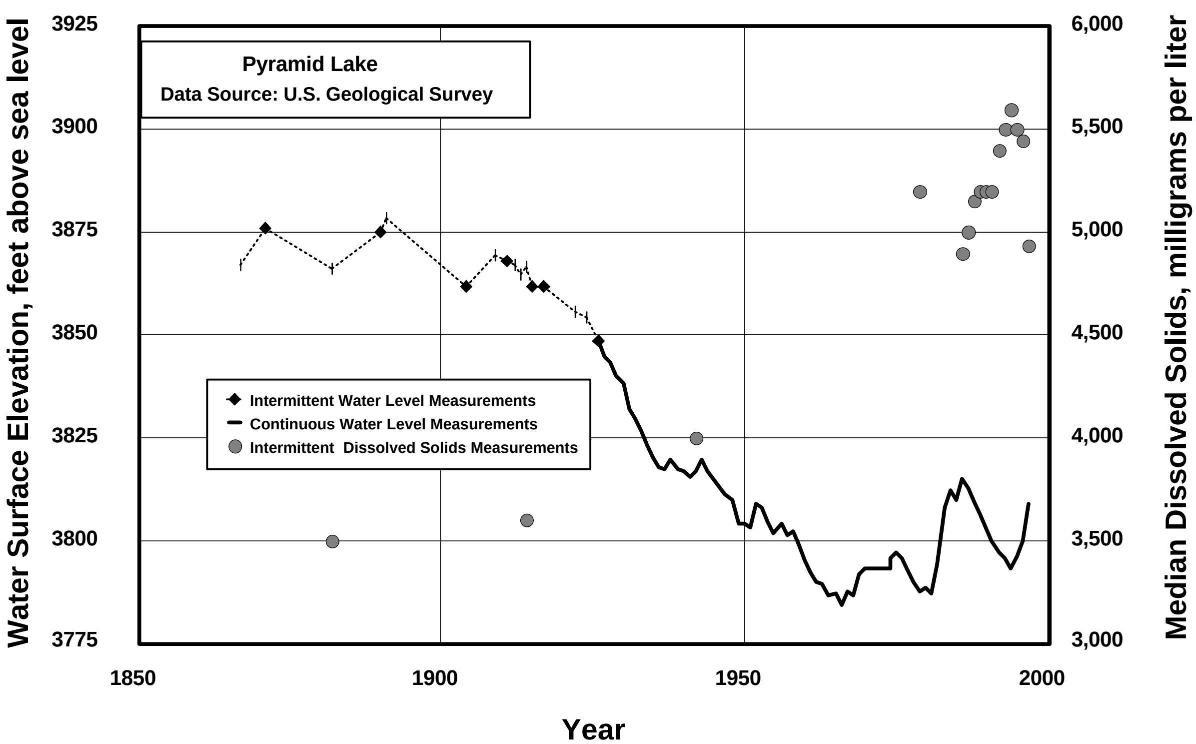


Fig. 4-10. Water Surface Elevations and Dissolved Solids Concentrations at Walker and Pyramid Lakes

The impacts on water quality from the municipal and industrial discharges have been greatly reduced over the last few years, with most point source polluters eliminated from direct discharges or stringently controlled. Nonpoint source pollution due mainly to agriculture, urban runoff and hydrologic modifications impacts various waters of Nevada. Water quality parameters of concern include nutrients, suspended solids, turbidity and bacteria which are being targeted in the State's Nonpoint Source Program administered by NDEP. Water quality has been improving due to the removal of point sources and the implementation of more stringent standards. The Nonpoint Source Program helps to further improve water quality by promoting public awareness, improved grazing and irrigation practices, erosion control measures and the implementation of best management practices.

Surface Water Quality Management and Data Collection. Nevada's surface water quality is regulated by NDEP and the SEC. Certain aspects of the Federal Clean Water Act are implemented by NDEP for programs within Nevada. With assistance from federal grants, NDEP operates a surface water quality monitoring program of water bodies in Nevada, regularly monitoring over 100 sampling points in the 14 hydrographic regions. Section 303(d) of the Clean Water Act requires the State to develop a list of water bodies that need additional measures beyond existing controls to achieve or maintain water quality standards. The Section 303(d) list, developed by NDEP, provides a comprehensive inventory of water bodies impaired by all pollution sources, including point sources and nonpoint sources. This inventory is the basis for targeting water bodies for watershed-based solutions. Nevada's first priority in targeting water bodies is impairment of the beneficial use standards. In general, a water body is included on the 303(d) list if the beneficial use standards were exceeded more than 25% of the time. The current 303(d) list is available from NDEP upon request. For a more complete description of NDEP water quality programs, refer to Part 1, Section 3 of the *State Water Plan*.

As of 1996, the USGS collected water quality data for 96 stream, canal, spring and drain sites throughout Nevada as part of their systematic data-collection program. In addition to routine monitoring, USGS is also conducting the National Water Quality Assessment Program (NAWQA) in Nevada and throughout the United States in response to the lack of long-term, consistent information on water quality nationwide. NAWQA Program goals are to describe the status and trends in the quality of the Nation's water resources and to provide scientific understanding of the major factors which affect surface and ground water quality. The Nevada NAWQA Project began in 1991 and includes the Las Vegas Valley area and the Carson and the Truckee River Basins. Project scientists are using multi-disciplinary approaches to compare and contrast the effects of urban and agricultural activities on water quality.

Groundwater

Groundwater in Nevada is an important water supply source. The surface water resources in our state have been virtually fully appropriated and future development must rely on either ground-water sources or the reallocation of surface water supplies. Groundwater provides about 40 percent of the total water supply used in Nevada and in some areas provides the entire supply. The extent to which groundwater is used may vary considerably from year to year. In many areas, groundwater is pumped to supplement surface water sources. As a result, groundwater usage in these areas increases during periods of low streamflow and decreases during high runoff periods.

Proper planning and management of our ground-water resources cannot occur without knowledge about aquifer location, perennial yield, recharge, storage volume, committed resources (water righted amounts), actual water usage, water levels, water quality, and projected trends. The following sections provide available background information on Nevada's groundwater resources.

Principal Ground-water Aquifers

Principal ground-water aquifers in Nevada are basin-fill aquifers, carbonate-rock aquifers, volcanic-rock aquifers, and volcanic- and sedimentary-rock aquifers (Figure 4-11). The basin-fill aquifers, composed primarily of alluvial, colluvial and lacustrine deposits, are the major aquifers in the State. Virtually all major ground-water development has been in the basin-fill aquifers with the withdrawals from the upper 500 feet of these aquifers. In eastern and southern Nevada, thick sequences of carbonate rock underlie many of the alluvial basins forming a complex regional aquifer system or systems that are largely undeveloped and not yet fully understood. The carbonate-rock aquifer supplies water to numerous springs which are used for irrigation. Volcanic-rock aquifers extend over hundreds of square miles but only one volcanic-rock aquifer in the Carson Desert (Churchill County) of west-central Nevada has been developed as a municipal water supply.

Within the Basin and Range Province, aquifers are generally not continuous, or regional, because of the complex faulting in the region. Of the aquifer types discussed above, any or all may be in, or underlie, a particular basin and constitute separate sources of water. However in some instance, interconnection between the aquifers may exist.

Groundwater and Surface Water Interaction

Groundwater and surface water cannot be viewed as independent and separate sources in water management decisions. In some areas, groundwater may discharge into streams and contribute significantly to surface water flows. Groundwater usage may lessen surface flows in these instances. Conversely, surface water infiltrates into the groundwater systems through natural causes and/or human activities (such as irrigation). As a result, changes in surface water flows and usage may impact groundwater levels.

Figure 4-11 Aquifers

Perennial Yield and Committed Resources

Perennial yield is the amount of usable water from a ground-water aquifer which can be economically withdrawn and consumed each year for an indefinite period of time without depleting the source. Estimates of perennial yield are necessary to provide the State Engineer with a guideline by which to limit groundwater allocations (committed resources).

Recognizing the need for more detailed groundwater information, such as perennial yield estimates, the State Engineer and the U.S. Geological Survey (USGS) began a cooperative groundwater study program in 1945 with funding from the State Legislature. A number of water resource bulletins have been produced from this program. However, the most statewide comprehensive groundwater study efforts did not begin until the State Legislature in 1960 authorized a series of ground-water reconnaissance studies be performed under the cooperative supervision of the Nevada Division of Water Resources (NDWR) and the USGS. This program, which extended until 1974, resulted in 60 reconnaissance reports covering the hydrology of 219 hydrographic areas. Based upon these reports, the water resources bulletins, and other more recent studies, estimates of perennial yield have been developed for the 256 hydrographic areas. The total combined perennial yield of the basin-fill aquifers statewide is approximately 2.1 million acre-feet per year. The perennial yield figures currently available are estimates only and provide guidelines for water planning and management. In developing these estimates, the USGS utilized the Maxey-Eakin method which was developed between 1947 and 1951. While some of the perennial yield estimates have been updated with more current methodologies, many of the yield estimates in use today were developed over 25 years ago.

In basins with significant groundwater discharge to streams, the USGS developed system yield estimates in addition to the groundwater perennial yield estimates. System yield is the amount of usable groundwater and surface water that can be economically withdrawn and consumed each year for an indefinite period of time without depleting the source. For these basins, the perennial yield estimates may include groundwater discharges to surface streams. Development of these groundwater aquifers could potentially reduce surface flows and impact downstream surface water users.

Under the authority granted in Nevada Revised Statutes 534, the State Engineer issues groundwater rights. The term “committed resource” represents the total volume of the permitted, certificated and vested groundwater rights which are recognized by the State Engineer and generally can be withdrawn from a basin or area in any given year. When reviewing groundwater right applications, the State Engineer considers the individual and regional perennial yield estimates, system yield estimates, and the committed resources amounts among other things in making determinations.

To assist in the tracking of the committed groundwater resources, NDWR maintains a computer database of state-issued water rights. Based upon this database, the total committed groundwater resource amount in Nevada equals about 3 million acre-feet per year (as of March/April 1998). The term “committed” refers to those water rights that are either permitted or certificated. Table 4-8 and Figure 4-12 summarizes the committed resources by hydrographic region and by type of use. Committed resource values presented in the *State Water Plan* are time sensitive and subject to change from future actions on pending applications and other procedures. It must be noted that the 3 million acre-feet figure is calculated from NDWR database output and represents the estimated amount of the groundwater resources committed (permitted or certificated) to a particular beneficial use. The database is still under development and all committed resource numbers presented in the *State Water Plan* are approximate. Actual groundwater withdrawal and consumption amounts are far less than the committed resource value of 3 million acre-feet. In 1995, approximately 1.6 million acre-feet of groundwater was withdrawn with about 0.7 million acre-feet consumed. There are a number of reasons for these differences:

- Some groundwater rights are *supplemental* to surface water rights. Supplemental groundwater is generally pumped only as needed to augment low surface water supplies. As a result, supplemental groundwater rights are not usually exercised to their fullest extent every year.

- Some groundwater rights are *supplemental* to other groundwater rights with one well pumped to augment the supply from another well. When this supplemental relationship exists between rights, the State Engineer assigns a combined annual pumpage duty for both wells which is less than the sum of each well’s individual duty. The NDWR database does not automatically account for these supplemental situations. NDWR staff must first make adjustments to the database numbers to avoid double counting of these supplemental commitments. These adjustments have been made to the database for about 35% of basins. In the other basins, committed resources values as taken from the NDWR may be overestimated due to double counting of the supplemental water rights.

- Some groundwater rights may not be exercised to their fullest extent every year. For example, municipalities are allowed to hold water rights in reserve as needed for future growth.

- Some groundwater rights are not currently being exercised as a water supply is being provided from another source. For example, groundwater being pumped as part of the mine dewatering operations at Barrick’s Post/Betze-Meikle Mine is utilized for irrigation in Boulder Flat Valley (Humboldt River Basin). Both the irrigation and mine dewatering are separately permitted with their permitted pumpage amounts included in Table 4-8. However under this situation, the irrigation operation is using the pit water rather than pumping the irrigation wells and exercising their groundwater rights. The NDWR database is not capable of adjusting for this type of substitution, and database printouts obtained for the *State Water Plan* include both the irrigation rights and the dewatering rights in the committed resource values.

Table 4-8. Approximate Perennial Yield and Committed Groundwater Resources (as of March/April 1998) by Use and Hydrographic Region

Hydrographic Region	Combined Perennial Yield, acre-feet per year	Committed Groundwater Resources by Category, acre-feet per year (as of March/April 1998)					
		Irrigation & Stock	Municipal & Quasi-municipal	Mining & Milling[1]	Commercial & Industrial	Other[2]	Total
1. Northwest Region	55,500	28,625	6	132	5	64	28,832
2. Black Rock Desert Region	178,825	215,658[3]	608	58,952[4]	920[5]	1,687[5]	277,825
3. Snake River Basin	62,100	8,091	1,145	7,813	4,877	511	22,437
4. Humboldt River Basin	463,900	492,307[3,6]	53,737	141,576	63,637[5]	91,055[7]	842,312
5. West Central Region	8,200	1,678	8,743	58	28,249[5]	1,289	40,017
6. Truckee River Region	76,425	34,989[3]	83,902[8]	5,172	68,030[5]	19,014	211,107
7. Western Region	17,850	18,662	5,174	5,174	518	508	25,328
8. Carson River Basin	70,255	95,926[3]	62,438	4,068	12,979[5]	13,196[5]	188,607
9. Walker River Basin	57,300	205,354[3]	14,949	8,657	12,383[9]	6,019	247,362
10. Central Region	798,460	573,277	50,978	96,765	37,141[5]	9,775[5]	767,936
11. Great Salt Lake Basin	63,150	28,155	3,506	1,305	732	13	33,711
12. Escalante Desert Basin	1,000	2	0	0	0	0	2
13. Colorado River Basin	219,800	78,057[3]	101,362[10]	11,171	35,895	19,165[11]	245,650
14. Death Valley Basin	24,550	22,325	2,154	6,086	638	333	31,536
TOTAL	2,097,315	1,803,106	388,702	342,221	266,004	162,629	2,962,662

General notes:

A. Data on committed resources were obtained from the Nevada Division of Water Resources water rights database and represent estimated resources committed as of March/April 1998.

B. The committed resources values include permitted and certificated amounts only.

C. These numbers are preliminary and intended to be used for planning purposes only. Totals may include water rights that have not been adjusted for supplemental relationships with other groundwater rights. Also, totals do not include any adjustment for supplemental relationships with surface water rights. Values are subject to change due to pending water right applications, and possible cancellations and forfeitures.

Other notes:

1 Mining is considered a temporary use by the State Engineer's Office and upon cessation of mining, many permits will expire. The "Mining & Milling" category includes only those rights associated with the consumptive use needs of the mines. Permits associated with dewatering operations are included in the "Other" category.

2 "Other" includes following uses: domestic, environmental, power generation, recreation, storage, wildlife, other/decreed. Includes environmental permits issued for environmental cleanup projects. These environmental permits are temporary and expire upon cessation of cleanup activities.

3 Portions of rights are supplemental to surface water and are used only when surface water is not available.

4 Majority of rights held for a mine operation that is no longer pumping.

5 Portion of rights include geothermal pumpage for power generation, with majority of geothermal water reinjected into geothermal reservoir.

6 Portion of rights not exercised as mine pit dewatering discharge is being used as a substituted water source. See Footnote 7.

7 Includes rights associated with mine pit dewatering. Portion of withdrawals are used as a water source for irrigation. See Footnote 6.

8 Actual annual pumpage limited to lower value by State Engineer restrictions.

9 Portion of rights include geothermal pumpage for power generation, with some of geothermal water not reinjected.

10 Includes permits that will be revoked when water right holders provided water from another source (Colorado River).

11 Includes environmental permits issued for environmental cleanup projects. These environmental permits are temporary and expire upon cessation of cleanup activities. Also includes permits granted for pumping of shallow poor quality groundwater in the Las Vegas area as needed to alleviate potential hazards resulting from rising groundwater levels caused by secondary recharge.

Figure 4-12. Estimated Committed Groundwater Resources by Type of Use and Hydrographic Region.

- The State Engineer has placed administrative limits on pumping in some areas. For example, the State Engineer has limited pumpage by Sierra Pacific Power Company from the Truckee Meadows Basin to an amount less than Sierra's water right duty. The NDWR database is not capable of reflecting this pumpage limit in any calculation of committed resource amounts. Any committed resource values taken from the NDWR database reflect only the permitted/certificated pumpage amounts, not any pumpage limits.

The committed resource figures derived from the NDWR database may not reflect long-term groundwater commitments for the following reasons:

- Mining is considered a temporary use by the State Engineer's Office. With some mines, existing water right permits will expire once the mining operations have ceased.

- Environmental permits issued for environmental cleanup projects are included in the committed resource figures in Table 4-7. The cleanup projects are considered temporary, and once a cleanup operation is complete the associated water rights expire.

- The NDWR database includes committed resource amounts associated with revocable groundwater permits issued in the Las Vegas area. These rights will be revoked when the water right holders are provided water from another source, such as the Colorado River.

Management of Groundwater Rights Information

The total committed groundwater resource values presented in Table 4-8 and Figure 4-12 were derived directly from the NDWR database as of March and April 1998. At that time (March/April 1998), approximately 85 percent of all state-issued water rights in Nevada had been entered into this database. However, the groundwater rights for 88 of the 256 basins have been completely entered into the database and adjusted for supplemental rights (Figure 4-13). As a result, the committed resource figures from the NDWR database for these 88 basins are more accurate than for the other 168 basins, and the committed resource totals derived from the NDWR database maybe slightly lower than the actual amount. Committed resource values for the 168 basins should be considered preliminary estimates. Also, the committed resource values in some basins change daily. Current estimates should be obtained from the Nevada Division of Water Resources.

Groundwater Availability

As the demand for groundwater has increased over the years, the State Engineer has had to increase administrative efforts in some of the groundwater basins. The State Engineer may designate a groundwater basin which is being depleted or is in need of additional administration. Basins are designated through orders issued by the State Engineer. By "designating" a basin, the State Engineer is granted additional authority in the administration of the groundwater resources within the designated basin. For example, the State Engineer may issue orders which define preferred uses, deny certain water uses, or curtail pumpage. Preferred uses may include domestic, municipal, quasi-municipal, industrial, irrigation, mining and stock-watering uses or any other beneficial use. Each basin is managed as a separate unit with the State Engineer issuing orders and rulings as needed for

Figure 4-13 Basins with GW rights on NDWR database the management of the groundwater resources. Figure 4-14 displays the designation status for the 256 groundwater basins in Nevada. This map is a useful tool to generally determine where the greatest impediments to groundwater development may exist. However, the associated State Engineer's orders and rulings need to be examined for a complete understanding of the management issues and water availability within a basin. The designation status of basins as defined by the State Engineer's orders have been divided into four general categories as shown in Table 4-9.

Table 4-9. Designated Groundwater Basin Categories

Designation Status	General Description of Associated State Engineer's Orders
Designated	State Engineer's order(s) do not define any administrative controls.
Designated - Irrigation Denied	State Engineer's order(s) state that irrigation is <u>not</u> a preferred use in these basins and applications for new irrigation appropriations will be denied.
Designated - Preferred Uses	State Engineer's order(s) list certain types of uses as preferred in these basins, and quantity restrictions may be placed on these preferred uses.
Designated - Preferred Uses; Irrigation Denied	State Engineer's order(s) list certain types of uses as preferred in these basins. Quantity restrictions may be placed on these preferred uses. State Engineer's order(s) also state that irrigation is <u>not</u> a preferred use in these basins and applications for new irrigation appropriations will be denied. Other uses may also be listed as denied.

Whether or not a basin is designated dictates the procedures to be followed in obtaining a groundwater permit. In undesignated basins, a person can drill a well in these basins prior to filing an application for a groundwater permit. In designated basins, a groundwater permit must be obtained prior to drilling a well. Domestic wells are exempt from the permitting process, however, drillers are required to notify the State Engineer of their intent to drill a domestic well and submit a well log following completion.

In general for basins with preferred uses defined, applications for preferred uses are considered by the State Engineer prior to applications for non-preferred uses. However, the State Engineer has the authority to deny applications for non-preferred uses even though the designation orders do not explicitly prohibit these uses. Regardless of the basin designation status, the State Engineer has the authority to deny a water application if: 1) there is not unappropriated water; 2) the proposed use will impair existing rights; 3) the proposed use will be detrimental to the public interest; and 4) the project is not feasible and is filed for speculative purposes.

Figure 4-15 presents a general picture of the uncommitted groundwater resources in Nevada. "Uncommitted groundwater resources" are assumed equal to perennial yield estimates less permitted and certificated water right amounts as extracted from the NDWR water rights database as shown on Table 4-7. Approximately 60% of the 256 basins have committed resource volumes below the perennial yield estimates. The following qualifiers apply to the data upon which this map is based:

Figure 4-14 - Designated basins

Figure 4-15.uncommited gw

- The perennial yield figures are estimates only and are subject to change following future studies.

- In some basins, groundwater aquifers discharge to streams thereby providing a portion of the supply for downstream surface water users. In these basins, development of the entire perennial yield amount could potentially impact surface water uses.

- The committed resource numbers upon which this map is based are subject to change on a daily basis as a result of new actions, such as approval of pending applications or forfeitures. About 1/3 of the groundwater basins have pending applications. The most current information can be obtained from NDWR.

Groundwater Data Collection

NDWR and USGS collect a majority of the groundwater usage and level data in Nevada as described in the following discussion.

Pumpage and Crop Inventories. As part of their groundwater management duties, NDWR performs annual estimates of pumpage or "pumpage inventories" for some of the groundwater basins. Generally, these pumpage inventories are based upon a mixture of both actual measurements and estimates. In other basins, NDWR performs crop inventories in which irrigated crop acreages and associated water use are estimated. Figure 4-16 shows the basin locations for these inventories and their status. Some pumpage data are submitted to NDWR by the permit holders as a requirement of water right permit conditions, however these data do not represent all of the groundwater use within these basins. Figure 4-17 shows the basin for which groundwater pumpage data are submitted to NDWR as required by water right conditions.

Groundwater Level Data. The USGS and NDWR are the primary agencies collecting groundwater level data on a statewide basis. In the report entitled "Water Resources Data, Nevada, Water Year 1996" which is part of an annual series, the USGS presents water level data for 145 primary observation wells (measured monthly or more frequently) and 1041 secondary observation wells (measured one to four times per year) within 98 hydrographic basins. These water level data are maintained in electronic databases. Some of the groundwater level data presented in USGS's annual report have been collected by other agencies and then compiled by the USGS. NDWR currently collects groundwater level data in 73 basins. Figure 4-18 shows the basins where the USGS and NDWR collect groundwater level data. Most of the NDWR data is collected once a year, typically in the spring. Only a portion of the NDWR data are maintained in the USGS database with the remaining data stored in paper files.

Groundwater levels fluctuate seasonally and annually in response to changes in pumpage and the climate. Figure 4-19 shows long-term groundwater levels for six selected wells throughout Nevada. In some areas, groundwater levels during the late 1980s and early 1990s tended to decline due to heavier than average reliance upon groundwater during the drought of that period, but have been recovering with the return to normal and above-normal precipitation.

Figure 4-16. Crop inventory

Figure 4-17. Pumpage data

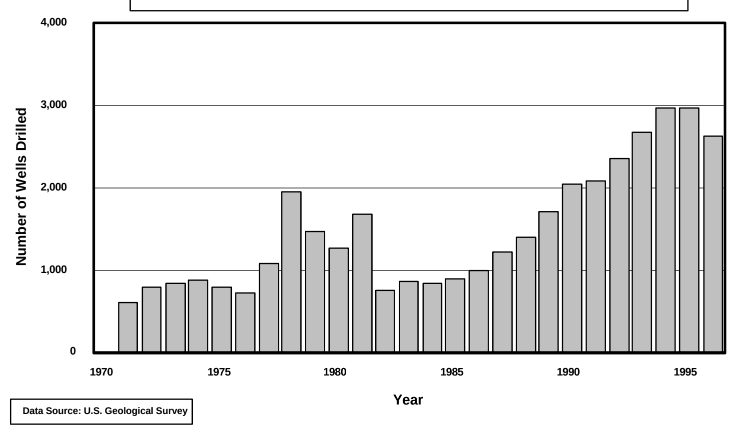
Figure 4-18. Level collection

Figure 4-19. Water levels

As shown on Figure 4-19, significant groundwater level declines have occurred in Diamond Valley. In response, the State Engineer has designated the basin and has taken actions to reduce total pumpage in the basin. Las Vegas Valley has also experienced significant groundwater level declines (Figure 4-19) due to overpumpage. Another result of overpumping groundwater is the reduction of artesian pressures in the aquifer, which leads to the compaction of aquifer materials and to land surface subsidence. Subsidence in the Las Vegas Valley has been monitored since 1935. Since that time, the land surface has subsided over five feet in many areas of the valley. A number of actions have been taken to address the basin overdraft and subsidence problems. Starting in 1987, the Las Vegas Valley Water District began an artificial recharge program to temporarily store Colorado River water in the principal aquifer during times of lower water use. The State Engineer has designated the basin and has taken actions to reduce pumpage in the basin. In 1997 the Nevada State Legislature created a Las Vegas Valley Groundwater Management Program for the oversight, protection and stabilization of the basin's groundwater supply.

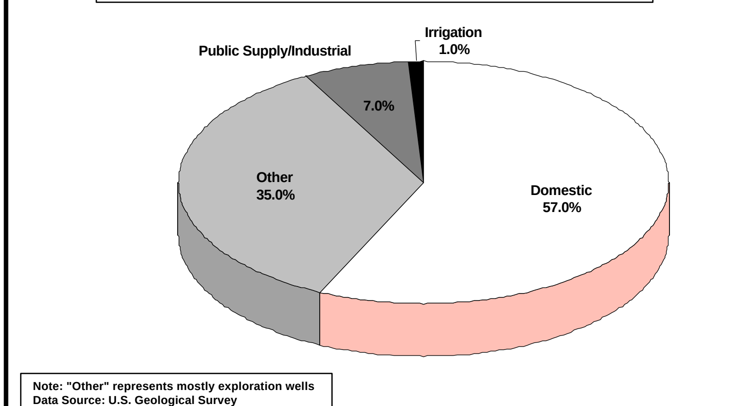
<u>Well Logs.</u> Since the 1940s, well logs have been submitted to the State Engineer's Office. These well logs include a variety of information such as: well location, drilling method, proposed use, well depth, and depth to water. Examination of these logs indicates that groundwater development in Nevada has continued to expand over the years. Figure 4-20 displays the increase experienced in the number of wells drilled annually from 1971 to 1996. In 1996, there were approximately 2,632 new wells drilled in Nevada. Of this total, about 1,500 wells were for domestic uses and about 900 were exploration wells (Figure 4-21). In 1996 the well drilling was concentrated in the north-central, northwestern, and southern parts of the State.

Fig. 4-20. Number of New Wells Drilled from 1971-96



In 1994, NDWR and USGS cooperatively developed a computer database for managing the well log information. Currently, the database contains information on approximately 50,000 wells in Nevada. The database does not contain any detailed information on the subsurface geology.

Fig. 4-21. Distribution of Wells Drilled in 1996 by Use



Groundwater Quality

The quality of water from most aquifers in Nevada is suitable or marginally suitable for most uses. Most aquifers contain water with a majority of the constituent concentrations not exceeding State and national drinking water standards. However, there are parts of some aquifers with constituent concentrations exceeding these standards. It is important to realize that these excessive concentrations of certain constituents in groundwater may result from both natural processes and/or human activities.

The quality of groundwater in the unconsolidated deposits in the Basin and Range alluvial aquifers varies from basin to basin. Dissolved-solids concentrations range from less than 500 parts per millions (ppm) to more than 10,000 ppm in some areas (Figure 4-22). By comparison, ocean water has dissolved-solids concentrations of about 35,000 ppm. Locally, saline water is present near thermal springs and in areas where the basin-fill aquifers include large amounts of soluble salts. In discharge or sink areas such as the Carson and Humboldt sinks, the dissolved-solid concentrations can make the water economically unuseable. Although highly mineralized water is common in aquifers beneath playas, a deeper freshwater flow system may be present in some areas.

Groundwater Quality Management and Data Collection. Groundwater quality is regulated by NDEP and the SEC. Certain aspects of the Federal Clean Water Act and the Safe Drinking Water Act are implemented by NDEP within Nevada. Groundwater quality is monitored by NDEP, and other State and Federal agencies. However, there is no ambient groundwater quality monitoring network in Nevada as there is with the surface water resources. Most of the available groundwater quality data are the result of special studies in specific areas, monitoring required by State permitting programs and by drinking water regulations. For instance, NDEP may require groundwater monitoring for groundwater discharge permits issued for industrial plants, land applications of treated sewage effluent, and geothermal injection wells. Groundwater monitoring also may be required in response to suspected contamination, such as mining sites or leaking fuel tanks.

Other NDEP activities include the development of the Comprehensive State Ground Water Protection Program (CSGWPP) and the Wellhead Protection Program (WHPP). NDEP initiated the CSGWPP to protect groundwater resources throughout Nevada and has received EPA endorsement on the program. The WHPP is intended to protect existing and future municipal groundwater resources. For a more complete description of NDEP water quality programs, refer to Part 1, Section 3 of the *State Water Plan*.

All community water systems are required to monitor water quality under the Federal Safe Drinking Water Act and State law for both groundwater and surface water systems. The State Health Division, Bureau of Health Protection Services, uses these data to check for compliance with the drinking water standards.

Figure 22 - tds

Another significant source of groundwater quality data is the USGS. The USGS undertakes a wide range of special studies in specific basins which results in the collection and compilation of groundwater quality data. As of 1996, the USGS is collecting water quality data for 111 wells within 11 of the 256 hydrographic basins. As stated above, most groundwater monitoring is short-term and site specific in response to a particular problem. This lack of continuous, long-term groundwater quality data makes any trend assessments a difficult proposition. In response to the lack of long-term, consistent information on water quality nationwide, the USGS developed the National Water-quality Assessment (NAWQA) Program. NAWQA Program goals are to describe the status and trends in the quality of the Nation’s water resources and to provide scientific understanding of the major factors that affect surface and ground water quality. The Nevada NAWQA Project began in 1991 and includes the Las Vegas Valley area and the Carson and the Truckee River Basins. Project scientists are using multi-disciplinary approaches to compare and contrast the effects of urban and agricultural activities on water quality.