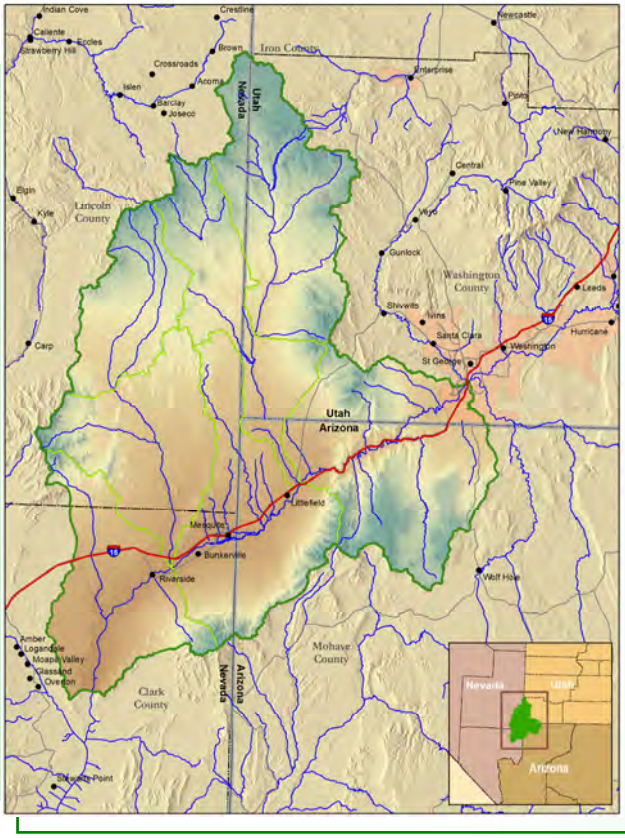
Lower Virgin River Watershed

Rapid Watershed Assessment Report June, 2009



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Section 1: Introduction

Overview of Rapid Watershed Assessments

A Rapid Watershed Assessment (RWA) is a concise report containing information on natural resource conditions and concerns within a designated watershed. The "rapid" part refers to a relatively short time period to develop the report as compared to a more comprehensive watershed planning effort. The “assessment” part refers to a report containing maps, tables and other information sufficient to give an overview of the watershed, including physical characteristics and socioeconomic trends.

The assessments involve the collection of readily available quantitative and qualitative information to develop a watershed profile, and sufficient analysis of that information to generate an appraisal of the conservation needs of the watershed. These assessments are conducted by conservation planners, using Geographic Information System (GIS) technology. Conservation Districts and other local leaders, along with public land management agencies, are involved in the assessment process.

A RWA serves as a communication tool between the Natural Resources Conservation Service (NRCS) and partners for prioritizing conservation work in selected watersheds. RWAs serve as a platform for conservation program delivery, provide useful information for development of NRCS and Conservation District business plans, and lay a foundation for future cooperative watershed planning.

General Description of Lower Virgin River Watershed

The Lower Virgin River Watershed is located in the northwestern corner of Arizona, the southwestern corner of Utah, and the southeastern corner of Nevada (Figure 1-1). Lower Virgin River drains about 2,063 square miles (1.3 million acres) of Utah, Nevada, and Arizona. It is the lower branch of the Virgin River, which then discharges into Lake Mead.

The watershed is located in Mohave County, Arizona, in Washington County, Utah, and in Lincoln and Clark Counties, Nevada.

The majority of the watershed is Federal land administered by the U.S. Bureau of Land Management. Smaller areas of Federal land are administered by the Forest Service, National Park Service, and Bureau of Reclamation. Most of the remainder of the land in the watershed is privately owned or managed by the Arizona and Nevada State Land Departments, and the Utah Trust Lands Administration.

Major land uses in the watershed include rangeland and cropland. Important crops include alfalfa, corn, and small grains. Recreational uses are also common activities both on private and public lands.

Major towns and cities include Bunkerville, Mesquite, and Riverside, Nevada, and Littlefield, Arizona. Conservation assistance is provided through the Clark County and Lincoln County Conservation Districts in Nevada, Dixie and E&I Conservation Districts in Utah, and the Littlefield-Hurricane Valley Conservation District in Arizona. The U.S. Department of Agriculture (USDA) Service Centers that serve the area are located in Las Vegas, Nevada, Cedar City, Utah, and Fredonia, Arizona.

Resource concerns in the watershed include soil erosion (wind and streambank), water quantity (aquifer depletion), water quality (excessive sediment and turbidity in surface water), air quality (rangeland fires), noxious and invasive plants, threatened or endangered plant and animal species, and urban encroachment on cropland. (NRCS Factsheet).

Section 2: Physical Description

Watershed Size

The Lower Virgin River Watershed covers approximately 1.3 million acres (2,063 square miles) in Arizona, Nevada and Utah. In Arizona, the watershed covers about 1.3% of the state. The watershed has an east-west width of about 50 miles, and a north-south length of about 65 miles. Fifty-three percent of the watershed is found in Nevada, 24% in Arizona, and 24% in Utah.

The Lower Virgin River Watershed was delineated by the U.S. Geological Survey and has been subdivided by the NRCS into smaller watersheds or drainage areas. Each drainage area has a unique hydrologic unit code number (HUC) and a name based on the primary surface water feature within the HUC. These drainage areas can be further subdivided into even smaller watersheds as needed. The Lower Virgin River Watershed has an 8-digit HUC of 15010010, and it contains the following 10-digit HUCs (Figure 2-1):

- 1501001001 Upper Beaver Dam Wash (Utah & Nevada)
- 1501001002 Lower Beaver Dam Wash (Arizona, Utah & Nevada)
- 1501001003 Black Rock Gulch - Virgin River (Arizona & Utah)
- 1501001004 Garden Wash (Nevada)
- 1501001005 Toquop Wash (Nevada)
- 1501001006 Sand Hollow Wash - Virgin River (Arizona, Utah & Nevada)
- 1501001007 Halfway Wash-Virgin River (Nevada).

Geology

The lower Virgin River Valley is a large alluvial basin bisected by the Virgin River and surrounded by the Hurricane Cliffs on the east, the Virgin Mountains on the south, the Mormon Mountains to the west, and the Clover Mountains on the north. These ranges expose rocks ranging in age from Precambrian crystalline basement rocks to Mesozoic continental sedimentary deposits. The Paleozoic sequence consists of a mostly carbonate section, which lies between Cambrian and Permian clastic deposits; the Mesozoic section consists of continental and marine deposits of siltstone, sandstone, limestone, gypsum, conglomerate, and shale, as shown in Figure 2-2.

In general, of the various bedrock units, only the Paleozoic carbonate units have potential for transmitting large quantities of water. The rest of the pre-Cenozoic sequence is well-consolidated and impermeable and tends to act as a barrier to groundwater movement.

The Muddy Creek Formation, extensively exposed throughout the Lower Virgin Watershed, has great variability in rock type from region to region. In the Mesquite basin, the unit is in several facies: basal conglomerate, conglomerate bed of Toquop Wash, fine-medium-grained siltstone and claystone, and upper conglomerate facies. The variability of the unit probably accounts for its importance as a producing aquifer, especially when faulted. Both the Muddy Creek Formation and some of the Mesozoic formations contain gypsum, which is water-soluble and introduces

sulfates into the groundwater system, causing very poor water quality and a 'rotten egg' smell. Some of the wells in the Mesquite basin have high concentrations of salts, which can be traced directly to groundwater encountering gypsum from the subsurface (USGS, 2000).

Soils

Soils within the Lower Virgin River Watershed are diverse and formed as the result of differences in climate, vegetation, geology, and physiography. Detailed soils information for the watershed is available from the Natural Resources Conservation Service (NRCS) within the following Soil Surveys: "Soil Survey of the Shivwits Area, Part of Mohave County, AZ"; "Soil Survey of the Virgin River Area, NV AZ"; and "Soil Survey of Lincoln County, NV Southern Part." Soils data and maps from these Soil Surveys can be accessed through the NRCS Web Soil Survey website: http://websoilsurvey.nrcs.usda.gov

Common Resource Areas

The USDA, Natural Resources Conservation Service (NRCS) defines a Common Resource Area (CRA) as a geographical area where resource concerns, problems, or treatment needs are similar (NRCS 2006). It is considered a subdivision of an existing Major Land Resource Area (MLRA). Landscape conditions, soil, climate, human considerations, and other natural resource information are used to determine the geographic boundaries of a Common Resource Area.

The Lower Virgin Watershed is comprised of nine Common Resource Areas (Figure 2-3 and Table 2-1).

The uppermost reaches of the watershed are comprised of CRA 35.6 "Colorado Plateau Pinyon-Juniper-Sagebrush" with elevations ranging from 5,500 to 7,000 feet and precipitation averaging 13 to 17 inches per year. This CRA occurs on high elevation plateaus and mountains. Vegetation includes pinyon, juniper, big sagebrush, cliffrose, Mormon tea, muttongrass, prairie junegrass, squirreltail, western wheatgrass, and blue grama. The soils in the area have a mesic soil temperature regime and an aridic ustic soil moisture regime. The dominant soil orders are Mollisols and Vertisols. Shallow, gravelly, cobbly and stony, medium and fine-textured soils occur on plains and mesa tops and cindery soils occur on cinder cones. Shallow to deep, gravelly, cobbly and stony, fine-textured soils occur on basaltic plains, mesas and hills.

Much of the upper watershed is comprised of CRA 35.3 "Colorado Plateau Sagebrush – Grasslands" with elevations ranging from 4,500 to 6,000 feet and precipitation averaging 10 to 14 inches per year. This CRA occurs on broad plateaus. Vegetation includes big sagebrush, juniper, pinyon, cliffrose, Mormon tea, fourwing saltbush, Indian ricegrass, needle and thread, western wheatgrass, galleta, and grama species. The soils in the area have a mesic soil temperature regime and an ustic aridic soil moisture regime. The dominant soil orders are Aridisols and Entisols. Shallow, medium and fine-textured soils and rock outcrop occur on plateaus and plains. Shallow, gravelly and cobbly,

moderately coarse to fine-textured soils and rock outcrop occur on hills and mountains.

A minor portion of the upper watershed is comprised of CRA 28A.1 “Sagebrush Basins and Slopes” with elevations ranging from 5,000 to 6,500 feet and precipitation averaging 17 to 27 inches. This CRA consists of basins, fan piedmonts and low terraces that are often internally drained. Vegetation includes Wyoming big sagebrush, black sagebrush, winterfat, Indian ricegrass, with singleleaf pinyon and Utah juniper in some areas. The soils in this area have mesic soil temperature regime and a xeric aridic soil moisture regime. The dominant soil orders are Aridisols and Entisols. Deep, fine-textured, sodium (salt) affected soils occur on the valley floors. Deep, medium to coarse-textured soils occur on low alluvial fans. Shallow and moderately deep, gravelly, medium to coarse-textured, soils occur on hills and low mountain slopes.

Much of the upper watershed is comprised of CRA 29.1 “Southern Nevada Basin and Range - Semiarid Uplands and Fans” with elevations ranging from 3,800 to 6,000 feet and precipitation averaging 10 to 16 inches. This CRA is dominated by low mountains and hills, and includes high elevation fans and intermontane valleys. Vegetation includes juniper-pinyon woodland, with Wyoming big sagebrush, mountain big sagebrush and black sagebrush. The soils in this area have predominantly a mesic soil temperature regime and an aridic soil moisture regime. The dominant soil orders are Aridisols and Entisols. Shallow and moderately deep, gravelly, medium to coarse-textured, soils on hills and low mountain slopes dominate. Rock outcrop is common.

A minor portion of the upper watershed is comprised of CRA 30.29 “Mojave Desert Basin and Range – Semiarid Range on Low Mountains and Hills” with elevations ranging from 3,200 to 6,000 feet and precipitation averaging 10 to 16 inches. This CRA is in the gently sloping to steep semiarid hills, plateaus and low mountains west of St. George. Vegetation is desertic with creosotebush, yucca, Joshua tree and annual forbs and grasses. Soils are aridic and are mostly well drained carbonatic and have mesic temperature regimes.

Most of the middle and lower watershed is comprised of CRA 30.23 “Middle Mohave Desert” with elevations ranging from 1,200 to 3,200 feet and precipitation averaging 6 to 9 inches per year. This CRA is dominated by basins, fans and low uplands. Vegetation includes creosotebush, white bursage, yucca, prickly pear and cholla species, Mormon tea, ratany, winterfat, bush muhly, threeawns, and big galleta. The soils in the area have a thermic soil temperature regime and a typic aridic soil moisture regime. The dominant soil orders are Aridisols and Entisols. Shallow and deep, gravelly, medium to coarse-textured, limy soils occur on valley slopes and hills. Deep, medium to coarse-textured soils occur on floodplains and low alluvial fans.

A small area of the middle watershed is comprised of 30.25 “Mojave Desert - Upper Mojave Desert” with elevations ranging from 2,800 to 5,000 feet and precipitation averaging 8 to 14 inches.

This CRA is dominated by mountains, high elevation fans and intermontane valleys. Vegetation includes Joshua tree, blackbrush, creosotebush, ratany, bush muhly, galleta, black grama, desert needlegrass and Indian ricegrass. At the upper elevations, Gambels oak, Utah juniper, singleleaf pinyon, black sagebrush, and Wyoming big sagebrush occur. The soils are dominantly mesic at altitudes greater than 3,800 feet with an aridic or ustic soil moisture regime. The dominant soil orders are Entisols, Aridisols, and Mollisols. Shallow and moderately deep well drained soils occur on steeper mountain backslopes and hill slopes. Deep, coarse to moderately fine-textured soils occur on plateaus. Rock outcrop often occurs in complex with shallow soils. The soils below 3,800 feet have a thermic soil temperature regime and a typic aridic soil moisture regime. The dominant soil orders are Aridisols and Entisols. Shallow to deep, gravelly, medium to coarse-textured, limy soils occur on fan piedmont slopes and hills.

A minor portion of the lower watershed is comprised of CRA 30.27 “Mojave Desert - Lower Mojave Desert” with elevations ranging from 400 to 2,000 feet and precipitating averaging 3 to 6 inches. This CRA is dominated by low mountains, fans and terraces. Vegetation includes creosotebush, white bursage, mormon tea, and brittlebush. The soils in this area have a hyperthermic soil temperature regime and a typic aridic soil moisture regime. The dominant soil orders are Aridisols and Entisols. Deep and moderately deep, gravelly, medium to coarse-textured, and sandy, salt affected, poorly to well drained soils occur on floodplains. Shallow to deep, gravelly, medium to coarse-textured, limy soils occur on fan piedmont slopes and low hills.

A small area of the watershed along the Virgin River is comprised of CRA 30.20 “Mojave Desert Basin and Range – Irrigated cropland” with elevations below 3,100 feet and precipitation averaging less than 9 inches per year. This CRA occurs in small irrigated areas in narrow valleys and hills. Soils are mostly aridic with thermic temperatures and have some salt concentrations that limit use.

Table 2-1: Lower Virgin River Watershed - Common Resource Areas

Common Resource Area Type	Area (sq. mi.)	Percent of Watershed
28A.1 Great Salt Lake Area – Sagebrush Basins and Slopes	23	1%
29.1 Southern Nevada Basin and Range – Semiarid Uplands and Fans	336	16.5%
30.20 Southern Nevada Basin and Range – Eastern Mountains	6	0.2%
30.23 Mojave Desert – Middle Mojave Desert	1,321	64%
30.25 Mojave Desert – Upper Mojave Desert	65	3%
30.27 Mojave Desert – Lower Mojave Desert	53	2.6%
30.29 Mohave Desert Basin and Range – Semiarid Range on Low Mountains and Hills	52	2.5%
35.3 Colorado Plateau Sagebrush – Grasslands	156	7.6%
35.6 Colorado Plateau Pinyon – Juniper - Sagebrush	52	2.5%

Data Sources: GIS map layer "virgin_cra_merge1.shp". Natural Resource Conservation Service (NRCS, 2009).

Slope Classifications

Slope, as well as soil characteristics and topography, are important when assessing the vulnerability of a watershed to erosion. About 43% of the Lower Virgin River Watershed has a slope greater than 15%, while about 29% of the watershed has a slope less than 5%.

Garden Wash Watershed and Halfway Wash – Virgin River Watershed have the least amount of slope, both with 27% of its area over 15% slope, and 51% and 49%, respectively, less than 5% slope. Upper Beaver Dam Wash Watershed has the greatest amount of slope, with 66% of the area greater than 15% slope (Table 2-2 and Figure 2-4).

Table 2-2: Lower Virgin River Watershed Slope Classifications.

Watershed Name	Area (sq. mi.)	Percent Slope		
		< 5%	5-15%	>15%
Upper Beaver Dam Wash 1501001001	340	8%	26%	66%
Lower Beaver Dam Wash 1501001002	238	20%	34%	46%
Black Rock Gulch-Virgin River 1501001003	423	20%	27%	53%
Garden Wash 1501001004	181	51%	22%	27%
Toquop Wash 1501001005	275	39%	29%	32%
Sand Hollow Wash-Virgin River 1501001006	335	35%	33%	32%
Halfway Wash-Virgin River 1501001007	272	49%	24%	27%
Lower Virgin River Watershed	2,064	29%	28%	43%

Data Sources: Derived from DEM, obtained from U.S. Geological Survey, April 8, 2006
http://edc.usgs.gov/geodata/

Streams, Lakes and Gaging Stations

There are seven listed active and inactive gaging stations in the Lower Virgin River Watershed (Figure 2-5 and Table 2-3.1). The gage at the Virgin River at Littlefield, AZ (USGS ID 09415000) registered the highest annual mean stream flow with 742 cfs.

Table 2-3.2 lists major lakes and reservoirs in the Watershed, as well as their watershed position, surface area, elevation and dam name. Lake Mead is the largest surface water body in the watershed with an area of 860 acres. Table 2-3.3 lists the major streams and their lengths. The longest stream lengths are 73 miles for the Virgin River (AZ, NV, UT), 50 miles for Toquop Wash (NV), and 48 miles for Beaver Dam Wash (UT).

Outstanding Arizona Waters

The Arizona Department of Environmental Quality (ADEQ) recognizes state resource waters of unique value as Outstanding Arizona Waters (OAW), a designation which affords such waters a Tier 3 level of antidegradation protection, meaning no degradation of current water quality can be tolerated. As stated in Antidegredation Implementation Procedures (ADEQ, 2007), a body of water is eligible to be considered for OAW classification if the following criteria are met:

- The surface water is a perennial water and is in a free-flowing condition;
- The surface water has good water quality. For the purpose of this regulation, “good water quality” means that the surface water has water quality that meets or is better than applicable water quality standards; and
- The surface water meets one or both of the following conditions: (a) is of exceptional recreational or ecological significance because of its unique

attributes; (b) threatened or endangered species are known to be associated with the surface water and maintenance of existing water quality is essential to maintenance or propagation of said species or the surface water provides critical habitat for a threatened or endangered species.

ADEQ currently recognizes 20 reaches of various water bodies throughout the state as Outstanding Arizona Waters, and is reviewing two additional streams for possible OAW classification.

Within the Lower Virgin River Watershed, there are currently no protected Outstanding Arizona Waters. Nevada and Utah have no "outstanding" water programs.

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Table 2-3.1: Lower Virgin River Watershed USGS Stream Gages and Annual Mean Stream Flow

USGS Gage ID	Site Name	Begin Date	End Date	Annual Mean Stream Flow (cfs)
09413200	Virgin River Near Bloomington, UT	1977	2009	222
09413500	Virgin River Near St. George, UT	1951	2007	192
09413700	Virgin River Above the Narrows Near Littlefield, AZ	1998	2007	146
09413900	Beaver Dam Wash Near Enterprise, UT	1992	2007	9
09414900	Beaver Dam Wash at Beaver Dam, AZ	1993	2007	3
09415000	Virgin River at Littlefield, AZ	1930	2007	742
09415250	Virgin River Above Lake Mead Near Overton, NV	2006	2008	108

Data Sources: USGS website, National Water Information System http://waterdata.usgs.gov/nwis/

Table 2-3.2: Lower Virgin River Watershed Major Lakes and Reservoirs

Lake Name (if known)	Watershed	Surface Area (acres)	Elevation (feet above mean sea level)	Dam Name (if known)
Lake Mead	Halfway Wash-Virgin River	860	1,214	Hoover Dam
Schroeder Lake	Upper Beaver Dam Wash	15	5,062	

Data Sources: GIS data layer "Lakes", Arizona State Land Department, Arizona Land Resource Information System (ALRIS), February 7, 2003 http://www.land.state.az.us/alris/index.html, GIS data layer "SGID_U024_LakesNHDHighRes", Utah GIS Data Portal (AGRC), October 2008 http://agrc.its.state.ut.us/. *GIS data layer "GreatBasin_WaterBodies" W. M. Keck Earth Sciences and Mining Research Information Center, October, 2008* http://keck.library.unr.edu/data/gbgeosci/gbgdb.htm

Table 2-3.3: Lower Virgin River Watershed Major Streams and Lengths.

Stream Name	10-digit Watershed Name	Stream Length (miles)
Abbott Wash (NV)	Sand Hollow Wash-Virgin River	6
Beaver Dam Wash (AZ)	Lower Beaver Dam Wash	10
Beaver Dam Wash (UT)	Upper Beaver Dam Wash, Lower Beaver Dam Wash	48
Big Bend Wash (AZ)	Sand Hollow Wash-Virgin River	8
Black Rock Gulch (AZ)	Black Rock Gulch-Virgin River	25
Castle Cliff Wash (AZ, UT)	Black Rock Gulch-Virgin River	19
Cedar Pockets Wash (AZ)	Black Rock Gulch-Virgin River	4
Coon Creek (AZ)	Sand Hollow Wash-Virgin River	8
East Fork Beaver Dam Wash (UT)	Upper Beaver Dam Wash	17
East Pass Wash (NV)	Lower Beaver Dam Wash	7
Garden Wash (NV)	Garden Wash	7
Halfway Wash (NV)	Halfway Wash-Virgin River	24
Jackson Wash (UT)	Upper Beaver Dam Wash	16
Mesquite Ditch (AZ, NV)	Sand Hollow Wash-Virgin River	8
Mokaac Wash (AZ)	Black Rock Gulch-Virgin River	8
Mountain Sheep Wash (AZ)	Black Rock Gulch-Virgin River	10
Nickel Creek (NV)	Halfway Wash-Virgin River	10
Sams Camp Wash (NV)	Garden Wash	25
Sand Hollow Wash (AZ, NV)	Sand Hollow Wash-Virgin River	25
Slaughter Creek (UT)	Upper Beaver Dam Wash	10
Snow Spring Wash (UT)	Upper Beaver Dam Wash	14
South Fork Toquop Wash (NV)	Toquop Wash	15
Sullivans Canyon (AZ	Black Rock Gulch-Virgin River	12
Toquop Wash (NV)	Garden Wash, Toquop Wash,	50
Town Wash (NV)	Sand Hollow Wash-Virgin River	12
Virgin River (AZ, NV, UT)	Black Rock Gulch-Virgin River, Sand Hollow Wash-Virgin River	73

Data Sources: GIS data layers "Streams", Arizona State Land Department, Arizona Land Resource Information System (ALRIS), October, 10, 2002, *ESRI data layer "dtl_streams", 2007, "SGID_U100_Streams", Utah GIS Portal 2008. http://www.land.state.az.us/alris/index.html*
GIS data layer "GreatBasin_Streams" W. M. Keck Earth Sciences and Mining Research Information Center, October, 2008 http://keck.library.unr.edu/data/gbgeosci/gbgdb.htm

Riparian Vegetation

Five types of riparian vegetation communities occur within the Lower Virgin River Watershed (Figure 2-6). Riparian areas encompass approximately 2,589 acres (4.0 sq.mi.) or less than 1.0% of the entire watershed. The majority of the riparian is made up of three riparian vegetation

communities. Tamarisk comprises 2,508 acres, or 97% of the riparian areas. Strand and Cottonwood Willow comprise the remaining 81 acres, or 3% of the riparian area (Table 2-4).

Sand Hollow Wash – Virgin River Watershed has the greatest amount of riparian vegetation with 1,766 acres (68% of the riparian areas). Black Wash Gulch – Virgin River Watershed accounts for the remaining 823 acres (32% of the riparian area).

Table 2-4: Lower Virgin River Watershed Riparian Vegetation (acres) by 10 Digit Watershed.*

10-digit Watershed Name	Riparian Vegetation Community			
	Cottonwood Willow	Strand	Tamarisk	Total Area (Acres)
Upper Beaver Dam 1501001001	-	-	-	-
Lower Beaver Dam 1501001002	-	-	-	-
Black Rock Gulch-Virgin River 1501001003	2	76	745	823
Garden Wash 1501001004	-	-	-	-
Toquop Wash 1501001005	-	-	-	-
Sand Hollow Wash-Virgin River 1501001006	-	3	1,763	1,766
Halfway Wash-Virgin River 1501001007	-	-	-	-
Total Lower Virgin River Watershed	2	79	2,508	2,589

**The riparian vegetation data is only available for the Arizona portion of the watershed only.*
Data Sources: GIS data layer "azriparian_att.shp", Arizona Geographic Information Council GeoData Portal (AGIC 2005), http://agic.az.gov/portal/dataList.do?sort=theme&dataset=0. Data Sources: GIS data layer "landcover", originated by Southwest Regional GAP program, 2005. http://ftp.nr.usu.edu/swgap/

Land Cover

The Riparian Vegetation map (Figure 2-6) and Land Cover map (Figure 2-7) were created from the Southwest Regional Gap Analysis Project land cover map (Lowry et. al, 2005). Within the Lower Virgin River Watershed, Table 2-5 identifies the Scrub/Shrub as the most common land cover type over the entire watershed, encompassing about 76% of the watershed. The next most common type is the Evergreen Forest, comprising 13% of the watershed.

Note: There are a total of 26 GAP vegetation categories present within the Lower Virgin Watershed boundary. Some of these categories occur only in small concentrations, and are not visible at the small scale in which the maps are displayed. Some of the vegetation categories were re-grouped in order to increase the legibility of the map. In collaboration with NRCS, staff was able to create a total of 12 grouped GAP vegetation categories, as shown on Table 2-5.

Table 2-5: Lower Virgin River Watershed Southwest Regional GAP Analysis Project Land Cover, Percent of 10-digit Watershed (Part 1 of 2).

Land Cover	10-digit Watershed Name			
	Upper Beaver Dam Wash 1501001001	Lower Beaver Dam Wash 1501001002	Black Rock Gulch-Virgin River 1501001003	Garden Wash 1501001004
Agriculture	-	0.09%	0.03%	-
Altered or Disturbed	< 0.00%	0.15%	0.02%	0.1%
Deciduous Forest	0.05%	-	-	-
Emergent Wetland	0.03%	0.1%	-	< 0.00%
Evergreen Forest	27%	8%	24%	4%
Grassland/ Herbaceous	4%	2%	0.2%	1%
Shrub/Scrub	61%	85%	65%	89%
Sparsely Vegetated, Barren	3%	3%	10%	3%
Urban, Low Intensity	-	-	0.6%	-
Urban, High Intensity	-	0.01%	0.4%	-
Woody Wetland	4%	2%	0.3%	2%
Area (Sq.mi.)	340	238	423	181

***Not necessarily irrigated land.*
Data Sources: GIS data layer "landcover", originated by Southwest Regional GAP program, 2005.
http://ftp.nr.usu.edu/swgap/

Table 2-5: Lower Virgin River Watershed Southwest Regional GAP Analysis Project Land Cover, Percent of 10-digit Watershed (Part 2 of 2).

Land Cover	10-digit Watershed Name			
	Toquop Wash 1501001005	Sand Hollow Wash-Virgin River 1501001006	Halfway Wash-Virgin River 1501001007	Lower Virgin River Watershed
Agriculture	-	1%	0.2%	0.2%
Altered or Disturbed	0.01%	2%	3%	0.7%
Deciduous Forest	-	-	-	0.01%
Emergent Wetland	-	0.01%	0.06%	0.03%
Evergreen Forest	2%	10%	3%	13%
Grassland/ Herbaceous	0.04%	0.02%	-	1%
Open Water	-	0.02%	< 0.00%	< 0.00%
Shrub/Scrub	90%	82%	76%	76%
Sparsely Vegetated, Barren	6%	2%	5%	5%
Urban, Low Intensity	-	1%	-	0.3%
Urban, High Intensity	0.06%	0.3%	0.4%	0.2%
Woody Wetland	2%	2%	12%	3%
Area (Sq.mi.)	275	335	272	1,670

***Not necessarily irrigated land.*
Data Sources: GIS data layer "landcover", originated by Southwest Regional GAP program, 2005.
http://ftp.nr.usu.edu/swgap/

Meteorological Stations, Precipitation and Temperature

For the years 1961-1990, the average annual precipitation for the Lower Virgin River Watershed was 10 inches (Table 2-6). Upper Beaver Dam Wash Watershed received the most rainfall with 15 inches of rain in an average year, while Lower Beaver Dam Wash, Black Rock Gulch-Virgin River, and Garden Wash Watersheds typically received 12, 11, and 12 inches per year, respectively. Average temperature for the Lower Virgin River Watershed ranged from 66.1 ^{o}F in the Lower Beaver Dam Wash Watershed to 60.7 ^{o}F in the Upper Beaver Dam Wash Watershed. Active meteorological stations are located in Lower Beaver Dam Wash, Upper Beaver Dam Wash, and Sand Hollow Wash - Virgin River Watersheds. Active meteorological stations located outside, but near, the watershed are at Overton Airport and Overton Beach (Figure 2-8).

The Western Regional Climate Center calculates the average minimum and maximum temperatures for each month for the period of record and then takes an annual average.

Table 2-6: Lower Virgin River Headwaters Watershed Meteorological Stations, Temperature and Precipitation.

10-digit Watershed Name	Meteorological Stations	Temperature (°F)			Precipitation (in/yr)		
		Min.	Max.	Avg	Min.	Max.	Weighted Average
Upper Beaver Dam Wash 1501001001	Lytle Ranch UT	42.4	78.9	60.7	11	27	15
Lower Beaver Dam Wash 1501001002	Beaver Dam AZ	81.8	50.4	66.1	5	19	12
Black Rock Gulch-Virgin River 1501001003	-	-	-	-	7	19	11
Garden Wash 1501001004	-	-	-	-	9	19	12
Toquop Wash 1501001005	-	-	-	-	5	15	9
Sand Hollow Wash-Virgin River 1501001006	Littlefield AZ Bunkerville NV	82.1 82.7	48.1 47.3	65.1 65.0	3	15	8
Halfway Wash-Virgin River 1501001007	-	-	-	-	3	15	6
Lower Virgin River Headwaters Watershed	-	-	-	-	*3*	*27*	*10*
Stations Near Watershed	Overton Airport	-	-	-	-	-	-
	Overton Beach	-	-	-	-	-	-

Data Sources: GIS data layer "precip_a_az" Water and Climate Center of the NRCS (1998); GIS data layer "NWS_Stations" Western Regional Climate Center (WRCC), Temperature data. July 15, 2004; http://www.wrcc.dri.edu/summary/climsmaz.htm

Land Ownership/Management

There are nine land ownership/management entities in the Lower Virgin River Watershed (Figure 2-9 and Table 2-7). The Bureau of Land Management (BLM) holds the most land, representing 88% of the watershed, followed by Private Land with 5%, State Land with 4%, and U.S. Forest Service with 2% of the land in the watershed.

Table 2-7: Lower Virgin River Watershed Land Ownership/Management (Percent of each 10-digit Watershed). (Part 1 of 2)

Land Owner	Upper Beaver Dam Wash 1501001001	Lower Beaver Dam Wash 1501001002	Black Rock Gulch-Virgin River 1501001003	Garden Wash 1501001004	Toquop Wash 1501001005
Bureau of Land Management	82%	93%	85%	100%	97%
Bureau of Land Management Wilderness Area	-	-	1%	-	-
Bureau of Reclamation	-	-	-	-	-
Indian Reservation	0.1%	-	-	-	-
National Park Service	-	-	-	-	-
Private Land	2%	2%	3%	-	3%
State Land	5%	5%	11%	-	-
State Parks	1%	-	-	-	-
U.S. Forest Service	9%	-	-	-	-
Area (square miles)	*340*	*238*	*423*	*181*	*275*

Data Sources: GIS data layer "ownership", Arizona State Land Department, Arizona Land Resource Information System (ALRIS), October 27, 2007 http://www.land.state.az.us/alris/index.html; GIS data layer "SGID_U024_LandOwnership", Utah GIS Data Portal, 2006; GIS data layer "NV_Landowner_200111", BLM, 2003.

Table 2-7: Lower Virgin River Watershed Land Ownership/Management (Percent of each 10-digit Watershed). (Part 2 of 2)

Land Owner	Sand Hollow Wash-Virgin River 1501001006	Halfway Wash-Virgin River 1501001007	Lower Virgin River Watershed
Bureau of Land Management (BLM)	84%	85%	88%
BLM Wilderness Area	-	-	0.3%
Bureau of Reclamation	-	6%	0.8%
Indian Reservation	-	-	0.01%
National Park Service	-	1%	0.2
Private Land	15%	7%	5%
State Land	1%	-	4%
State Parks	-	-	0.2%
U.S. Forest Service	-	-	2%
Area (square miles)	*335*	*272*	*2,064*

Data Sources: GIS data layer "ownership", Arizona State Land Department, Arizona Land Resource Information System (ALRIS), October 27, 2007 http://www.land.state.az.us/alris/index.html; GIS data layer "SGID_U024_LandOwnership", Utah GIS Data Portal, 2006; GIS data layer "NV_Landowner_200111", BLM, 2003.

Land Use

The Land Use map was created from the Southwest Regional GAP Analysis Project land cover map (Lowry et. al, 2005).

The land cover condition during the early 1990's was determined using the National Land Cover Dataset (NLCD). The NLCD classification contains 21 different land cover categories (USGS, NLCD Land Cover Class Definitions); however, these categories have been consolidated into five land use types (Figure 2-10 and Table 2-8). The five groupings for the land use categories are:

- Agriculture (Crop), which includes confined feeding operations; cropland and pasture; orchards, groves, vineyards, nurseries and ornamental horticulture; and, other agricultural land.

- Forest, includes areas characterized by tree cover (natural or semi-natural woody vegetation, generally greater than 6 meters tall); tree canopy accounts for 25-100 percent of the cover

- Water, identifies all areas of surface water, generally with less than 25% cover of vegetation/land cover

- Range, which includes herbaceous rangeland; mixed range; and, shrub and brush rangeland.

- Urban (high density and low density), which includes residential areas; commercial and services; industrial and commercial complexes; mixed urban or built-up land; other urban or built-up land; strip mines quarries and gravel pits; transportation, communication and utilities.

The most common land use type is Range which makes up 81% of the watershed. Forest is the next most common type which comprises about 13% of the total area watershed.

Table 2-8: Lower Virgin River Watershed Land Use, Percent of 10-digit Watershed (Part 1 of 2)

Land Use Type	10-digit Watershed Name				
	Upper Beaver Dam Wash 1501001001	Lower Beaver Dam Wash 1501001002	Black Rock Gulch-Virgin River 1501001003	Garden Wash 1501001004	Toquop Wash 1501001005
Agriculture	-	0.1%	0.03%	-	-
Barren Land	3%	3%	10%	3%	6%
Forest	28%	8%	24%	4%	2%
Open Water	-	-	-	-	-
Range	69%	89%	65%	93%	92%
Urban, Low Intensity	-	-	0.6%	-	-
Urban, High Intensity	-	0.01	0.4%	-	0.06%
Area (square miles)	340	238	423	181	275

Data Sources: GIS data layer "landcover", originated by Southwest Regional GAP program, 2005. http://ftp.nr.usu.edu/swgap/

Table 2-8: Lower Virgin River Watershed Land Use, Percent of 10-digit Watershed (Part 2 of 2)

Land Use Type	10-digit Watershed Name		
	Sand Hollow Wash-Virgin River 1501001006	Halfway Wash-Virgin River 1501001007	Lower Virgin River Watershed
Agriculture	1%	0.2%	0.2%
Barren Land	2%	5%	5%
Forest	10%	3%	13%
Open Water	0.02%	< 0.00%	< 0.00%
Range	86%	91%	81%
Urban, Low Intensity	1%	-	0.3%
Urban, High Intensity	0.3%	0.4%	0.2%
Area (square miles)	335	272	1,670

Data Sources: GIS data layer "landcover", originated by Southwest Regional GAP program, 2005. http://ftp.nr.usu.edu/swgap/

Mines - Primary Ores

Table 2-9 and Figure 2-11 show the types of ores being mined in the Lower Virgin River Watershed. The most common type of ore type is Copper with 24 mines. Other common ore types in the area include gold, gypsum, sand and gravel, and manganese.

Table 2-9: Lower Virgin River Watershed
Mines – Primary Ores

Ore Type	Total Number of Mines
Aluminum	3
Arsenic	1
Barium	5
Beryllium	5
Clay	3
Copper	24
Fluorine	6
Geothermal	6
Gallium	2
Gold	17
Gypsum	16
Iron	8
Kaolin	1
Lead	7
Manganese	11
Mercury	5
Mica	3
Nickel	2
Sand and Gravel	13
Silver	6
Titanium	1
Tungsten	9
Uranium	2
Volcanic Materials	1
Zinc	2

Note: If a mine contains more than one ore, only the major ore is noted. Data Source: "mines"
Arizona Land Information Service, 2006; "SGID_U100_Mineral" Utah GIS Portal, 2008; "mrds-fUS32"USGS Mineral Database, 2000

Section 3: Resource Concerns

Introduction

Conservation Districts and other local leaders, along with NRCS and other resource management agencies, have identified priority natural resource concerns for this watershed. These concerns can be grouped under the broad resource categories of Soil, Water, Air, Plants, or Animals (SWAPA). Refer to Table 3-1 for a listing of priority resource concerns by land use within the Lower Virgin River Watershed.

Table 3-1: Lower Virgin River Watershed Priority Resource Concerns by Land Use

Resource Category	Cropland Concerns	Rangeland Concerns	Forest Concerns	Urban Concerns
Soil Erosion		✓ Wind Erosion ✓ Streambank Erosion		
Water Quality				
Water Quantity	✓ Inefficient Water Use on Irrigated Land	✓ Rangeland Hydrologic Cycle		
Air Quality				
Plant Condition		✓ Noxious & Invasive Plants		✓ Noxious & Invasive Plants
Fish & Wildlife		✓ Inadequate Water		
Domestic Animals				

(NRCS, 2009)

Soil Erosion

Severe streambank erosion is a concern along the Lower Virgin River and tributaries during high flow events. This type of erosion not only results in the loss of productive soils and habitat, but endangers lives and property. Sediment deposition also occurs during these events and causes damages to structures and croplands along the stream courses. Much of the upper watershed has burned in recent years, resulting in higher than normal runoff and exacerbating flooding and erosion damages.

Soil erosion is defined as the movement of soil from water (sheet and rill or gully) or wind forces requiring treatment when soil loss tolerance levels are exceeded. Sheet and rill erosion is a concern particularly on rangeland in areas of shallow soils and poor vegetative cover. Soil loss results in reduced water holding capacity and plant productivity. Gully erosion can be a significant problem in areas of steep slopes and deep soils. Loss of vegetative cover and down-cutting of streams contribute to gully formation. Wind erosion is locally significant where adequate vegetative cover is not maintained.

Conservation practices applied to address this resource concern are

generally those that help improve vegetative cover, stabilize sites, and control water flows. Practices may include critical area planting, deferred grazing, grade stabilization structures, herbaceous wind barriers, prescribed grazing, range planting, stream channel stabilization, tree and shrub establishment, water and sediment control basins, water spreading, windbreak establishment, and wildlife upland habitat management.

Water Quality

The Virgin River from the Nevada-Arizona border to Lake Mead is included on the Nevada Division of Environmental Protection's (NDEP) 2006 303(d) List of Impaired Waters. The river from the Arizona state line to Mesquite is listed for iron, total phosphorus, selenium and temperature; and from Mesquite to the river mouth at Lake Mead for iron, manganese, total phosphorus and temperature (NDEP, 2009).

Boron total maximum daily loads (TMDLs) for both reaches of the river were developed by NDEP in 2002 and approved by the U.S. Environmental Protection Agency in 2003 (Sertic, 2009).

The Arizona Department of Environmental Quality's 2006/2008 Impaired Waters List identifies selenium and suspended sediment as contaminants of the Lower Virgin River (ADEQ, 2008). This list contains assessment units that were classified as impaired by ADEQ during current and previous assessment listing cycles. The Lower Virgin River was listed in 2004.

Parameters responsible for Virgin River Watershed water impairment in Utah are boron and thermal modification (Utah DEQ 303(d) Report). These parameters are listed as assessment Category 5 which indicates that the water quality standard is not attained and is caused by a pollutant. The assessment unit (AU) is found not supporting one or more of its designated beneficial uses as determined by current water quality standards and assessment methodologies. This category constitutes the Section 303 (d) list of water (Utah DEQ 2004). Figure 3-1 shows the Assessed Water reaches for Nevada, Arizona, and Utah.

Water pollution is a resource concern whenever accelerated soil erosion contributes excessive sediment to perennial waters that support aquatic fauna. Conservation practices used to address this resource concern are generally those that improve vegetative cover and reduce upland and stream bank erosion. Practices may include critical area planting, filter strips, heavy use area protection, prescribed grazing, range planting, sediment basins, stream bank protection, upland wildlife habitat management, and windbreak establishment.

Water Quantity

The Virgin River Basin is one of the largest free-flowing river basin watersheds in the Western United States. Although there are some dams within the watershed, there aren't any on the Virgin River main stem. The basin is currently being impacted by significant development and population growth. From 2000 to 2007, Nevada, Arizona and Utah had the highest three population growth rates in the nation (Army Corps, 2008).

Nevada

The Virgin Valley area of Clark County, Nevada includes much of the lower watershed and the communities of Mesquite and Bunkerville. Water use in the lower watershed is changing from agricultural to residential and municipal as the population grows and land uses change. It is estimated that the population will grow from approximately 18,000 to 60,000 by 2021. Water supply in the lower basin is comprised of a combination of surface and groundwater (Army Corps, 2008).

Water quantity is a resource concern whenever water supplies are inadequate to meet the needs for agricultural or domestic uses. Conservation practices applied to address this resource concern on irrigated cropland are generally those that improve the quantity and efficient distribution of water. Practices may include irrigation land leveling, irrigation system, irrigation water conveyance (ditch or pipeline), irrigation water management, and structure for water control.

Arizona

Although 2,000 square miles of the watershed are located in Arizona, it is a sparsely populated area. Principle communities include Beaver Dam, Littlefield, and Colorado City. Like everywhere else, these communities are expected to grow in the future with estimated growth in the Beaver Dam/Littlefield area to reach 5,500 by 2050. This is compared to the population in 2000 of 1,500. In 2001-2003, groundwater demand averaged 2,950 acre-feet per year. During the same period, surface water use averaged only 1,650 acre-feet per year due to declining agricultural demand. Irrigation comprises the major basin demand for surface and groundwater (Army Corps, 2008).

Utah

Growth in Kane County, Utah over the past 15 years has averaged 3.0 percent per year. It is projected to increase from 6,200 to 24,000 by the year 2035. Under present projections, population is expected to exceed current water supplies in the future. Projects are being planned to strengthen water development and delivery systems to assist in meeting the future demand (Army Corps, 2008).

Population in Washington County is expected to increase from 130,000 at present, to 650,000 in the next 30-45 years. Currently, 72,000 acre feet of water are available to meet demand, but demand is expected to reach 174,000 acre feet per year in 2038. A combination of conservation and new

water development is expected to help meet future demand (Army Corps, 2008).

In order to meet future water demands in Southern Utah, plans for construction of a new pipeline from Lake Powell are under consideration. In spite of stringent water conservation efforts, current resources may not meet water supply demands in 1012, and planned water resource projects will only extend that supply to meet demand through 2020 (Army Corps, 2008).

The planned pipeline would originate at Lake Powell near Glenn Canyon Dam, and would deliver water to Sand Hollow Reservoir, 10 miles east of St. George. The proposed pipeline would carry 70,000 acre feet of water to Washington County, 10,000 acre feet of water to Kane County and 20,000 acre feet of water to Iron County (Army Corps, 2008).

Air Quality

There are no known air quality concerns in the watershed (Figure 3-2).
Air quality is a resource concern whenever human activities contribute significantly to airborne sediment and smoke, resulting in property damage and health problems. Conservation practices applied to address this resource concern are generally those that reduce wind erosion and smoke. Practices may include atmospheric resource quality management, critical area planting, heavy use area protection, and windbreak establishment.

Environmental Sites

There are no environmental National Priority Listing (NPL Superfund) sites located within the Lower Virgin River Watershed. This data set contains coordinates of sites listed in the Comprehensive Environmental Response Compensation, and Liability System (CERCLIS), also known as 'Superfund'. The data was furnished by the Utah Department of Environmental Quality, Division of Environmental Response & Remediation (DERR).

Plant Condition

Most of the land within the Lower Virgin River Watershed (approximately 90%) is managed by the U.S. Bureau of Land Management (BLM). There are about 20 active BLM allotments within the watershed. Most of the allotments are seasonal use (fall through spring) with the remaining yearlong allotments on rotational grazing systems. The grazing impact is low due to the presence of few animals. Invasive plants are a resource concern on the allotments.

Plant condition is a resource concern whenever plants do not manufacture sufficient food to continue the growth cycle or to reproduce.

Conservation practices applied to address this resource concern are generally those that maintain or improve the health, photosynthetic capability, rooting and reproductive capability of vegetation. Practices may include

brush management, critical area planting, deferred grazing, fencing, herbaceous wind barriers, nutrient management, pest management, prescribed grazing, prescribed burning, range planting, recreation area improvement, wildlife upland habitat management, and windbreak establishment.

Noxious and Invasive Plants

Invasive species of major concern in the Lower Virgin River Watershed include tamarisk (*tamarix spp.*), red brome (*bromus rubens*) and cheatgrass (*bromus tectorum*). Tamarisk is a concern where dense stands have become established in stream courses, crowding out native species, and constricting the flow in the channels. This condition exacerbates flooding and erosion damages during flow events. Red brome and cheatgrass are a concern where these annual grasses have spread over vast areas of rangeland, building up a high fuel load. This condition results in damaging wildfires, causing increased runoff and erosion on the uplands.

Noxious and invasive plants are a resource concern whenever these species cause unsuitable grazing conditions for livestock or wildlife and due to their potential to out-compete native species which are generally preferred for wildlife habitat value. Increases in noxious and invasive plants can result from poor grazing management, drought, and other causes.

Conservation practices applied to address this resource concern are generally those that control the establishment or reduce the population of noxious and invasive plant species. Practices may include brush management, deferred grazing, fencing, forest stand improvement, pest management, prescribed burning, prescribed grazing, and wildlife upland habitat management.

Drought and Wildfire

The Desert Southwest has been in an extended drought since 1996. The Lower Virgin River Watershed area, however, has experienced only slightly below normal precipitation over the past decade at about 83% of average annual precipitation. In some areas of the watershed, however, drought conditions persist, leading to high vegetation stress, high fire potential, below-normal streamflow, decreasing water supplies and deteriorating range and pasture conditions. The Climate Assessment for the Southwest (CLIMAS) website (www.ispe.arizona.edu/climas), the Arizona Department of Water Resources website (www.azwater.gov/dwr/drought), the Nevada Department of Conservation and Natural Resources website (http://dcnr.nv.gov/nrp01/content.htm), and the Utah Division of Water Resources website (www.water.utah.gov/DroughtConditions/) provide information on drought status in the Lower Virgin River Watershed area.

Domestic Animal Concerns

Domestic animal concerns occur whenever the quantity and quality of food are not adequate to meet the nutritional requirements of animals, or

adequate quantity and quality of water is not provided.

Conservation practices applied to address this resource concern are generally those that maintain or improve the quantity, quality, and diversity of forage available for animals, reduce the concentration of animals at existing water sources, and insure adequate quantity and reliability of water for the management of domestic animals. Practices may include brush management, deferred grazing, fencing, pest management, prescribed burning, prescribed grazing, pipelines, ponds, range planting, water spreading, wells, spring development, watering facility, and wildlife upland habitat management.

Species of Concern

There are 69 threatened and endangered species, species of concern, or candidate species listed for the Lower Virgin Watershed (U. S. Fish and Wildlife Service website). In 1990, Arizona voters created the Heritage Fund, designating up to $10 million per year from lottery ticket sales for the conservation and protection of the state's wildlife and natural areas. The Heritage Fund allowed for the creation of the Heritage Data Management System (HDMS) which identifies elements of concern in Arizona and consolidates information about their status and distribution throughout the state (Arizona Game & Fish website, 2006).

The Lower Virgin Watershed contains 37 species that are either listed, species of concern, or candidate species, under the U.S. Endangered Species Act (Table 3-2). The watershed provides habitat for the Southwestern Willow Flycatcher (Empidonax traillii extimus), and eight other species which are classified as being in imminent jeopardy of extinction.

Table 3-2: Lower Virgin River Watershed Species of Concern Classifications

Species Name	Common Name	USESA (1)	STATE (AZ) (2)	BLM (AZ) (3)	USFS (AZ) (4)	STATE (NV) (5)	STATE (UT) (6)	USFS (UT) (7)
Accipiter gentilis	Northern Goshawk						CS	KH
Arctomecon humilis	Dwarf Bearclaw-poppy	LE						
Asio flammeus	Short-eared Owl						SPC	
Astragalus geyeri var triguetrus	Beaver Dam Milkvetch	SC		S				
Astragalus holmgreniorum	Paradox Milkvetch	LE						
Athene cunicularia	Burrowing Owl	LE	HS				SPC	
Bufo microscaphus	Arizona Toad	SC			S		SPC	
Buteo regalis	Ferruginous Hawk						SPC	
Buteogallus anthracinus	Common Black-Hawk		WSC		S			
Callisaurus draconoides	Zebra-tailed Lizard						SPC	
Camissonia brevipes	Golden Suncup	SC						
Catostomus clarkii	Desert Sucker	SC		S			SPC	
Catostomus latipinnis	Flannelmouth Sucker	SC		S	S		CS	
Charadrius montanus	Mountain Plover						SPC	
Cicindela oregona maricopa	Maricopa Tiger Beetle	SC		S	S			
Cirsium virginense	Virgin Thistle	SC	SR					
Coccyzus americanus	Yellow-billed Cuckoo	C					S-ESA	
Coleonyx variegatus	Western Banded Gecko						SPC	
Corynorhinus townsendii	Townsend's Big-eared Bat						SPC	KH
Crenichthys baileyi baileyi	White River Springfish	LE				S1		
Crenichthys baileyi grandis	Hiko White River Springfish	LE				S1		
Crotalus cerastes	Sidewinder						SPC	
Crotalus mitchellii	Speckled Rattlesnake						SPC	
Crotalus scutulatus	Mojave Rattlesnake						SPC	
Dipsosaurus dorsalis	Desert Iguana						SPC	
Dolichonyx oryzivorus	Bobolink						SPC	
Echinocactus polycephalus var xeranthemoides	Grand Canyon Cottontop Cactus		SR					

Species Name	Common Name	USESA (1)	STATE (AZ) (2)	BLM (AZ) (3)	USFS (AZ) (4)	STATE (NV) (5)	STATE (UT) (6)	USFS (UT) (7)
Empidonax traillii extimus	Southwestern Willow Flycatcher	LE	WSC		S	S1B	S-ESA	KH
Enceliopsis argophylla	Silverleaf Sunray			S				
Eriogonum corymbosum var nilesil	Las Vegas Buckwheat	C						
Eriogonum viscidulum	Sticky Buckwheat	SC		S				
Escobaria vivipara var rosea	Viviparous Foxtail Cactus		SR					
Euderma maculatum	Spotted Bat	SC	WSC				SPC	KH
Falco peregrinus anatum	American Peregrine Falcon	SC	WSC		S			KH
Gila robusta	Roundtail Chub	LE				S1	CS	
Gila seminuda	Virgin Chub	LE	WSC		S		S-ESA	
Gopherus agassizii	Desert Tortoise	LT	WSC			S4	S-ESA	SPH
Haliaeetus leucocephalus	Bald Eagle						SPC	KH
Heloderma suspectum	Gila Monster	SC		S			SPC	
Idionycteris phyllotis	Allen's Big-eared Bat	SC		S			SPC	
Lampropeltis pyromelana infralabialis	Utah Mountain Kingsnake				S			
Lasiurus blossevillii	Western Red Bat						SPC	
Lepidomeda mollispinis	Virgin Spinedace	SC	WSC				CS	
Lepidomeda mollispinis pratensis	Big Spring Spinedace	LT				S1		
Leptotyphlops humilis	Western Threadsnake						SPC	
Lithobates onca	Relict Leopard Frog	C	WSC		S			
Lithobates yavapaiensis	Lowland Leopard Frog	SC	WSC		S			
Lupinus latifolius ssp leucanthus	Broadleaf Lupine				S			
Macrotus californicus	California Leaf-nosed Bat	SC	WSC					
Melanerpes lewis	Lewis's Woodpecker						SPC	
Myotis thysanodes	Fringed Myotis						SPC	
Myotis yumanensis	Yuma Myotis	SC						
Nyctinomops macrotis	Big Free-tailed Bat	SC		S			SPC	

Species Name	Common Name	USESA (1)	STATE (AZ) (2)	BLM (AZ) (3)	USFS (AZ) (4)	STATE (NV) (5)	STATE (UT) (6)	USFS (UT) (7)
Opuntia shipplei var shipplei	Whipple Cholla		SR					
Pediocactus sileri	Siler Pincushion Cactus	LT	HS	S				
Pediomelum castoreum	Beaver Dam Scurf Pea	SC						
Pelecanus erythrorhynchos	American White Pelican						SPC	
Penstemon petiolatus	Sheep Range Beardtongue			S				
Plagopterus argentissimus	Woundfin	LE	WSC				S-ESA	
Pyrgulopsis deserta	Desert Springsnail			S	S		SPC	
Rana onca	Relict Leopard Frog	C					S-ESA	
Rhinichthys osculus	Speckled Dace	SC		S				
Sauromalus ater	Common Chuckwalla						SPC	
Sphaeralcea gierischii	Gierisch's globemallow	C						
Spiranthes diluvialis	Ute Lady's Tresses	LT						SPH
Townsendia smithii	Blackrock Ground Daisy			S				
Tricardia watsonii	Three Hearts			S				
Vulpes macrotis	Kit Fox						SPC	
Xantusia vigilis	Desert Night Lizard						SPC	

Data Sources: Utah Automated Geographic Reference Center (AGRC 2009)

(1) USEA Federal U.S. Status

LE Listed Endangered: imminent jeopardy of extinction.

LT Listed Threatened: imminent jeopardy of becoming Endangered .

C Candidate. Species for which USFWS has sufficient information on biological vulnerability and threats to support proposals to list as Endangered or Threatened under ESA. However, proposed rules have not yet been issued because such actions are precluded at present by other listing activity.

SC Species of Concern

(2) State Status – Arizona Sensitive Species List (2008) Arizona Game and Fish Department

HS Highly Safeguarded: no collection allowed.

SR Salvage Restricted: collection only with permit.

WSC Wildlife of Special Concern in Arizona. Species whose occurrence in Arizona is or may be in jeopardy, or perceived threats or populations declines.

(3) BLM Status – Arizona BLM U.S. Bureau of Land Management (2005 Animals, 2005 Plants), Arizona State Office

S Sensitive: those taxa occurring on BLM Field Office Lands in Arizona which are considered sensitive by the Arizona State Office

(4) U.S. Forest Service – Arizona U.S. Department of Agriculture, Forest Service, Region 3

S Sensitive: those taxa occurring on national Forests in Arizona which are considered sensitive by the Regional Forester.

(5) State Status – Nevada Nevada's Protected Species List, Nevada Fish and Wildlife Office, 2008
S1 Critically imperiled due to extreme rarity, imminent threats, or biological factors
S1B Critically imperiled due to extreme rarity, imminent threats, or biological factors, only in captivity or cultivation within the state.
S4 Apparently secure, though frequently quite rare in parts of its range.

(6) State Status – Utah Sensitive Species List (2007) Utah Division of Wildlife Resources
CS Species receiving special management under a conservation agreement in order to preclude the need for federal listing.
S-ESA Federally-listed or candidate species under the U.S. Endangered Species Act.
SPC Wildlife species of concern in Utah

(7) USFS U.S. Forest Service US Department of Agriculture, Intermountain Region Proposed, Endangered, Threatened and Sensitive Species (2008)
KH Known distribution species and/or habitat.
SPH Suspected or potential habitat

Resource Concern Summary

The following information is excerpted from the "*Virgin River Watershed Comprehensive Watershed Analysis*" recently completed by the U.S. Army Corps of Engineers (USACOE, 2008):

Major resource concerns, as identified with stakeholders, and confirmed in review of previous reports, include: Floodplain Management; Land Use Planning; Invasive Species; Water Availability; and River Function. Floodplain regulations are in place and studies and projects underway throughout the watershed. However, multiple flood risks remain and management of that risk is an ongoing issue with technical, regulatory, environmental, communication, and education needs identified.

Communication among agencies and the public has room for improvement, inconsistencies occur across jurisdictions, lack of watershed wide plans, and lack of recognition of the relationships between uplands and floodplains. Rural communities have expressed a need for useful planning tools and data.

Invasive species include tamarisk, cheat grass, and red shiner. Although numerous individual efforts to address tamarisk are underway, and some collaboration is occurring, there is no comprehensive watershed scale coordination or sharing of data.

Water supply and water quality are important aspects of the watershed and needs are described in numerous reports. With growing populations and drought the pressures for the finite water supply will only continue to grow. Water conservation, additional water sources, and evaluation of existing sources are discussed as needs. Groundwater and surface water interaction and salinity have also been expressed as areas of concern within the watershed.

River function is a balance of sediment and water transport that results in channel morphology and associated biotic communities. It includes unusual events and is dynamic. The issue

includes habitat, channel maintenance and endangered species, some of which are currently being addressed (USACOE, 2008).

BLM and other local, state and federal agencies are participants in the Mojave Desert Initiative (MDI) (USFWS, 2007). MDI was established as a forum for government agencies and other partners to collaboratively address wildfire and invasive species issues within the Mohave Basin and Range eco-region of the Mojave Desert in Arizona, Nevada and Utah. The majority of the Lower Virgin River Watershed lies within this eco-region.

The major goals of the MDI include: Protect remaining unburned Mojave Desert vegetation and reduce re-burning; Restore strategically located islands, key habitat areas, and corridors; Improve communication, collaboration, and coordination; and Maximize leveraged funding. Priority actions identified by the MDI include: Develop regional priorities and guidance to minimize or avoid further habitat loss to fire; Define the Mojave Desert Eco-region for the Mojave Desert Initiative purpose; and Complete regional assessment to identify priority areas of work and develop project selection criteria. High density unburned desert tortoise critical habitat has been identified by the MDI as the first priority for protection and restoration (BLM, 2009).

Conservation Progress/Status

Conservation progress for the previous five years in the Lower Virgin River Watershed has focused on addressing the following primary resource concerns

- ✓ Soil Erosion – Wind
- ✓ Soil Erosion – Streambank
- ✓ Soil Condition – Rangeland Site Stability
- ✓ Water Quantity – Rangeland Hydrologic Cycle
- ✓ Water Quantity – Inefficient Water Use on Irrigated Land
- ✓ Plant Condition – Productivity, Health and Vigor
- ✓ Plant Condition – Noxious and Invasive Plants
- ✓ Fish and Wildlife – Inadequate Water

The following table (Table 3-3) presents conservation accomplishments in this watershed during fiscal years (FY) 2004 through 2008, according to the NRCS Progress Reporting System

Table 3-3: Lower Virgin River Watershed Conservation Treatment Applied

Lower Virgin River Watershed (15010010) Conservation Treatment Applied	FY04-08 TOTAL
Clearing and Snagging (code 326) (acres)	14,900
Conservation Crop Rotation (code 328) (acres)	27
Irrigation Water Conveyance, Pipeline, Plastic (code 430) (feet)	600
Irrigation Water Management (code 449) (acres)	27
Residue Management (code 329) (acres)	27
Streambank and Shoreline Protection (code 580) (ft)	22,009
Windbreak/Shelterbelt Establishment (code 380) (acres)	4,970

(NRCS, 2009)

Section 4: Census, Social and Agricultural Data

This section discusses the human component of the watershed and the pressure on natural resources caused by humans and by population change.

Population Density, 1990

Census block statistics for 1990 were compiled from information prepared by Geo-Lytics (Geo-Lytics, 1998). These data were linked with census block data and used to create a density map (Figure 4-1) through a normalization process using a grid of 7 km squares. This process involves calculating density per census block and intersecting it with the grid, which is then used to calculate the number of people and thus density per grid square.

Table 4-1 shows the tabulated minimum, maximum and mean number of people per square mile in 1990 for each 10-digit watershed. In 1990, the mean population density for the entire watershed was 3.0 people per square mile in Nevada, 0.2 people per square mile in Arizona, and 10 people per square mile in Utah. Black Rock Gulch - Virgin River Watershed (Utah) had the highest population mean with 31 people per square mile. Black Rock Gulch - Virgin River Watershed (Utah) had the highest maximum population density of 809 people per square mile. Black Rock Gulch - Virgin River Watershed (AZ) had the lowest density with a mean of 0.1 people per square mile.

For 1990, the population density for Utah and Nevada was calculated at the census block group level, while the density for Arizona was calculated at the census block level due to data availability issues. Census block data was available for all three states.

Population Density, 2000

The Census Block 2000 statistics data were downloaded from the Environmental Systems Research Institute (ESRI) website (ESRI Data Products, 2003)

A population density map and table (Figure 4-2 and Table 4-2) were created from these data. The mean population density in 2000 was 9.0 people per square mile in Nevada, 3.0 people per square mile in Arizona, and 9.0 people per square mile in Utah. Sand Hollow Wash – Virgin Wash Watershed (Nevada) had the highest mean population density with 50 people per square mile. Sand Hollow Wash – Virgin Wash Watershed (Nevada) also had the highest maximum density of 3174 people per square mile.

Population Density Change, 1990-2000

The 1990 and 2000 population density maps were used to create a population density change map. The resulting map and table (Figure 4-3 and Table 4-3) show population increase or decrease over the ten year time frame. Overall, mean population density increased by 6.0 people per square mile in Nevada, increased by3.0 people per square mile in Arizona, and decreased by 1.o person per square mile in Utah, during this ten-year time period. Short Creek Watershed (AZ) Black Rock Gulch - Virgin River Watershed (Utah) had the largest increase in mean population at 301 people per sq.mi.

Housing Density, 2000 and 2030

The Watershed Housing Density Map for the years 2000 and 2030 were created with data developed by David M. Theobald (Theobald, 2005). Theobald developed a nationwide housing density model that incorporates a thorough way to account for land-use change beyond the "urban fringe."

Exurban regions are the "urban fringe", or areas outside suburban areas, having population densities greater than 0.68 – 16.18 ha (1.68 – 40 acres) per unit. Theobald stresses that exurban areas are increasing at a much faster rate than urban sprawl, are consuming much more land, and are having a greater impact on ecological health, habitat fragmentation and other resource concerns.

Theobald estimates that the exurban density class has increased at a much faster rate than the urban/suburban density classes. Theobald's model forecasts that this trend will continue and may even accelerate by 2030. This indicates that development patterns are shifting more towards exurban, lower density, housing units, and are thereby consuming more land. He suggests that exurban development has more overall effect on natural resources because of the larger footprint and disturbance zone, a higher percent of impervious surfaces, and higher pollution because of more vehicle miles traveled to work and shopping.

Housing density for the year 2000 indicates that about 93% of the watershed is classified has no data associated with it, 5.0% is classified as "undeveloped private," and 0.7% is classified as "rural" (Figure 4-4 and Table 4-4). For 2030, (Figure 4-5 and Table 4-5) 93% of the watershed still has no data, "undeveloped private" land decreases to 4% of the watershed, and "rural" land increases to 1.0% of the watershed.

*Table 4-1: Lower Virgin River Watershed 1990 Population Density (people/square mile)**

10-digit Watershed Name	Area (sq. miles)	Population Density (people/sq.mi.)		
		Min	Max	Mean
Upper Beaver Dam Wash (NV) H1501001001	55	0.03	1.6	0.6
Upper Beaver Dam Wash (UT) H1501001001	285	0.2	4	2
Lower Beaver Dam Wash (AZ) H1501001002	18	0.01	12	1
Lower Beaver Dam Wash (NV) H1501001002	144	< 0.00	0.3	0.3
Lower Beaver Dam Wash (UT) H1501001002	76	< 0.00	2	2
Black Rock Gulch-Virgin River (AZ) H1501001003	300	0	12	0.1
Black Rock Gulch-Virgin River (UT) H1501001003	123	0.3	809	31
Garden Wash (NV) H1501001004	181	0.3	0.3	0.3
Toquop Wash (NV) H1501001005	275	0.3	178	2
Sand Hollow Wash – Virgin River (AZ) H1501001006	174	0	12	0.3
Sand Hollow Wash – Virgin River (NV) H1501001006	159	0.07	157	6
Sand Hollow Wash – Virgin River (UT) H1501001006	2	0.3	17	1.2
Halfway Wash – Virgin (NV) River H1501001007	272	0.3	178	6
Total Lower Virgin River Watershed (AZ)	492	0	12	0.2
Total Lower Virgin River Watershed (NV)	1,086	0	178	3
Total Lower Virgin River Watershed (UT)	486	0	809	10

Note: Adjacent watersheds may share a grid square. Data Sources: Census block statistics for 1990 were compiled from a CD prepared by Geo-Lytics (GeoLytics, Inc.1998. Census 1990. Census CD + Maps. Release 3.0.), Utah GIS Data Portal, October 2008, U.S. Census.

** The population density for Utah was calculated at the census block group level, while the density for Arizona was calculated at the census block level due to data availability issues. Census block groups are larger than census blocks.*

Table 4-2: Lower Virgin River Watershed 2000 Population Density (people/square mile)

10-digit Watershed Name	Area (sq. miles)	Population Density (people/sq.mi.)		
		Min	Max	Mean
Upper Beaver Dam Wash (NV) H1501001001	55	0	0.07	0.01
Upper Beaver Dam Wash (UT) H1501001001	285	0	1.7	0.2
Lower Beaver Dam Wash (AZ) H1501001002	18	2	177	20
Lower Beaver Dam Wash (NV) H1501001002	144	0	0.02	< 0.00
Lower Beaver Dam Wash (UT) H1501001002	76	0	0.7	0.02
Black Rock Gulch-Virgin River (AZ) H1501001003	300	0	177	1.3
Black Rock Gulch-Virgin River (UT) H1501001003	123	0	1,205	33
Garden Wash (NV) H1501001004	181	0	0.02	0.01
Toquop Wash (NV) H1501001005	275	0	15	0.2
Sand Hollow Wash – Virgin River (AZ) H1501001006	174	0	177	6
Sand Hollow Wash – Virgin River (NV) H1501001006	159	0	3174	50
Sand Hollow Wash – Virgin River (UT) H1501001006	2	0	0	0
Halfway Wash – Virgin (NV) River H1501001007	272	0	26	0.6
Total Lower Virgin River Watershed (AZ)	492	0	177	3
Total Lower Virgin River Watershed (NV)	1,086	0	3174	9
Total Lower Virgin River Watershed (UT)	486	0	1205	9

Note: Adjacent watersheds may share a grid square. Data Sources: Census block statistics for 1990 were compiled from a CD prepared by Geo-Lytics (GeoLytics, Inc.1998. Census 1990. Census CD + Maps. Release 3.0.) Utah GIS Data Portal, October 2008, U.S. Census.

Table 4-3: Lower Virgin River Watershed Population Density Change, 1990-2000 (people/square mile)

10-digit Watershed Name	Area (sq. miles)	Population Density (people/sq.mi.)		
		Min	Max	Mean
Upper Beaver Dam Wash (NV) H1501001001	55	-1.6	-0.02	-0.6
Upper Beaver Dam Wash (UT) H1501001001	285	-4	-0.2	-2
Lower Beaver Dam Wash (AZ) H1501001002	18	1.5	166	19
Lower Beaver Dam Wash (NV) H1501001002	144	-0.3	< -0.00	-0.3
Lower Beaver Dam Wash (UT) H1501001002	76	-2.0	< -0.00	-1.8
Black Rock Gulch-Virgin River (AZ) H1501001003	300	-6	166	1.2
Black Rock Gulch-Virgin River (UT) H1501001003	123	-373	760	301
Garden Wash (NV) H1501001004	181	-0.34	-0.32	-0.3
Toquop Wash (NV) H1501001005	275	-168	15	-2
Sand Hollow Wash – Virgin River (AZ) H1501001006	174	0	166	6
Sand Hollow Wash – Virgin River (NV) H1501001006	159	-151	3,032	44
Sand Hollow Wash – Virgin River (UT) H1501001006	2	-2	-0.3	-1
Halfway Wash – Virgin (NV) River H1501001007	272	-168	23	-6
Total Lower Virgin River Watershed (AZ)	492	-6	166	3
Total Lower Virgin River Watershed (NV)	1,086	-168	3,032	6
Total Lower Virgin River Watershed (UT)	486	-373	760	-1

Note: Adjacent watersheds may share a grid square. Data Sources: Census block statistics for 1990 were compiled from a CD prepared by Geo-Lytics (GeoLytics, Inc.1998. Census 1990. Census CD + Maps. Release 3.0.) Utah GIS Data Portal, October 2008, U.S. Census.

Table 4-4: Lower Virgin River Watershed Housing Density 2000 (Percent of Watershed), Part 1 of 2

Housing Density	Upper Beaver Dam Wash 1501001001	Lower Beaver Dam Wash 1501001002	Black Rock Gulch-Virgin River 1501001003	Garden Wash 1501001004	Toquop Wash 1501001005	Sand Hollow Wash-Virgin River 1501001006
No Data	92%	93%	87%	100%	99%	98%
Undeveloped Private	6%	4%	11%	-	1%	0.5%
Rural	2%	0.02%	0.7%	-	-	0.4%
Exurban	< 0.00%	3%	1%	-	-	1.5%
Suburban	-	0.04%	0.2%	-	-	< 0.00%
Urban	-	0.02%	0.09%	-	-	< 0.00%

Note: the dataset used for this analysis only covers 7% of the entire Lower Virgin River Watershed. Source: Theobald, D. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecology and Society 10(1): 32. [online] URL: http://www.ecology and society.org/vol10/iss1/art32/

Table 4-4: Lower Virgin River Watershed Housing Density 2000 (Percent of Watershed), Part 2 of 2

Housing Density	Halfway Wash-Virgin River 1501001007	Lower Virgin River Watershed	Lower Virgin River Watershed (sq. miles)
No Data	89%	93%	1926
Undeveloped Private	10%	5%	107
Rural	0.7%	0.7%	14
Exurban	0.04%	0.7%	15
Suburban	< 0.00%	0.05%	1
Urban	0.01%	0.05%	1

Note: the dataset used for this analysis only covers 7% of the entire Lower Virgin River Watershed. Source: Theobald, D. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecology and Society 10(1): 32. [online] URL: http://www.ecology and society.org/vol10/iss1/art32/

Table 4-5: Lower Virgin River Watershed Housing Density 2030 (Percent of Watershed), Part 1 of 2

Housing Density	Upper Beaver Dam Wash 1501001001	Lower Beaver Dam Wash 1501001002	Black Rock Gulch-Virgin River 1501001003	Garden Wash 1501001004	Toquop Wash 1501001005	Sand Hollow Wash-Virgin River 1501001006
No Data	92%	93%	87%	100%	99%	98%
Undeveloped Private	6%	4%	6%	-	1%	0.3%
Rural	2%	0.2%	4%	-	-	0.3%
Exurban	0.06%	2%	2%	-	-	1%
Suburban	-	0.4%	0.5%	-	-	0.06%
Urban	-	0.04%	0.5%	-	-	< 0.00%

Note: the dataset used for this analysis only covers 7% of the entire Lower Virgin River Watershed. Source: Theobald, D. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecology and Society 10(1): 32. [online] URL: http://www.ecology and society.org/vol10/iss1/art32/

Table 4-5: Lower Virgin River Watershed Housing Density 2030 (Percent of Watershed), Part 2 of 2

Housing Density	Halfway Wash-Virgin River 1501001007	Lower Virgin River Watershed	Lower Virgin River Watershed (sq. miles)
No Data	89%	93%	1926
Undeveloped Private	10%	4%	86
Rural	1%	1%	28
Exurban	0.1%	0.9%	19
Suburban	< 0.00%	0.1%	3
Urban	0.01%	0.1%	2

Note: the dataset used for this analysis only covers 7% of the entire Lower Virgin River Watershed. Source: Theobald, D. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecology and Society 10(1): 32. [online] URL: http://www.ecology and society.org/vol10/iss1/art32/

Lower Virgin River Watershed Agricultural Statistics

The lower Virgin River Watershed straddles three states, Nevada, Utah, and Arizona. Arizona is known as one of the most productive and efficient agricultural regions in the world, with beauty that also provides the food and fiber to sustain life in the desert. Arizona is also one of the most diverse agricultural producing states in the nation, producing more than 160 varieties of vegetables, livestock, field crops and nursery stock. The climate, natural resources, agribusiness infrastructure and farm heritage help make agriculture a $9.2 billion dollar industry employing more than 72,000 individuals.

On the margins of the productive portion of Arizona agricultural land, most farms in the Lower Virgin River Watershed

(Nevada, and Utah and Arizona combined) are small or moderately sized. Ninety-three percent of all farms in the watershed are less than 1,000 acres in size, and 51% are less than 50 acres (Table 4-6 and Figure 4-6). Of the 136 farms that have pasture and rangeland, 57 have 100 or more acres (Table 4-7 and Table 4-7). Of the 124 farms that harvest crops, 66% are 49 acres or less in size (Table 4-8 and Figure 4-8).

The NASS (National Agricultural Statistics Service, United States Department of Agriculture) has farm data by zip code. We used the U.S. Census Bureau ZIP Census Tabulation Areas (ZCTA) to generate maps. A typical 5-digit ZCTA (there are 3-digit ZCTAs as well) is typically nearly identical to a 5-digit U.S. Postal Service ZIP code, but there are some distinctions. Unlike ZIP codes, ZCTA areas are spatially complete and they are easier to map. The Bureau created special `XX ZCTAs (ZCTAs with a valid 3-digit ZIP but with “XX” as last two characters of the code) which represent large unpopulated areas where it made no sense to assign a census block to an actual ZIP code. Similarly, HH ZCTAs represent large bodies of water within a 3-digit zip area. There is typically no population in either an XX or HH ZCTA.

Data is withheld by NASS for categories with one to four farms. This is to protect the identity of individual farmers. Farm counts for these zip codes are included in the "State Total" category. Some categories only contained stars instead of numbers. Each star was counted as one farm. But because each star could represent as many as 4 farms, each number on the tables are actually greater than or equal to the number listed. In some cases this results in percentages that add up to more or less than 100 percent.

Tables Include data from zip codes both contained within the watershed and zip codes crossing watershed boundaries, which may incorporate some error in these tabulations.

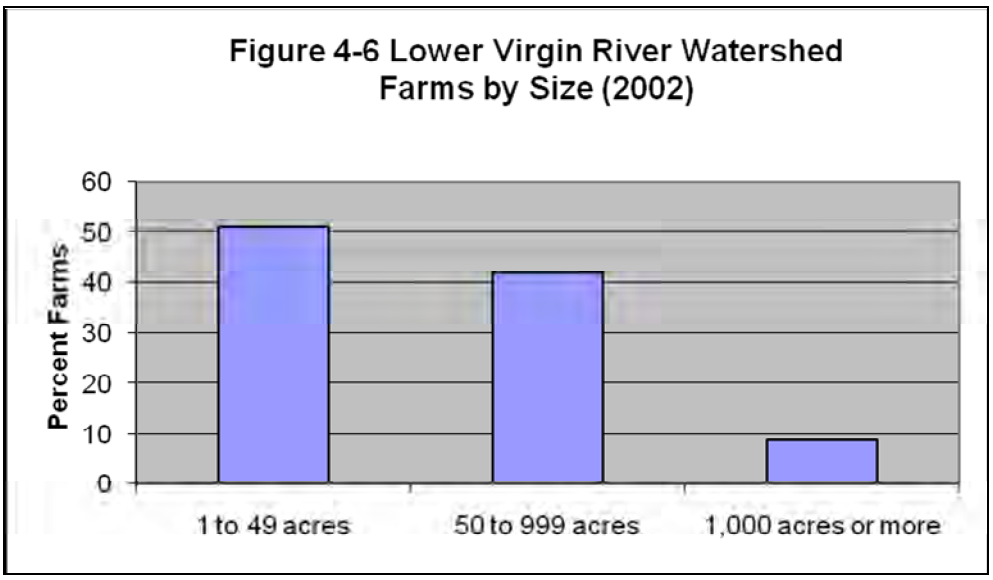

Table 4-6: Lower Virgin River Watershed Farms by Size

All farms	1 to 49 acres	50 to 999 acres	>1000 acres
321	51%	42%	9%

NASS defines a "farm" as an operation with at least $1000 in agricultural sales from agriculture. Percents rounded. Data source: NASS (National Agricultural Statistics Service, United States Department of Agriculture)

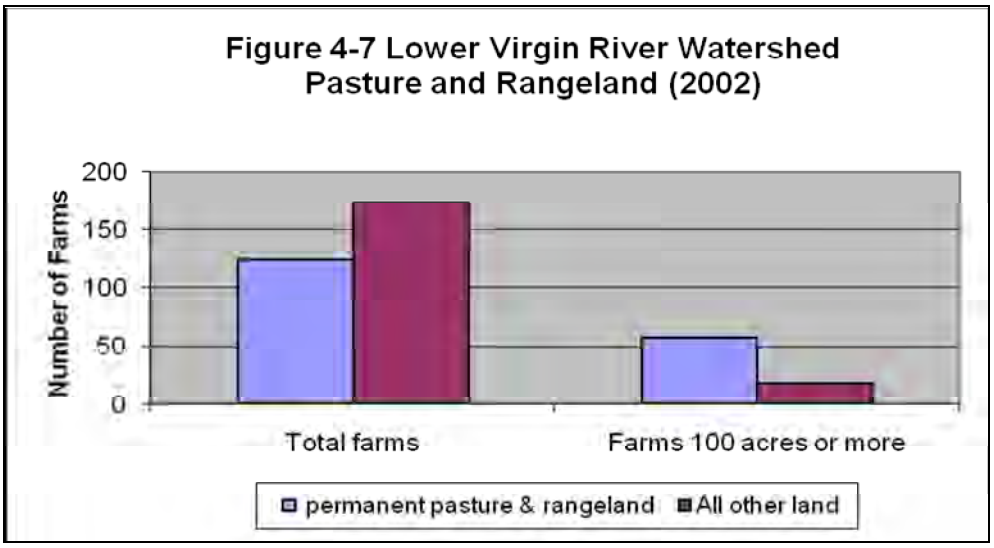

Table 4-7: Lower Virgin River Watershed Pasture and Rangeland (2002)

Category	Total farms	Farms 100 acres or more
Permanent pasture and rangeland	124	57
All other land	174	18

Grazing lands are the USDA Pastureland, as defined by NASS, includes cropland used only for pasture or grazing, woodland pastured, and other pastureland and rangeland. Percents rounded. Data source: NASS (National Agricultural Statistics Service, United States Department of Agriculture)

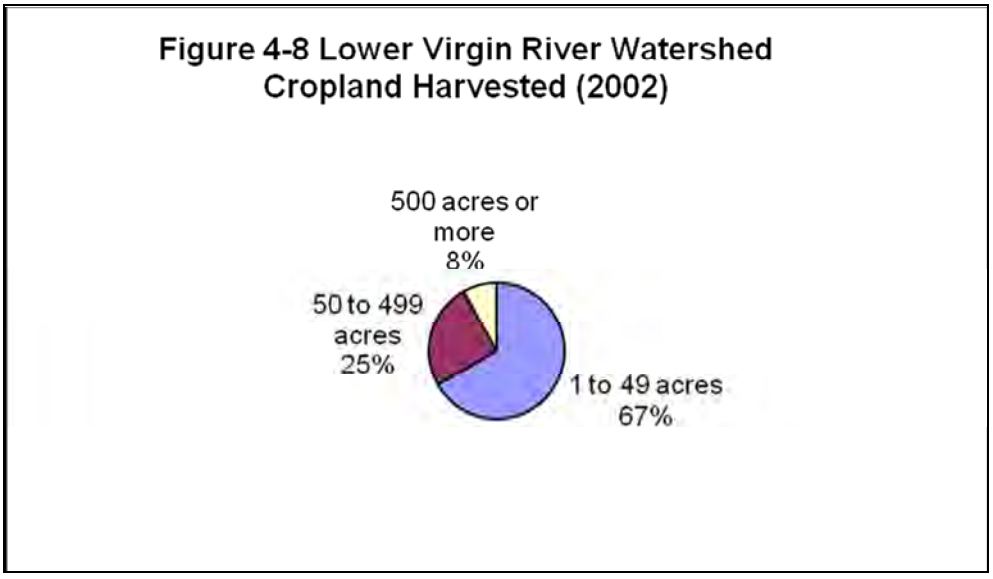

Table 4-8: Lower Virgin River Watershed Cropland Harvested

Total farms	1 to 49 acres	50 to 499 acres	>500 acres
151	66%	25%	8%

According to the NASS, "harvested cropland" includes all land from which crops were harvested, including: cut hay; all land in orchards; citrus groves; and, nursery and greenhouse crops. Land from which two or more crops were harvested was counted only once even though there was more than one use of that land. Percents rounded. Data source: NASS (National Agricultural Statistics Service, United States Department of Agriculture).

Section 5: Resource Assessment Tables

The following Resource Assessment Tables summarize current and desired future natural resource conditions for the Lower Virgin River Watershed. The tables present information on benchmark and future conservation systems and practices, qualitative effects on primary resource concerns, and estimated costs for conservation implementation. Conservation District Board members, NRCS conservationists, and other people familiar with conservation work in the watershed were consulted for estimating current and future natural resource conditions.

The tables show three levels of conservation treatment (Baseline, Progressive, Resource Management System) for each of the major land uses within the watershed (crop and range). **Baseline** is defined as a low level of conservation adoption with landowners who are typically not participating in conservation programs. There are, however, a few practices that have been commonly adopted by all landowners in this watershed. **Progressive** is defined as an intermediate level of conservation adoption with landowners who are actively participating in conservation programs and have adopted several practices but not satisfied all of the Quality Criteria in the NRCS Field Office Technical Guide. **Resource Management System** (RMS) is defined as a complete system of conservation practices that addresses all of the Soil, Water, Air, Plant, and Animal (SWAPA) resource concerns typically seen for this land use in this watershed.

For each land use, the results of the assessment are presented in two parts. Part 1 (Assessment Information) summarizes the conservation practices at each treatment level and the quantities of practices for current benchmark conditions and projected future conditions. Part 1 also displays the four primary resource concerns, along with individual practice effects and an overall Systems Rating (ranging from a low of 1 to a high of 5) indicating the effectiveness of the conservation system used at each treatment level. Part 2 (Conservation Cost Table) summarizes the installation, management, and related costs by conservation practice and treatment level for the projected future conditions by federal and private share of the costs. Part 2 also displays the benchmark and future conservation conditions status bars.

Credit goes to NRCS in Oregon for development of the template for these Resource Assessment Tables.

WATERSHED NAME & CODE	LOWER VIRGIN RIVER - 15010010				LANDUSE ACRES	1,000		
LANDUSE TYPE	CROPLAND				TYPICAL UNIT SIZE ACRES	100		
ASSESSMENT INFORMATION					CALCULATED PARTICIPATION	10%		
	Benchmark Conditions	Future Conditions			RESOURCE CONCERNS			
Conservation Systems by Treatment Level	Total Units	Existing Unchanged Units	New Treatment Units	Total Units	Soil Erosion – Wind	Water Quantity – Inefficient Water Use on Irrigated Land	Plant Condition – Noxious and Invasive Plants	
Baseline				**System Rating ->**	**0**	**0**	**0**	
No Conservation Practices being applied at this level	0	0	0	0	0	0	0	
Total Acreage at Baseline	**400**	**360**	**0**	**360**				
Progressive				**System Rating ->**	**1**	**4**	**2**	
Conservation Crop Rotation (ac.) 328	300	270	20	290	3	3	3	
Irrigation Water Conveyance, Pipeline (ft.) 430	3,000	2,700	200	2,900	0	5	2	
Total Acreage at Progressive Level	**600**	**540**	**40**	**580**				
RMS				**System Rating ->**	**4**	**4**	**2**	
Conservation Crop Rotation (ac.) 328	0	30	30	60	3	3	3	
Irrigation Water Conveyance, Pipeline (ft.) 430	0	300	300	600	0	5	2	
Irrigation Water Management (ac.) 449	0	0	60	60	2	5	2	
Residue Management, No-Till/Strip Till/Direct Seed (ac.) 329	0	0	60	60	5	2	-1	
Total Acreage at RMS Level	**0**	**0**	**60**	**60**				

WATERSHED NAME & CODE	LOWER VIRGIN RIVER - 15010010	LANDUSE ACRES	1,000
LANDUSE TYPE	CROPLAND	TYPICAL UNIT SIZE ACRES	100
CONSERVATION COST TABLE		CALCULATED PARTICIPATION	10%

	FUTURE	FEDERAL				PRIVATE		
Conservation Systems by Treatment Level	New Treatment Units	Installation Cost 50%	Management Cost - 3 yrs 100%	Technical Assistance 20%	Total Present Value Cost	Installation Cost 50%	Annual O & M + Mgt Costs 100%	Total Present Value Cost
Progressive								
Conservation Crop Rotation (ac.) 328	20	$0	$600	$120	$665	$0	$200	$321
Irrigation Water Conveyance, Pipeline (ft.) 430	200	$1,000	$0	$200	$1,200	$1,000	$40	$1,173
Subtotal	**40**	**$1,000**	**$600**	**$320**	**$1,865**	**$1,000**	**$240**	**$1,494**
RMS								
Conservation Crop Rotation (ac.) 328	30	$0	$900	$180	$997	$0	$300	$482
Irrigation Water Conveyance, Pipeline (ft.) 430	300	$1,500	$0	$300	$1,800	$1,500	$60	$1,760
Irrigation Water Management (ac.) 449	60	$0	$1,800	$360	$1,994	$0	$600	$964
Residue Management, No-Till/Strip Till/Direct Seed (ac.) 329	60	$0	$1,800	$360	$1,994	$0	$600	$964
Subtotal	**60**	**$1,500**	**$4,500**	**$1,200**	**$6,785**	**$1,500**	**$1,560**	**$4,169**
Grand Total	**100**	**$2,500**	**$5,100**	**$1,520**	**$8,650**	**$2,500**	**$1,800**	**$5,664**

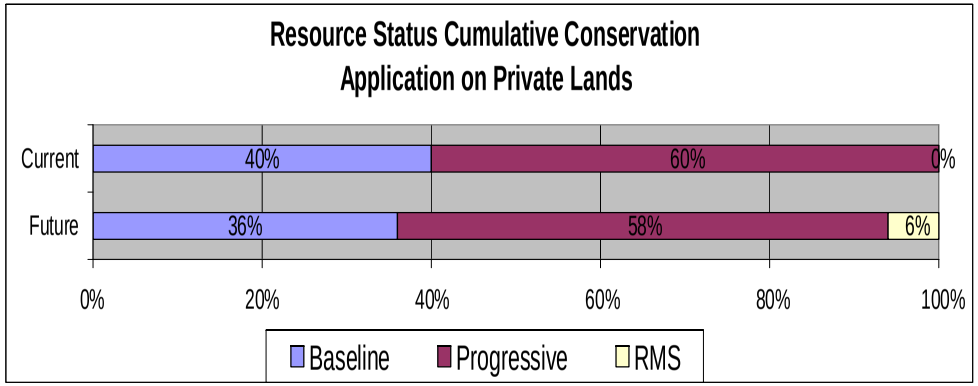

Chart Refers To	
Landuse Type	CROPLAND
Calculated Participation Rate	10%

Average PV Costs per Ac		
System	Federal	Private
Prog	$46.62	$37.36
RMS	$113.08	$69.49

WATERSHED NAME & CODE	LOWER VIRGIN RIVER - 15010010				LANDUSE ACRES	1,000,000		
LANDUSE TYPE	RANGE				TYPICAL UNIT SIZE ACRES	50,000		
ASSESSMENT INFORMATION					CALCULATED PARTICIPATION	5%		
	Benchmark Conditions	Future Conditions			RESOURCE CONCERNS			
Conservation Systems by Treatment Level	Total Units	Existing Unchanged Units	New Treatment Units	Total Units	Soil Erosion – Wind	Plant Condition - Productivity, Health and Vigor	Plant Condition - Noxious and Invasive Plants	Domestic Anima – Inadequate Quantities and Quality of Feed and Forage
Baseline				**System Rating ->**	**0**	**0**	**0**	**0**
No Conservation Practices being applied at this leve	0	0	0	0	0	0	0	0
Total Acreage at Baseline	**950,000**	**902,500**	**0**	**902,500**				
Progressive				**System Rating ->**	**0**	**0**	**0**	**0**
Fence (ft.) 382	500	475	475	950	0	1	0	1
Pipeline (ft.) 516	2,000	1,900	1,900	3,800	0	0	0	0
Total Acreage at Progressive Leve	**50,000**	**47,500**	**47,500**	**95,000**				
RMS				**System Rating ->**	**3**	**4**	**3**	**3**
Fence (ft.) 382	0	25	25	50	0	1	0	1
Pipeline (ft.) 516	0	100	100	200	0	0	0	0
Prescribed Grazing (ac.) 528	0	0	2,500	2,500	5	5	4	5
Upland Wildlife Habitat Management (ac.) 645	0	0	125	125	0	4	4	1
Total Acreage at RMS Level	**0**	**0**	**2,500**	**2,500**				

WATERSHED NAME & CODE	LOWER VIRGIN RIVER - 15010010	LANDUSE ACRES	1,000,000
LANDUSE TYPE	RANGE	TYPICAL UNIT SIZE ACRES	50,000
CONSERVATION COST TABLE		CALCULATED PARTICIPATION	5%

	FUTURE	FEDERAL				PRIVATE		
Conservation Systems by Treatment Level	New Treatment Units	Installation Cost 50%	Management Cost - 3 yrs 100%	Technical Assistance 20%	Total Present Value Cost	Installation Cost 50%	Annual O & M + Mgt Costs 100%	Total Present Value Cost
Progressive								
Fence (ft.) 382	475	$713	$0	$143	$855	$713	$29	$836
Pipeline (ft.) 516	1,900	$7,600	$0	$1,520	$9,120	$7,600	$304	$8,916
Subtotal	**47,500**	**$8,313**	**$0**	**$1,663**	**$9,975**	**$8,313**	**$333**	**$9,752**
RMS								
Fence (ft.) 382	25	$38	$0	$8	$45	$38	$2	$44
Pipeline (ft.) 516	100	$400	$0	$80	$480	$400	$16	$469
Prescribed Grazing (ac.) 528	2,500	$1,875	$0	$375	$2,250	$1,875	$0	$1,875
Upland Wildlife Habitat Management (ac.) 645	125	$0	$488	$98	$540	$0	$163	$261
Subtotal	**2,500**	**$2,313**	**$488**	**$560**	**$3,315**	**$2,313**	**$180**	**$2,649**
Grand Total	**50,000**	**$10,625**	**$488**	**$2,223**	**$13,290**	**$10,625**	**$513**	**$12,401**

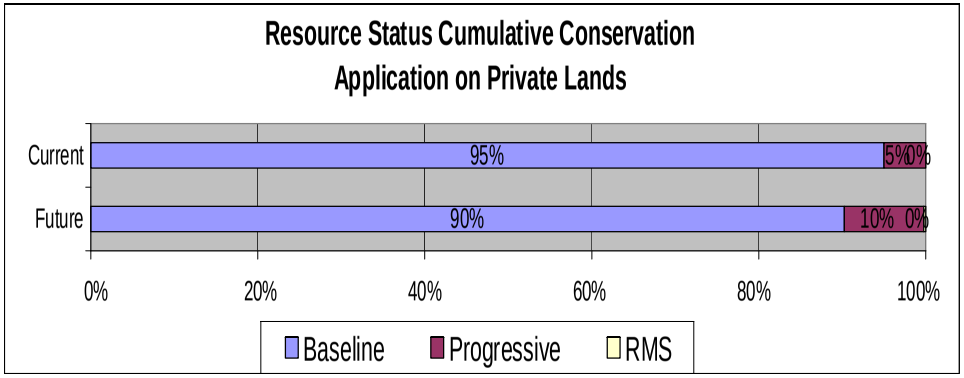

Chart Refers To	
Landuse Type	RANGE
Calculated Participation Rate	5%

Average PV Costs per Ac		
System	Federal	Private
Prog	$0.21	$0.21
RMS	$1.33	$1.06

Section 6: References

Arizona Association of Conservation Districts (http://www.aaocd.org/)

Arizona Dept. of Agriculture (http://www.azda.gov/)

Arizona Department of Environmental Quality. 2007. Antidegradation Implementation Procedures, Draft.

Arizona Department of Environmental Quality. 2007. Water Quality Improvement Manual, http://www.azdeq.gov/environ/water/watershed/download/manual.pdf.

Arizona Dept. of Environmental Quality, Water Quality Monitoring & Assessment (http://azdeq.gov/environ/water/assessment/assess.html)

Arizona Department of Environmental Quality (ADEQ). Draft 2006 Status of Ambient Surface Water Quality in Arizona – Arizona's Integrated 305(b) Assessment and 303(d) Listing Report. Arizona Department of Environmental Quality, Phoenix, Arizona.

Arizona Department of Environmental Quality. 2008. Arizona's 2006/2008 Impaired Waters
http://lists.azdeq.gov/environ/water/assessment/download/2008/2006_2008.pdf

Arizona Department of Environmental Quality, Air Quality Division, http://www.azdeq.gov/environ/air/plan/notmeet.html#phoenix

Arizona Department of Water Resources, Arizona Drought Preparedness Plan, Background & Impact Assessment Section, Governor's Drought Task Force, Governor Janet Napolitano, October 8, 2004. http://www.azwater.gov/dwr/content/find_by_program/GDTF/conclusion/Background_Section_100804FINAL.pdf

Arizona Department of Water Resources (ADWR), 2007. Arizona Water Atlas, Vol. 6, web published at http://www.azwater.gov/dwr/

Arizona Game & Fish Dept. Heritage Database
http://www.azgfd.gov/w_c/edits/species_concern.shtml)

Arizona Game & Fish website, 2006,
http://www.azgfd.gov/w_c/heritage_program.shtml.

Arizona State Land Department, Arizona Land Resource Information System (ALRIS), GIS data layer "cra_a_az," 2004. http://www.land.state.az.us/alris/index.html.

Arizona State Land Department, Arizona Land Resource Information System (ALRIS), GIS data layer "Geology," February 7, 2003. http://www.land.state.az.us/alris/index.html.

Arizona State Land Department, Arizona Land Resource Information System (ALRIS), GIS data layer "Lakes," February 7, 2003, http://www.land.state.az.us/alris/index.html.

Arizona State Land Department, Arizona Land Resource Information System (ALRIS), GIS data layer "mines", February 7, 2002 http://www.land.state.az.us/alris/index.html

Arizona State Land Department, Arizona Land Resource Information System (ALRIS), GIS data layer "natveg", June 12, 2003 http://www.land.state.az.us/alris/index.html

Arizona State Land Department, Arizona Land Resource Information System (ALRIS), *GIS data layer "ownership", October 27, 2007* *http://www.land.state.az.us/alris/index.html*

Arizona State Land Department, Arizona Land Resource Information System (ALRIS), GIS data layer "Streams", Arizona, October, 10, 2002 http://www.land.state.az.us/alris/index.html.

Brown, David E., and Charles H. Lowe, Biotic Communities of the Southwest 1:1,000,000 scale, August 1980.

Bureau of Land Management Arizona Website (http://www.blm.gov/az/st/en.html)

Bureau of Land Management, State of Nevada. October 2008. http://www.blm.gov/nv/st/en/prog/more_programs/geographic_sciences/gis/geospatial_data.html

Chronic, Halka. 1983. Roadside Geology of Arizona. Mountain Press Publishing Company, Montana.

Clark County Nevada, Southern Nevada GIS Data Portal. October 2008. http://gisgate.co.clark.nv.us/gismo/freedata.htm

Climate Assessment for the Southwest (CLIMAS) website www.ispe.arizona.edu/climas, information on Arizona's drought status.

Environmental Protection Agency (EPA) website http://epa.gov/air/airtrends/aqtrnd95/pm10.html

ESRI Data Products, http://arcdata.esri.com/data/tiger2000/tiger_download.cfm Census 2000. October 17, 2003.

GeoLytics, Inc. 1998. Census 1990. Census CD + Maps. Release 3.0.

Gordon, N.D., T.A. McMahon, and B.L. Finlayson. 1992. Stream Hydrology; Chapter 4- Getting to know your stream. John Wiley & Sons, New York, NY

Kamilli, R.J. and S.M. Richard, eds. Geologic Highway map of Arizona: Tucson, Arizona Geological Society and Arizona Geological Survey. 1998. 1 sheet containing text and figures, scale 1:1,000,000.

Lowry, J. H, Jr., R. D. Ramsey, K. Boykin, D. Bradford, P. Comer, S. Falzarano, W. Kepner, J. Kirby, L. Langs, J. Prior-Magee, G. Manis, L. O'Brien, T. Sajwaj, K. A. Thomas, W. Rieth, S. Schrader, D. Schrupp, K. Schulz, B. Thompson, C. Velasquez, C. Wallace, E. Waller and B. Wolk. 2005. /Southwest Regional Gap Analysis Project: Final Report on Land Cover Mapping Methods/, RS/GIS Laboratory, Utah State University, Logan, Utah

National Agricultural Statistics Service (http://www.nass.usda.gov/)

Natural Resources Conservation Service (NRCS), 2007, Table generated by NRCS Phoenix Office

Natural Resources Conservation Service (NRCS) Fact Sheet, Lower Virgin River Watershed

Natural Resources Conservation Service (NRCS) Website 2006, Technical Guide – New Mexico http://www.nm.nrcs.usda.gov/technical/fotg/transmittals/fotg-1.doc

Natural Resources Conservation Service Arizona Website (http://www.az.nrcs.usda.gov/)

Natural Resources Conservation Service Arizona GIS Webpage (http://www.az.nrcs.usda.gov/technical/gis/index.html)

Natural Resources Conservation Service Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/)

Natural Resources Conservation Service Water & Climate Center (http://www.wcc.nrcs.usda.gov/)

Nevada Division of Environmental Protection (NDEP), 2009, Email from Kathy Sertic, April 2.

Nevada Natural Heritage Program, Dept. of Conservation and Natural Resources. October 2008. http://heritage.nv.gov/gis/gis.htm

Southern Arizona Data Services Program, GIS data layer "Arizona Gap Analysis Project Vegetation Map", University of Arizona, 2004, http://sdrsnet.srnr.arizona.edu/index.php, originated by Arizona Game & Fish Department, Habitat Branch, 1993, this dataset was digitized from the August 1980 David E. Brown & Charles H. Lowe 1:1,000,000 scale, 'Biotic Communities of the Southwest'.

Southwest Regional GAP Project (http://fws-nmcfwru.nmsu.edu/swregap/

Theobald, D. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecology and Society 10(1): 32. [online] URL: http://www.ecology and society.org/vol10/iss1/art32/.

United States Army Corps of Engineers, 2008, Virgin River Watershed: Comprehensive Watershed Analysis, Utah, Arizona & Nevada, October.

United States Army Corps of Engineers, 2009, Virgin River and Its Tributaries, Utah, Arizona, and Nevada, Initial Assessment for Regional Flood Warning.

United States Department of Agriculture, GIS Data Analysis, obtained from U.S. Forest Service, Southwestern Region, Forest Health office, Feb. 26, 2007

United States Environmental Protection Agency, Surf Your Watershed (http://www.epa.gov/surf/)

United States Environmental Protection Agency, Air Quality Trends, http://epa.gov/air/aritrends/aqtrnd95/pm10.html.

United States Fish & Wildlife Service (USFWS), (2007), Mohave Desert Initiative (MDI), Journal Entry, December 11, http://www.fws.gov/arsnew/regmap.cfm?arskey=23087.

United States Fish & Wildlife Service, Threatened and Endangered Species Listed for Arizona, http://ecos.fws.gov.

United States Fish & Wildlife Service Arizona Ecological Services http://www.fws.gov/southwest/es/arizona/

United States Forest Service (USFS), Terrestrial Ecosystem Surveys. Surveys are available for National Forest Lands within the watershed.

United States Forest Service Southwestern Region (http://www.fs.fed.us/r3/)

United States Geological Survey, NLCD Land Cover Class Definitions, http://landcover.usgs.gov/classes.php

United States Geological Survey, October 8, 2008, derived from DEM, http://seamless.usgs.gov/

United States Geological Survey website, National Water Information System http://waterdata.usgs.gov/nwis/

United States Geological Survey, 2000, Geophysical Constraints on the Virgin River Depression, Nevada, Utah, and Arizona, Open-File Report 00-407 http://geopubs.wr.usgs.gov/open-file/of00-407/of00-407n.pdf

University of Nevada, Reno - W.M. Keck Earth Sciences and Mining Research Information Center. http://keck.library.unr.edu/datawarehouse.html

Utah Automated Geographic Reference Center (AGRC). October 2008 http://agrc.its.state.ut.us/

Western Regional Climate Center (WRCC), Temperature data. July 15, 2004. http://www.wrcc.dri.edu/summary/climsmaz.html.

Zehner, R.E., Coolbaugh, M.F., and Shevenell, Lisa, 2006, Regional groundwater geochemical trends in the Great Basin: Implications for Geothermal Exploration, GRC Transactions 2006, HTTP://www.unr.edu/Geothermal.

GLOSSARY

Drainage Basin	A region or area bounded by a topographic divide and occupied by a drainage system, also known as a watershed.
Drought	There is no universally accepted quantitative definition of drought. Generally, the term is applied to periods of less than average precipitation over a certain period of time; nature's failure to fulfill the water wants and needs of man.
Flood	A flood is an overflow or inundation that comes from a river or other body of water and causes or threatens damage. It can be any relatively high streamflow overtopping the natural or artificial banks in any reach of a stream. It is also a relatively high flow as measured by either gage height or discharge quantity.
Groundwater	The supply of fresh and saline water found beneath the Earth's surface which is often used for supplying wells and springs. Because groundwater is a major source of drinking water, there is a growing concern over areas where leaching agricultural or industrial pollutants are contaminating groundwater.
Soil Moisture Regimes	**Aridic** is a soil moisture regime that has no water available for plants for more than half the cumulative time that the soil temperature at 50 cm (20 in.) below the surface is >5°C (41° F), and has no period as long as 90 consecutive days when there is water for plants while the soil temperature at 50 cm (20 in.) is continuously >8°C (46°F). **Udic** is a soil moisture regime that is neither dry for as long as 90 cumulative days nor for as long as 60 consecutive days in the 90 days following the summer solstice at periods when the soil temperature at 50 cm (20 in.) below the surface is above 5°C (41° F). **Ustic** is a soil moisture regime that is intermediate between the aridic and udic regimes and common in temperate subhumid or semiarid regions, or in tropical and subtropical regions with a monsoon climate. A limited amount of water is available for plants but occurs at times when the soil temperature is optimum for plant growth.
Soil Orders	A soil order is a group of soils in the broadest category. In the current USDA classification scheme there are 12 orders, differentiated by the presence or absence of diagnostic horizons.
Soil Temperature Regimes	**Hyperthermic** is a soil temperature regime that has mean annual soil temperatures of 22°C (72°F) or more and >5°C (41° F) difference between mean summer and mean winter soil temperatures at 50 cm (20 in.) below the surface. **Thermic** is a soil temperature regime that has mean annual soil temperatures of 15°C (59°F) or more but <22°C (72°F), and >5°C (41° F) difference between mean summer and mean winter soil temperatures at 50 cm (20 in.) below the surface.

	Mesic A soil temperature regime that has mean annual soil temperatures of 8°C (46°F) or more but <15°C (59°F), and >5°C (41° F) difference between mean summer and mean winter soil temperatures at 50 cm (20 in.) below the surface.
Surface Water	Water on the earth's surface. Lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, wetlands, marshes, inlets, canals, and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, navigable or non-navigable, and including the beds and banks of all watercourses and bodies of surface water, that are wholly or partially inside or bordering the state or subject to the jurisdiction of the state; except that waters in treatment systems which are authorized by state or federal law, regulation, or permit, and which are created for the purpose of waste treatment.
Watershed	The area of land that contributes surface run-off to a given point in a drainage system and delineated by topographic divides.

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