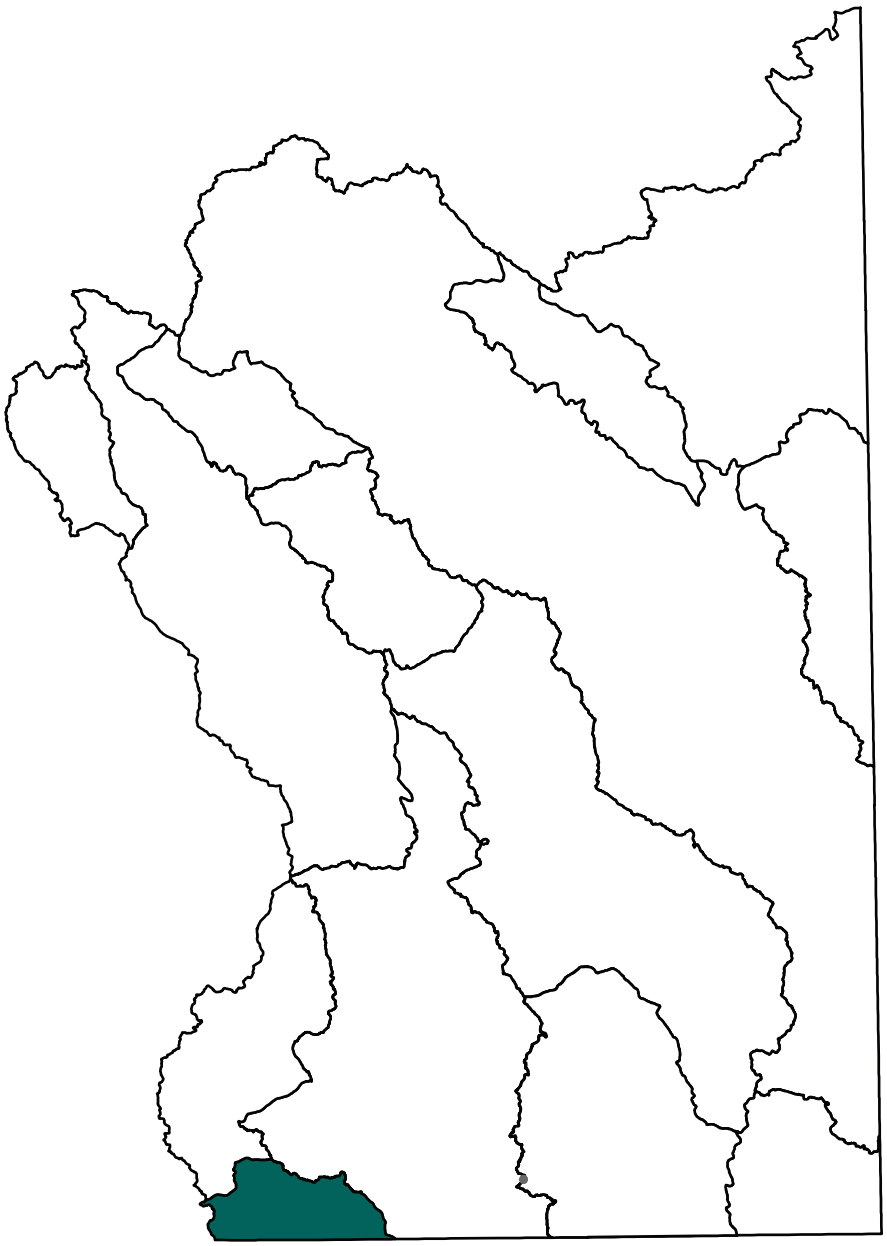
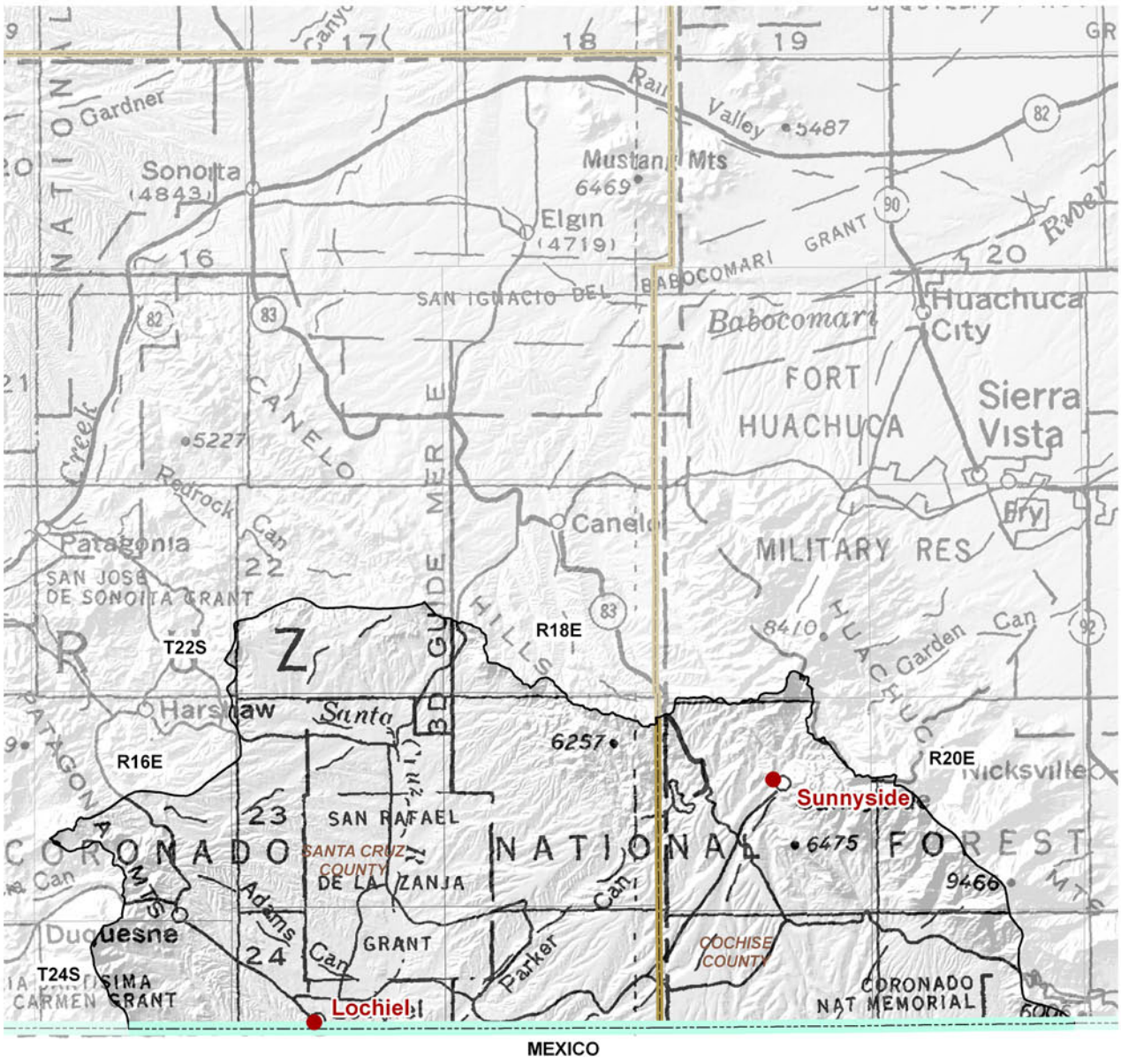
Section 3.12
San Rafael Basin



3.12.1 Geography of the San Rafael Basin

The San Rafael Basin is a small, 229 square mile basin in the southwest corner of the planning area. Geographic features and principal communities are shown on Figure 3.12-1. The sparsely populated basin is characterized by a high-elevation mountain range, a valley and Great Basin grassland and madrean evergreen woodland vegetation. (see Figure 3.0-10) Riparian vegetation includes cottonwood/willow and strand along the Santa Cruz River.

- Principal geographic features shown on Figure 3.12-1 are:
  - The Santa Cruz River east of Lochiel
  - Parker Canyon west of Sunnyside
  - Huachuca Mountains along the eastern basin boundary, which include the highest point in the basin at 9,466 feet
  - The lowest point at 4,600 feet at Lochiel where the Santa Cruz River exits the basin.
- Not well shown on Figure 3.12-1 is the San Rafael Valley to the east of Lochiel



0 3 6 Miles

Base Map: USGS 1:500,000, 1981

Figure 3.12-1
San Rafael Basin
Geographic Features

International Boundary
COUNTY
City, Town or Place

3.12.2 Land Ownership in the San Rafael Basin

Land ownership, including the percentage of ownership in each category, is shown for the San Rafael Basin in Figure 3.12-2. Principal features of land ownership are the lack of diversity in land ownership, 99% of land is under federal or private ownership, and the large portion of land managed by the National Forest Service. A description of land ownership data sources and methods is found in Volume 1, Appendix A. More detailed information on National Parks, Monuments, Riparian, Conservation, Wildlife and Wilderness Areas is found in Section 3.0.3. Land ownership categories are discussed below in the order of percentage from largest to smallest in the basin.

National Forest

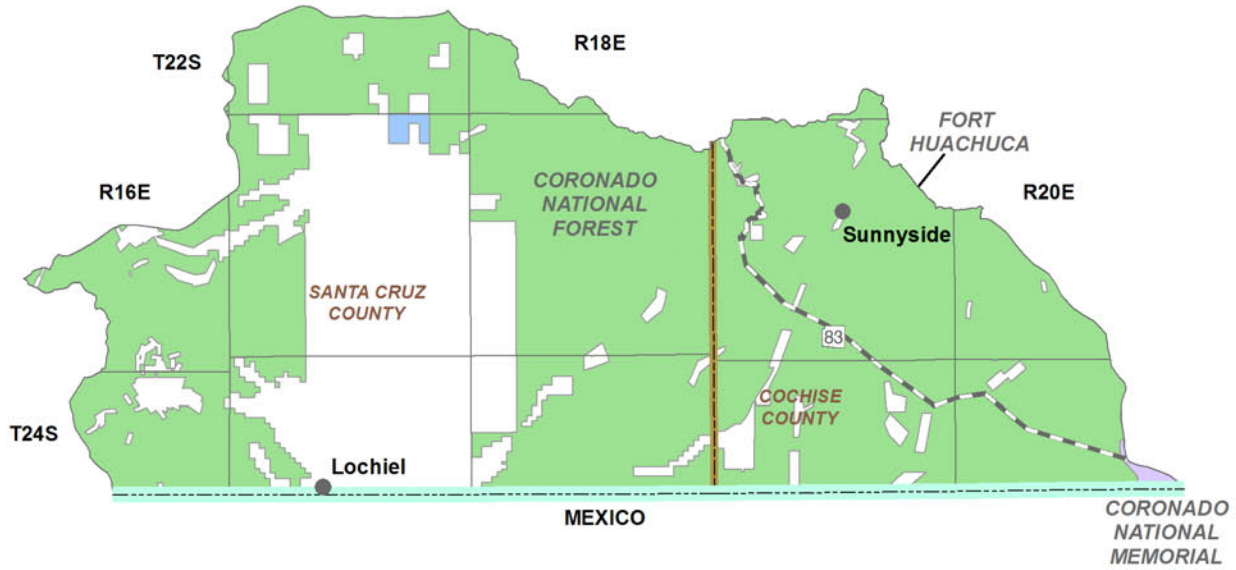
- 73.0% of land is federally owned and managed by the United States Forest Service (USFS).
- Forest land is in the Coronado National Forest, Sierra Vista Ranger District.
- The basin includes most of the Miller Peak Wilderness area. (see Figure 3.0-13)
- Primary land uses are recreation, grazing and timber production.

Private

- 26.3% of land is private.
- There is a large concentration of private land in the Santa Cruz County portion of the basin.
- Private land in-holdings are located throughout the national forest lands in the basin.
- Primary land uses are domestic and grazing.

National Park Service (NPS)

- 0.2% of land is federally owned and managed by the National Park Service.
- All park lands are within the small portion of Coronado National Memorial in the basin.
- Primary land use is recreation.



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Source: ALRIS, 2004

0 3 6 Miles

Land Ownership (Percentage in Basin)

- National Forest (73.1%)
- Private (26.3%)
- State Trust (0.3%)
- National Park Service (0.2%)
- U.S. Military (0.1%)

International Boundary
COUNTY
Major Road
City, Town or Place

Figure 3.12-2
San Rafael Basin
Land Ownership

3.12.3 Climate of the San Rafael Basin

Climate data from a NOAA/NWS Coop Network station are complied in Table 3.12-1 and the location is shown on Figure 3.12-3. Figure 3.12-3 also shows precipitation contour data from the Spatial Climate Analysis Service (SCAS) at Oregon State University. The San Rafael Basin does not contain Evaporation Pan, AZMET and SNOTEL/Snowcourse stations. More detailed information on climate is found in Section 3.0.4. A description of the climate data sources and methods is found in Volume 1, Appendix A.

NOAA/NWS Coop Network

- Refer to Table 3.12-1A
- There is one NOAA/NWS Coop network climate station in the basin at San Rafael Ranch with an average monthly maximum temperature of 74.1°F and average minimum temperature of 42.6°F.
- Annual average precipitation is 17.26 inches and most precipitation, 10.60 inches on average, occurs in the summer season. Summer precipitation is more than three times that of any other season.

SCAS Precipitation Data

- See Figure 3.12-3
- Other precipitation data shows rainfall as high as 38 inches at the Huachuca Mountains along the eastern basin boundary and as low as 18 inches in the San Rafael Valley.

Table 3.12-1 Climate Data for the San Rafael Basin

A. NOAA/NWS Co-op Network:

Station Name	Elevation (in feet)	Period of Record Used for Averages	Average Temperature Range (in F)		Average Total Precipitation (in inches)				
			Max/Month	Min/Month	Winter	Spring	Summer	Fall	Annual
San Rafael Ranch	4,740	1892-1968	74.1/Jul	42.6/Jan	2.81	1.16	10.60	2.70	17.26

Source: WRCC, 2005

B. Evaporation Pan:

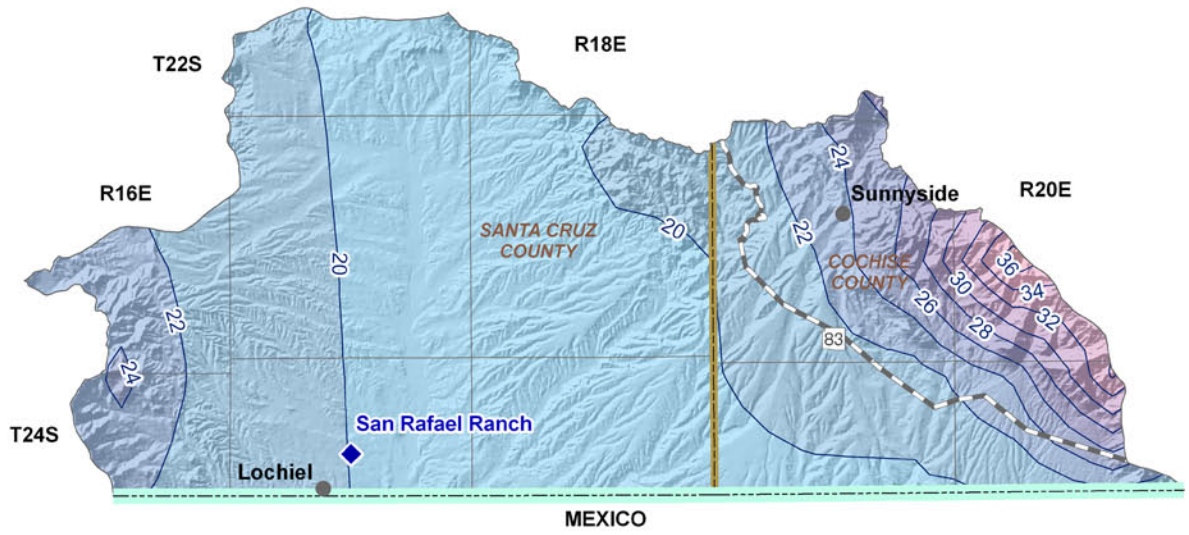
Station Name	Elevation (in feet)	Period of Record Used for Averages	Avg. Annual Evap (in inches)
None			

C. AZMET:

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

D. SNOTEL/Snowcourse:

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



Average Annual Precipitation
(1961-1990)
Inches per year

- 18-20
- 20-22
- 22-24
- 24-26
- 26-28
- 28-30
- 30-32
- 32-34
- 34-36
- 36-38

Meteorological Stations

- NOAA NWS
- Precipitation Contour
- International Boundary
- COUNTY
- Major Road
- City, Town or Place

0 3 6 Miles

ARIZONA DEPARTMENT OF WATER RESOURCES ©

Precipitation Data Source:
Oregon State University, 1998

Figure 3.12-3
San Rafael Basin
Meteorological Stations and Annual Precipitation

3.12.4 Surface Water Conditions in the San Rafael Basin

Streamflow data, including average seasonal flow, average annual flow and other information is shown in Table 3.12-2. The basin does not contain flood ALERT equipment. Reservoir and stockpond data, including maximum storage or maximum surface area of large reservoirs and type of use of the stored water, are shown in Table 3.12-3. The location of streamflow gages identified by USGS number and large reservoirs are shown on Figure 3.7-4. There were no runoff contours for this basin. Descriptions of stream, reservoir and stockpond data sources and methods are found in Volume 1, Appendix A.

Streamflow Data

- Refer to Table 3.12-2.
- Data from one real-time station located at the Santa Cruz River are shown on the table and on Figure 3.12-4.
- The average seasonal flow is highest in the Summer (July-September) and lowest in the Spring (April-June).
- Maximum annual flow was 12,600 acre-feet in 1955 and minimum annual flow was 123 acre-feet in 1962.

Reservoirs and Stockponds

- Refer to Table 3.12-3.
- Surface water is stored or could be stored in one large reservoir and one small reservoir in the basin.
- The large reservoir is used for recreation and has a total maximum storage of 4,400 acre-feet.
- There are an estimated 258 stockponds in this basin.

Table 3.12-2 Streamflow Data for the San Rafael Basin

Station Number	USGS Station Name	Drainage Area (in mi^2)	Gage Elevation (in feet)	Period of Record	Average Seasonal Flow (% of annual flow)				Annual Flow (in acre-feet/year)				Years of Annual Flow Record
					Winter	Spring	Summer	Fall	Minimum	Median	Mean	Maximum	
9480000	Santa Cruz River near Lochiel	82.2	4,620	1/1949-current (real time)	6	2	84	9	123 (1962)	1,419	2,388	12,600 (1955)	21

Source: USGS (NWIS) 2005 & 2008

Notes:
Statistics based on Calendar Year
Annual Flow statistics based on monthly values
Summation of Average Annual Flows may not equal 100 due to rounding
Period of record may not equal Year of Record used for annual Flow/Year statistics due to only using years with a 12 month record
In Period of Record, current equals November 2008
Seasonal and annual flow data used for the statistics was retreived in 2005

Table 3.12-3 Reservoirs and Stockponds in the San Rafael Basin

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

MAP KEY	RESERVOIR/LAKE NAME (Name of dam, if different)	OWNER/OPERATOR	MAXIMUM STORAGE (AF)	USE[1]	JURISDICTION
1	Parker Canyon	AZ Game & Fish	4,400	R	State

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

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

Source: Compilation of databases from ADWR & others

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

Total number: 0
Total maximum storage: 0 acre-feet

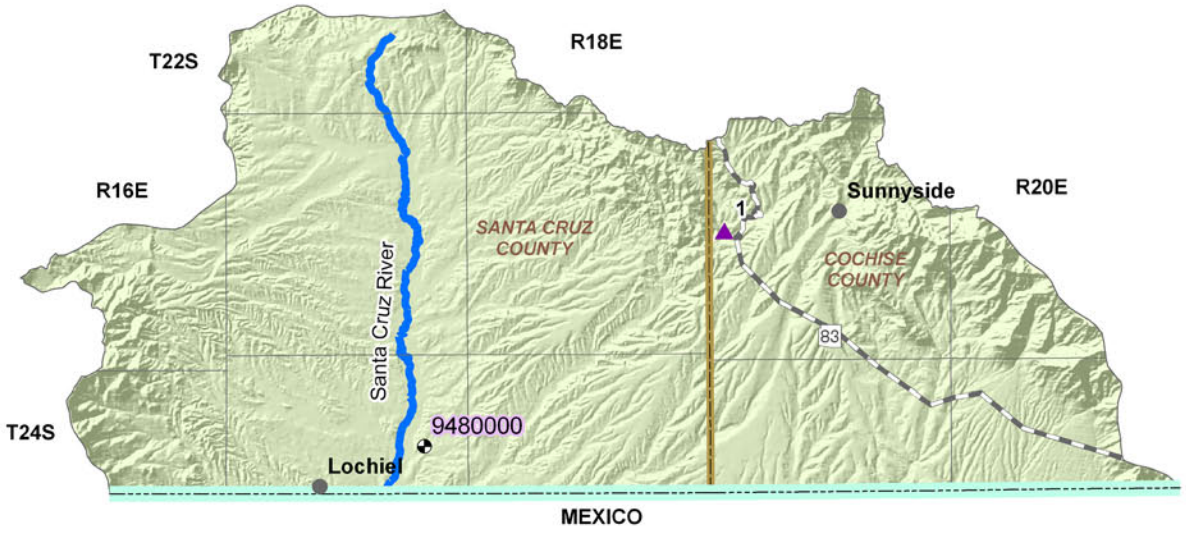
D. Other Small Reservoirs (between 5 and 50 acres surface area)[2]

Total number: 1
Total surface area: 6 acres

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

Total number: 258 (from water right filings)

Notes:
[1]R=recreation
[2]Capacity data not available to ADWR



Stream Data Source: ALRIS, 2005

0 3 6 Miles

Figure 3.12-4
San Rafael Basin
Surface Water Conditions

Stream Channel (width of line reflects stream order)
Large Reservoir 1
USGS Gage & Station ID 9999999
International Boundary
COUNTY
Major Road
City, Town or Place

3.12.5 Perennial/Intermittent Streams and Major Springs in the San Rafael Basin

Minor springs with discharge rates and date of measurement, and the total number of springs in the basin are shown in Table 3.12-4. There are no major springs identified in this basin. The locations of perennial and intermittent streams are shown on Figure 3.12-5. Descriptions of data sources and methods for intermittent and perennial reaches and springs are found in Volume 1, Appendix A.

- There is one perennial stream, the Santa Cruz River, located east of Lochiel. This reach is the headwaters of the Santa Cruz River.
- Several intermittent streams are located in the eastern portion of the basin.
- There is one minor spring in the basin.
- Listed discharge rates may not be indicative of current conditions. The unnamed spring in this basin was last measured in 1981.
- The total number of springs identified by the USGS varies from 23 to 24, depending on the database reference.

Table 3.12-4 Springs in the San Rafael Basin

A. Major Springs (10 gpm or greater):

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

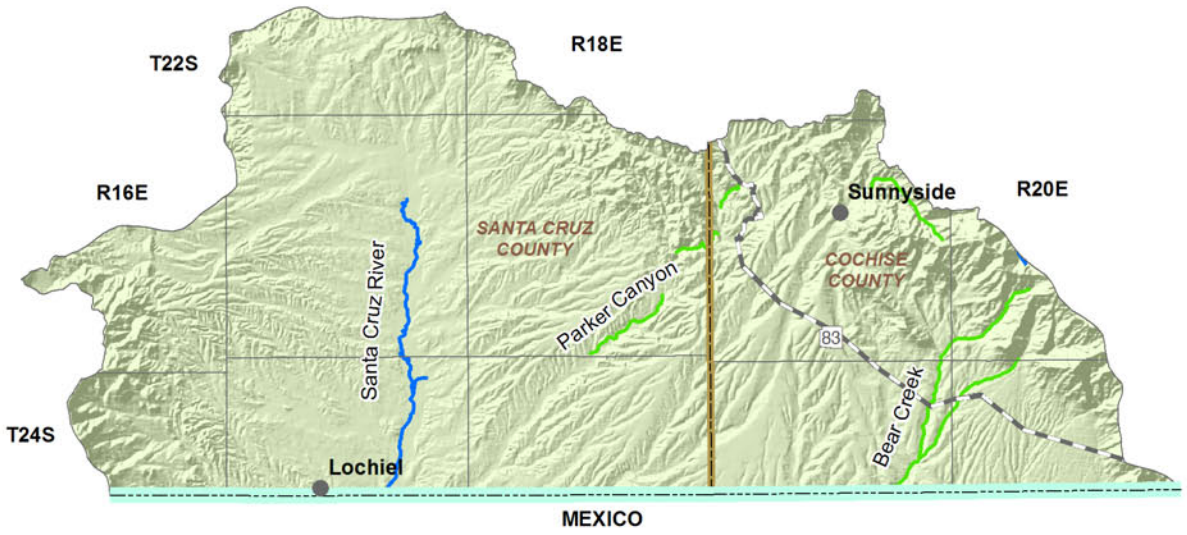
B. Minor Springs (1 to 10 gpm):

Name	Location		Discharge (in gpm)[1]	Date Discharge Measured
	Latitude	Longitude		
Unnamed	312726	1102350	1	10/22/1981

Source: Compilation of databases from ADWR & others

C. Total number of springs, regardless of discharge, identified by USGS (see ALRIS, 2005a and USGS, 2006a): 23 to 24

Notes:
[1]Most recent measurement identified by ADWR



Stream Data Source: AGFD, 1993 & 1997

0 3 6 Miles

Figure 3.12-5
San Rafael Basin
Perennial/Intermittent Streams and Major (>10 gpm) Springs

Intermittent Streams
Perennial Streams
International Boundary
COUNTY
Major Road
City, Town or Place

3.12.6 Groundwater Conditions of the San Rafael Basin

Major aquifers, well yields, estimated natural recharge, estimated water in storage, number of index wells and date of last water-level sweep are shown in Table 3.12-5. Figure 3.12-6 shows aquifer flow direction and water-level change between 1990-1991 and 2003-2004. Figure 3.12-7 contains hydrographs for selected wells shown on Figure 3.12-6. Figure 3.12-8 shows well yields in three yield categories. A description of aquifer data sources and methods as well as well data sources and methods, including water-level changes and well yields are found in Volume 1, Appendix A.

Major Aquifers

- Refer to Table 3.12-5 and Figure 3.12-6.
- The major aquifers in the basin are recent stream alluvium, composed of well-sorted silt, sand and gravel, and basin fill, consisting of clay, silt, sand and gravel.
- The streambed alluvium and the basin fill are hydrologically connected.
- Flow direction is generally from north to south.

Well Yields

- Refer to Table 3.12-5 and Figure 3.12-8.
- As shown on Figure 3.12-8 well yields in this basin range from less than 100 gallons per minute (gpm) to 1,000 gpm.
- One source of well yield information, based on 12 reported wells, indicates that the median well yield in this basin is 145 gpm.

Natural Recharge

- Refer to Table 3.12-5
- Principal sources of recharge in this basin are mountain-front recharge and infiltration from runoff in washes.
- The natural recharge estimate for this basin is 5,000 acre-feet per year.

Water in Storage

- Refer to Table 3.12-5.
- Storage estimates for this basin range from four million acre-feet to five million acre-feet to a depth of 1,200 feet.

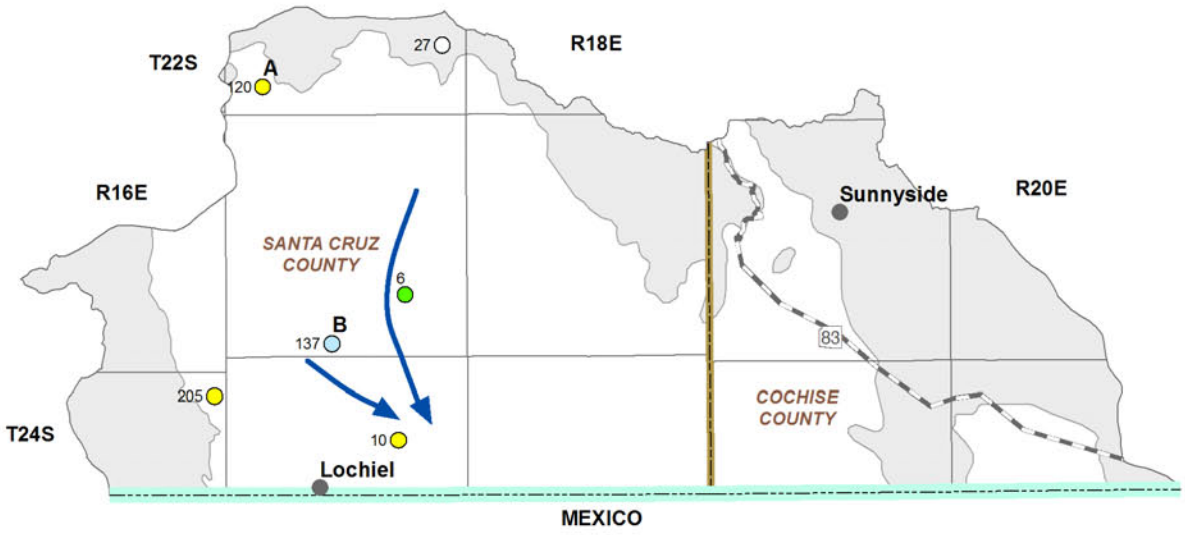
Water Level

- Refer to Figure 3.12-6. Water levels are shown for wells measured in 2003-2004.
- The Department annually measures 10 index wells in this basin. Hydrographs for two of these wells are shown in Figure 3.12-7.
- The deepest recorded water level in 2003-2004 was 205 feet northwest of Lochiel and the shallowest was six feet northeast of Lochiel.

Table 3.12-5 Groundwater Data for the San Rafael Basin

Basin Area, in square miles:	229	
Major Aquifer(s):	**Name and/or Geologic Units**	
	Recent Stream Alluvium	
	Basin Fill	
Well Yields, in gal/min:	Range 7 - 700 Median 145 (12 wells reported)	Reported on registration forms for large (> 10-inch) diameter wells
	Range 3 - 465	ADWR (1994b)
	Range 0 - 2,500	Anning and Duet (1994)
Estimated Natural Recharge, in acre-feet/year:	5,000	Freethey and Anderson (1986)
Estimated Water Currently in Storage, in acre-feet:	5,000,000[1] (to 1,200 ft)	Freethey and Anderson (1986)
	4,000,000 (to 1,200 ft)	Arizona Water Commission (1975)
Current Number of Index Wells:	10	
Date of Last Water-level Sweep:	2005 (38 wells measured)	

[1]Predevelopment Estimate



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

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

- Between -15 and -1
- Between -1 and +1
- Between +1 and +15
- Change Data Not Available
- Generalized Flow Direction
- Consolidated Crystalline & Sedimentary Rocks
- Unconsolidated Sediments
- International Boundary
- COUNTY
- Major Road
- City, Town or Place

0 3 6 Miles

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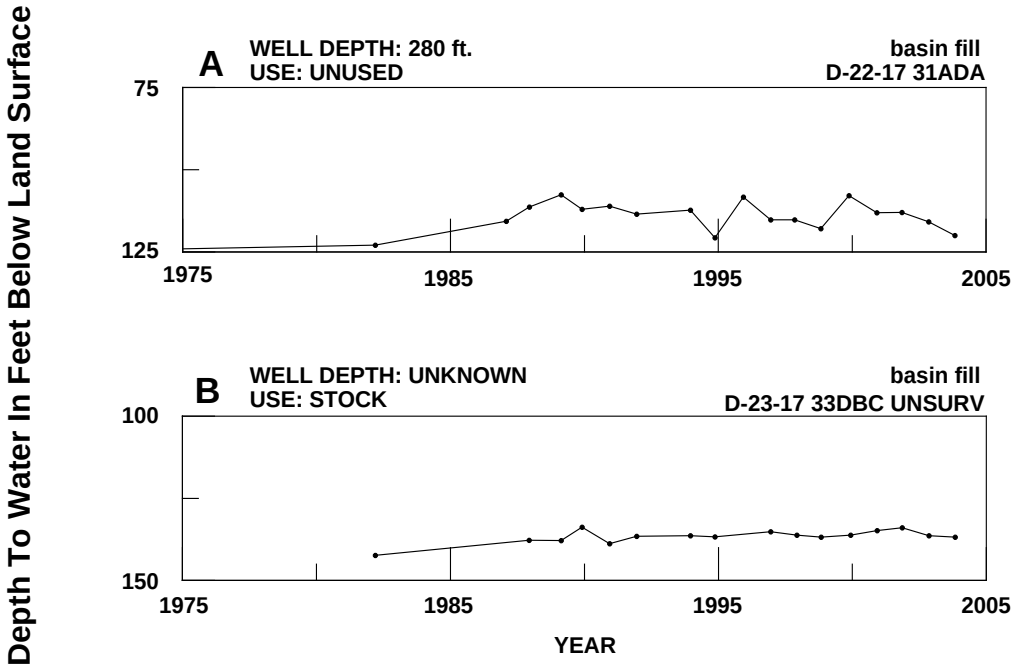
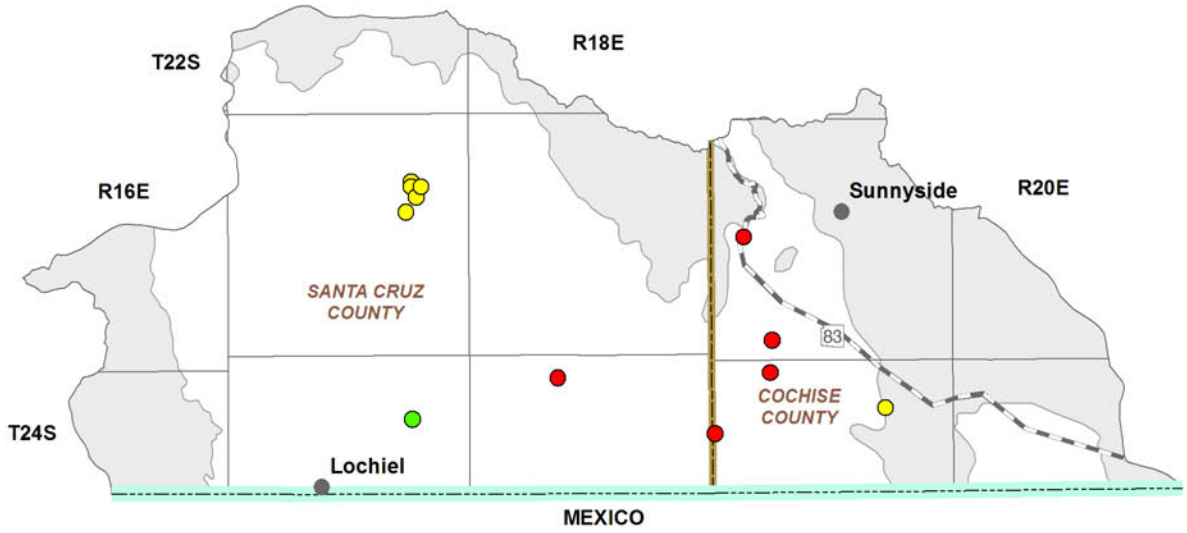
Figure 3.12-6
San Rafael Basin
Groundwater Conditions

Figure 3.12-7
San Rafael Basin
Hydrographs Showing Depth to Water in Selected Wells



In Hydrograph B UNSURV indicates there is no land survey for the area the well is in, and the coordinates are projected based on latitude and longitude.



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0 3 6 Miles

Figure 3.12-8
San Rafael Basin
Well Yields

Well Yields
- Between 500 and 1000 gals/min
- Between 100 and 500 gals/min
- Less than 100 gals/min

Consolidated Crystalline & Sedimentary Rocks

Unconsolidated Sediments

International Boundary

COUNTY

Major Road

City, Town or Place

3.12.7 Water Quality of the San Rafael Basin

Sites with parameter concentrations that have equaled or exceeded drinking water standard(s) (DWS), including location and parameter(s) are shown in Table 3.12-6A. Impaired lakes and streams with site type, name, length of impaired stream reach, area of impaired lake, designated use standard and parameter(s) exceeded is shown in Table 3.12-6B. Figure 3.12-9 shows the location of exceedences and impairment keyed to Table 3.12-6. A description of water quality data sources and methods is found in Volume 1, Appendix A. Not all parameters were measured at all sites; selective sampling for particular constituents is common.

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

- Refer to Table 3.12-6A.
- Six sites have parameter concentrations that have equaled or exceeded DWS.
- Frequently equaled or exceeded parameters include arsenic and lead.
- Other parameters commonly equaled or exceeded in the sites measured in this basin were radionuclides, cadmium and antimony.

Lakes and Streams with impaired waters

- Refer to Table 3.12-6B.
- Water quality standards for mercury were equaled or exceeded in Parker Canyon Lake.
- Parker Canyon Lake is part of the ADEQ water quality improvement effort called the Total Maximum Daily Load (TMDL) program. Sampling to create a TMDL report is ongoing.

Table 3.12-6 Water Quality Exceedences in the San Rafael Basin[1]

A. Wells, Springs and Mines

Map Key	Site Type	Site Location			Parameter(s) Concentration has Equaled or Exceeded Drinking Water Standard (DWS)[2]
		Township	Range	Section	
1	NR	23 South	16 East	21	As
2	NR	23 South	16 East	22	As
3	Well	23 South	16 East	22	Rad
4	NR	23 South	16 East	34	Cd
5	Well	23 South	19 East	18	Pb
6	Well	24 South	16 East	2	Pb, Sb

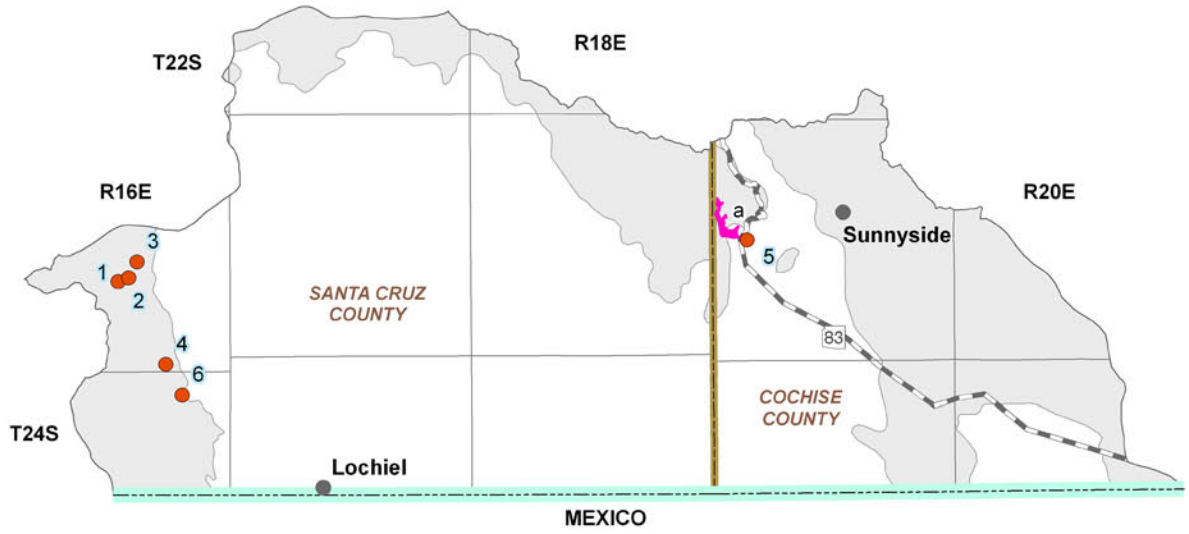
Source: Compilation of databases from ADWR & others

B. Lakes and Streams

Map Key	Site Type	Site Name	Length of Impaired Stream Reach (in miles)	Area of Impaired Lake (in acres)	Designated Use Standard[3]	Parameter(s) Exceeding Use Standard[2]
a	Lake	Parker Canyon	NA	123	FC	Hg

Source: ADEQ 2005

Notes:
Because of map scale, feature locations may appear different than the location indicated on the table
NR = Information not available to ADWR
NA = Not applicable
[1] Water quality samples collected in 2002.
[2] As = Arsenic
Sb = Antimony
Cd = Cadmium
Pb = Lead
Hg = Mercury
Rad = One or more of the following radionuclides - Gross Alpha, Gross Beta, Radium, and Uranium
[3] FC = Fish Consumption



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0 3 6 Miles

Figure 3.12-9
San Rafael Basin
Water Quality Conditions

Well, Spring or Mine Site that has equaled or exceeded DWS 1
Impaired Stream or Lake a
Consolidated Crystalline & Sedimentary Rocks
Unconsolidated Sediments
International Boundary
COUNTY
Major Road
City, Town or Place

3.12.8 Cultural Water Demands in the San Rafael Basin

Cultural water demand data including population, number of wells and the average well pumpage and surface water diversions by the municipal, industrial and agricultural sectors are shown in Table 3.12-7. There is no recorded effluent generation in this basin. The USGS National Gap Analysis Program, the source of cultural demand map data, showed no demand centers for this basin. A description of cultural water demand data sources and methods is found in Volume 1, Appendix A. More detailed information on cultural water demands is found in Section 3.0.7.

Cultural Water Demands

- Refer to Table 3.12-7.
- Population remained almost unchanged from 1980 to 2003. Projections suggest that the population will increase slightly through 2050.
- Groundwater pumping remained constant from 1971 to 2003 with less than 300 acre-feet pumped per year.
- All water use in this basin is groundwater, there are no recorded surface water diversions.
- Municipal demand is the only use in this basin and is minimal, less than 300 acre-feet per year. This includes domestic and stock watering use.
- As of 2005 there were 224 registered wells with a pumping capacity of less than or equal to 35 gallons per minute and 26 wells with a pumping capacity of more than 35 gallons per minute.

Table 3.12-7 Cultural Water Demands in the San Rafael Basin[1]

Year	Estimated and Projected Population	Number of Registered Water Supply Wells Drilled		Average Annual Demand (in acre-feet)						Data Source
				Well Pumpage			Surface-Water Diversions			
		Q ≤ 35 gpm	Q > 35 gpm	Municipal	Industrial	Agricultural	Municipal	Industrial	Agricultural	
1971		173[2]	24[2]	<300			NR			ADWR (1994a) USGS (2005)
1972										
1973										
1974										
1975										
1976				<300			NR			
1977										
1978										
1979										
1980	143									
1981	142	5	1	<300			NR			
1982	142									
1983	141									
1984	141									
1985	140									
1986	140	17	1	<300			NR			
1987	139									
1988	138									
1989	138									
1990	137									
1991	138	14	0	<300	NR	NR	NR			USGS (2007)
1992	139									
1993	140									
1994	141									
1995	142									
1996	143	5	0	<300	NR	NR	NR			
1997	144									
1998	145									
1999	146									
2000	147									
2001	149	10	0	<300	NR	NR	NR			
2002	151									
2003	154									
2004	156									
2005	158									
2010	169									
2020	177									
2030	182									
	WELL TOTALS:	**224**	**26**							

Notes:
NR=Not reported
[1] Does not include evaporation losses from stockponds and reservoirs, or effluent
[2] Includes all wells through June 1980.

3.12.9 Water Adequacy Determinations in the San Rafael Basin

There are no water adequacy applications on file with the Department as of December 2008 for the San Rafael Basin. A description of the Water Adequacy Program is found in Volume 1, Appendix C. Adequacy determination data sources and methods are found in Volume 1, Appendix A.

San Rafael Basin

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