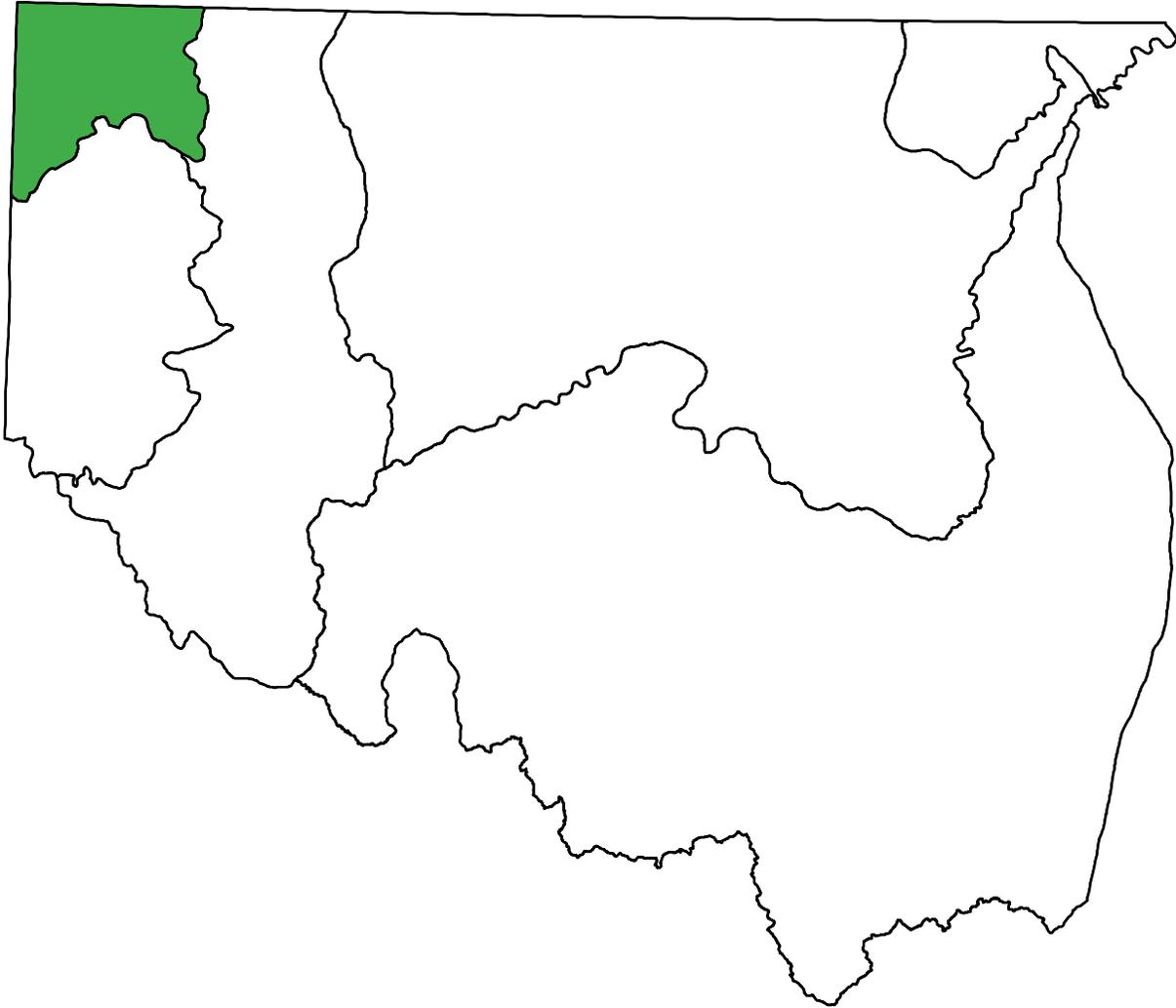


Section 6.6

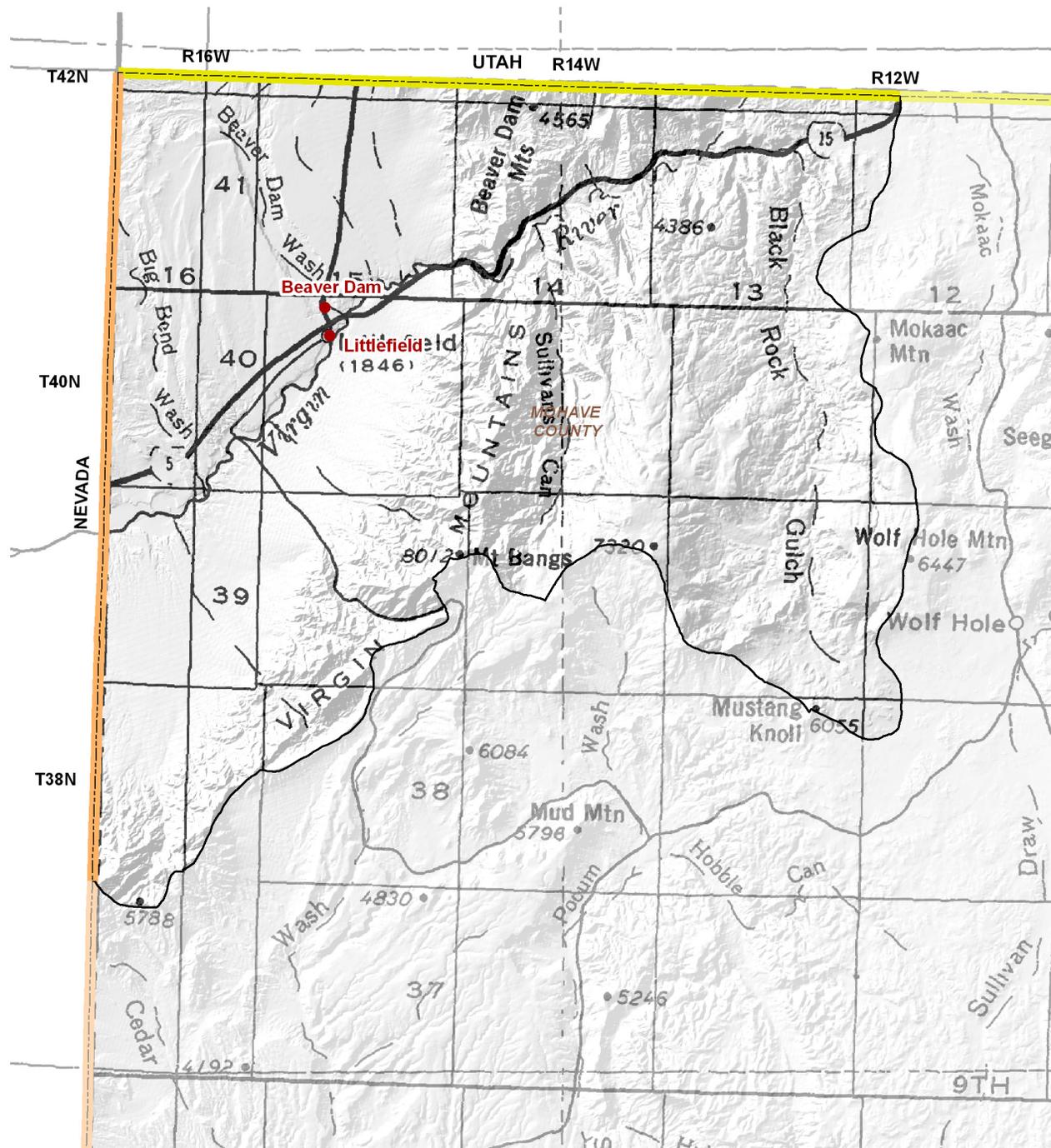
Virgin River Basin



6.6.1 Geography of the Virgin River Basin

The Virgin River Basin, located in the northwestern-most part of the planning area is 434 square miles in area. Geographic features and principal communities are shown on Figure 6.6-1. The basin is characterized by mountains and a broad valley west of the mountains. Vegetation is primarily Mohave desertscrub with smaller areas of Great Basin desertscrub, Great Basin conifer woodland, interior chaparral and a small area of Rocky Mountain and madrean montane conifer forest. (See Figure 6.0-11) Riparian vegetation along the Virgin River is predominantly tamarisk.

- Principal geographic features shown on Figure 6.6-1 are:
 - The Virgin River running from the northeast to southwest and the lowest point at 1,600 feet where the river exits the basin
 - Virgin and Beaver Dam Mountains in the center of the basin
 - Mt. Bangs on the southern basin boundary, the highest point in the basin at 8,012 feet



Base Map: USGS 1:500,000, 1981

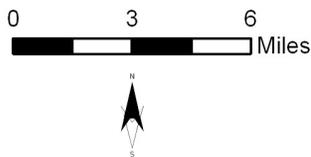


Figure 6.6-1
Virgin River Basin
Geographic Features

Nevada State Boundary
Utah State Boundary
City, Town or Place



6.6.2 Land Ownership in the Virgin River Basin

Land ownership, including the percentage of ownership by category, for the Virgin River Basin is shown in Figure 6.6-2. The principal feature of land ownership in this basin is the large portion of land managed by the U.S. Bureau of Land Management. A description of land ownership data sources and methods is found in Volume 1, Appendix A. More detailed information on protected areas is found in Section 6.0.4. Land ownership categories are discussed below in the order from largest to smallest percentage in the basin.

U.S. Bureau of Land Management (BLM)

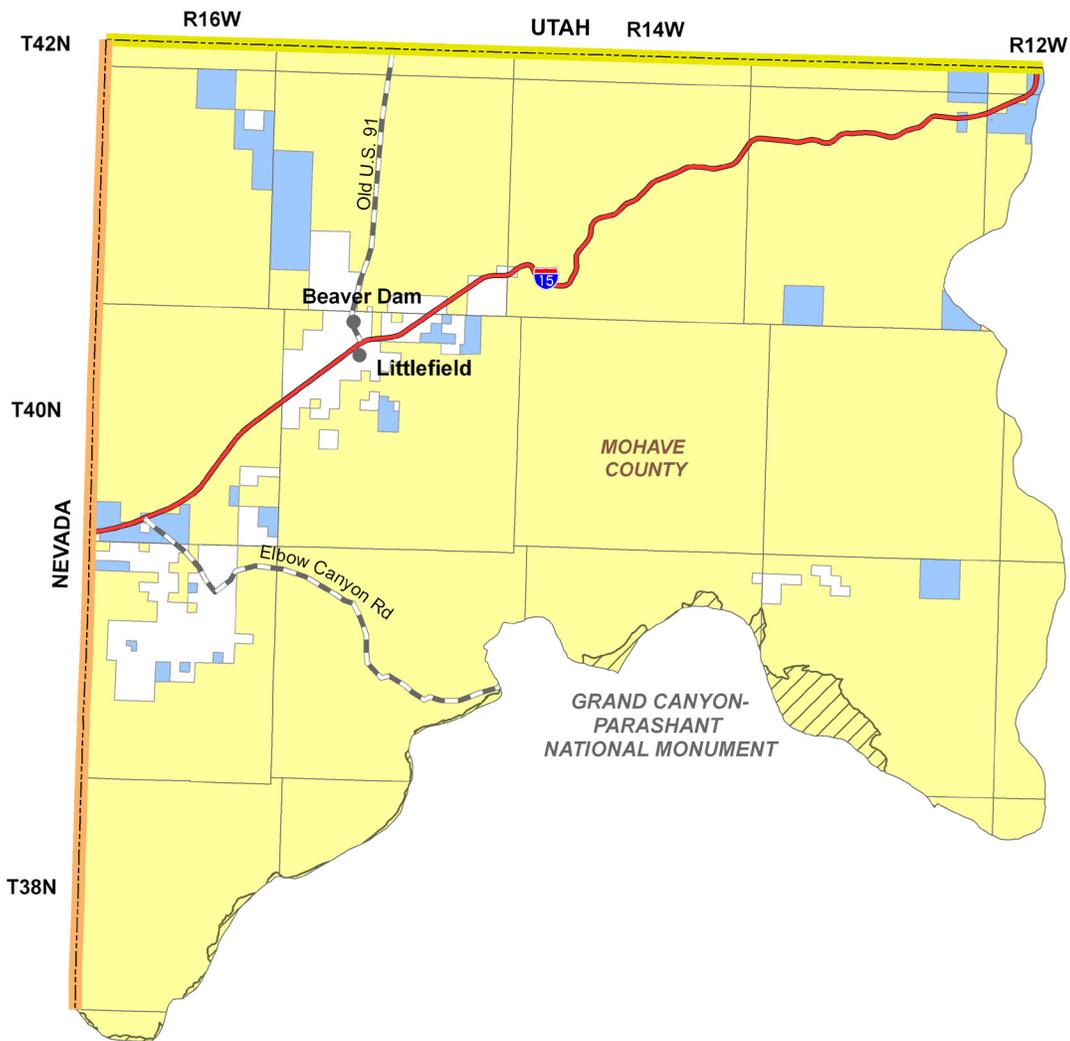
- 91.7% of the land is federally owned and managed by the Arizona Strip Field Office of the Bureau of Land Management.
- A small portion of BLM land is managed as the Grand Canyon-Parashant National Monument. The basin includes the 19,600 acre Beaver Dam Mountains Wilderness and a portion of the 87,900 acre Paiute Wilderness, located in the eastern portion of the basin. (see Figure 6.0-14)
- Primary land use is recreation, resource conservation and grazing.

Private

- 5.0% of the land is private.
- The majority of the private land is in the vicinity of Beaver Dam/Littlefield and west of Elbow Canyon Road in an area known as “Scenic.”
- Land uses include domestic, commercial and agriculture.

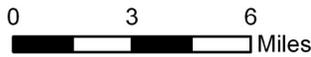
State Trust Land

- 3.3% of the land is held in trust for the public schools under the State Trust Land system.
- State land is located throughout the basin and is interspersed with BLM and private lands.
- Primary land use is grazing.



**Land Ownership
(Percentage in Basin)**

- U.S. Bureau of Land Management (91.7%) 
- Private (5.0%) 
- State Trust (3.3%) 
- National Monument 
- Nevada State Boundary 
- Utah State Boundary 
- Interstate Highway 
- Major Road 
- City, Town or Place 



**Figure 6.6-2
Virgin River Basin
Land Ownership**



Source: ALRIS, 2004
Bureau of Land management, 1999 & 2000

6.6.3 Climate of the Virgin River Basin

Climate data from NOAA/NWS Co-op Network stations are compiled in Table 6.6-1 and the locations are shown on Figure 6.6-3. Figure 6.6-3 also shows precipitation contour data from the Spatial Climate Analysis Service (SCAS) at Oregon State University. The Virgin River Basin does not contain Evaporation Pan, AZMET or SNOTEL/Snowcourse stations. More detailed information on climate in the planning area is found in Section 6.0.3. A description of the climate data sources and methods is found in Volume 1, Appendix A.

NOAA/NWS Co-op Network

- Refer to Table 6.6-1A
- Temperatures at the one NOAA/NWS Co-op Network station range from an average annual high of 89.5°F in July to an average annual low of 45.5°F in January.
- The highest average seasonal rainfall occurs in the winter season (January-March) when 40% of the annual rainfall occurs. Average annual rainfall is 7.59 inches.

SCAS Precipitation Data

- See Figure 6.6-3
- Additional precipitation data shows average annual rainfall as high as 16 inches in the southeastern portion of the basin and as low as four inches in the western portion of the basin.

Table 6.6-1 Climate Data for the Virgin River Basin

A. NOAA/NWS Co-op Network:

Station Name	Elevation (in feet)	Period of Record Used for Averages	Average Temperature Range (in F)		Average Precipitation (in inches)				
			Max/Month	Min/Month	Winter	Spring	Summer	Fall	Annual
Beaver Dam	1,880	1971-2000	89.5/Jul	45.5/Jan	3.05	0.89	1.68	1.97	7.59

Source: WRCC, 2005

B. Evaporation Pan:

Station Name	Elevation (in feet)	Period of Record Used for Averages	Avg. Annual Evap (in inches)
None			

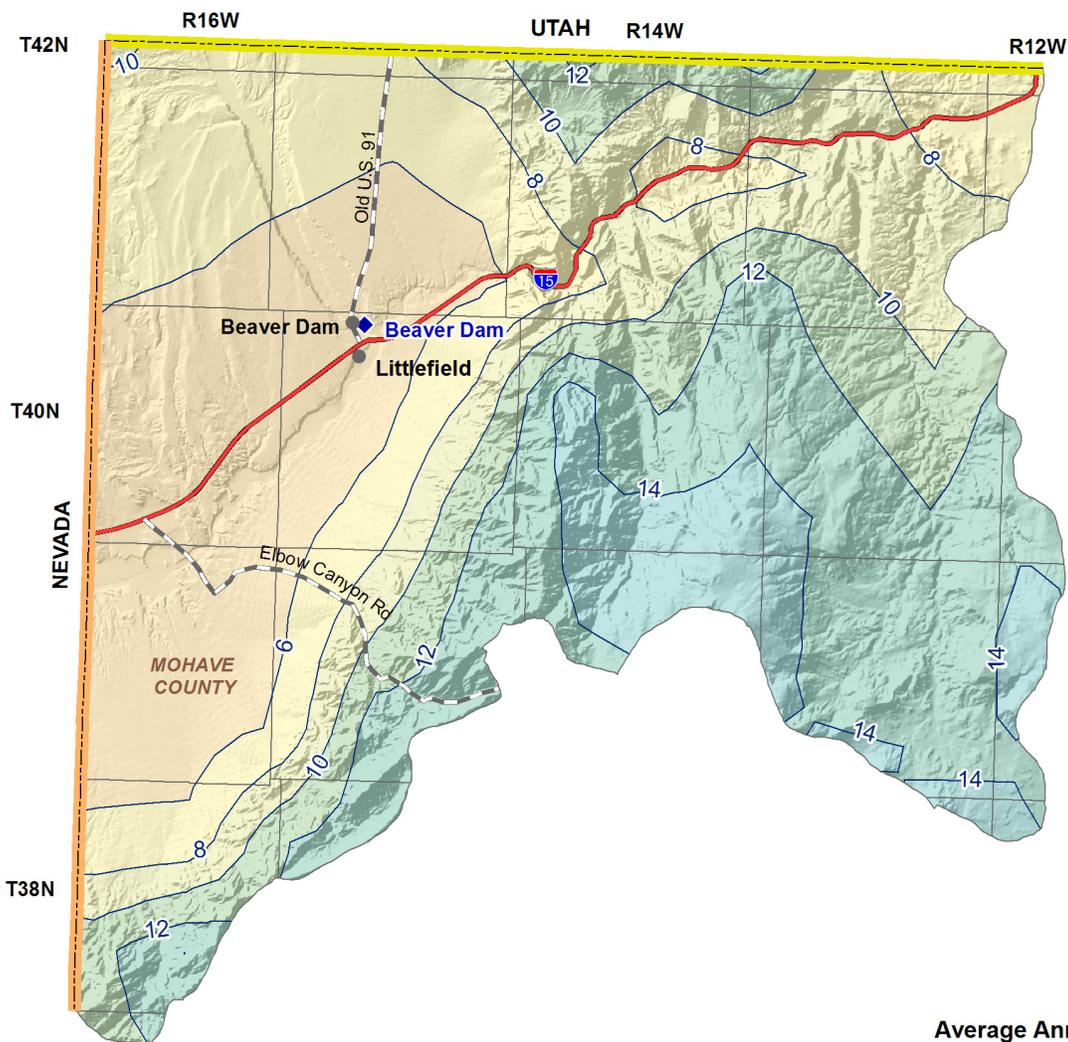
Source: WRCC, 2005

C. AZMET:

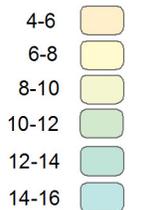
Station Name	Elevation (in feet)	Period of Record	Average Annual Reference Evapotranspiration, in inches (Number of years to calculate averages)
None			

D. SNOTEL/Snowcourse:

Station Name	Elevation (in feet)	Period of Record	Average Snowpack, at Beginning of the Month, as Inches Snow Water Content (Number of measurements to calculate average)					
			Jan.	Feb.	March	April	May	June
None								



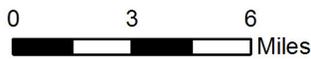
**Average Annual
Precipitation
(1961-1990)**
inches per year



Meteorological Stations

NOAA/NWS

- Precipitation Contour
- Nevada State Boundary
- Utah State Boundary
- Interstate Highway
- Major Road
- City, Town or Place



**Figure 6.6-3
Virgin River Basin
Meteorological Stations
and Annual Precipitation**



Precipitation Data Source: Oregon State University, 1998



6.6.4 Surface Water Conditions in the Virgin River Basin

Streamflow data, including average seasonal flow, average annual flow and other information are shown in Table 6.6-2. Flood ALERT equipment in the basin is shown in Table 6.6-3. Reservoir and stockpond data, including maximum storage or maximum surface area, are shown in Table 6.6-4. The location of streamflow gages identified by USGS number, flood ALERT equipment, USGS runoff contours and large reservoirs are shown on Figure 6.6-5. Descriptions of stream, reservoir and stockpond data sources and methods are found in Volume 1, Appendix A.

Streamflow Data

- Refer to Table 6.6-2.
- Data from three real-time stations located at two watercourses are shown in the table and on Figure 6.6-5.
- In general, average seasonal flow is highest in the winter (January-March).
- The maximum annual flow was 597,522 acre-feet in 2005 at the Virgin River at Littlefield station with a contributing drainage area of 5,090 square miles. This annual flow is not shown on Table 6.6-2 because the statistics are current as of December 2004.
- Figure 6.6-4 shows the periodic flood events in the Virgin River recorded at the Littlefield gage from 1930-2006.

Flood ALERT Equipment

- Refer to Table 6.6-3.
- As of October 2005 there was one station in the basin.

Reservoirs and Stockponds

- Refer to Table 6.6-4.
- There are no large reservoirs and one small reservoir with a total surface area of six acres.
- There are 45 registered stockponds in the basin.

Runoff Contour

- Refer to Figure 6.6-5.
- Average annual runoff is highest, 0.5 inches per year or 26.65 acre-feet per square mile, at the southeastern tip of the basin and decreases to 0.1 inches, or 5.33 acre-feet per square mile, to the north and west.

Figure 6.6-4 Annual Flows (acre-feet) Virgin River at Littlefield, Arizona, water years 1930-2006 (Station # 9415000)

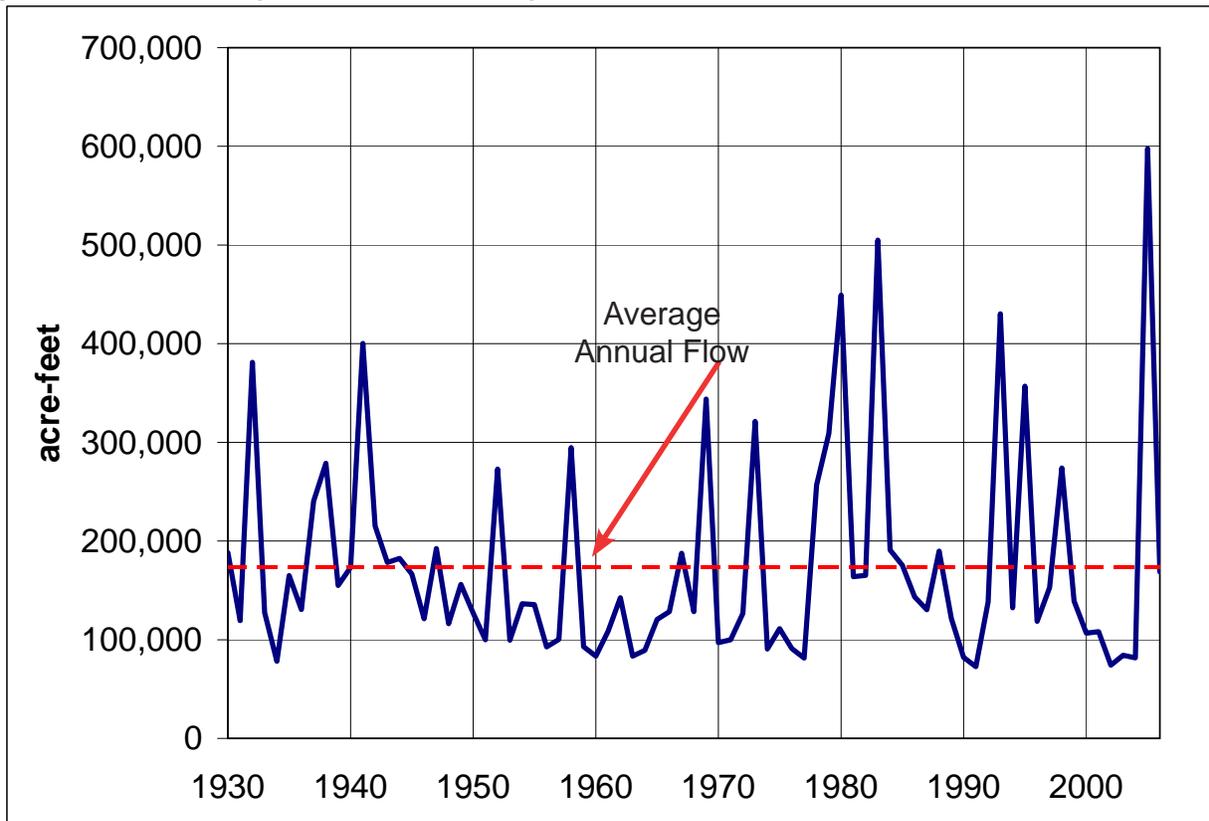


Table 6.6-2 Streamflow Data for the Virgin River Basin

Station Number	USGS Station Name	Drainage Area (in mi ²)	Gage Elevation (in feet)	Period of Record	Average Seasonal Flow (% of annual flow)				Annual Flow (in acre-feet/year)				Years of Annual Flow Record
					Winter	Spring	Summer	Fall	Minimum	Median	Mean	Maximum	
9413700	Virgin River above the Narrows near Littlefield	4,415	2,000	6/1998-current (real time)	31	21	19	29	68,506 (2000)	71,764	92,644	137,663 (2001)	3
9414900	Beaver Dam Wash at Beaver Dam	575	1,850	2/1993-current (real time)	42	21	17	20	1,151 (2002)	1,709	1,572	1,947 (1996)	5
9415000	Virgin River at Littlefield	5,090	1,764	10/1929-current (real time)	32	33	15	20	73,140 (1977)	141,935	174,502	506,912 (1983)	72

Source: USGS (NWIS) 2005 & 2008

Notes:

NA = Not available

Statistics based on Calendar Year

Annual Flow statistics based on monthly values

Summation of Average Annual Flows may not equal 100 due to rounding

Period of record may not equal Year of Record used for annual Flow/Year statistics due to only using years with a 12 month record

In Period of Record, current equals November 2008

Seasonal and annual flow data used for statistics current through 12/2004



Table 6.6-3 Flood ALERT Equipment in the Virgin River Basin

Station ID	Station Name	Station Type	Install Date	Responsibility
7570	Beaver Dam	Weather Station	NA	Mohave County FCD

Source: ADWR 2005c

Notes:

FCD = Flood Control District

NA = Not available at this time

Table 6.6-4 Reservoirs and Stockponds in the Virgin River Basin

A. Large Reservoirs (500 acre-feet capacity and greater)

MAP KEY	RESERVOIR/LAKE NAME (Name of dam, if different)	OWNER/OPERATOR	MAXIMUM STORAGE (AF)	USE	JURISDICTION
None identified by ADWR at this time					

B. Other Large Reservoirs (50 acre surface area or greater)

MAP KEY	RESERVOIR/LAKE NAME (Name of dam, if different)	OWNER/OPERATOR	MAXIMUM SURFACE AREA (acres)	USE	JURISDICTION
None identified by ADWR at this time					

Source: Compilation of databases from ADWR & others

C. Small Reservoirs (greater than 15 acre-feet and less than 500 acre-feet capacity)

Total number: 0

Total maximum storage: 0 acre-feet

D. Other Small Reservoirs (between 5 and 50 acres surface area)¹

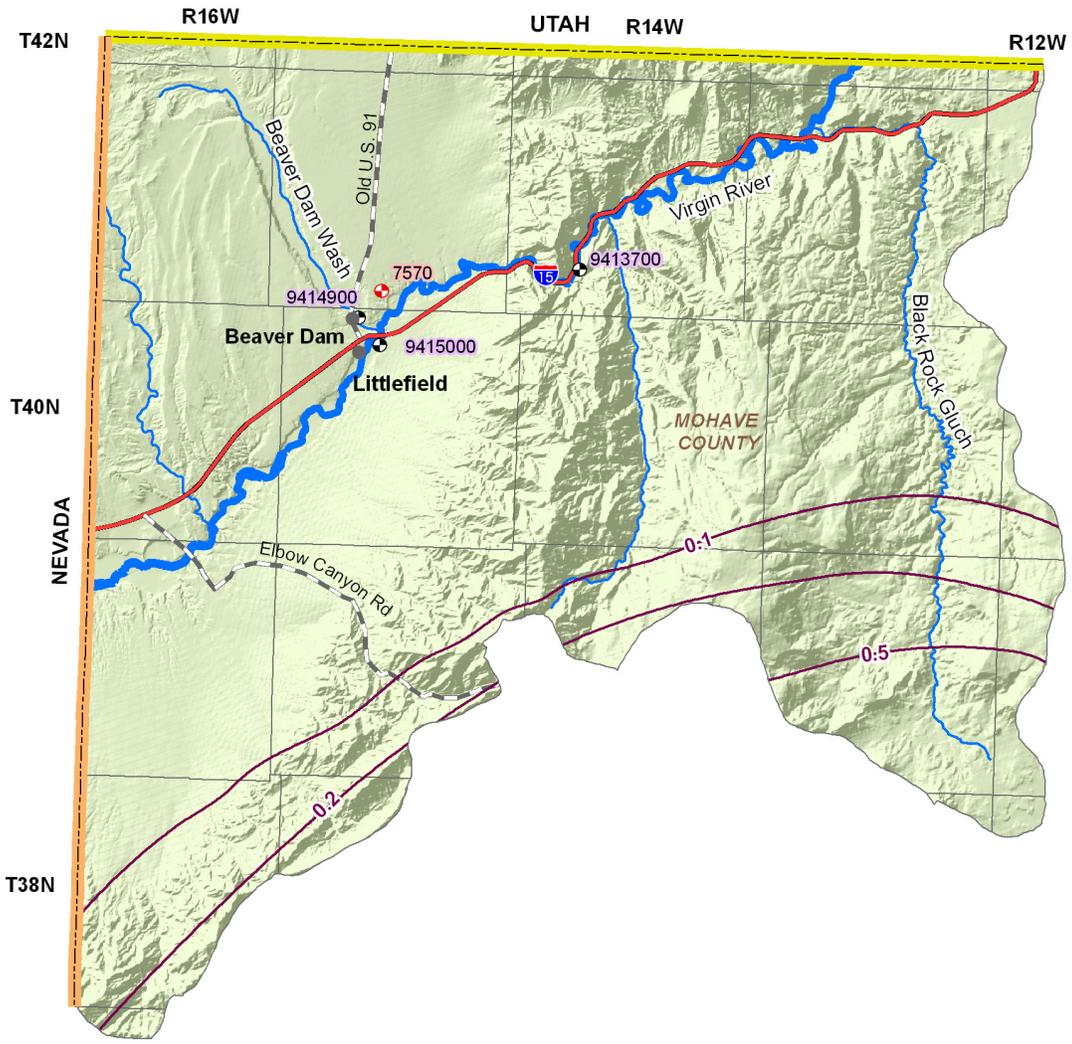
Total number: 1

Total surface area: 6 acres

E. Stockponds (up to 15 acre-feet capacity)

Total number: 45

¹ Capacity data not available to ADWR



Stream Data Source: ALRIS, 2005

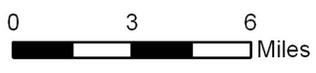


Figure 6.6-5
Virgin River Basin
Surface Water Conditions

- USGS Annual Runoff Contour for 1951-1980 (in inches)
- Stream Channel (width of line reflects stream order)
- USGS Gage and Station ID
- Flood ALERT Equip. & Station ID
- Nevada State Boundary
- Utah State Boundary
- Interstate Highway
- Major Road
- City, Town or Place

6.6.5 Perennial/Intermittent Streams and Major Springs in the Virgin River Basin

Major springs with discharge rates and date of measurement and the total number of springs in the basin are shown in Table 6.6-5. The locations of major springs and perennial streams are shown on Figure 6.6-6. Descriptions of data sources and methods for intermittent and perennial reaches and springs are found in Volume 1, Appendix A.

- There are no intermittent streams. Perennial streams are the Virgin River and a short reach of Beaver Dam Wash.
- There are eight springs along a seven mile reach of the Virgin River near the Narrows. The total discharge for these springs is between 8,980 gpm and 22,400 gpm.
- The total number of springs, regardless of discharge, identified by the USGS varies from 23 to 25, depending on the database reference.

Table 6.6-5 Springs in the Virgin River Basin

A. Major Springs (10 gpm or greater):

Map Key	Name	Location		Discharge (in gpm) ¹	Date Discharge Measured
		Latitude	Longitude		
1	Littlefield (multiple)	365539	1134950	8,980 - 22,400 ²	During or prior to 2000
2	Beaver Dam Wash (multiple)	365411	1135615	1,120 ³	During or prior to 1997

B. Minor Springs (1 to 10 gpm):

Name	Location		Discharge (in gpm)	Date Discharge Measured
	Latitude	Longitude		
None identified by ADWR at this time				

Source: Compilation of databases from ADWR & others

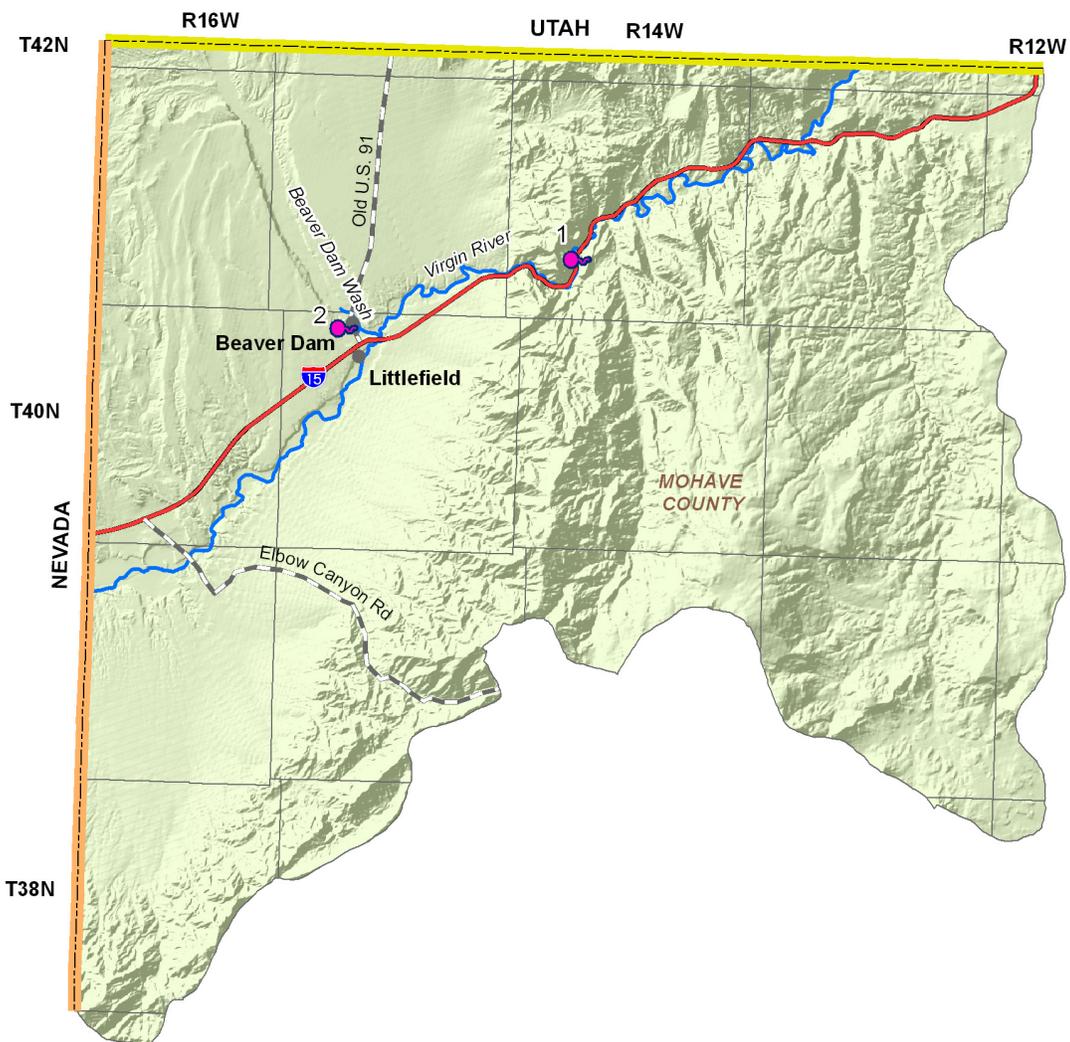
C. Total number of springs, regardless of discharge, identified by USGS (see ALRIS, 2005a and USGS, 2006): 23 to 25

Notes:

¹ Most recent measurement identified by ADWR

² Discharge of 8 springs in a 7 mile reach from the Narrows to the Littlefield gage

³ Estimation of discharge along Beaver Dam Wash above Littlefield gage



Stream Data Source: AGFD, 1993 & 1997

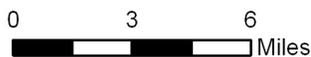


Figure 6.6-6
Virgin River Basin
Perennial/Intermittent Streams
and Major (>10 gpm) Springs

- Spring
- Perennial Stream
- Nevada State Boundary
- Utah State Boundary
- Interstate Highway
- Major Road
- City, Town or Place



6.6.6 Groundwater Conditions of the Virgin River Basin

Major aquifers, well yields, estimated natural recharge, estimated water in storage, number of index wells and date of last water-level sweep are shown in Table 6.6-6. Figure 6.6-7 shows aquifer flow direction and water-level change between 1990-1991 and 2003-2004. Figure 6.6-8 contains hydrographs for selected wells shown on Figure 6.6-7. Figure 6.6-9 shows well yields in five yield categories. A description of aquifer data sources and methods as well as well data sources and methods, including water-level changes and well yields are found in Volume 1, Appendix A.

Major Aquifers

- Refer to Table 6.6-6 and Figure 6.6-7.
- Major aquifers in the basin include basin fill and sedimentary rock (Muddy Creek Formation).
- Flow direction is generally toward the west following Beaver Dam Wash and the Virgin River drainages.

Well Yields

- Refer to Table 6.6-6 and Figure 6.6-9.
- As shown on Figure 6.6-9, well yields in this basin range from less than 100 gallons per minute (gpm) to greater than 2,000 gpm.
- One source of well yield information, based on 53 reported wells, indicates that the median well yield in this basin is 650 gpm.

Natural Recharge

- Refer to Table 6.6-6.
- The natural recharge estimate for this basin is greater than 30,000 acre-feet per year (AFA).

Water in Storage

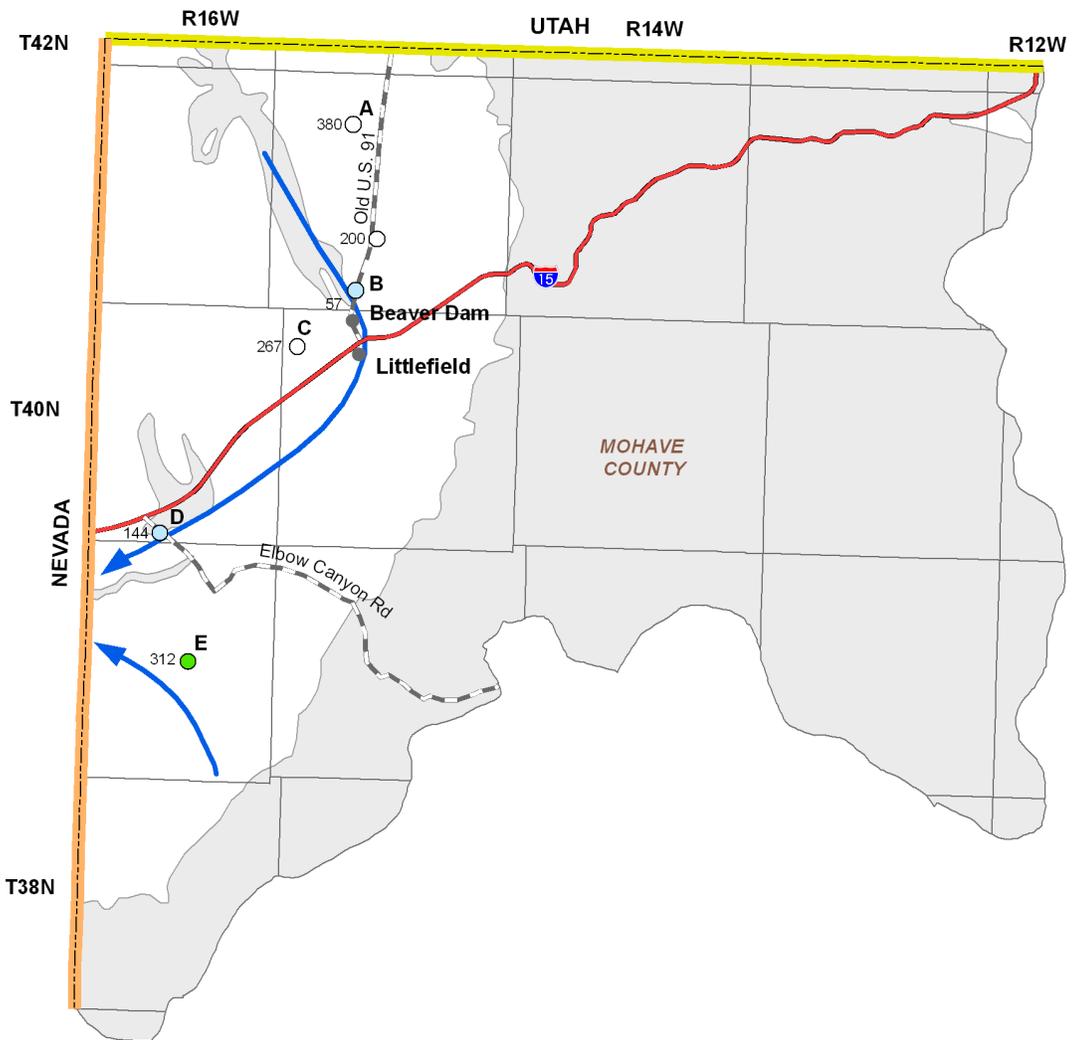
- Refer to Table 6.6-6.
- The storage estimate for this basin is 1.7 million acre-feet (maf) of water in storage to a depth of 1,200 feet.

Water Level

- Refer to Figure 6.6-7. Water levels are shown for wells measured in 2003-2004.
- The Department annually measures six index wells in this basin. Hydrographs for four of these wells and one other well are shown in Figure 6.6-8. Index well hydrographs are: A, B, D and E.
- There is one ADWR automated groundwater level monitoring device located near Littlefield.
- The deepest recorded water level in the basin is 380 feet in the northern portion of the basin and the shallowest is 57 feet north of Beaver Dam.

Table 6.6-6 Groundwater Data for the Virgin River Basin

Basin Area, in square miles:	434	
Major Aquifer(s):	Name and/or Geologic Units	
	Basin Fill	
	Sedimentary Rock (Muddy Creek Formation)	
Well Yields, in gal/min:	Range 3-5,500 Median 650 (53 wells reported)	Reported on registration forms for large (>10-inch) diameter wells (Wells55)
	Range 0-2,000	ADWR (1990 and 1994b)
	Range 0-2,500	Anning and Duet (1994)
Estimated Natural Recharge, in acre-feet/year:	>30,000	Virgin Valley Water District (2005)
Estimated Water Currently in Storage, in acre-feet:	1,700,000 (to 1,200 ft)	ADWR (1994b)
Current Number of Index Wells:	6	
Date of Last Water-level Sweep:	1991 (65 wells measured)	



Water-level change in feet between 1990-1991 and 2003-2004

H = number is depth to water in feet during 2003-2004; letter is hydrograph

Between -1 and +1

Between +1 and +15

Change Data Not Available

Generalized Flow Direction

Consolidated Crystalline & Sedimentary Rocks

Unconsolidated Sediments

Nevada State Boundary

Utah State Boundary

Interstate Highway

Major Road

City, Town or Place

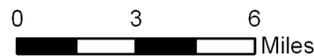
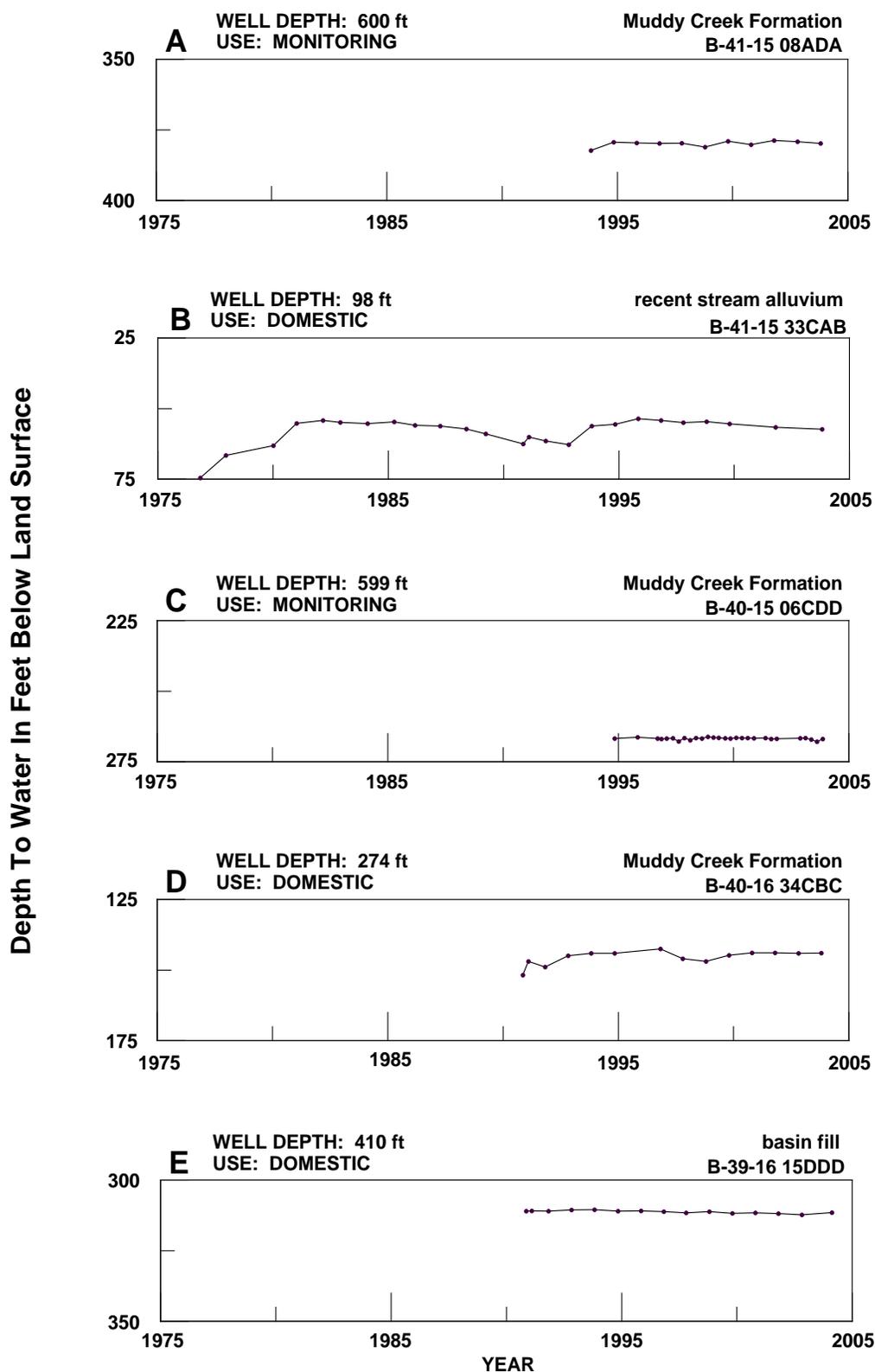
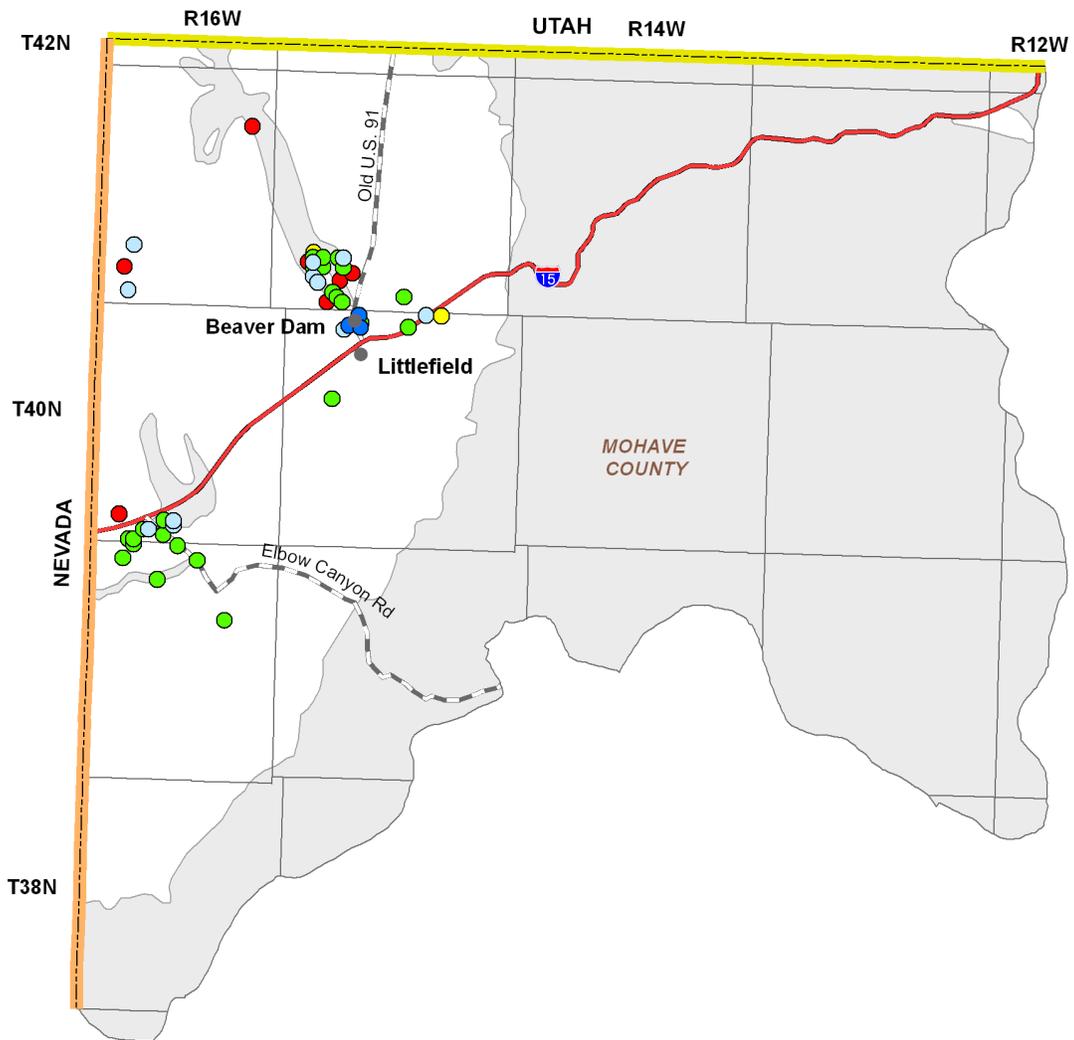


Figure 6.6-7
Virgin River Basin
Groundwater Conditions



Figure 6.6-8
Virgin River Basin
Hydrographs Showing Depth to Water in Selected Wells





Well Yields

- Greater than 2000 gals/min ●
- Between 1000 and 2000 gals/min ●
- Between 500 and 1000 gals/min ●
- Between 100 and 500 gals/min ●
- Less than 100 gals/min ●
- Consolidated Crystalline & Sedimentary Rocks
- Unconsolidated Sediments
- Nevada State Boundary —
- Utah State Boundary —
- Interstate Highway —
- Major Road —
- City, Town or Place ●

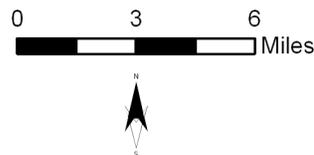


Figure 6.6-9
Virgin River Basin
Well Yields



6.6.7 Water Quality of the Virgin River Basin

Wells, springs and mine sites with parameter concentrations that have equaled or exceeded drinking water standard(s), including location and parameter(s) are shown in Table 6.6-7A. Impaired lakes and streams with site type, name, length of impaired reach, area of impaired lake, designated use standard and parameter(s) exceeded is shown in Table 6.6-7B. Figure 6.6-10 shows the location of water quality occurrences keyed to Table 6.6-7. All community water systems are regulated under the Safe Drinking Water Act and treat water supplies to meet drinking water standards. Not all parameters were measured at all sites; selective sampling for particular constituents is common. A description of water quality data sources and methods is found in Volume 1, Appendix A.

Well, Mine or Spring sites that have equaled or exceeded drinking water standards (DWS)

- Refer to Table 6.6-7A.
- Thirteen wells have parameter concentrations that have equaled or exceeded drinking water standards.
- The most common standard equaled or exceeded was arsenic. Other standards equaled or exceeded were radionuclides, nitrates and lead.

Lakes and Streams with impaired waters

- Refer to Table 6.6-7B.
- Water quality standards for suspended sediment concentration and selenium were exceeded in one 10-mile stream reach, the Virgin River from Beaver Dam Wash to Big Bend Wash.
- This reach is not part of the ADEQ water quality improvement effort called the Total Maximum Daily Load (TMDL) Program at this time.

Table 6.6-7 Water Quality Exceedences in the Virgin River Basin¹

A. Wells, Springs and Mines

Map Key	Site Type	Site Location			Parameter(s) Concentration has Equaled or Exceeded Drinking Water Standard (DWS) ²
		Township	Range	Section	
1	Well	41 North	15 West	32	As
2	Well	41 North	15 West	32	As
3	Well	40 North	15 West	3	As, Rad
4	Well	40 North	15 West	3	As
5	Well	40 North	15 West	3	As
6	Well	40 North	15 West	4	As
7	Well	40 North	15 West	5	As
8	Well	40 North	15 West	5	As
9	Well	40 North	16 West	33	NO3
10	Well	39 North	16 West	3	Pb
11	Well	39 North	16 West	11	As
12	Well	39 North	16 West	11	As
13	Well	39 North	16 West	15	As

Source: Compilation of databases from ADWR & others

B. Lakes and Streams

Map Key	Site Type	Site Name	Length of Impaired Stream Reach (in miles)	Area of Impaired Lake (in acres)	Designated Use Standard ³	Parameter(s) Exceeding Use Standard ²
a	Stream	Virgin River (Beaver Dam Wash to Big Bend Wash)	10	NA	A&W	Se, Suspended sediment concentration

Source: ADEQ 2005d

Notes:

NA = Not Applicable

¹ Water quality samples collected between 1997 and 2002.

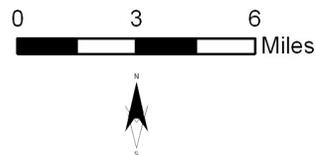
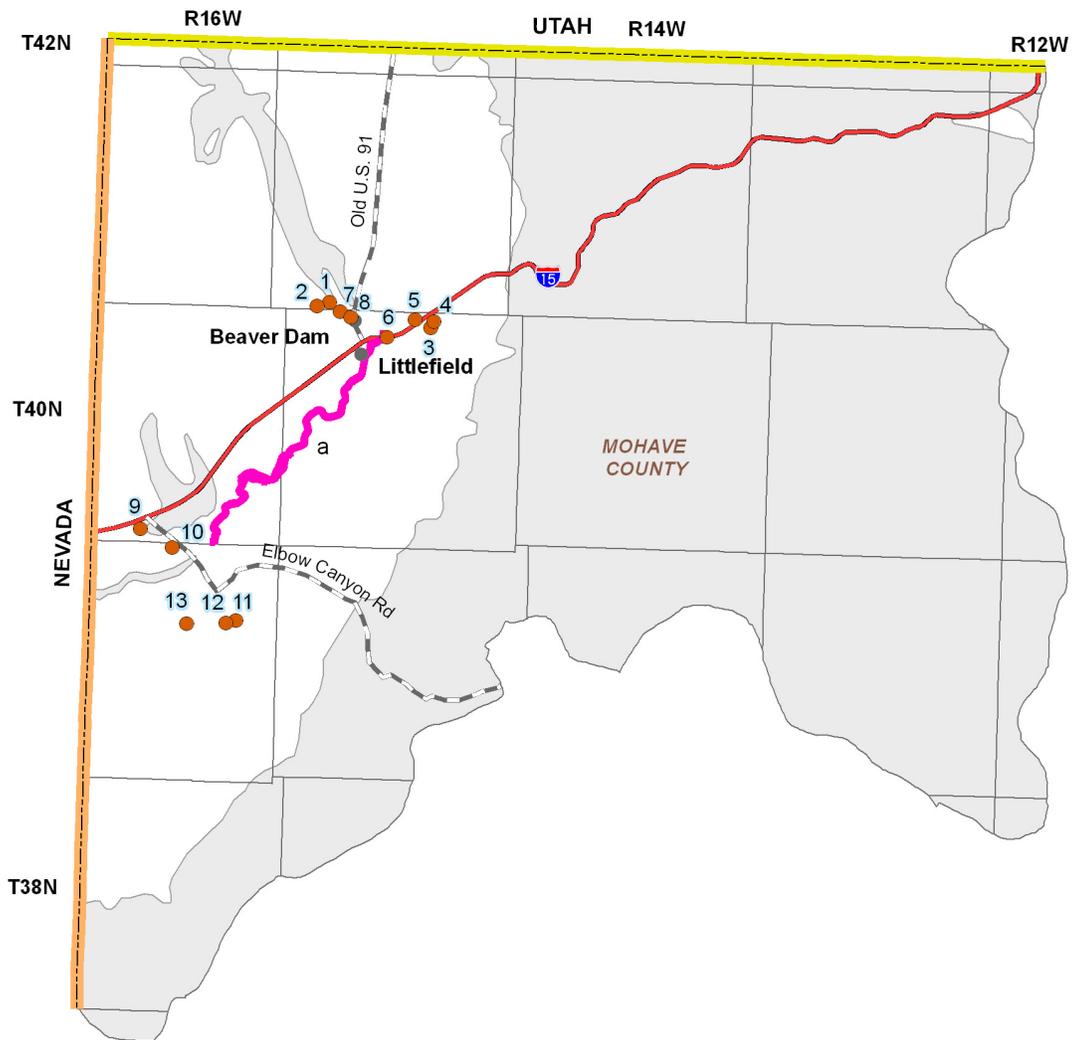
² As = Arsenic

NO3 = Nitrate

Rad = One or more of the following radionuclides - Gross Alpha, Gross Beta, Radium, and Uranium

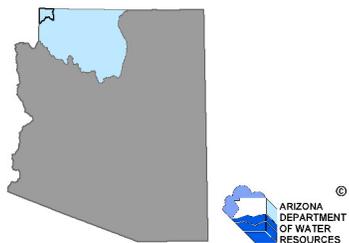
Se = Selenium

³ A&W = Aquatic and Wildlife



- Well, Spring or Mine Site that has Equaled or Exceeded DWS ● 1
- Impaired Stream or Lake ~ a
- Consolidated Crystalline & Sedimentary Rocks
- Unconsolidated Sediments
- Nevada State Boundary
- Utah State Boundary
- Interstate Highway I-15
- Major Road
- City, Town or Place ●

Figure 6.6-10
Virgin River Basin
Water Quality Conditions



6.6.8 Cultural Water Demand in the Virgin River Basin

Cultural water demand data including population, number of wells and the average well pumpage and surface water diversions by the municipal, industrial and agricultural sectors are shown in Table 6.6-8. Effluent generation including facility ownership, location, population served and not served, volume treated, disposal method and treatment level is shown in Table 6.6-9. Figure 6.6-11 shows the location of demand centers. A description of cultural water demand data sources and methods is found in Volume 1, Appendix A. More detailed information on cultural water demand is found in Section 6.0.7.

Cultural Water Demand

- Refer to Table 6.6-8 and Figure 6.6-11.
- Population in this basin increased from 99 in 1980 to 1,532 in 2000 and is projected to reach 3,267 by 2030.
- Groundwater demand increased from 5,000 AFA on average in 1971-1975 to approximately 9,150 AFA on average from 1996-2000. In 2001-2005 groundwater demand was 2,950 AFA on average.
- Surface water demand was 3,000 AFA on average from 1971-1990 and increased to approximately 6,350 acre-feet in 1996-2000. In 2001-2005 surface water use was approximately 1,650 AFA on average due to declining agricultural demand.
- Most basin demand for both surface water and groundwater is for irrigation. Agricultural demand centers are found in the vicinity of Beaver Dam/Littlefield and Elbow Canyon Road. Flooding in January 2005 destroyed some of the agricultural fields in this basin.
- All recorded industrial demand in the basin is for two golf courses.
- There are two sand and gravel operations in the vicinity of Scenic and Beaver Dam, their water demand was not available.
- As of 2005 there were 248 registered wells with a pumping capacity of less than or equal to 35 gallons per minute (gpm) and 136 wells with a pumping capacity of more than 35 gpm.

Effluent Generation

- Refer to Table 6.6-9.
- There are four wastewater treatment facilities in this basin, but information on population served, effluent generation and disposal method is available only for the Beaver Dam Sewer Company Wastewater Treatment Plant. This plant serves 119 people, generates 6.2 acre-feet of effluent and discharges to a watercourse.

Table 6.6-8 Cultural Water Demand in the Virgin River Basin¹

Year	Estimated and Projected Population	Number of Registered Water Supply Wells Drilled		Average Annual Demand (in acre-feet)						Data Source
				Well Pumpage			Surface-Water Diversions			
		Q ≤ 35 gpm	Q > 35 gpm	Municipal	Industrial	Agricultural	Municipal	Industrial	Agricultural	
1971		21 ²	37 ²	5,000			3,000			ADWR (1994a)
1972										
1973										
1974										
1975										
1976										
1977										
1978		6,000			3,000					
1979										
1980	99									
1981	109									
1982	119	11	16	6,000			3,000			
1983	129									
1984	139									
1985	150									
1986	160									
1987	170	43	32	7,000			3,000			
1988	180									
1989	190									
1990	200									
1991	333									
1992	466	71	22	<300	700	7,800	NR	<300	5,800	USGS (2007) ADWR (2008b) ADWR (2005a)
1993	600									
1994	733									
1995	866									
1996	999									
1997	1,133	37	15	<300	700	8,300	NR	<300	6,200	
1998	1,266									
1999	1,399									
2000	1,532									
2001	1,598									
2002	1,664	65	14	<300	700	2,100	NR	<300	1,500	
2003	1,729									
2004	1,795									
2005	1,860									
2010	2,188									
2020	2,783									
2030	3,267									
WELL TOTALS:		268	136							

¹ Does not include effluent of evaporation losses from stockponds and reservoirs.

² Includes all wells through 1980.

NR - Not reported

Table 6.6-9 Effluent Generation in the Virgin River Basin

Facility Name	Ownership	City/Location Served	Population Served	Volume Treated/Generated (acre-feet/year)	Disposal Method									Current Treatment Level	Population Not Served	Year of Record	
					Water-course	Evaporation Pond	Irrigation	Golf Course/Turf/Landscape	Municipal Reuse	Wildlife Area	Discharged to Another Facility	Infiltration Basins	Other				
Beaver Dam Sewer Co. WWTP	Virgin River ID	Beaver Dam	119	6.2	X										Secondary	NA	2002
Biasi WWTP	Private	Beaver Dam															
Shadow Ridge WWTP	NA	Littlefield															
Virgin Acres WWTP	NA	Beaver Dam															

Source: Compilation of databases from ADWR & others

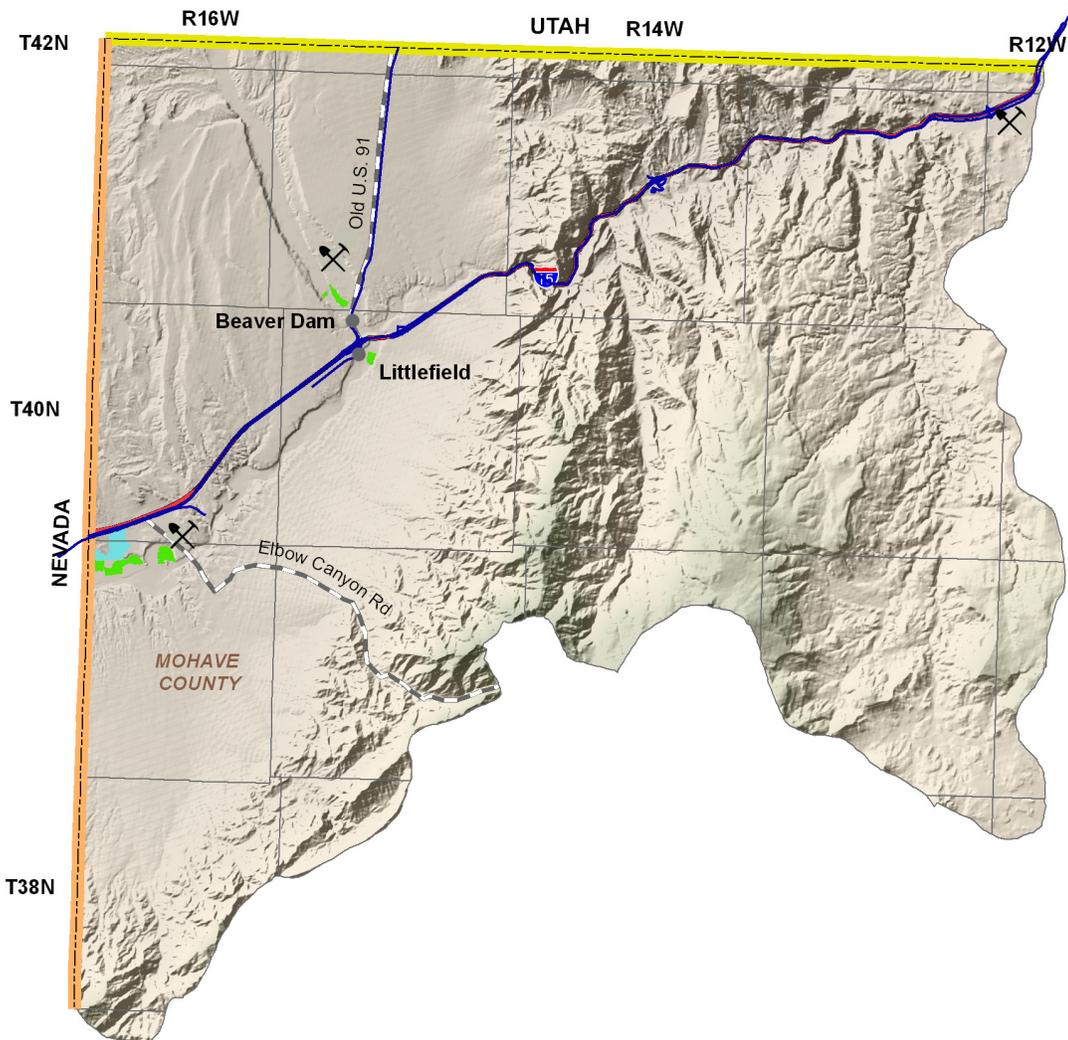
Notes:

Year of Record is for the volume of effluent treated/generated

NA: Data not currently available to ADWR

WWTP: Waste Water Treatment Plant

ID: Improvement District



Primary Data Source: USGS National Gap Analysis Program, 2004; ADWR, 2007

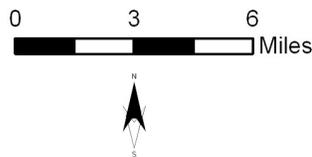


Figure 6.6-11
Virgin River Basin
Cultural Water Demand

- Demand Centers**
- Agriculture 
 - M&I - Low Intensity 
 - Small Mine\Quarry 
 - Nevada State Boundary 
 - Utah State Boundary 
 - Interstate Highway 
 - Major Road 
 - City, Town or Place 

6.6.9 Water Adequacy Determinations in the Virgin River Basin

Water adequacy determination information including the subdivision name, location, number of lots, adequacy determination, reason for the inadequacy determination, date of determination and subdivision water provider are shown in Table 6.6-10A and B for water reports and analysis of adequate water supply. Figure 6.6-12 shows the locations of subdivisions keyed to the Table. A description of the Water Adequacy Program is found in Volume 1, Appendix C. Adequacy determination data sources and methods are found in Volume 1, Appendix A.

- All subdivisions receiving an adequacy determination are in Mohave County. Fifteen water adequacy determinations for 1,643 lots have been made in this basin through December, 2008. One thousand six hundred and seventeen lots in 14 subdivisions, or 99% of lots, were determined to be adequate.
- The one determination of inadequacy was because the applicant chose not to submit the necessary information, and/or the available hydrologic data was insufficient to make a determination.
- There are two Analysis of Adequate Water Supply applications for a total of 27,700 lots.

Table 6.6-10. Adequacy Determinations in the Virgin River Basin¹

A. Water Adequacy Reports

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	ADWR Adequacy Determination	Reason(s) for Inadequacy Determination ³	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section						
1	Beaver Dam Estates	Mohave	41 North	15 West	5	48	53-500309	Adequate		5/6/1992	Beaver Dam East Domestic W.I.D.
2	Beaver Dam Oasis	Mohave	41 North	15 West	33	9	53-500310	Adequate		1/23/1992	Dry Lot Subdivision
4	Beaver Dam Resort, Inc.	Mohave	40 North	15 West	4, 5	191	53-500311	Adequate		10/1/1987	Beaver Dam Water Company
5	Beaver Dam Virgin Acres #1	Mohave	41 North	15 West	32	51	53-300115	Adequate		7/10/1996	Beaver Dam Water Company
6	Desert Springs Ranchos	Mohave	40 North	15 West	3	21	53-500585	Adequate		1/13/1994	Dry Lot Subdivision
7	Fairview Mobile Home Estates	Mohave	40 North	16 West	32	26	53-500629	Inadequate	A1	11/30/1987	Beaver Dam Water Company
9	Shadow Ridge	Mohave	39 North	16 West	17, 21	478	53-700568	Adequate		12/4/2008	Beaver Dam Water Company
10	Shadow Ridge, Phase 1	Mohave	39 North	16 West	21	67	53-402211	Adequate		12/6/2006	Beaver Dam Water Company
11	Terra Vista Skies	Mohave	40 North	16 West	32	30	53-400852	Adequate		7/21/2006	Beaver Dam Water Company
12	Virgin Acres - B	Mohave	41 North	15 West	32	40	53-300568	Adequate		12/4/1998	Beaver Dam Water Company
13	Virgin Acres	Mohave	41 North	15 West	29, 32	320	53-501641	Adequate		9/25/1995	Biasi Water Company, Inc.
14	Virgin Acres	Mohave	41 North	15 West	32	65	53-300485	Adequate		7/24/1998	Beaver Dam Water Company
15	Virgin Acres, aka Biasi Ranch Estates	Mohave	41 North	15 West	29	19	53-401814	Adequate		9/8/2005	Biasi Water Company, Inc.
16	Virgin Village I & II	Mohave	41 North	15 West	32	93	53-300507	Adequate		10/7/1998	Biasi Water Company, Inc.
17	Vista Verde	Mohave	40 North	16 West	33	185	53-500057	Adequate		3/10/2008	Beaver Dam Water Company

B. Analysis of Adequate Water Supply

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section				
3	Beaver Dam Ranch	Mohave	40 North	15 West	5, 6, 7, 8, 17, 18	23,420	43-500093	7/9/2008	Beaver Dam Water Company
8	Michael T. Black Properties	Mohave	39 North	16 West	11, 14	4,280	43-700506	7/9/2008	Virgin Mountain Utilities

Source: ADWR 2008a

Notes:

¹Each determination of the adequacy of water supplies available to a subdivision is based on the information available to ADWR and the standards of review and policies in effect at the time the determination was made. In some cases, ADWR might make a different determination if a similar application were submitted today, based on the hydrologic data and other information currently available, as well as current rules and policies.

² Prior to February 1995, ADWR did not assign file numbers to applications for adequacy. Between 1995-2006 all applications for adequacy were given a file number with a 22 prefix. In 2006 a 53 prefix was assigned to all water adequacy reports and applications regardless of their issue date.

³ A. Physical/Continuous

- 1) Insufficient Data (applicant chose not to submit necessary information, and/or available hydrologic data insufficient to make determination)
- 2) Insufficient Supply (existing water supply unreliable or physically unavailable; for groundwater, depth-to-water exceeds criteria)
- 3) Insufficient Infrastructure (distribution system is insufficient to meet demands or applicant proposed water hauling)

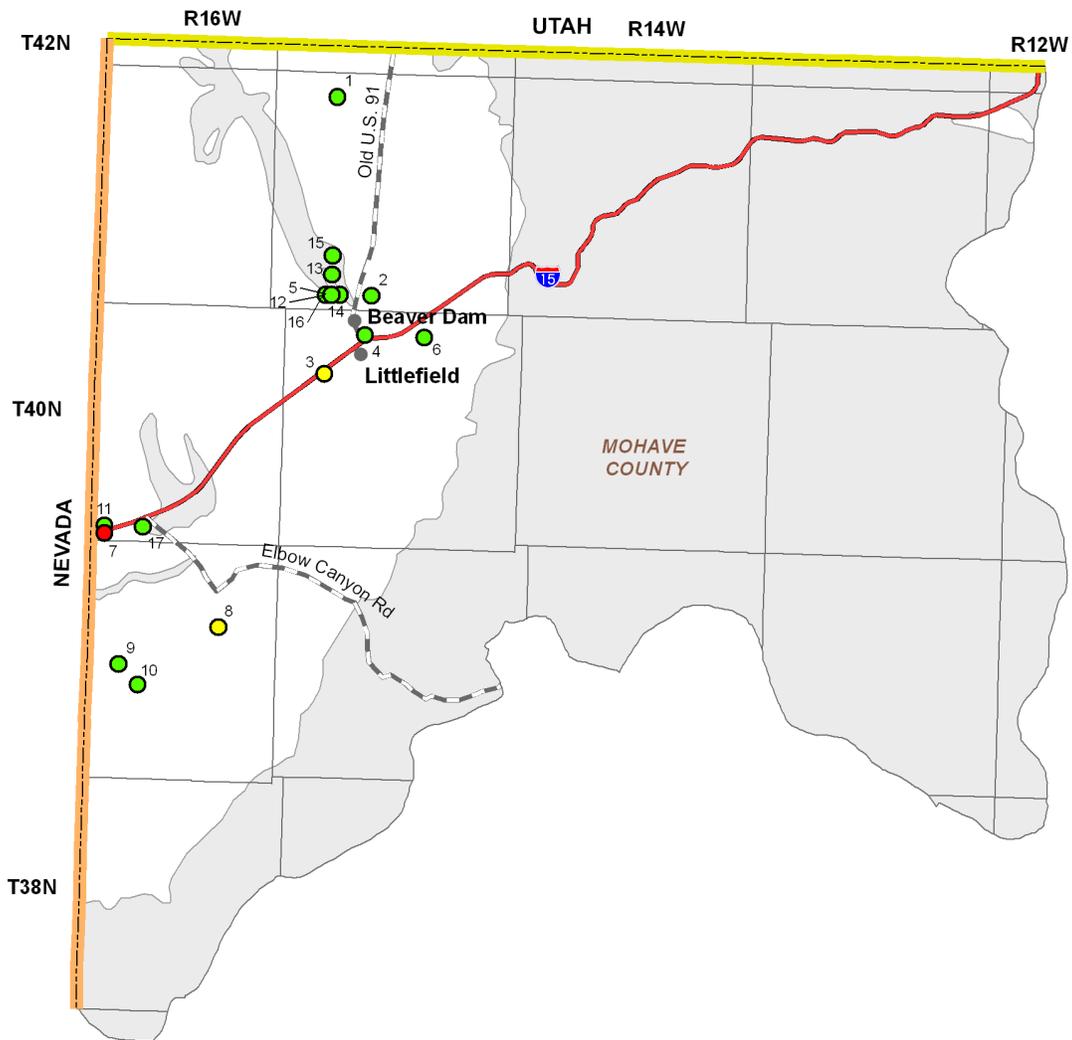
B. Legal (applicant failed to demonstrate a legal right to use the water or failed to demonstrate the provider's legal authority to serve the subdivision)

C. Water Quality

D. Unable to locate records

NA = Not available to ADWR at this time





Adequacy Determinations

Adequate



Inadequate



Analysis of Adequate Water Supply



Consolidated Crystalline & Sedimentary Rocks



Unconsolidated Sediments



Nevada State Boundary



Utah State Boundary



Interstate Highway



Major Road



City, Town or Place

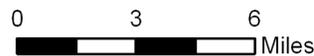


Figure 6.6-12
Virgin River Basin
Adequacy Determinations



Virgin River Basin

References and Supplemental Reading

References

A

- Anning, D.W. and N.R. Duet, 1994, Summary of ground-water conditions in Arizona, 1987-90, USGS Open-file Report 94-476.
- Arizona Department of Economic Security (DES), 2005, Workforce Informer: Data file, accessed August 2005, <http://www.workforce.az.gov>. (Cultural Water Demand Table)
- Arizona Department of Environmental Quality, 2005a, ADEQSWI: Data file, received September 2005. (Effluent Generation Table)
- _____, 2005b, ADEQWWTP: Data file, received August 2005. (Effluent Generation Table)
- _____, 2005c, Azurite: Data file, received September 2005. (Effluent Generation Table)
- _____, 2005d, Impaired lakes and reaches: GIS cover, received January 2006.
- _____, 2005e, WWTP and permit files: Miscellaneous working files, received July 2005. (Effluent Generation Table)
- _____, 2004, Water quality exceedences for drinking water providers in Arizona: Data file, received September 2004. (Water Quality Map/Table)
- Arizona Department of Water Resources (ADWR), 2008a, Assured and adequate water supply applications: Project files, ADWR Hydrology Division.
- _____, 2008b, Industrial demand outside of the Active Management Areas 1991-2007: Unpublished analysis by ADWR Office of Resource Assessment Planning.
- _____, 2005a, Agricultural Surface Water Use Estimates: Unpublished analysis, ADWR Office of Resource Assessment Planning.
- _____, 2005b, Automated recorder sites: Data files, ADWR Basic Data Unit.
- _____, 2005c, Flood warning gages: Database, ADWR Office of Water Engineering.
- _____, 2005d, Groundwater Site Inventory (GWSI): Database, ADWR Hydrology Division. (Groundwater Conditions Table)
- _____, 2005e, Registry of surface water rights: ADWR Office of Water Management. (Reservoirs and Stockponds Table)
- _____, 2005f, Wells55: Database. (Groundwater Conditions Table)
- _____, 1994a, Arizona Water Resources Assessment, Vol. I, Inventory and Analysis.
- _____, 1994b, Arizona Water Resources Assessment, Vol. II, Hydrologic Summary.
- _____, 1990, Draft outline of basin profiles for the state water assessment: ADWR Statewide Planning Division, Memorandum to L. Linser, D.W., January, 16, 1990.
- Arizona Game and Fish Department (AGFD), 1997 & 1993, Statewide riparian inventory and mapping project: GIS cover.
- Arizona Land Resource Information System (ALRIS), 2005a, Springs: GIS cover, accessed January 2006 at <http://www.land.state.az.us/alris/index.html>.
- _____, 2005b, Streams: GIS cover, accessed 2005 at <http://www.land.state.az.us/alris/index.html>.
- _____, 2004, Land ownership: GIS cover, accessed in 2004 at <http://www.land.state.az.us/alris/index.html>.

B

- Bales, J.T. and R.L. Laney, 1992: Geohydrological reconnaissance of the Lake Mead NRA-Virgin River, Nevada to Grand Wash Cliffs, Arizona: USGS Water Resources Investigations Report 91-4158, 29 p. (Water Quality Map/Table)
- Bureau of Land Management, 1999, National Monuments, GIS Cover.

E

- Environmental Protection Agency (EPA), 2005a, Surf Your Watershed: Facility reports, accessed April 2005 at http://oaspub.epa.gov/enviro/ef_home2.water. (Effluent Generation Table)
- _____, 2005b, 2000 and 1996, Clean Watershed Needs Survey: datasets, accessed March 2005 at <http://www.epa.gov/owm/mtb/cwns/index.htm>. (Effluent Generation Table)

G

- Gebert, W.A., D.J. Graczyk and W.R. Krug, 1987, Average annual runoff in the United States, 1951-1980: GIS Cover, accessed March 2006 at <http://aa179.cr.usgs.gov/metadata/wrdmeta/runoff.htm>. (Surface Water Conditions Map)

J

- Johnson, L., 1996: Beaver Dam Wash surface water quality intensive survey, Nov. 1993- Sept. 1994: ADEQ report, 22 p. (Water Quality Map/Table)

O

- Oregon State University, Spatial Climate Analysis Service (SCAS), 1998, Average annual precipitation in Arizona for 1961-1990: PRISM GIS cover, accessed in 2006 at www.ocs.orst.edu/prism.

U

- United States Geological Survey (USGS), 2008 & 2005, National Water Information System (NWIS) data for Arizona: Accessed October 2008 at <http://waterdata.usgs.gov/nwis>.
- _____, 2007, Water withdrawals for irrigation, municipal, mining, thermoelectric-power, and drainage uses in Arizona outside of the active management areas, 1991-2005: Data file, received November 2007.
- _____, 2006, Springs and spring discharges: Dataset, received November 2004 and January 2006 from USGS office in Tucson, AZ.
- _____, 2004, National Gap Analysis Program - Southwest Regional Gap analysis study- land cover descriptions: Electronic file, accessed January 2005 at <http://earth.gis.usu.edu/swgap>.
- _____, 1981, Geographic digital data for 1:500,000 scale maps: USGS National Mapping Program Data Users Guide.

V

- Virgin Valley Water District, 2005, Geology and hydrology of the Virgin River Valley in Nevada, Arizona and Utah.

W

Western Regional Climate Center (WRCC), 2005, Precipitation and temperature stations: Data file, accessed December 2005 at <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwDI~GetCity~USA>.

Supplemental Reading

Andersen, M., 2005, Assessment of water availability in the Lower Colorado River basin: in Conservation and Innovation in Water Management: Proceedings of the 18th annual Arizona Hydrological Society Symposium, Flagstaff, Arizona, September, 2005.

Arizona Department of Water Resources, 1993, Water resource study Virgin River Basin: Arizona Department of Water Resources Unpublished Report.

Arizona Department of Environmental Quality, 1995, Beaver Dam Wash surface water quality intensive survey, November 1993- September 1994: ADEQ Open File Report 95-4.

Bales, J.T., and R.L. Laney, 1992, Geohydrologic reconnaissance of Lake Mead National Recreation area: Virgin River, Nevada to Grand Wash Cliffs, Arizona: USGS Water Resources Investigations Report 91-4185, 29 p.

Beaver Dam Water Company, 2005, Hydrologic Report for Beaver Dam Water Company, Palms Well No. 2 Registration Number 55-551856 on Assured and Adequate Water Supply. Prepared for Arizona Department of Water Resources.

Bio/West Inc, 1995, Virgin River geomorphic and hydrological studies related to channel forming flows: Utah Division of Wildlife Resources Report.

Black, K.R. and S.J. Rascona, 1991, Maps showing groundwater conditions in the Virgin River basin, Mohave County, Arizona, Lincoln and Clark Counties, Nevada –1991: ADWR Hydrologic Map Series #22.

Burbey, T.J., and others, 2006. Three-dimensional deformation and strain induced by municipal pumping, part 1: Analysis of field data. *Journal of Hydrology* 319 (2006)

Bureau of Land Management, 2005, Draft resource management plan and draft Environmental Impact Statement for Vermilion Cliffs National Monument, and the Grand Canyon Parashant National Monument: BLM Arizona Field Office and NPS joint report, 2005.

Carlson, D.D. and D.F. Meyer, 1995, Flood on the Virgin River, January 1989, in Utah, Arizona and Nevada, USGS Water Resources Investigations Report 94-4159.

Dettiger, M., J. Harrill, D. Schmidt, 1995, Distribution of carbonite rock aquifers and the potential for their development, southern Nevada and adjacent parts of California , Arizona and Utah: USGS Water Resources Investigations Report 91-4146, 100 p.

- Dixon, G.L. and T.C. Katzer, 2005, Geology and hydrology of the Lower Virgin River Valley in Nevada, Arizona and Utah: Virgin Valley Water District report.
- Enright, M. 1996. Selected hydrologic data for the Beaver Dam Wash area, Washington County, Nevada, and Mohave County, Arizona, 1991-1995: U.S. Geological Survey Open-File Report 96-493.
- Fogg, J.L., 1998, Beaver Dam Wash instream flow assessment: Bureau of Land Management, March 1998.
- Freilich, Leitner & Carlisle, 2005, Mohave County General Plan: Water Resources Element.
- GEO Consultants, 2001, Hydrologic Study, Assured and Adequate Water Supply, Virgin Mountain Utilities Company, T39N R 16W Portions of Sections 10, 11, 14 and 15, Mohave County, Arizona. Prepared for Arizona Department of Water Resources.
- Glancy, P.A. and Van Denburgh, A.S., 1969, Water Resources - Reconnaissance Series Report 51, Water-Resources Appraisal of the Lower Virgin River Valley Area, Nevada, Arizona and Utah, USGS Cooperative Report.
- GEO Consultants, 2001, Hydrologic Study, Assured and Adequate Water Supply, Virgin Mountain Utilities Company, T39N R 16W Portions of Sections 10, 11, 14 and 15, Mohave County, Arizona. Prepared for Arizona Department of Water Resources.
- Grand Canyon Wildlands Council, 2002, Arizona Strip springs, seeps and natural ponds: Inventory, assessment and development of recovery priorities: Arizona Water Protection Fund Project 99-074.
- Hereford, R., G. Webb and S. Graham, 2002, Precipitation history of the Colorado Plateau region, 1990 – 2000: USGS Fact sheet 119-02.
- Holmes, W.F. and others, 1997, Hydrology and Water Quality of the Beaver Dam Wash Area, Washington County, Utah, Lincoln County, Nevada and Mohave County, Arizona. U.S. Geological Survey Water-Resources Investigation Report 97-4193.
- JE Fuller/Hydrology & Geomorphology, Inc., SWCA Consultants, and Water Research Center University of Arizona 1998, Preliminary report on the Arizona Stream Navigability Study for the Virgin River in Arizona: Arizona State Land Department Report.
- Johnson, M., 2002, Hydrology and groundwater conditions of the tertiary muddy creek formation in the Lower Virgin River basin of southeastern Nevada, northwestern Arizona: Proceedings from Geological Society of America- Rocky Mountain Section annual meeting May 2002.

- Katzer, T. and K. Brothers, 1995, To capture a river-water supply development of the Virgin River, Clark County, Nevada, in *Water in the 21st century; conservation demand and supply: Proceedings from American Water Resources Association*, April 1995.
- Laney, R.L., and J.T. Bales, 1996, Geohydrologic reconnaissance of Lake Mead National Recreation Area – Las Vegas Wash to Virgin River, Nevada: USGS Water Resources Investigations Report 96-4033, 44 p.
- Langenheim, V.E., J.M. Glen, R.C. Jachens, G.L. Dixon, T.C. Katzer and R.L. Morin, 2000, Geophysical constraints on the Virgin River depression, Nevada, Utah and Arizona: USGS Open File Report 00-407.
- Las Vegas Water District, 1991, Distribution of carbonate rock aquifers and the potential for their development, southern Nevada and adjacent parts of California, Arizona, and Utah: USGS Water Resources Investigations Report 91-4146.
- Leslie & Associates, 1991, Water Adequacy Report for Beaver Dam Estates. Prepared for Arizona Department of Water Resources.
- Metcalf, L., 1995. Ground water – Surface Water Interactions in the Lower Virgin River Area Arizona and Nevada. M.S. Thesis Department of Geoscience – University of Nevada – Las Vegas.
- National Park Service, 1990, Simulation of groundwater flow and water level declines that could be caused by proposed withdrawal, Navajo Sandstone, southwestern Utah and northwestern Arizona: USGS Water Resource Investigations Report 90-4105.
- Prudic, D.E., and others, 1995, Conceptual Evaluation of Regional Ground-Water Flow in the Carbonate-Rock Province of the Great Basin, Nevada, Utah, and Adjacent States, U.S. Geological Survey Professional Paper 1409-D
- Robertson, F.N., 1991, Geochemistry of groundwater in alluvial basins in Arizona, and adjacent parts of Nevada, New Mexico and California: USGS Professional Paper 1406-C, 90 p.
- Rowley – Leslie Associates, 1987, Water Adequacy Report for Beaver Dam Resort. Prepared for Arizona Department of Water Resources.
- Southern Nevada Water Authority, 2000, Analysis of Gains and Losses in Virgin River Flow Between Bloomington, Utah and Littlefield, Arizona.
- Towne, D., 1997, Ambient groundwater quality of the Virgin River basin: a 1997 baseline study: ADEQ Open - File Report 99-4.
- Trudeau, D., J. Hess and R. Jacobson, 1983, Hydrogeology of the Littlefield Springs, Arizona: *Ground Water*, Vol. 21, No. 3, May-June 1983

United States Geological Survey, 1997, Hydrology and water quality of the Beaver Dam Wash area, Washington County, Utah, Lincoln County, Nevada, and Mohave County, Arizona: USGS Water Resource Investigations Report 97-4193.

Warner, S., 2003, Using GPS to Quantify Three Dimensional Storage and Aquifer Deformation in the Virgin Valley River, NV, M.S. Thesis in Geosciences, Virginia Polytechnic Institute and State University.

Washington County Water Conservation District, 1993, The Virgin River: the Lifeblood of Progress-Past, Present and Future.

Zohdy, A.A.R., and others, 1994, A Direct-Current Resistivity Survey of the Beaver Dam Wash Drainage in Southwest Utah, Southeast Nevada, and Northwest Arizona, U.S. Geological Survey Open-File report 94-676