Chapter 7
Environmental Resources and Conservation

Volume II of the Environmental Resources and Conservation Element provides information on existing conditions for natural resources in Douglas County, including air quality, energy, floodplains, soils and steep slopes, and water.

Air Quality

Douglas County would like to ensure, as much as possible, the preservation of clean, pure air. Close monitoring of the air quality is essential to its preservation. Pollutants which are of particular concern when monitoring air quality are: Particulates (PM_{10}), Fine Particulates ($PM_{2.5}$), Carbon Monoxide (CO), and Ozone (O_3).

- Particulates are breathable particulate matter that are generated primarily from residential wood burning, industry, construction activities, motor vehicles, open burning, and windblown dust. PM_{10} particulates are those with a diameter of 10 micrometers or less and $PM_{2.5}$ particulates are those with a diameter of 2.5 micrometers or less.
- Carbon Monoxide (CO) is an "odorless, invisible gas" which is emitted primarily from combustion sources such as motor vehicle engines, wood burning, and aircraft operations.
- Ozone (O_3) is the result of interaction with chemical hydrocarbons, nitrogen oxides, and sunlight.

The primary source of pollutants in the county are from auto emissions, dirt roads, fuel burning (including wood burning stoves), wildfires, paving materials, agricultural burning, and agricultural dust.

The Nevada Division of Environmental Protection, Bureau of Air Quality Planning, Nevada Air Quality Trend Report 1998-2009 dated January 2011 provides the most recent data on air quality trends in Douglas County.

Geology/Seismic

The dominant topographic features of Douglas County (Lake Tahoe, Carson Range, Carson Valley, and the Pinenut Mountains) are expressions of the horst and graben structure of the region. This type of structure is typified by alternating uplifted and downdropped fault blocks bounded by parallel faults. The Carson Range of the Sierra Nevada Mountains and the Pinenut Mountains are surface expressions of large uplifted fault blocks or horsts, while Lake Tahoe and the Carson Valley are grabens, or fault blocks which have dropped relative to adjoining fault blocks.

The major fault lines in Douglas County largely align with the Carson Valley. The western fault line, named the Genoa Fault, lies at the base of the Carson Range, running along the developed areas of Foothill and Genoa. It is this fault zone which forms the steep eastern slope of these mountains. Indeed, the majority of this slope is a 4,000 foot fault scarp at the base of which is a younger scarp of approximately 44 feet, which extends for ten (10) miles. This younger scarp, which was in existence when the first settlers arrived in 1854, was formed by 44 feet of vertical ground displacement during earthquakes some time within the past several hundred years. Another major fault line lies at the east side of the valley where the Pinenut Mountain Range begins. This fault system reaches as much as six miles in width (USGS 1985). The topography formed by this zone of faults is reflected in the eastside river terraces and foothills of the Pinenut Mountains. In the foothills, Tertiary and Quaternary sediments have been displaced from a few feet to 20 feet, producing many small fault scarps. Other portions of the eastside fault zone underlie the Gardnerville Ranchos, Fish Springs, and Johnson Lane areas. Many other smaller faults lie within the Carson Valley and underlie or are adjacent to several of the towns and communities in Douglas County, including Minden, Gardnerville, Indian Hills, and Jacks Valley. The Carson Valley itself has been filled with well-bedded fine-grained Tertiary lake sediments overlain by recent alluvial deposits. The depth of the sediments is greater than 1,000 feet. Much of the valley is poorly drained and has a high water table. The third major fault line generally follows the eastern boundary of Douglas County.

Douglas County faults have experienced significant movements. The Genoa fault and its related systems and Antelope Valley fault to the southeast of the Carson Valley may be capable of magnitude (M) 7.5 earthquakes. Since 1852, several moderate to strong earthquakes have been reported. The largest recorded earthquake in the region occurred in 1887 on the Genoa fault which was a M6.3 quake. A M6.1 quake occurred south of Gardnerville in 1994.

Predicting when an earthquake will occur is difficult; however, predicting the response of the ground surface to seismic vibration can be much more plausible. Site geology, therefore, is essential in predicting the results of future earthquakes. Recording earthquakes at various locations can indicate how sites will respond to varying levels of seismic energy. The geology of the Carson Valley suggests that conditions exist in this area for significant amplification of ground motion due to the presence of saturated, poorly consolidated sediments. The western section of the Carson Valley, traversed by the Carson River, is an area which is prone to liquefaction due to the saturated conditions. Maps 7.1 thru 7.4 at the end of this section depict the geologic features of each region.

Additionally, the presence of steep slopes exacerbates the geologic hazards of an area. In the Carson Valley, slopes of 0-15 percent, 15-30 percent, and 30 percent or greater have been mapped. The entire western side of the valley is composed of slopes of 30 percent or greater. Interestingly, the break between the steep slopes, 30 percent, and more gentle gradients coincide almost precisely with the Genoa Fault. It is the steep slopes above this fault which are most hazardous. Refer to Slopes, Maps 7.9 thru 7.12.

The following figure shows the geologic makeup and the major faults of each community of Douglas County:

Figure 7.1
Geologic Conditions of Douglas County Communities

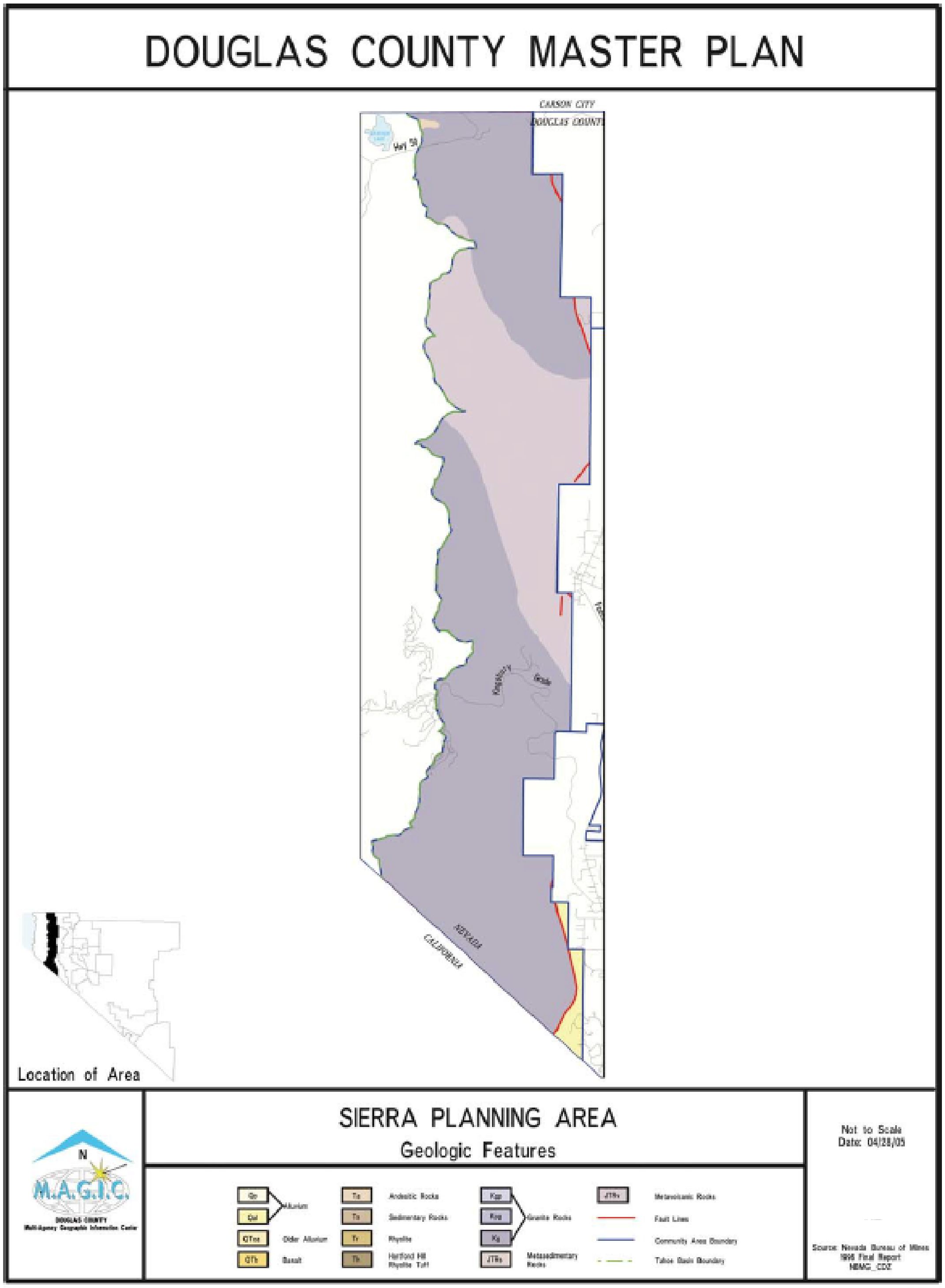
Community	Geologic Makeup	Location of Geologic Makeup	Major Faults
Agriculture	Alluvium Deposits	Majority	Within One Mile of
	Granitic Rock	N.W. Corner	Genoa Fault
Airport	Alluvium Deposits	Majority	6 Miles from Genoa Fault
East Valley	Older Alluvium Deposits	Eastern Half	7 Miles from Genoa Fault
	Recent Alluvium Deposits	Western Half	
Fish Springs	Alluvium Deposits	West Cntrl & East	8 Miles from Genoa Fault
	Older Alluvium Deposits	S.W. Corner East	
	Metasedimentary Rocks	Majority	
	Sedimentary		
Foothill	Alluvial Fans	Majority	Close Proximity to Genoa Fault
	Alluvium Deposits	Majority	
	Granite Rocks	West	
Genoa	Alluvial Fans	Majority	Close Proximity to Genoa Fault
	Alluvium Deposits	Majority	
	Metavolcanic Rock	West	
	Granitic Rocks	West	
Indian Hills/	Granitic Rocks	Majority	Close Proximity to Genoa Fault
Jacks Valley	Alluvium Deposits		Several Holocene Faults
Johnson Lane	Alluvial Fans and	Majority	7 Miles from Genoa Fault
	Alluvium Deposits	Northeast and East	
	Metavolcanic and Sedimentary Rock		
Central Valley	Alluvium Deposits	Majority	6 Miles from Genoa Fault
Minden-Gardnerville	Alluvium Deposits	Majority	6 Miles from Genoa Fault

Pinenut	Older Alluvium, Andesitic, Sedimentary and Granite Rocks	Majority	An Active Fault in the Northern End of the Plan Area
Ranchos	Alluvium Deposits Older Alluvium	Majority Eastern Half	6 Miles from Genoa Fault
Ruhenstroth	Older Alluvium Alluvium Deposits Sedimentary Rock Andesitic Rock	South & Northern Majority Southeast Small Portion	8 Miles to Genoa Fault
Sierra	Metavolcanic and Granite Rock	Majority	Close Proximity to Genoa Fault
Topaz Area	Alluvium Deposits Andesitic and Metavolcanic Rock	Majority Small Portion	Close Proximity to the Fault, Parallel to HWY 395
Topaz Lake	Andesitic and Metavolcanic Rock Alluvial Fans	Small Portions Majority	One Potential Fault West of and Parallel to HWY 395

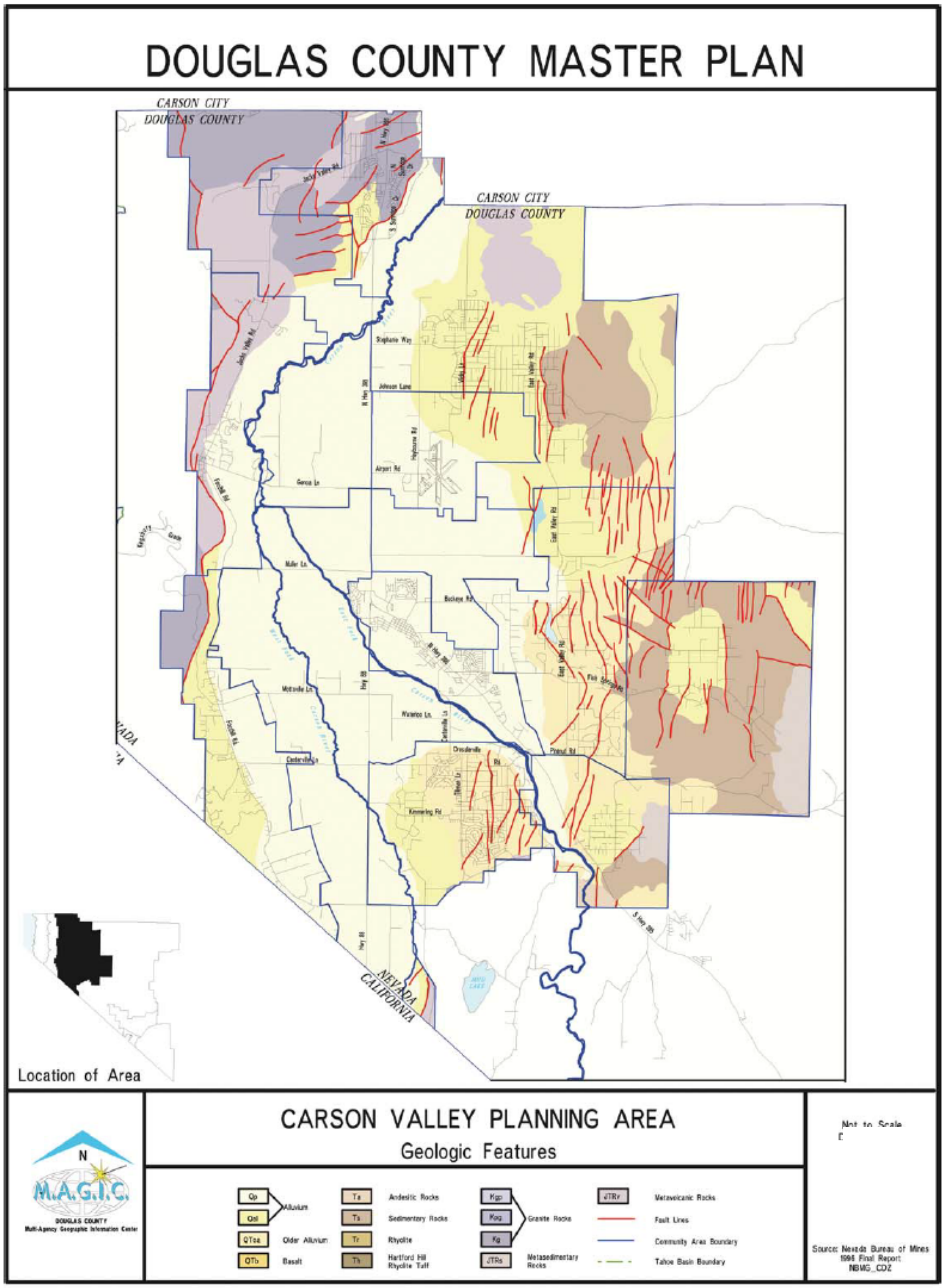
Source: Nevada Bureau of Mines Bulletin 75, 1969

In addition to earthquakes and dramatic mountains, geothermal activity and mineralization are often associated with faulting. In the case of the Carson Valley, a fairly large area with geothermal energy potential has been identified. At Walley's Hot Springs, Hobo Hot Springs, and Saratoga Hot Springs, geothermal water reaches the surface. The lands between and around these springs have been identified as having a non-electric geothermal energy potential.

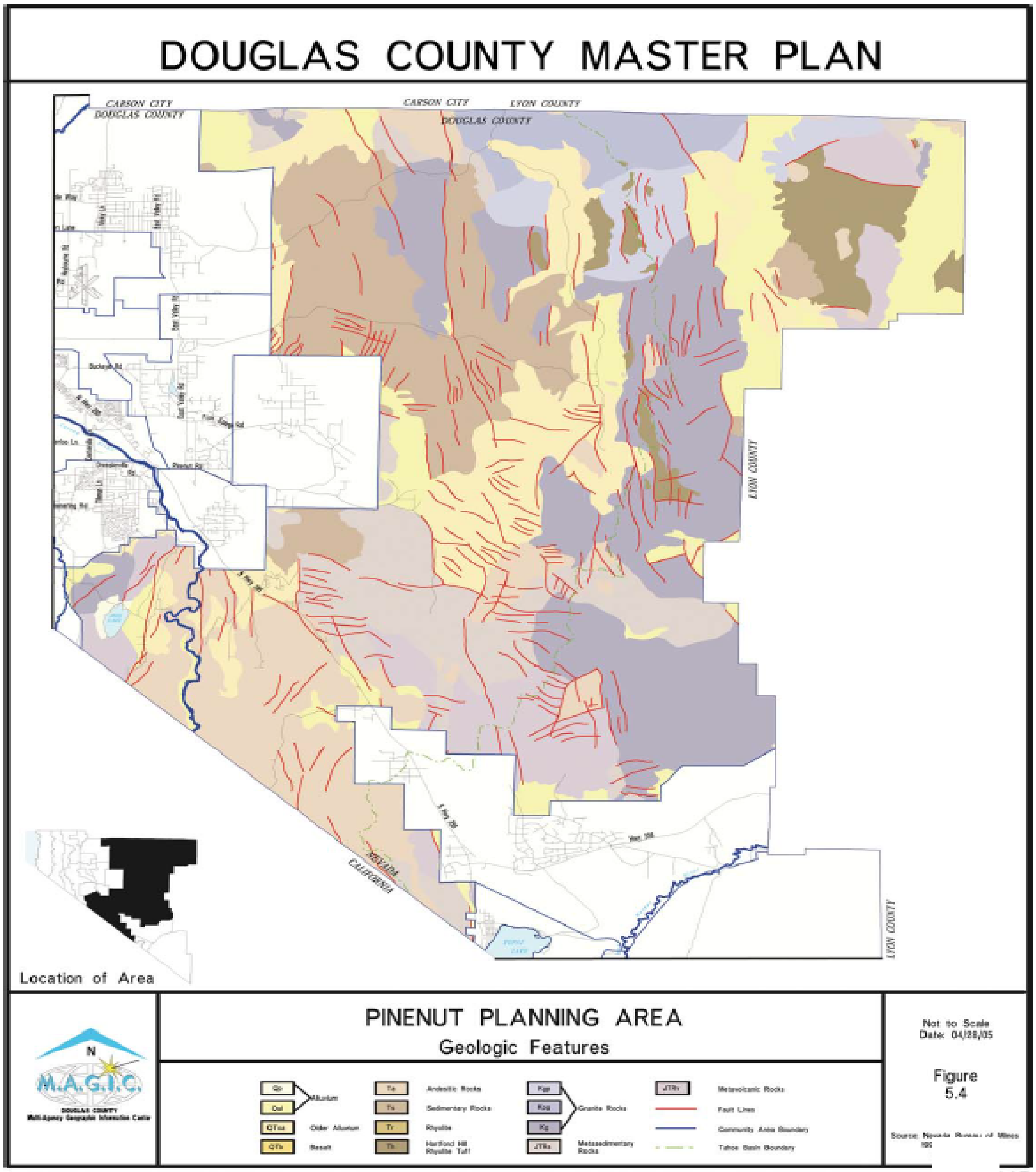
Map 7.1
Sierra Geologic Features



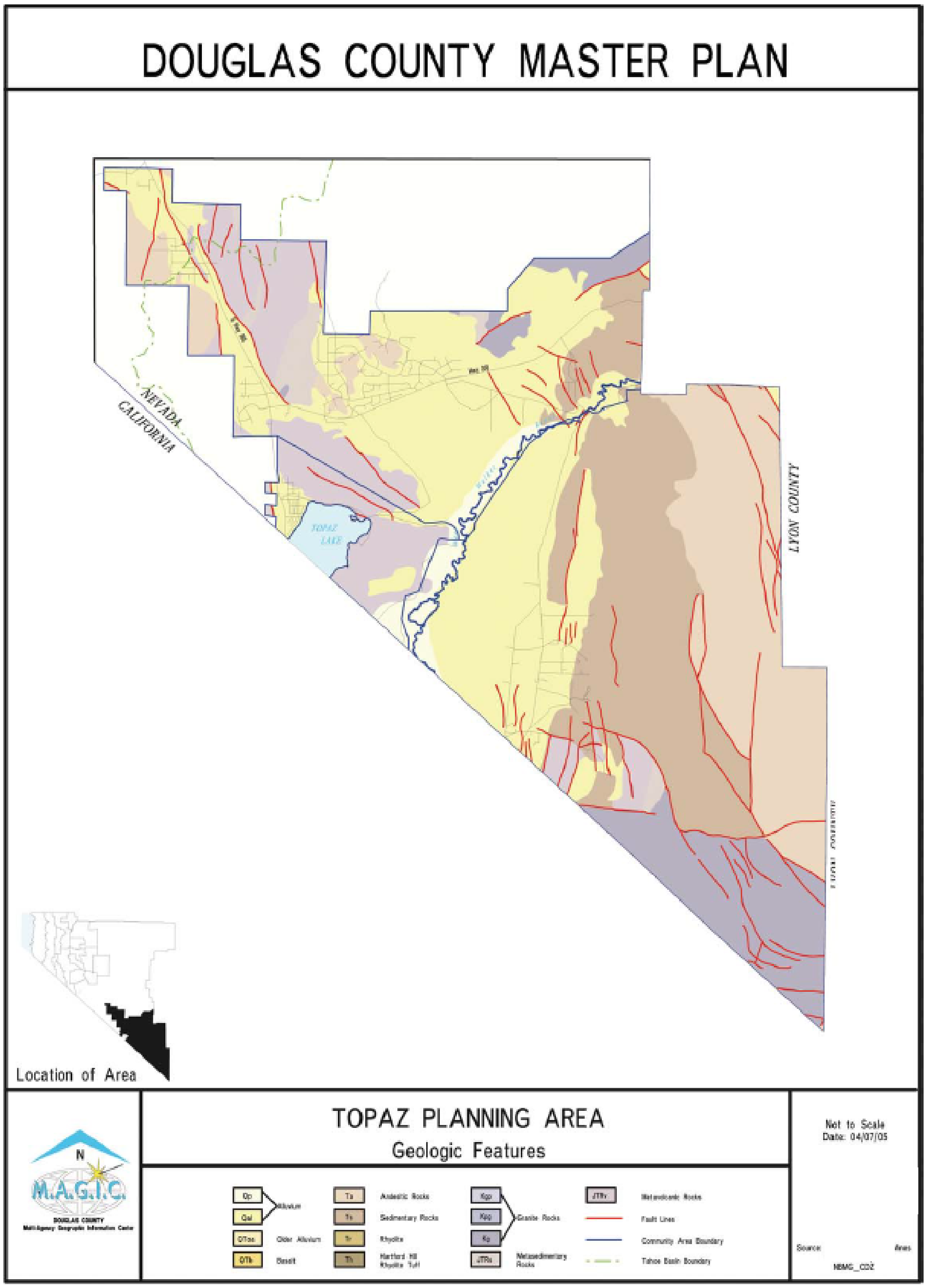
Map 7.2
Carson Valley Geologic Features



Map 7.3
Pinenut Geologic Features



Map 7.4
Topaz Geologic Features



Soils

The general soils maps identify 16 major soil units within Douglas County. Each of these soil units has unique qualities and characteristics. The Natural Resource and Conservation Service has described these features, which have direct impact on the suitability of the soils for various land uses. The following information and tables are edited and excerpted from the 1984 Survey for each of the landscapes, they show the general soil characteristics of the county, providing additional information about an aspect of the natural environment that may affect planning for the county. More precise site-specific analysis would be necessary to determine the suitability of soils on a particular parcel for future development.

Soils lying on floodplains and low stream terraces are nearly level to moderately sloping. They typically range from moderate to deep to very deep. These soils have a high water table and are subject to flooding.

Figure 7.2
Areas dominated by Soils on Floodplains and Low Stream Terraces

General Soil Type	Urban Development Limitation	Sanitary Facility
Cradlebaugh-Voltaire	High water table, flooding, & wetness	Percolation slowly
Kimmerling-Ophir-Jubilee	High water table, flooding & wetness	Percolation slowly
Hussman-Dressler-Ormsby	Seasonal high water table, flooding & wetness	Percolation slowly- Poor filter
Gardnerville-Dangberg-Fettic	High water table, flooding & wetness	Percolation slowly

Soils lying on alluvial fans and terraces are primarily well drained. Of these soils, those that are located along the mountain fronts are sometimes coarse in texture, resulting in excessively drained soils. These are very deep soils that are nearly level to steep. They range in texture from fine to coarse. Some of these soils have high clay content, which are subject to high shrinkage and swelling.

Figure 7.3
Areas Dominated by Well Drained Soils on Alluvial Fans and Terraces

General Soil Type	Urban Development Limitation	Sanitary Facility
Haybourne-Turria-Springmeyer	Some areas steep slope Moderate shrink-swell Cutbanks cave	Poor filter Percolation slowly
Mottsville-Toll-Holbrook	Flooding Cutbanks cave	Poor filter Stones present
Indian Creek Phing-Reno	Cemented hard pan Shrink-swell	Percolation slowly

Soils located on foothills and high terraces are also well drained. They range from shallow to very deep. This soil grouping is known to have a well developed subsoil which is underlain by bedrock.

Figure 7.4
Areas Dominated by Well Drained Soils on Foothills and High Terraces

General Soil Type	Urban Development Limitation	Sanitary Facility
Pulcan-Puett-Chalco	Severe shrink-swell Shallow depth to rock	Percolation slowly Shallow depth to rock
Uhaldi-Pula-Nosrac	Steep slopes	Percolation slowly Shallow depth to rock
Stodick-Indiano-Loomer	Steep slopes Large stones Shallow depth to rock	Percolation slowly Shallow depth to rock

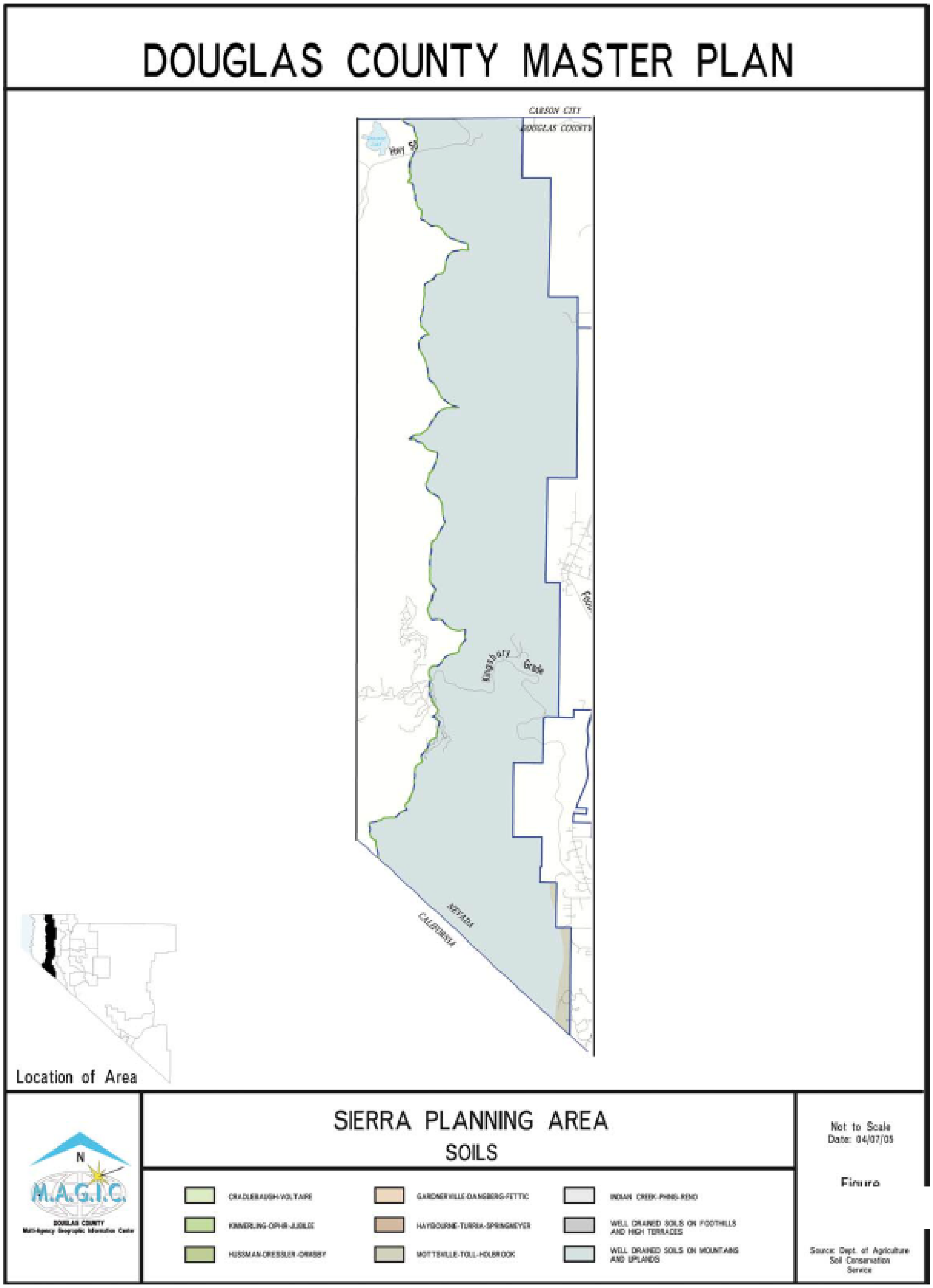
The soils located on the mountains and uplands are well drained. These are moderately steep to very steep and range from shallow to very deep. The soils in the Carson Range have a frost-free period between 30 to 80 days, while those in the Pinenuts, Wellington Hills and Topaz Lake areas have a frost free period from 60 to 120 days. These soils are shallow to very deep over bedrock.

Figure 7.5
Areas Dominated by Well Drained Soils on Mountains and Uplands

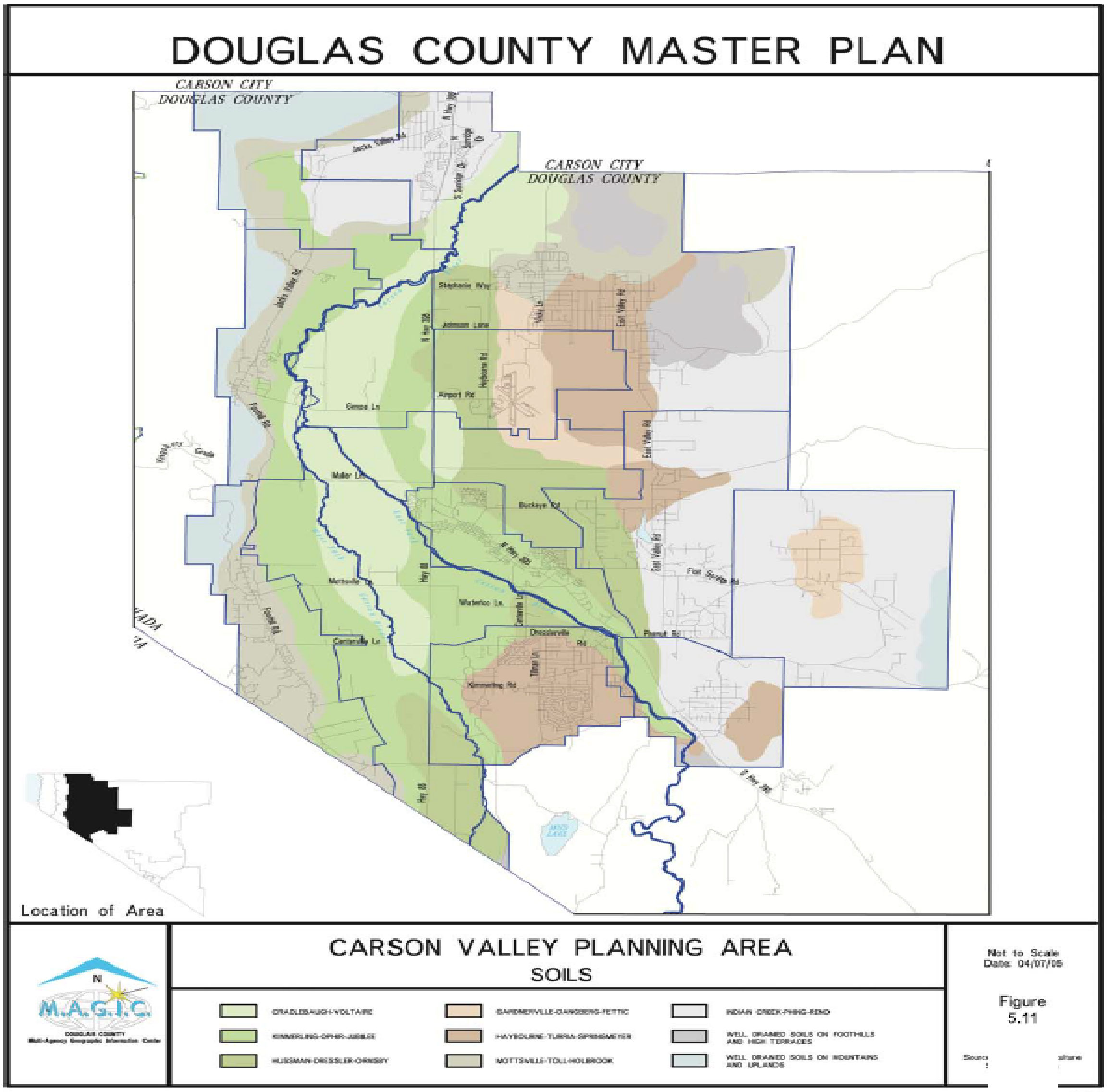
General Soil Type	Urban Development Limitation	Sanitary Facility
Cagle-Duco-Nosvac	Shallow depth to rock Steep slopes Severe shrink-swell Large Stones	Percolation slowly Shallow depth to rock
Trid-Drit-Roloc	Steep slopes Shallow depth to rock Moderate shrink-swell	Large stones Shallow depth to rock
Glean-Genoa-Sup	Shallow depth to rock Steep slopes Large stones	Large stones Shallow depth to rock
Corbett-Toiyabe	Steep slopes Shallow depth to rock Cutbacks cave	Shallow depth to rock
Vicee Franktown-Rock Outcrop	Steep slopes Rock outcrop	Large stones Shallow depth to rock
Witefels-Temo	Steep slopes Cutbanks cave Shallow depth to rock	Poor filter Shallow depth to rock

Maps 7.5 thru 7.8 depict the generalized soil types for each region.

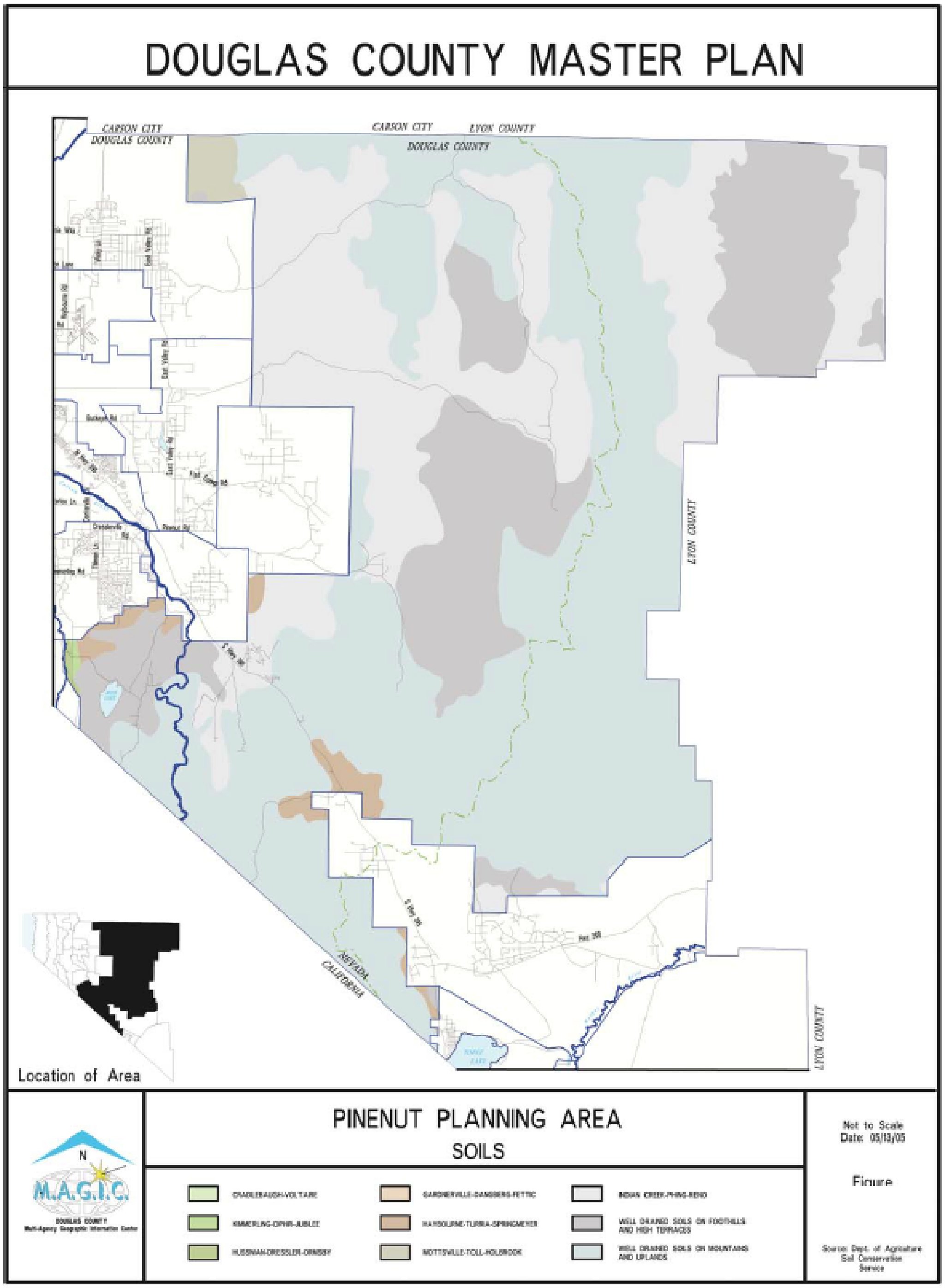
Map 7.5
Sierra Soils



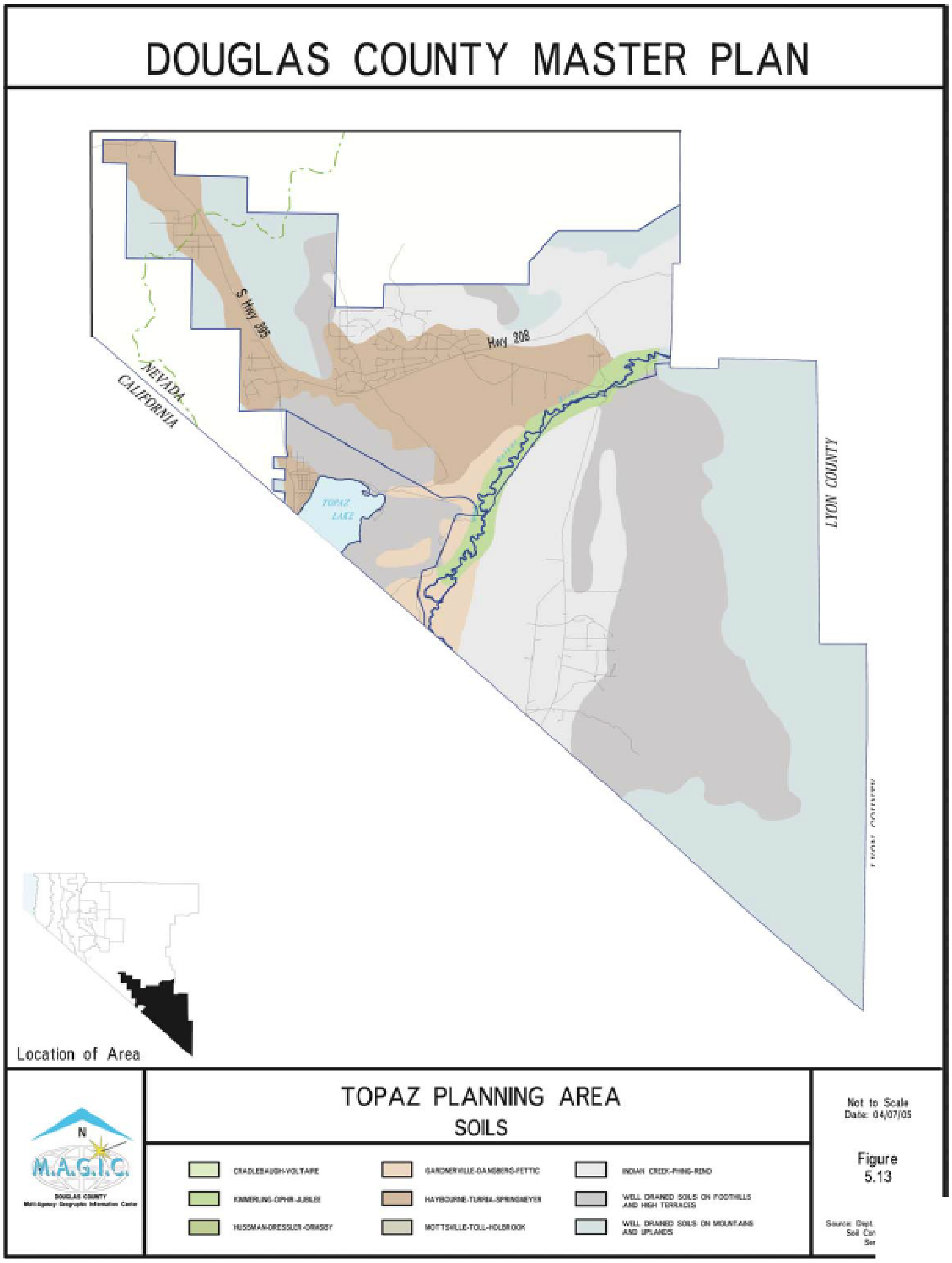
Map 7.6
Carson Valley Soils



Map 7.7
Pinenut Soils



Map 7.8
Topaz Soils



Slopes - Hillsides – Ridgelines

Elevations of the Carson Range and Pinenut mountains reach to over 10,000 feet above sea level, while the Carson Valley floor dips to 4,625 feet above sea level. Approximately 35 percent of the county has slopes between 10 and 30 percent, and 25 percent has slopes greater than 30 percent. Thus, over half the county has slopes severe enough to affect development potential.

Slope of the land is an important consideration in planning for development. Slopes, in conjunction with soil types, geological and seismic hazards, and scenic vistas, are potential limitations to development. In terms of construction and service costs, land with 0 to 5 percent slope is generally most suitable for high density development. These slopes predominate throughout most of the Carson Valley floor. Typically, problems associated with development on slight slopes are minimal, although surface drainage may be difficult. Development on steep slopes, hillsides, and ridgelines can degrade the aesthetic value of the natural environment and can also represent hazards to the land itself.

Slopes between 10 percent and 30 percent typically have development limitations. Providing community services and infrastructure is often difficult and expensive and requires extensive grading for access. For this reason, development needs to be limited to low overall densities, and restricted to areas which would not be significantly impacted. Slopes above 30 percent have severe development limitations that would preclude most development except very low intensity uses.

Limitations to development on steeper slopes are often magnified by poor soil conditions. For this reason, even properties with moderate slopes may be unsuitable for development, depending on the predominant soil type. Other limitations to development in moderate to steep slope areas are geological hazards, such as landslides and seismic hazards. Landslides can be expected to occur in canyons, ravines, and other areas with steep slopes. Seismic hazards and flash floods are also a concern in the county in areas with steep slopes.

Fire hazards are of special concern to Douglas County, given the nature of the terrain and the growing population. Areas of the county with narrow canyons and saddles are conducive to the rapid spread of fire. The steeper the slope, the more rapid the rate at which the fire spreads; locations where slopes of 10 percent or greater have been identified as areas of concern. Also, vegetation plays a major role in the spread of wildfires, primarily vegetation that grows in areas of little moisture content or vegetation that is known to ignite quickly. Limited access to sites is another major factor in the identification of fire hazard zones.

The slope information illustrated on the Sierra, Carson Valley, Pinenut, and Topaz Regional Plan Maps (Maps 7.9 thru 7.12) for Moderate to Steep Slopes, is based on topographic information available from United States Geographical Survey (USGS) Quadrangle Mapping.

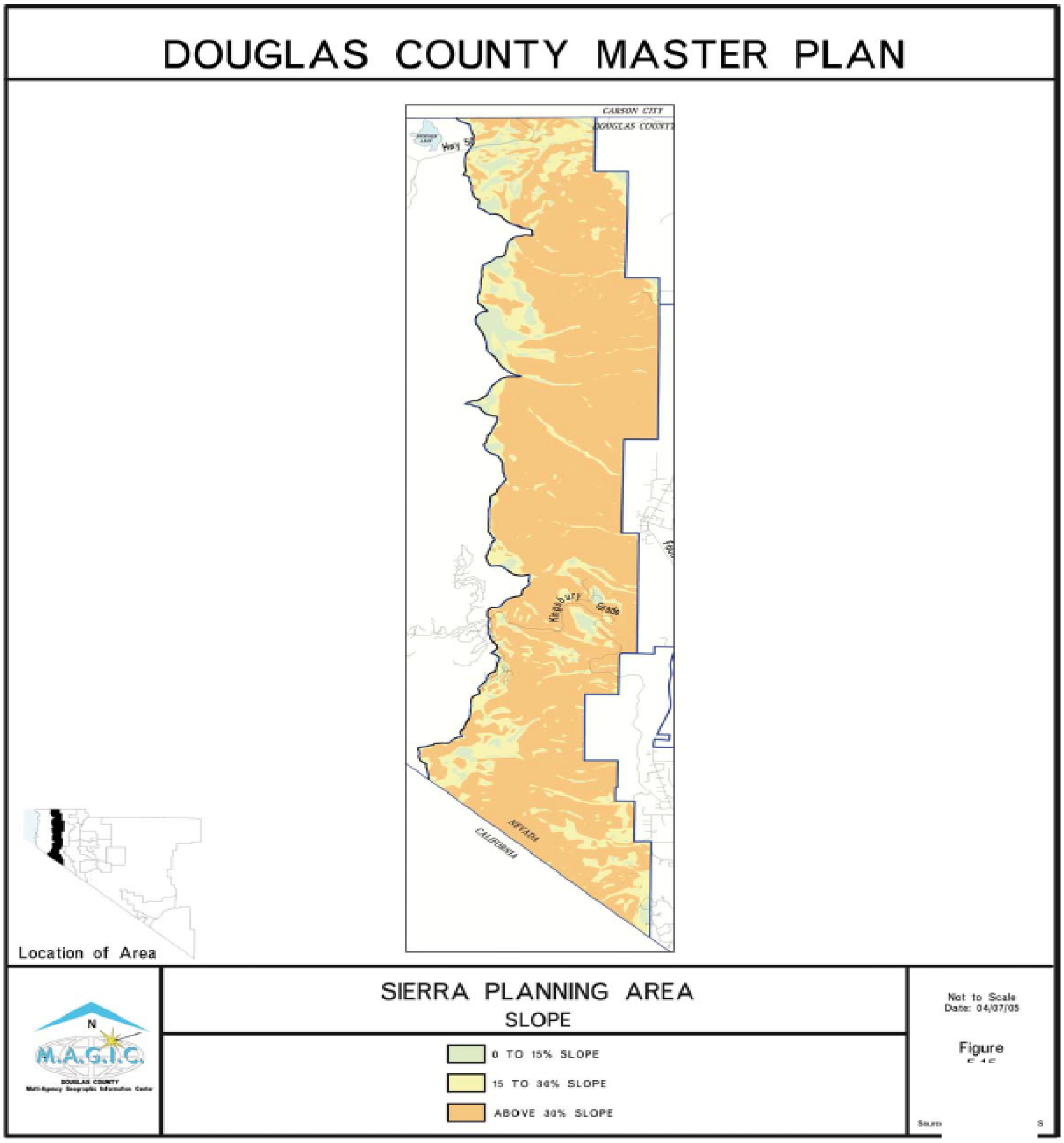
Steep slopes and ridgelines are important land forms in Douglas County, which contribute to its character and aesthetics; the steep slopes and ridgelines merit strong consideration within the Master Plan to ensure their preservation. The steep slopes are important from an aesthetic, ecological, and public safety perspective. Development on these slopes can be hazardous due to soil instability and potential for land failure due to inappropriate grading or construction techniques.

The following figure describes the slope characteristics of each community:

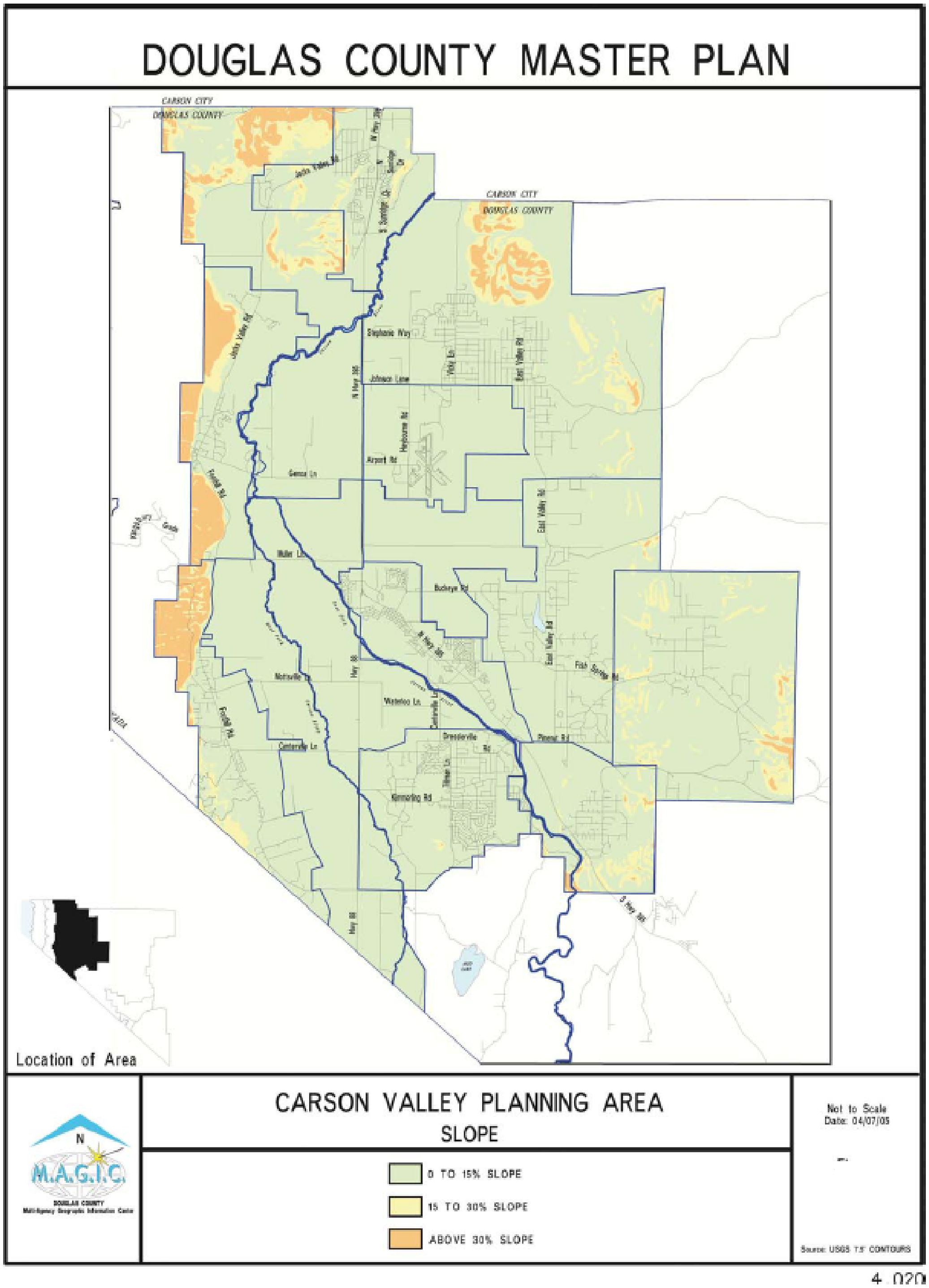
Figure 7.6
Generalized Slope Characteristics

Community	Slope Characteristics
Agriculture	Generally 0 - 5 percent slope; northwest portion exceeds 15 percent.
Airport	Relatively flat and gently slopes to the northwest.
East Valley	Relatively flat with some areas of moderate (15 - 30%) to steep (30%) slopes at the higher elevations.
Foothill	Gentle slopes to the east; northwestern edge exceeds 30 percent.
Genoa	Central portion slopes to the east; western edge exceeds 30 percent
Indian Hills/Jacks Valley	Majority of community is on rolling hills with some slopes exceeding 15 percent.
Johnson Lane	Western portion is relatively flat; steep slopes in east and northwest; east 1/3 has moderate slopes (15 - 30%).
Central Valley	Relatively flat.
Ranchos	Gentle slopes to the northwest; relatively flat, small portions experience (5 - 15%); Dressler Butte only slope exceeding 15 percent.
Ruhenstroth	Relatively flat; steep slopes to the east.
Minden-Gardnerville	Relatively flat.
Topaz Lake	Gentle sloping alluvial fan (5 -10%); steep (+30%) at extreme north end.
Topaz Areas	Steep slopes at western end, northern section of TRE, and areas near Wild Oat Mountain.
Pinenuts	Eastern portion contains steep slopes, gradually decreasing to (0 - 15%) to the western edge.
Sierra	Majority of community contains steep slopes.

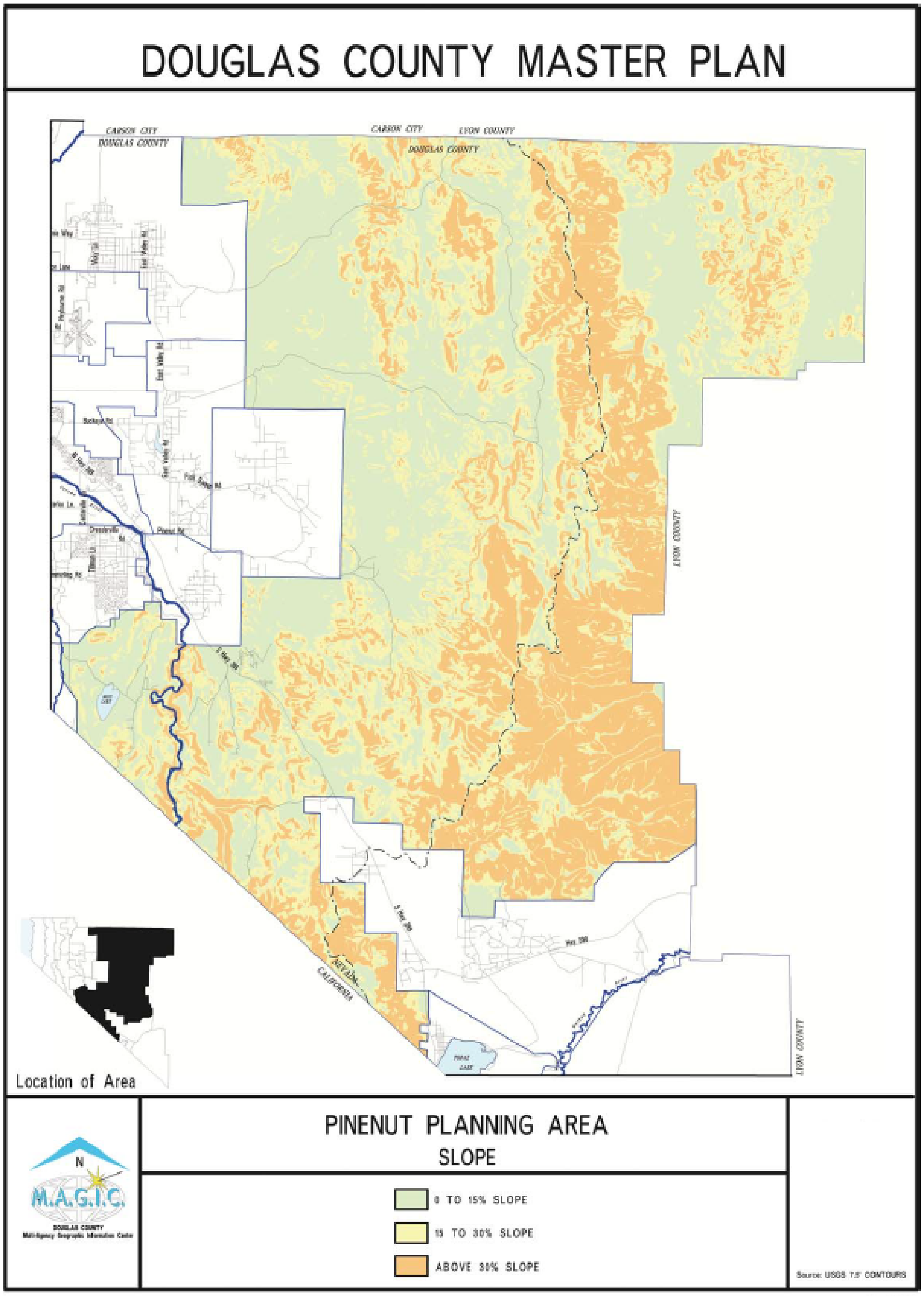
Map 7.9
Sierra Moderate to Steep Slopes



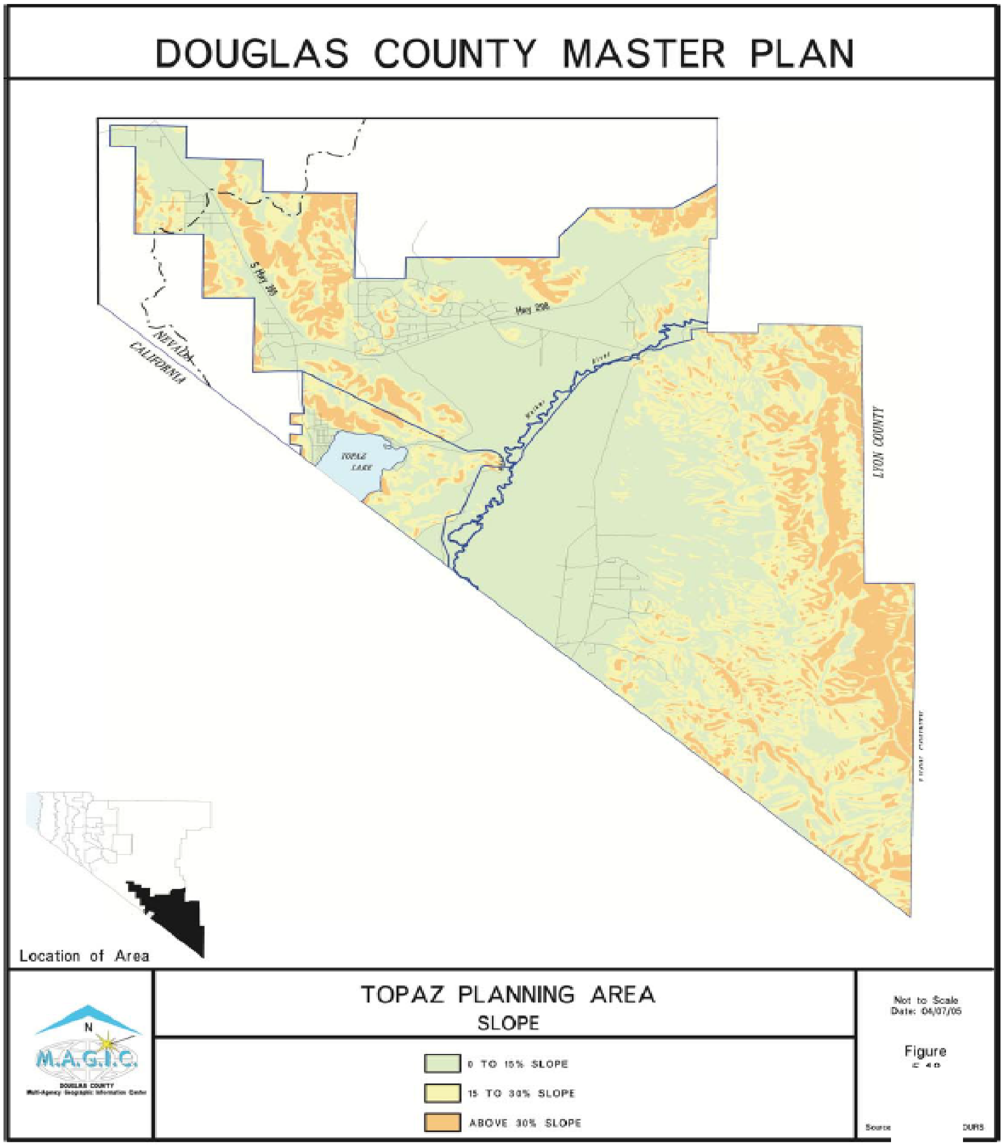
Map 7.10
Carson Valley Moderate to Steep Slopes



Map 7.11
Pinenut Moderate to Steep Slopes



Map 7.12
Topaz Moderate to Steep Slopes



Climate

Douglas County lies between two mountain ranges that have a marked influence on the climate. The two ranges are the Carson Range to the west, which affects the climate mainly in the winter, and the Pinenut Mountains to the east, which affects the climate mainly in the summer. The Carson Range is part of the Sierra Nevada. It rises from the valley floor to an elevation of about 10,000 feet within a distance of 10 miles. The Pinenut Mountains generally rise to elevations of 7,000 to 9,500 feet. On the valley floor, the highest elevation is approximately 5,400 feet (near Woodfords, California) and the lowest is approximately 4,625 feet (in the northern part of Douglas County).

The climate of Douglas County is continental. The summers are short and often hot, and the winters are moderately cold. The percentage of possible sunshine averages 78 percent for the year; 90 percent for the summer, 66 percent for the winter, but the abundant sunshine is somewhat offset by the shortness of the growing season. The average daily maximum temperature in July is 90º F, and average daily minimum temperature in January is 18º F.

The Sierra Nevada effectively reduces the moisture content of storms that sweep in from the Pacific Ocean. Winter is by far the wettest part of the year; more than half the annual precipitation is received during the period November through February.

Total precipitation averages 9.37 inches a year at Minden, but variations of about 25 percent are common from year to year. The annual precipitation is greater than these amounts by about 58 percent of the time.

In winter, because the Sierra Nevada is a barrier to the flow of air toward the east, there is considerable difference between the amount of precipitation received at the higher elevations and the amount received at the lower elevations.

The summer showers are a product of the moist air from the Gulf of Mexico. The blocking effect of the Pinenut Mountains to the flow of air toward the northwest is strong, but not nearly so pronounced as that of the Carson Range to the flow of air toward the east in winter. An average of only 12 thunderstorms a year has been recorded.

Flooding and Drainage

Major Drainage Basins

Precipitation in Douglas County falls onto three major drainage basins or watersheds. These watersheds are: Carson River, Walker River and Lake Tahoe basins. The Carson River is the largest drainage basin within Douglas County. All precipitation within this basin drains to the Carson River. The river flows from south to north towards Carson City in two forks, East and West, which join in the middle of the Carson Valley. The Walker River Basin drains portions of the south and east ends of the county and flows primarily from southwest to northeast. The Lake Tahoe basin drains to Lake Tahoe then to the Truckee River in California. Stormwater Management for the Tahoe Basin is under the direction of the TRPA. Maps 7.13 thru 7.16 depict the FEMA floodplains.

Floods are natural and recurrent events. The problems associated with flooding are compounded when man competes with rivers, streams, and lakes for the use of the floodplain.

Floodplains are valuable areas requiring protection. They provide a water storage function, affecting downstream flow, water quality and quantity, and land suitable for human activities. In Douglas County, floodplains provide opportunities for agricultural activity, open space, and recreation. The nature and extent of use within the floodplain should be compatible with the risk involved and the degree of protection that can be provided.

Flooding

A number of damaging floods have occurred in the Carson Valley, Topaz Lake, and Topaz Ranch Estates as a result of heavy rainfall on accumulated snow pack, long duration rains, or by summer cloudbursts.

Floods from snow melt caused by heavy, long duration rainfall can occur anytime between October and March. Flooding is more severe when antecedent rainfall has resulted in saturated ground conditions, when the ground is frozen and infiltration is minimal, or when warm rain on the snow in higher elevations of the tributary areas adds snow melt to rain flood run-off. These storms are also known as wet-mantle storms.

Severe but localized flooding may also result from cloud burst storms centered over the Carson River tributary basins. These storms may occur from late spring to early fall, but generally occur in June, July, and August. Run-off from cloud bursts is characterized by high peak flows with a short duration falling on dry soils with a thin depleted vegetal cover, where the soil mantel is only superficially moistened by rain. These storms are also known as dry-mantle storms.

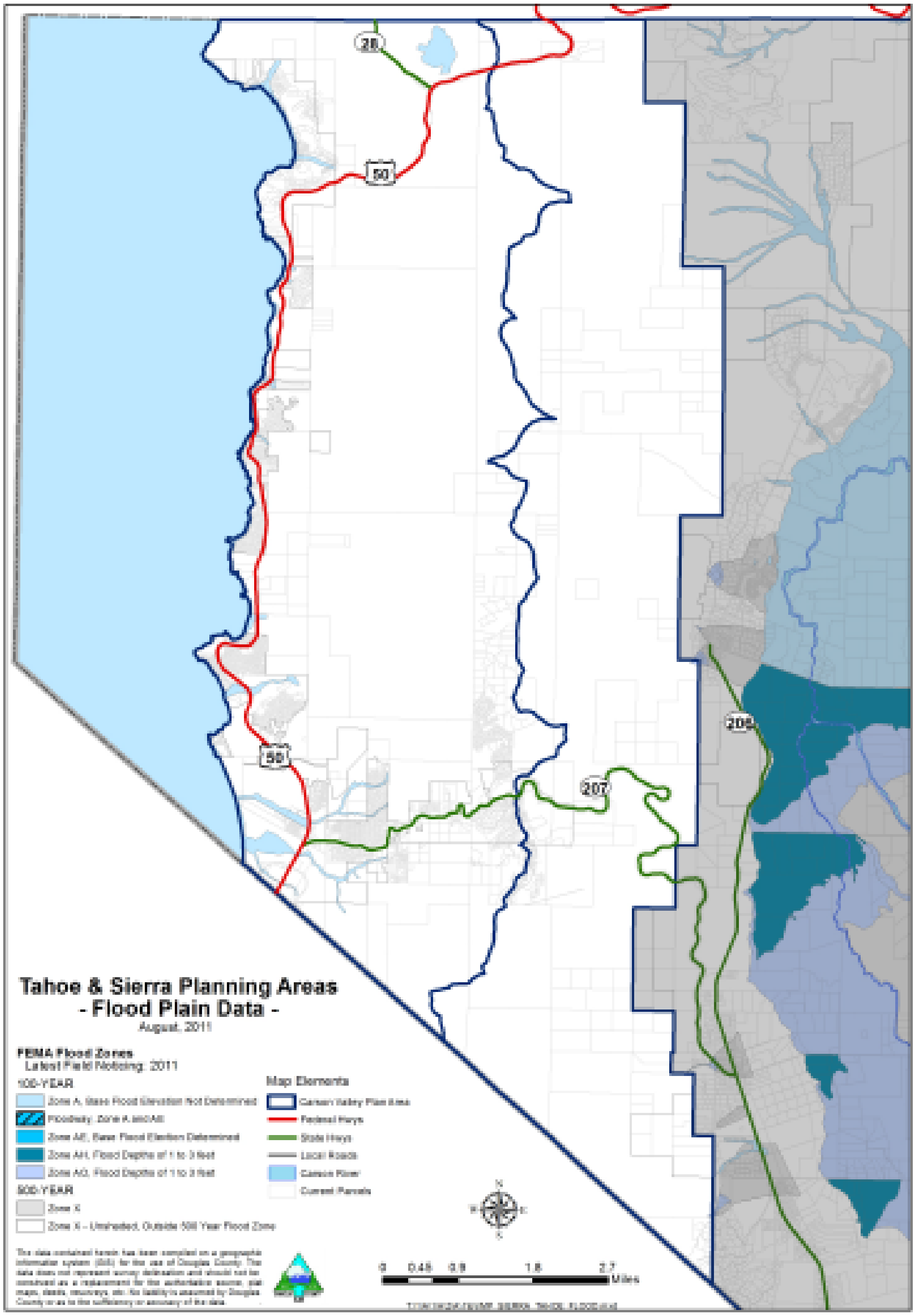
Although higher peak flows per square mile of drainage may result from cloud bursts, the winter rain flood is more damaging because of the greater volume of flow, longer periods of sustained flow, wider area of inundation, and larger areas of population.

Carson River Flooding

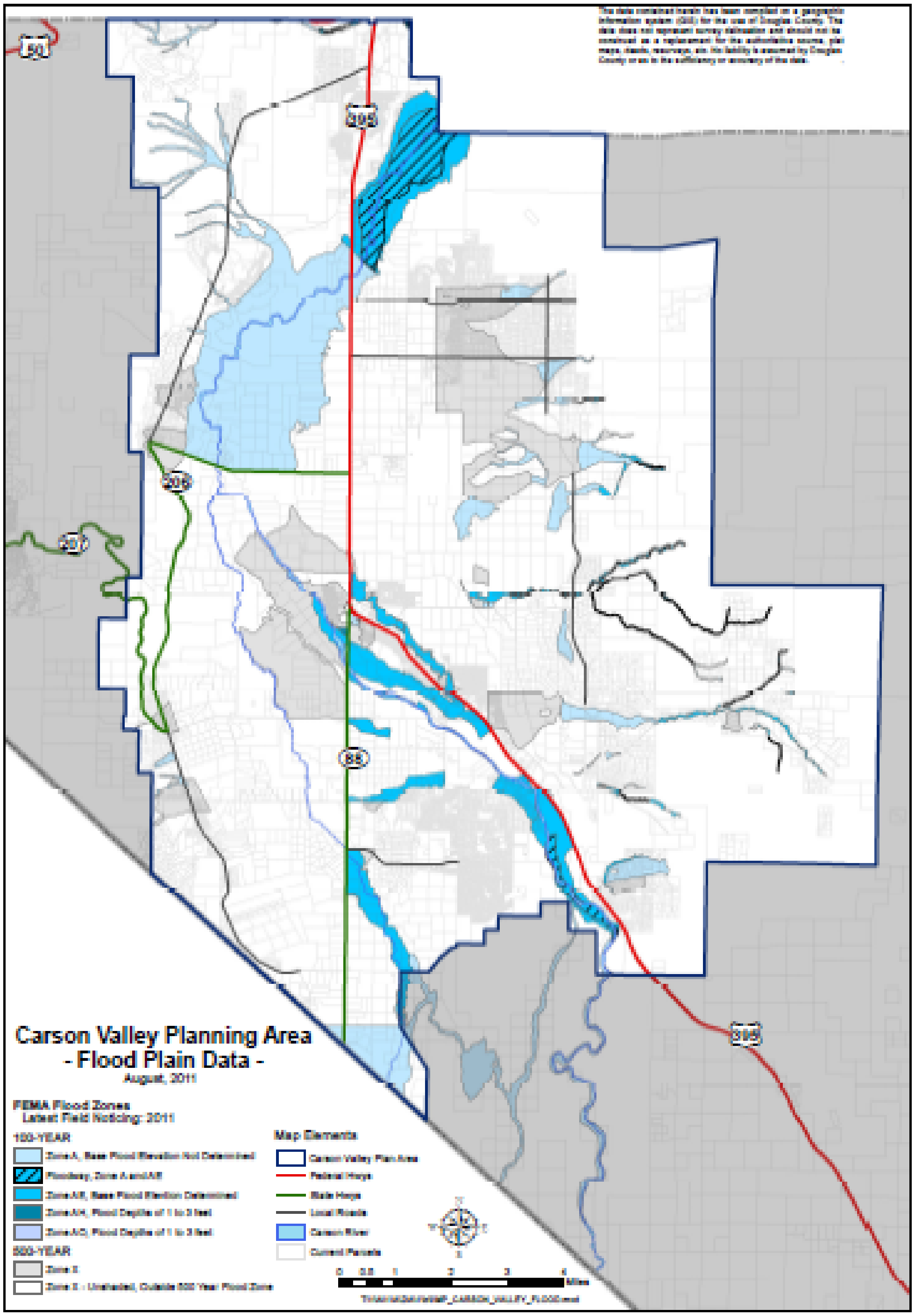
A number of damaging floods in the Carson River Basin have occurred as a result of spring run-off and wet mantle storms. All major floods of the East and West Forks of the Carson River, with the exception of the flood occurring in the spring of 1890, have been caused by wet mantle storms.

Of the significant flood events that have been recorded, more than 25 have occurred in the Carson Valley. The major floods of record occurred in 1852, 1861-62, 1867-68, 1906, 1907, 1937, 1955, 1963, 1964, and 1997. The flood of 1890 is regarded as the most severe early flood, although there are no accurate records of floods prior to 1937. The flooding that occurred during the March 1 to June 15, 1890, time period resulted from the harsh winter of 1889-1890.

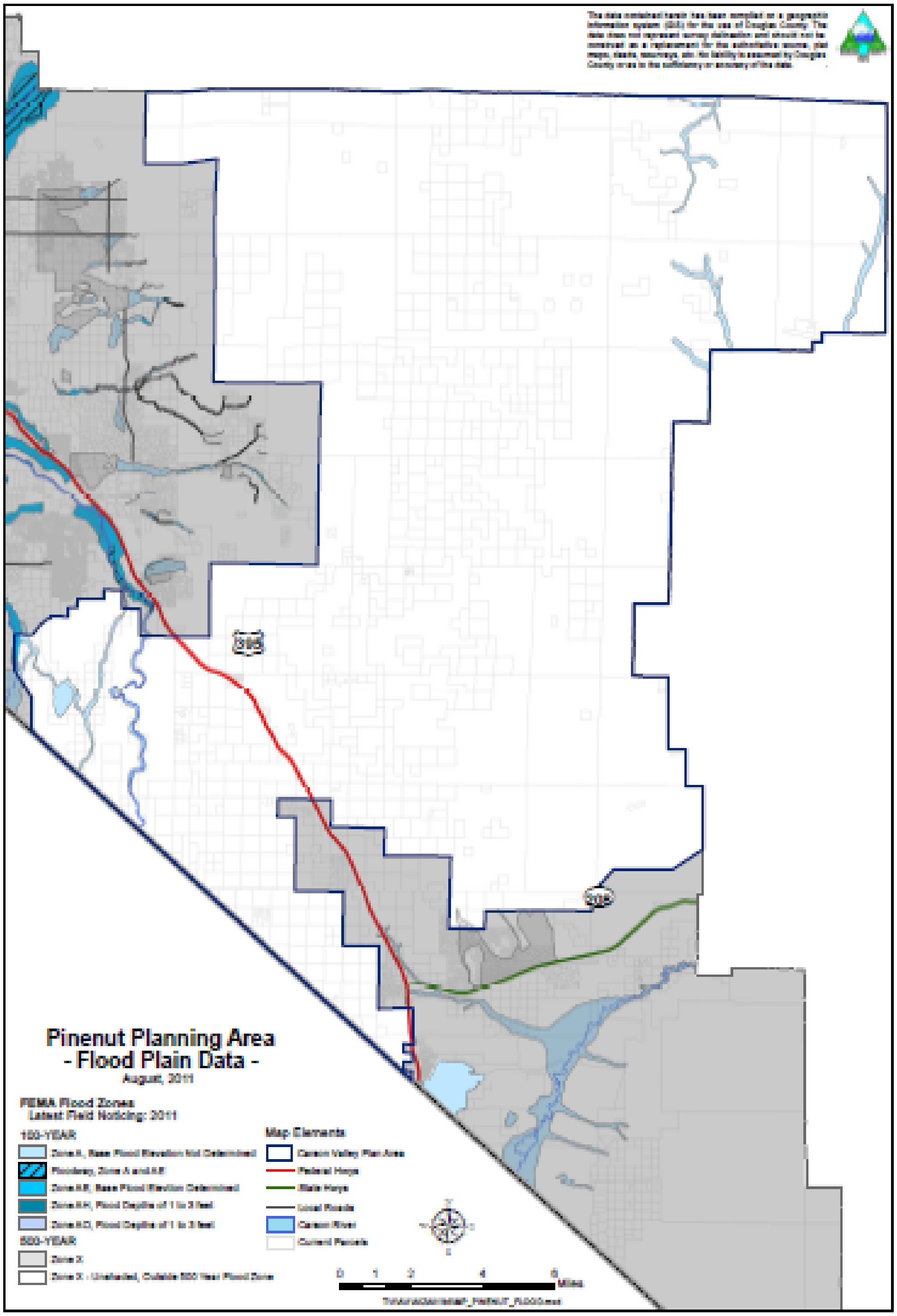
Map 7.13
Tahoe and Sierra Floodplain



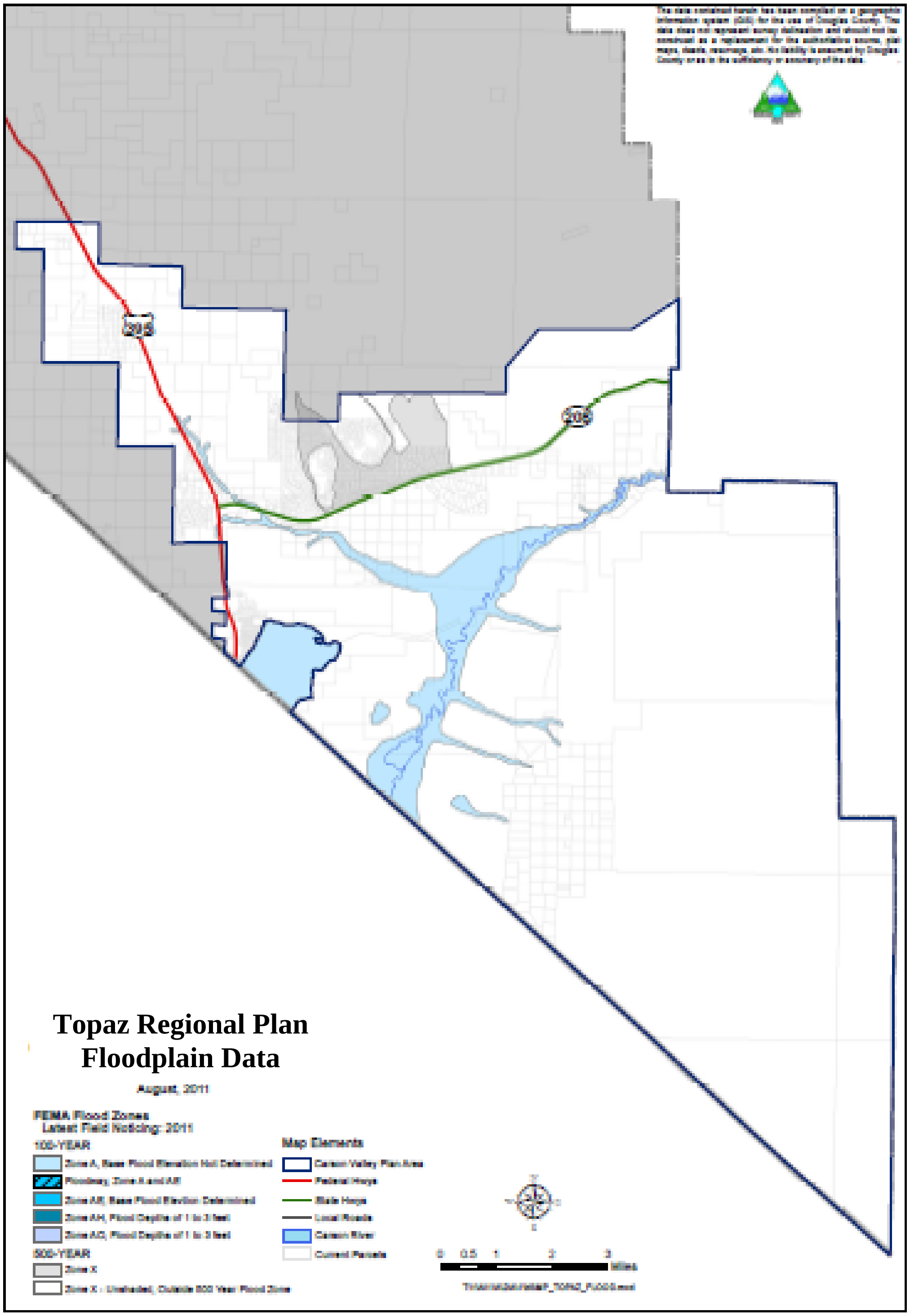
Map 7.14
Carson Valley Floodplain



Map 7.15
Pinenut Floodplain



Map 7.16
Topaz Floodplain



The most damaging and apparently the largest flood events have occurred since 1950. Flood damages have increased as development within the floodplain has increased, but the extent and severity of flooding in the Carson Valley has probably been influenced more by the construction of elevated roadways across the floodplain than by any other activity of man.

In 1950, floods in November and December reached 25- and 15-year frequencies, respectively. They were both caused by rain falling on snow and saturated ground. Damages for this 2-month period were estimated at $825,000.

The flood event of December 1955 was caused by heavy rainfall on snow, in what was probably the heaviest sustained downpour in the history of western Nevada. This storm period was characterized by approximately 60 hours of continuous precipitation that dropped in excess of 10 inches of moisture in the upper watershed areas. This precipitation was mostly in the form of rain below the 9,000 foot elevation, with 10.37 inches recorded at Woodfords, California. The flood crest that resulted from the storm, estimated to be an 86-year event on the East Fork, is the largest flood recorded in the valley. The damages were established at $1.5 million.

The most damaging flood on record was the New Year's flood of 1997. In December 1996, several moderate to heavy snowstorms built up a large snowpack (more than 180 percent of normal) in the higher altitudes of the Sierras with two to three feet on the valley floors. A series of three subtropical storms originating in the central Pacific Ocean brought heavy rainstorms to the region. The last of these storms moved through the region from late December 30, 1996, to early January 2, 1997. These storms brought heavy, unseasonably warm rain to the Sierras and melted almost 80 percent of the snowpack in the Sierra Nevada below about 7,000 feet. Recorded precipitation was 16.4 inches at Ebbetts Pass (8,700 ft) and 3.5 inches at Minden.

About 53.2 square miles of the Carson River Basin were flooded. The combined floodwater formed a lake across the valley floor 2 to 3 feet deep, overflowing Muller Lane and closing State Route 88 for two days. About one foot of water covered Highway 395 near Cradlebaugh Bridge, which has been damaged numerous times in the past during floods. On January 2, 1997, the flow at the East Fork of the Carson River near Gardnerville peaked at 20,300 cubic feet per second (cfs). This is the highest figure ever recorded.

Three factors generally cause flooding along the East and West Forks of the Carson River: insufficient capacity, obstruction to flow along waterways, and the natural slope of the channel.

Available recorded data on channel capacities are vague. Channel capacities along the Carson River forks fluctuate annually as reaches of the channel deteriorate or improve. It is a general rule of thumb that a flood hazard exists on the East Fork of the Carson River if flow exceeds 5,500 cubic feet per second and if flow within the West Fork of the Carson River exceeds 1,000 cubic feet per second.

The East and West Forks of the Carson River have both natural and man-made obstructions, which impede the channel capacities.

Natural Obstructions

Natural obstructions to flood flow include brush and other vegetation growing along the stream banks in floodway areas and ice. During floods, brush growing in floodways impedes flood flows and results in backwater and increased flood heights. Brush washed out during floods and carried downstream may collect on bridges or plug culverts, thus creating a damming effect resulting in overbank flow. As flood flow increases, masses of debris may break loose allowing a wall of water and debris to surge downstream until another obstruction is encountered. Such was the case during the March 1986 flood event when a large tree and debris were caught at the Rocky Slough-Virginia Ditch Diversion structure located on the East Fork of the Carson River. Although the river flow was not as large as previous historic flows, the obstruction caused a damming effect at that location and major erosion of the stream bank took place until the debris could be removed.

Due to the Carson River Basin's high elevation and low winter temperatures, ice on the river can also become a problem. Ice formed in and along the river during the low freezing temperatures can be broken up and set in motion by a few successive warm days or by rains. The ice then becomes floating debris and hence eventually creates hazards. As night temperatures fall, the ice solidifies into larger structures enabling greater amounts of ice and debris to pile up behind. As temperatures warm and rain melts more snow, the damming problem intensifies.

Man-Made Obstructions

Man-made obstructions to flood flow in the region consist of a number of bridges, culverts, and irrigation diversion structures. Debris collecting on these obstructions may increase to the point where structural capability is exceeded and the structure is destroyed. This type of flood event occurred in January 1980 on the East Fork of the Carson River when debris accumulated along the piles supporting the Riverview Bridge. As the debris and flow increased, the substructure and superstructure were damaged and had to be replaced by the present structure.

During high flows, the man-made obstructions can raise water levels to the extent that local flooding and erosion occur. Irrigation structures, which naturally restrict channel flow, and public roadways, which are elevated above the local terrain, also act as dikes, which block and divert the water causing additional flooding.

The Carson River and adjoining lands that can become inundated during flooding have a natural slope toward the northwest. Most of the channels and irrigation canals are oriented toward the north. Because of the orientation of the existing irrigation canals, floodwater during flood events tends to travel down the natural slope to the northwest causing overflows from each canal to the next down-slope canal. This occurrence intensifies as the storm frequency increases causing eventual inundation of large areas of the valley between the irrigation canals. Siltation deposits can also be a problem with the north orientation of the existing irrigation canals because of the natural northwest slope of the valley.

If irrigation canals were opened, designed for flood drainage, designed to handle siltation, and regularly maintained, they would aid in alleviating a portion of the floodwaters from the Carson River.

Carson River Tributary Basin Flooding

The Carson River Basin is narrow for the most part. Its sides are composed of various mountain ranges, each with associated drainage networks. The drainage basins on the eastern side of the Sierra Nevada Mountains and the basins within the Pinenut Mountains can generate two different types of flood events consisting of wet-mantle storms or dry-mantle storms.

Wet-Mantle Flooding

The earliest recorded flood damage in Genoa occurred on January 20-26, 1886, during a flood event in the Carson Valley. The resulting flood from rain on snow on the small drainage areas west of Genoa caused damage to most buildings and streets. In March 1890, snowmelt caused the failure of a small dam in Genoa Canyon and several buildings were damaged.

Dry-Mantle Flooding

Damages from this type of flood are localized, but often severe, in the form of range and watershed erosion in the upper reaches of the watershed, and flooding and sediment deposition on agricultural lands and rural and urban developments within the flood area. These floods are also referred to as cloudbursts and flash floods.

Dry-mantle flooding has occurred in Genoa, the Johnson Lane area, Topaz Ranch Estates, the Fish Springs area, the Ruhenstroth area, and other basins located on the east side of the Carson Valley.

Genoa is also vulnerable to damage from severe thunderstorms. On August 5, 1971, several occurred in the vicinity. A flash flood (dry-mantle) came down Sierra Canyon 0.8 miles north of Genoa and spewed mud, rocks, and debris throughout the community and across Foothill Road, which parallels the Sierra front through the Carson Valley. The drainage area encompassed 3.1 square miles and discharged an estimated 344 cubic feet of water per second.

The Johnson Lane area lies above the Carson River floodplain, but has several alluvial fan washes, including the Johnson Lane Wash, the Buckbrush Wash, and the Airport Wash that have produced large dry-mantle cloud burst flows. The Johnson Lane area around these washes has continued to grow in population over the past few years. Large population growth in this area will dictate that flood plain management and possibly flood protection measures be taken. Protection and management in this area has become increasingly important in light of the frequent flood occurrence with cloud bursts occurring in this area.

The East Valley, Fish Springs, Pinenut, and Ruhenstroth areas have also experienced several large cloudbursts in recent years causing short duration, high-flow events to occur. These areas have a multitude of alluvial fans with encroachment by development near the high flood-prone areas. Floodplain management and flood protection measures should also be considered in these regions of the Carson Valley.

Topaz Ranch Estates has several alluvial fan dry-stream basins, such as Minnehaha Canyon, that have experienced both wet- and dry-mantle storms in recent years. These storms have been particularly damaging to property, roads, and road structures due to encroachment and development near the stream basins.

In addition to water, flooding can carry significant amounts of silt, sand, and debris. Debris may consist of sediment, boulders, rocks, and trees. This flow is often called a debris flow and can cause significant damage to structures and roadways. Debris flows have the highest potential of occurring in smaller, steeper watersheds along the eastern slopes of the Carson Range or after the vegetation has been destroyed by fire which leads to increased erosion.

Watersheds that may impact areas of current or proposed development and are tributaries of the Carson River and the Walker River are listed on Map 7.17.

Federal Emergency Management Agency Floodplains

Douglas County entered the National Flood Insurance Program (NFIP) in January 1974. A flood insurance study was completed on the East and West Forks of the Carson River, the Genoa area, and Topaz Ranch Estates area of Douglas County. A subsequent updated study was completed on several stream basins along the east and west sides of the Carson Valley between 1986 and 1990.

In 2008, FEMA updated the Flood Insurance Rate Maps (FIRM) used by the County in determining flood zone information for several eastern Carson Valley Basins (Buckbrush Wash, Johnson Lane Wash, Buckeye Creek, etc.), which changed the flood zone for approximately 5,000 parcels in the valley. The maps went into effect on January 20, 2010.

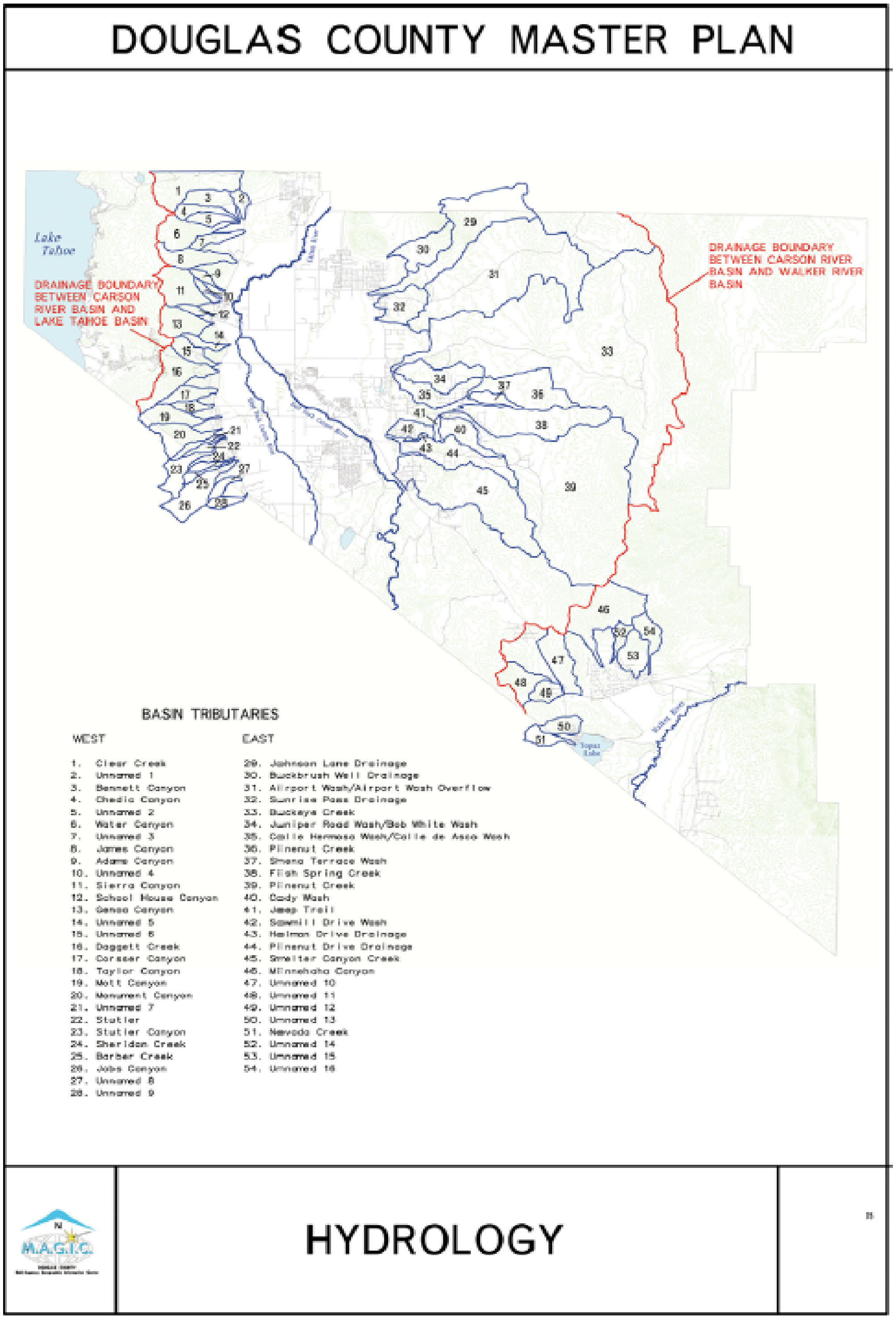
Revisions to the floodplain mapping are on-going and the limits to further areas of flood studies are dependent on limited FEMA funding. Not all of the county has been analyzed. Future analysis may result in change to the current floodplain mapping and designations.

In August 2008, Douglas County adopted the Carson River Watershed Regional Floodplain Management Plan. The Plan was also adopted by other jurisdictions along the Carson River, including Carson City, Lyon County, Churchill County, and Alpine County, California. The Plan's objectives relate to floodplain management strategies that will reduce flood damage.

Douglas County's participation in the NFIP provides a basis for flood planning in areas mapped and designated flood-prone. According to the Program's regulations, a community can adopt floodway ordinances which prohibit encroachment (including fill, new construction, and other development) that would result in any increase in flood levels. The County's floodplain management ordinance (refer to Douglas County Code, Chapter 20.50) was updated in October 2008 to meet NFIP and FEMA requirements.

The floodway is based on the principle that the regulated area must be designed to carry the water of the base flood without increasing the water surface elevation of the flood more than one foot at any point. Development within a designated floodway is prohibited.

Map 7.17
Hydrology



The principal Carson Valley floodplain areas are along the west side of Highway 395 with smaller portions to the east, along the East Fork of the Carson River. The Master Plan recognizes that the entire length of the Carson River should be used for open space, and agricultural maintenance. Thus, the flood-prone areas of the Carson River need to remain principally undeveloped.

Flooding Frequency

Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, and 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for floodplain insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual occurrence) in any 50-year period is approximately 40 percent, and for any 90-year period the risk increases to approximately 60 percent. The analyses reported here reflect flooding potentials based on conditions existing in the county at the time of completion of the flood study. Maps and flood elevations are amended periodically to reflect changes.

Flood Insurance Rate Map Description

The FIRM for Douglas County, Nevada, is for insurance purposes, the principal result of the Flood Insurance Study (FIS). This map contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water surface elevations of the base (100-year) flood. The map was developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Insurance Administration. Not all of the county has been analyzed and continued work by FEMA may result in additional designations.

Flood Insurance Zones

The entire area of Douglas County was divided into zones, each having a specific flood potential hazard. Each zone was assigned one of the following flood insurance zone designations listed below:

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations or Flood Hazard Factors determined.
Zone AE:	Special Flood Hazard Areas and areas where base flood elevations determined.
Zone AH:	Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
Zone AO:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1 and 3 feet; depths are shown, but no Flood Hazard Factors are determined.
Zone X (shaded):	Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.
Zone X (unshaded):	Areas determined to be outside the 500-year floodplain.

Carson River Flood Management

Several options exist for minimizing the impacts of flooding of the Carson River. One option involves the possible use of existing irrigation facilities to provide additional conveyance capacity around the populated areas of the county. Another option that should be investigated is using the existing irrigation ditches to convey a portion of the peak flows to wetlands for detention. The irrigation ditches or canals that could be used to convey Carson River flood waters are shown on Map 7.18. These ditches were identified by the Water Conveyance Advisory Committee, which is made up of the County's major ditch users.

Since the Carson River typically floods while the irrigation system is not being used, the system could help to relieve some flooding by adding additional flow capacity for Carson River flood flows. This type of solution would require the County and the ditch owners to come to an agreement on how this system would be operated and maintained. The issues which should be considered are: 1) the improvements required to utilize the ditches for flood control, 2) the additional maintenance the County or other entities should provide for using the irrigation systems, and 3) whether the capacity of the ditches can be improved for additional flood control while maintaining the operational integrity of the system.

In addition to the possibility of conveying a portion of the Carson River flows using the existing irrigation canals and ditches, flows could also be conveyed to wetlands such as those near the Douglas County Airport. This could be accomplished by using portions of the Allerman Canal and its associated reservoirs and would require agreements with ditch and land owners for use and joint maintenance of the ditches.

Tributary Basin Floodplain Management

Watershed Prioritization

Non-structural flood control measures should be used as much as possible within tributary basins.

Each urban and rural watershed within the county that feeds into a major drainageway should be prioritized according to severity of historical flooding. Priority should be given to watersheds that traverse through existing urbanized areas with high risk to life and property. Additional information and data compiled by the Douglas County Community Development Department on past storm events and damage should also be used in prioritization of watersheds.

Figures 7.7 thru 7.9 provide suggested initial listings for high, medium, and lower priority of the Carson River and East Walker River tributaries. The priorities are based on flooding problems and flood damage and should be reviewed and addressed to resolve flood issues.

Map 7.18
Carson Valley Drainage

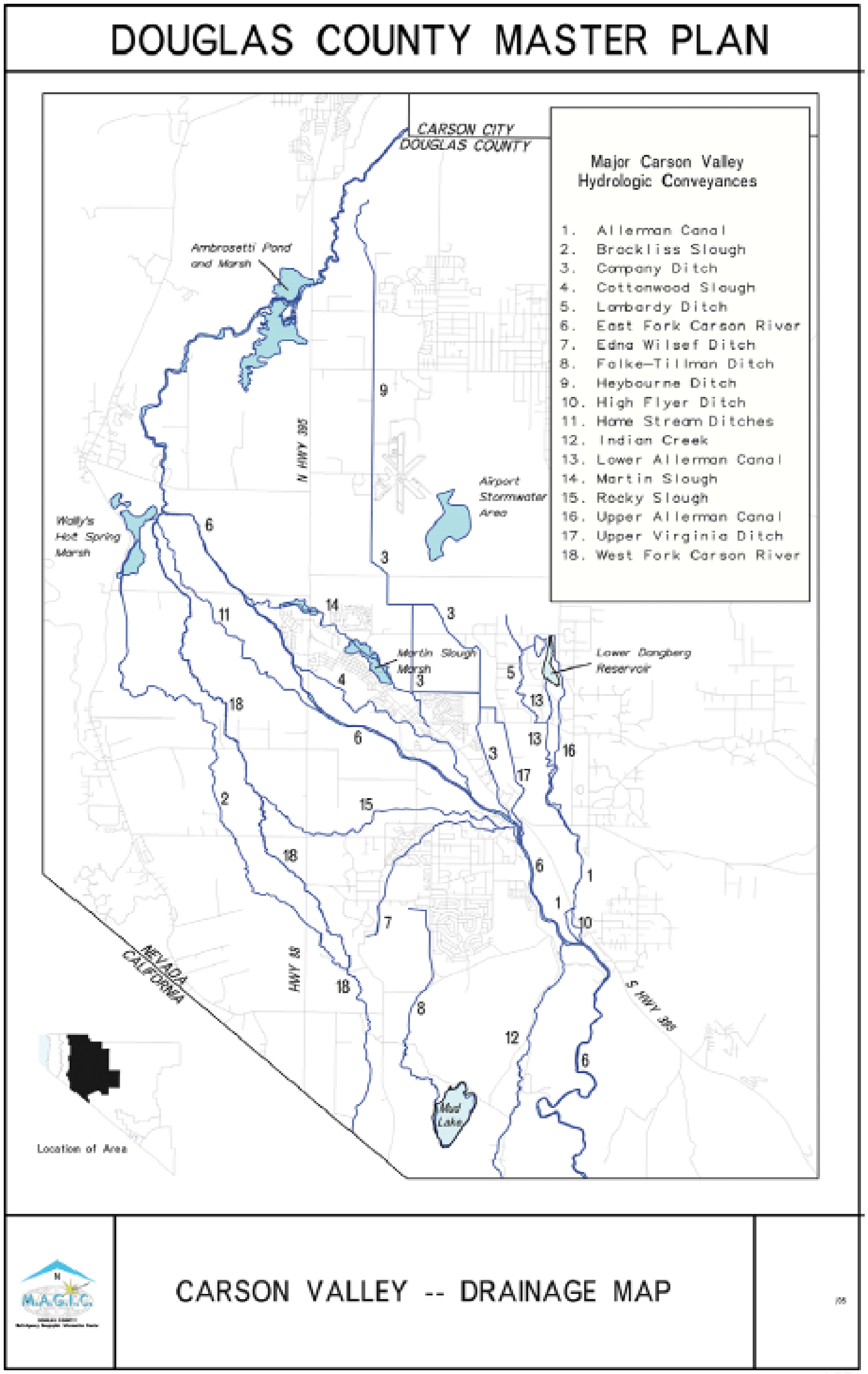


Figure 7.7
High Priority

BASIN TRIBUTARY	LOCATION
Johnson Lane Wash	Johnson Lane
Minnehaha Canyon Wash	Topaz Ranch Estates
Buckbrush Wash	Johnson Lane
Smelter Creek	Ruhenstroth
Pinenut Creek	Fish Springs
School House Canyon	Genoa
Genoa Canyon	Genoa
Bennet Canyon	Jacks Valley
Chedic Canyon	Jacks Valley
Water Canyon	Jacks Valley
James Canyon	Genoa
Sierra Canyon	Genoa
Daggett Creek	Mottsville
Taylor Canyon	Mottsville
Mott Canyon	Mottsville
Monument Canyon	Sheridan
Stutler Canyon	Sheridan
Sheridan Creek	Sheridan
Barber Creek	Sheridan
Jobs Canyon	Sheridan

Figure 7.8
Medium Priority

BASIN TRIBUTARY	LOCATION
Airport Wash	Johnson Lane
Buckeye Creek	East Valley
Juniper Road Wash	Fish Springs
Calle Hermosa Wash	Fish Springs
Sheena Terrace Wash	Fish Springs
Fish Springs Creek	Fish Springs
Pinenut Drive Drain	Pinenut
Unnamed 14	Topaz Ranch Estates
Unnamed 10	Topaz Ranch Estates
Unnamed 11	Topaz Ranch Estates
Unnamed 12	Topaz Ranch Estates

Figure 7.9
Low Priority

BASIN TRIBUTARY	LOCATION
Sunrise Pass Drainage	Johnson Lane
Sawmill Road Wash	Pinenut
Jeep Trail Tributary	Pinenut
Cody Wash Tributary	Pinenut
Helman Drive Drain	Pinenut
Unnamed 16	Topaz Ranch Estates
Unnamed 15	Topaz Ranch Estates
Unnamed 13	Topaz Lake
Nevada Creek	Topaz Lake
Clear Creek	Jacks Valley
Unnamed 1	Jacks Valley
Unnamed 2	Jacks Valley
Unnamed 3	Jacks Valley
Adams Canyon	Genoa
Unnamed 4	Genoa
Unnamed 5	Mottsville
Unnamed 6	Mottsville
Corsser Canyon	Mottsville
Unnamed 7	Mottsville
Stutler Canyon Tributary	Sheridan
Unnamed 8	Sheridan
Unnamed 9	Sheridan

Alluvial Fan Flood Management

Identifying and providing solutions to alluvial fan and flash flooding in Douglas County requires a comprehensive approach. A combination of watershed evaluation and development planning is necessary to provide the proper safety in the community.

Areas that are already developed and experiencing flooding problems will need evaluation and implementation of structural and non-structural solutions to alleviate flooding to an acceptable level. This involves prioritization of the watersheds that need evaluation, a clear sense of what information is needed to accomplish evaluation, and the use of evaluation results to plan development and flood control improvements.

The following areas have had flooding-related problems:

- Johnson Lane Community (Buckbrush Wash and Johnson Lane Drainage)
- Topaz Ranch Estates (Minnehaha Canyon)
- Pine Nut Creek
- Smelter Canyon Creek
- Buckeye Creek
- Pine Nut Drive Drain
- Airport Wash
- Genoa Canyon
- School House Canyon
- Stutler Canyon

Areas yet to be developed should be evaluated for flooding potential, and a watershed planning approach should be used to guide proper future development in these areas. An example of good planning in alluvial fan flooding areas is zoning and dedication of portions of developments to open space for watershed-wide flood control. This benefits the community by providing a higher level of protection and lower flood insurance rates.

The following is a list of structural and non-structural tools that may be used for flood management:

- Upper Watershed Management
- Zoning Limitations
- Open Space for Flood Control
- Local Levies and Street Conveyance
- Armored Fills
- Debris Basins and Channels
- Regional or Localized Basins
- Storm Drains

One of the major problems with the majority of the tributary basins is their damage course in route to the Carson River. The route to the major drainage for these basins is often through populated areas that have encroached into the alluvial fan floodplain or are close to the flood channel. This makes it difficult to make structural flood-proofing improvements.

Existing irrigation canals that run in a northerly direction can be improved to accommodate drainage and flood flows as noted previously. In addition to the main northerly conveyance structures, a number of irrigation canals run in an east to west direction toward the Carson River. These ditches, which traverse through private agricultural property, could be improved to take flood flows from tributary basins and direct the storm water to the Carson River. Solutions to limited channel and structural capacity under Highway 395 would need to be resolved for this alternative.

Development Considerations

Development regulations relating to stormwater management should protect the public from flooding and pollution hazards and provide cost-effective storm drainage. These regulations should consider peak flows, sedimentation, and water quality in proposals for new development. Development regulations should also address protection of developments from existing flood hazards and guard against flood hazards that the development could create. Development policies must continue to meet or exceed FEMA requirements in order to maintain the County's eligibility for the NFIP.

Design criteria should be carefully considered to evaluate drainage facility requirements. Generally, storm run-off from a development or project site should be detained or retained on-site to the extent that the post-development peak run-off leaving the site will not exceed the predevelopment peak run-off leaving the site. Other development considerations to be considered include treatment of stormwater to mitigate adverse water quality impacts before disposal into the river system in the county. This can be done on-site, but basin or regional treatment is preferred. The Towns have indicated a preference for utilizing regional basins as opposed to multiple smaller detention basins.

Point and Non-Point Pollution

The need to protect surface waters from the impact of human activities in Douglas County is a growing concern as urbanization continues. Increased urban growth brings with it water quality impacts as the result of additional pollution. The quality of surface water is dependent upon activities within the watershed area. Sedimentation can be caused by natural processes, development, and agricultural activities. Pollution of surface waters can be caused by a variety of sources, some traceable and some not.

Urbanization impacts the quality of surface water by introducing pollutants directly into the water. These pollutants are generated from sources such as chemical fertilizers, pesticides, refuse, raw sewage, industrial activity, and automobile-related facilities and reach water by natural run-off, storm drains, and illegal dumping. Grease traps, detention ponds, hazardous waste collection, sand/oil separators, low impact development (LID) techniques, and other measures can reduce undesirable impacts of urbanization on water quality.

Potential Wetlands

Wetlands are natural areas which are either permanently or intermittently inundated or saturated by water because the water table is close to the surface of the ground, and the area can support life that is capable of adapting to the saturated conditions. The most common types of wetlands in the county are freshwater marshes and wet meadows, although small potholes and riparian environments are also found in some areas. Additionally, the Carson Valley contains areas of wetlands, which are irrigation induced.

These areas serve as key locations for groundwater recharge, provide natural flood protection and control, act as sediment traps and water pollution filtration systems, and offer unique habitat for many plant, fish, and wildlife species. These factors contribute to make wetlands important resources. In addition, many wetlands have scenic and recreational appeal which makes them valuable from an economic and recreational standpoint when protected as open space. Their protection as important county resources is a component of this Plan.

The areas of potential wetlands for the Carson Valley generally coincide with the east and west forks of the Carson River. The areas of potential wetlands within the Pinenut region are in the Mud Lake area in the far west edge of the plan area. Limited areas of potential wetlands of Topaz Lake are near the shoreline, in the northwest corner, and a narrow band along Nevada Creek and along the East Fork of the Walker River. The areas of potential wetlands for the Topaz Ranch/Holbrook community are along the intermittent stream to the east of Highway 395. These potential wetlands are only generally classified and further study is necessary to delineate any wetlands.

Douglas County may want to examine the potential for wetland mitigation banking. Wetland mitigation banking is the process of creating, restoring, enhancing, or preserving wetland areas in an effort to mitigate the destruction of existing wetlands. The objective is in replacing the functions, both biological and aesthetic, that are lost because of development. The Towns of Minden and Gardnerville have been successful in implementing programs to protect wetland in areas along the Martin Slough.

Water Resources

Douglas County has three major valleys: the Lake Tahoe Basin along the western border (about 70 square miles), Carson Valley in the central part (about 420 square miles), and Antelope Valley in the southeastern corner of the county (about 110 square miles). Two major river systems flow in a northerly direction through the county: the Carson River through Carson Valley and the West Walker River through Antelope Valley.

Groundwater is the principal source of drinking water for most of Douglas County except in the Lake Tahoe Basin where the lake is the primary source. Groundwater is also used for irrigation in Carson and Antelope Valleys.

There are terms used in these reports that are important to understand when discussing water resources. These include:

- Carson River Basin: The hydrological-geological area of the entire Carson River watershed from the Carson-Iceberg Wilderness in California to the Carson Sink in Churchill County, NV.
- Carson Valley Basin: The hydrographic area defined by the Nevada State Engineer on June 14, 1977 with Order 684. A small portion is in Carson City and the remainder is in Douglas County.
- Carson Valley: The area of the Carson Valley Basin that is in Douglas County.

The first two terms are defined in both the 1975 Glancy-Katzer report and the 1986 Maurer report. The third is a term defined by Vasey in his 1994 report to indicate the Douglas County portion of the Carson River watershed, and it is the portion he is referring to when he assumes the annual groundwater recharge within the Carson Valley to be 35,000 acre-feet and the population number to be 47,000.

In addition, the document entitled Carson Valley Comprehensive Water Plan 1994, prepared by Vasey Engineering, summarizes data from many of these documents and has provided the basis for the conclusions and recommendations contained with this Plan. The 1994 Water Plan is incorporated by reference as a part of the Douglas County Master Plan, as well as testimony from the State Water Engineer related to local water resource availability.

Water Quality

Land use has a direct relation to the potential for contamination of ground and surface waters. There are two types of contamination sources associated with land use: 1) point sources, which have the potential for discharging directly into the surface water or have the potential for injecting contaminants directly into the soil which potentially could reach groundwater; and 2) non-point sources, which are generally land management activities, and have the potential for impacting surface waters and groundwater by distributing potential contaminants over the land's surface. Ironically, it is the non-point sources which pose the greatest threat to groundwater resources. The contamination from these sources generally builds up gradually over the long term.

The quality of a river can best be assessed by the beneficial uses established for each reach and the associated water quality standards which are established at a level to protect the most sensitive use designated. Additionally, Nevada has legislated that any surface waters of the state whose quality is higher than the applicable standards of water quality as of the date when those standards become effective, must be maintained in their higher quality.

<u>Carson Valley (Carson River Basin)</u>

Groundwater

In general, the quality of groundwater in much of the county meets drinking water standards and criteria and is, therefore, suitable for most purposes. In Carson Valley, concentrations of most constituents generally increase in a northerly and easterly direction, corresponding to the direction of groundwater flow (Garcia, 1989).

Garcia and Thodal found, however, that there were instances where primary and secondary drinking water standards were exceeded at specific locations. Standards for fluoride, nitrate, arsenic, iron, and manganese were exceeded in the Jacks Valley/Indian Hills area with the potential source of contamination being septic tanks. Standards for sulfate, fluoride, dissolved solids, nitrate, arsenic, iron and manganese were exceeded in the Johnson Lane area with the potential source of contamination again being septic tanks. Standards for iron were exceeded in the Genoa, Minden-Gardnerville, and Gardnerville Ranchos area with the potential source of contamination being agricultural and urban runoff and septic tanks. Manganese levels exceeding standards were found in the Airport area and in the Ruhenstroth area; nitrate, iron, and manganese were found at levels exceeding standards. Additionally, groundwater in the west, central, and northeastern parts of Carson Valley is influenced by mixing with geothermal water. No overall trends of groundwater contamination were indicated.

Surface Water (Carson River)

A report prepared by the Bureau of Water Quality Planning of the Division of Environmental Protection in 1994 described the beneficial uses of the Carson River, associated standards, and results of periods of monitoring. The report recommended that all previously adopted beneficial uses be retained and that, with few exceptions, the required standards to maintain existing quality (RMHQ) not be modified. The change in RMHQ values for several of the parameters was associated with the removal of municipal wastewater from the river.

The Carson River has the following beneficial uses from the state line to the Lahontan Reservoir:

1. Irrigation;
2. Watering of livestock;
3. Recreation involving contact with water;
4. Recreation not involving contact with water;
5. Industrial supply;

6. Municipal or domestic supply, or both;
7. Propagation of wildlife;
8. Propagation of aquatic life, more specifically, the species of concern are rainbow trout, brown trout, catfish, smallmouth bass, walleye, channel catfish, and white bass.

The parameters evaluated in the 1994 report include temperature, pH, total phosphates, total nitrogen, nitrate, nitrite, ammonia (un-ionized), dissolved oxygen, suspended solids, turbidity, color, total dissolved solids, chlorides, sulfate, sodium absorption rate, alkalinity, and fecal coliform.

Antelope Valley (Topaz Lake and West Walker River Basin)

The Topaz Lake Area Water & Wastewater Master Plan, prepared by Consulting Engineering Services (CES) in 1991 for Douglas County, summarized numerous reports relating to water quality in the Topaz Lake area.

Groundwater

In the Topaz Lake area, standards were exceeded for nitrate, arsenic, iron, and manganese. Nitrate concentrations in water appeared to be increasing in two areas with the source appearing to be septic tank effluent. The CES Master Plan identifies the areas and the investigations that have taken place.

Surface Water

Data summarizing the surface water quality of the West Walker River was not developed for this Master Plan due to the limited urban development potential adjacent to the river. Extensive studies, however, have been performed on Topaz Lake water quality. The most significant concern appears to be increasing nitrogen loading to the lake from septic tank effluent.

The Walker River and Topaz Lake have the following beneficial uses from the state line to the Walker Lake:

1. Irrigation;
2. Watering of livestock;
3. Recreation involving contact with water;
4. Recreation not involving contact with water;
5. Industrial supply;
6. Municipal or domestic supply, or both;
7. Propagation of aquatic life, more specifically, the species of concern are rainbow trout, brown trout, cutthroat trout, Lahontan cutthroat trout, brook trout, kokanee salmon, silver salmon, mountain white fish, catfish, channel catfish, and largemouth bass.

Water Quantity

General

The general policy of the State Engineer is to limit groundwater withdrawals from a basin to the annual average recharge to the basin. The State Engineer will make a final determination on what the groundwater withdrawal limit is when the actual pumpage approaches the annual recharge or if the groundwater basin begins to show adverse effects from pumpage.

Additionally, groundwater basins may be "Designated" by the State Engineer. In Designated Basins, the State Engineer may establish preferred uses of water within such basins as well as limit withdrawals. No wells can be drilled in a designated basin until a permit is issued by the State Engineer, unless it is a well for domestic purposes limited to 1,800 gallons per day for one household, family, lawn, garden, and domestic animals. The State Engineer may prohibit the drilling of wells for domestic use in areas within designated basins where water can be supplied by a community water system.

Carson Valley (Carson River Basin)

Groundwater

The estimated quantity of groundwater stored in the upper 100 feet of saturated valley fill is approximately 700,000 acre-feet. Water Reconnaissance Report 59 (Glancy and Katzer, 1975) and Water Resources Investigations Report 86-4328 (Maurer, 1986), both prepared by the U.S. Geological Survey, contain estimates of potential annual groundwater recharge to the Carson Valley Basin. These reports estimate 41,000 (Glancy and Katzer) and 49,000 acre-feet per year in the (Mauer).

Annual groundwater recharge within the Carson Valley was assumed to be 35,000 acre-feet in the Carson Valley Comprehensive Water Plan (Vasey, 1994). According to this report, pumpage "will begin to exceed the potential annual recharge of 35,000 acre-feet as the population approaches 47,000 people" in the Carson Valley. Water conservation and the use of treated effluent to replace both supplemental and non-supplemental groundwater being pumped for irrigation purposes could reduce the groundwater pumpage below 35,000 acre-feet per year by the year 2015. The use of surface water to recharge the groundwater basin and/or the use of surface water through storage and treatment for municipal purposes would be required to meet population demands beyond the anticipated population of this Master Plan.

The Carson Valley Groundwater Basin was designated by the State Engineer on June 14, 1977, with Order 684.

Surface Water

The water budget for the Carson Valley is dominated by the Carson River flows. The majority of the stream flow enters the valley via the West and East Forks of the Carson River, with additional flows from streams and springs, originating on slopes on the east and west sides of the valley. Stream flows entering Carson Valley average 280,000 acre-feet per year for the East Fork and 80,000 acre-feet per year for the West Fork.

The Carson River Decree states that the waters of the Carson River and its tributaries are fully appropriated. Any new uses of the Carson River or its tributaries will require changes in existing rights.

Secondary Treated Sewage Effluent

An additional water resource available in the Carson Valley is secondary treated effluent. To date, secondary treated effluent has been used primarily for irrigation purposes during the summer months.

Secondary treated effluent is imported into the valley by Incline Village General Improvement District (IVGID) and Douglas County Sewer Improvement District No. 1. (DCSID No. 1). Both IVGID and DCSID No.1 store treated effluent in the valley for agricultural reuse during the irrigation season.

Minden-Gardnerville Sanitation District (MGSD) stores treated effluent in a reservoir along Muller Lane and then pumps a portion of the treated effluent to a second reservoir in the Buckeye Creek area east of East Valley Road. During the summer, effluent is utilized by downstream users for irrigation purposes.

The County's North Valley Wastewater Treatment Facility currently contains an on-site storage reservoir and discharges its treated effluent to a Rapid Infiltration Basin and the IVGID wetlands. The County is currently developing an irrigation reuse program.

IHGID operates a secondary sewer treatment facility servicing Indian Hills, Ridgeview as well as the Jacks Valley School. Currently, treated effluent is stored and used for golf course irrigation.

Figure 7.10
Treated Effluent – Carson Valley

Treatment Facility	Present Place of Use/Storage
IVGID	Schneider Ranch, Bentley Kirman Tract and Wetlands
DCSID No. 1	Settelmeyer Ranch and Bentley Ranches
MGSD	Danberg Holding, Gallepi Ranch, and Bentley Ranches
NVWWTP	*On-site storage reservoir, Rapid Infiltration Basin, Kirman Tract, and* IVGID Wetlands
IHGID	Sunridge Golf Course

A portion of the imported treated effluent, which totals over 5,000 acre-feet annually could be considered additional groundwater recharge in the basin.

Future treated effluent flows could increase the water resources available for development in the valley. Alternative uses of the effluent, which may be beneficial to the development of additional water supplies include:

- Use of treated effluent to supplement existing surface water rights rather than supplemental wells, thereby reducing the pumpage of the groundwater resource.
- Use of treated effluent to replace the use of existing surface water rights for irrigation and use the surface water rights to recharge the Groundwater Basin.

Antelope Valley (Topaz Lake and West Walker River Basin)

Groundwater

The estimated quantity of groundwater stored in the upper 100 feet of saturated valley fill in the Nevada part of the Antelope Valley is approximately 200,000 acre-feet (Glancy, 1971). Water Reconnaissance Report 53, by the U.S. Geological Survey, contains an estimate of 5,000 acre-feet per year potential groundwater recharge to the Nevada part of the Antelope Valley.

Surface Water

The water budget for the Antelope Valley is dominated by river flows. The majority of the stream flow enters the valley via the West Walker River. Stream flows entering Antelope Valley average 165,000 acre-feet per year.

<u>Water Rights and Ground Water Pumping</u>

Carson Valley

The Carson Valley Groundwater Pumpage Inventory report, which is published annually by the State of Nevada Department of Conservation and Natural Resources Division of Water Resources, provides current and historical data related to water resources.

Future Water Resource Demand

Forecasts have been made of water demands for the various communities both on community water systems and individual wells, as well as other uses to determine the overall demand on the groundwater resources in the county. The forecasts are based on land uses projected in the land use element and the methodology contained in the Carson Valley Comprehensive Water Plan, 1994.

In summary, the water plan states that overall water demand in 2015 is estimated to be approximately 40,700 acre-feet in the Carson Valley and 6,100 acre-feet in the Antelope Valley. The longer-term demand based on the proposed land uses is 66,000 acre-feet in the Carson Valley and 10,500 acre-feet in the Antelope Valley.

Annual groundwater recharge within the Carson Valley was assumed to be 35,000 acre-feet in the Carson Valley Comprehensive Water Plan (Vasey, 1994). According to this report, pumpage "will begin to exceed the potential annual recharge of 35,000 acre-feet as the population approaches 47,000 people" in the Carson Valley. Water conservation and the use of treated effluent to replace both supplemental and non-supplemental groundwater being pumped for irrigation purposes could reduce the groundwater pumpage below 35,000 acre-feet per year by the year 2015. The use of surface water to recharge the groundwater basin and/or the use of surface water through storage and treatment for municipal purposes would be required to meet population demands beyond the anticipated population of this Master Plan.

As previously discussed, when actual pumpage in Carson Valley approaches 35,000 acre-feet annually, the State Engineer may begin to regulate withdrawals. If some adverse effect of pumping is detected before the withdrawal of 35,000 acre-feet, the State Engineer may also regulate pumpage.

Municipal water use is based on 1.12 acre-feet per household per year based on the State Engineer's water right requirements for use on Municipal systems and Douglas County's Water Ordinance. Actual water usage reported by the water purveyors in the Valley varies from as low as 0.41 acre-feet per year per EDU at Indian Hills to as high as 1.33 acre-feet per connection in Minden. Water conservation could reduce the municipal requirements in areas where the household use is high. It is estimated that reductions in municipal requirements could be realized through water conservation in certain areas which could result in reducing the municipal demands by as much as 2,000 acre-feet in the year 2015 and 4,000 acre-feet for longer-term development.

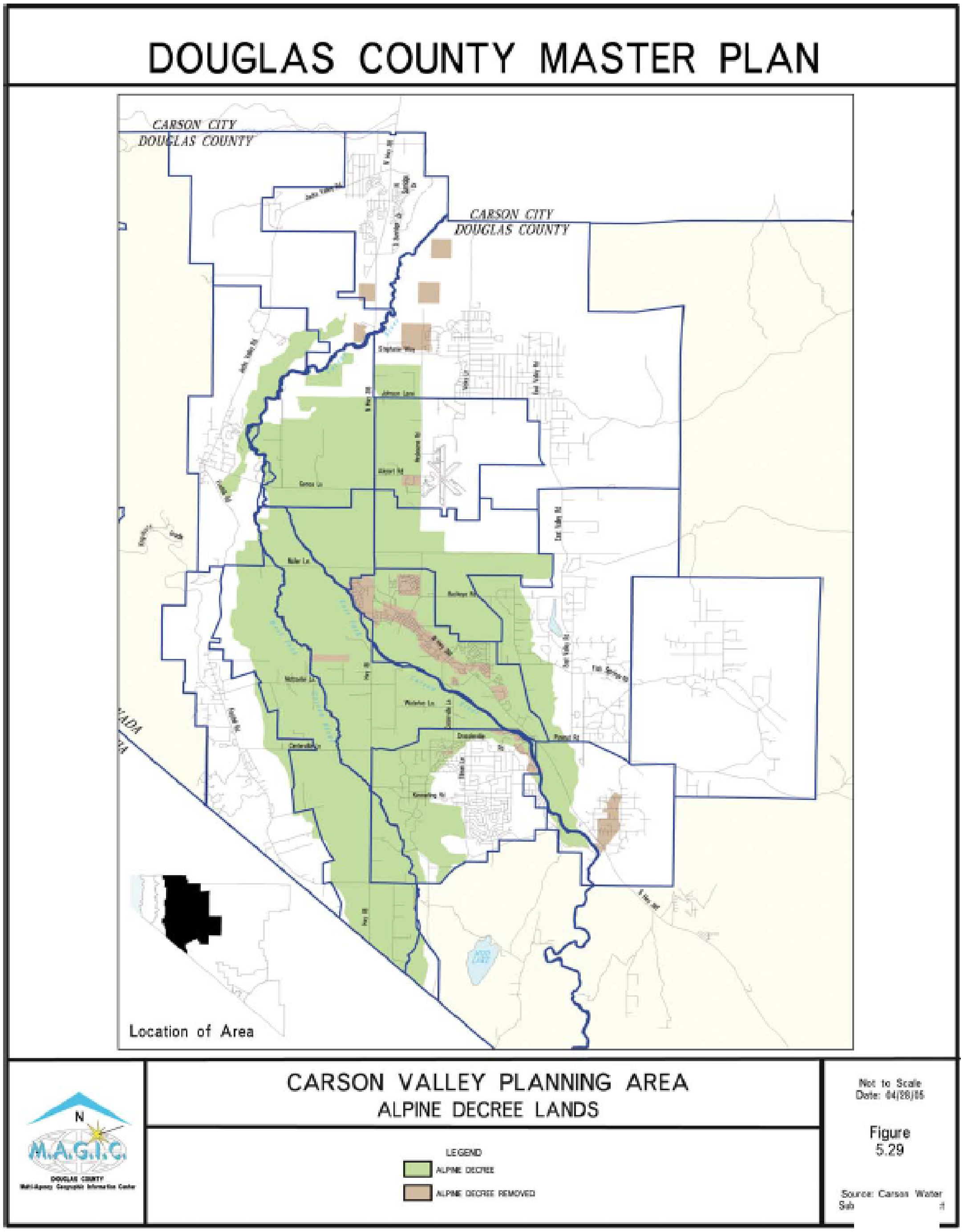
Additional treated sewage effluent will be available from MGSD, the IHGID, and the North Valley facility in the future, which could be used to irrigate the crops presently being irrigated with both supplemental and non-supplemental groundwater. By 2015, treated effluent flows from these three plants may be approximately 6,700 acre-feet per year and about 11,500 acre-feet per year for longer-term development. A portion of this water could be used to reduce the amount of water pumped for irrigation purposes.

Other programs, such as the use of surface water to recharge the groundwater basin either through injection wells or infiltration basins, could be used to increase the amount of groundwater available to meet future demands. The amount of surface water that could be recharged to the basin is unknown at the present time.

It also appears that the use of surface water to recharge the groundwater basin and/or through storage and treatment for a drinking water supply, will be required to avoid exceeding the estimated potential groundwater recharge for longer-term development in Carson Valley.

Adequate resources exist for the Antelope Valley area for the projected population in 2015 with conversion of some groundwater agricultural rights. Further development will require utilization of surface supplies and conversion of most of the groundwater agricultural rights.

Map 7.19
Carson Valley Alpine Decree Lands



Wildlife/Vegetation

The Natural Resource and Conservation Service has identified five general wildlife areas within Douglas County (SCS, 1984). These wildlife areas are based on soil type, plant species, and general land uses; they define particular habitats available within the county. In addition, vegetation also provides fuel for wildland fires which is of significant concern in Douglas County.

Wildlife Area 1 is identified as open land and wetland wildlife habitat. It is generally associated with soil units 1, 2, 3, and 4 and is commonly found in the floodplains, low terraces, and alluvial fans in the Carson and Antelope Valleys.

Wildlife Area 2 is defined in areas of soil units 5, 6, and 7. These are gradually sloping lands on alluvial fans and terraces. This is one of two wildlife areas which provides habitat for rangeland wildlife.

Wildlife Area 3 is also considered part of the county’s rangeland habitat. However, it includes lands which are steeper, at higher elevations, and, as a result, drier than the habitat in Wildlife Area 2. Soil units 8 and 10 are found in this area.

Wildlife Area 4 is the drier part of the woodland wildlife habitat. It is associated with soil units 9, 11, 12, and 13, and is found in the Pinenuts and Wellington Hills.

Wildlife Area 5 is the wetter woodland habitat. This habitat is found in the Carson Range in areas with soil units 14, 15, and 16.

There are a variety of species of wildlife and vegetation found in Douglas County that are distinctive to particular land resources. The West Walker River supports trout; the east and west forks of the Carson River support trout and catfish. Pheasant, valley quail, cottontail rabbit, meadowlark and killdeer are found in open grasslands and cultivated areas. Wetland wildlife include ducks, geese, heron, muskrat, and beaver. Common rangeland wildlife include jack rabbits, coyote, chukar, partridge, and a variety of non-game birds and rodents. Woodland wildlife includes such species as the mule deer, black bear, mountain lion, some wild turkeys, and cottontail and pygmy rabbits. The upland areas include game birds such as the valley land mountain quail and blue grouse.

In addition to these habitat areas, eagle nesting grounds are located in the mountains at the southern end of the Carson Valley in California. While the nests are outside Douglas County, development of Carson Valley could impact the eagle’s hunting grounds.

The Nevada Natural Heritage Program (NNHP) has identified sightings of sensitive flora and fauna in Douglas County; it does not, however, identify habitat areas for individual species. The term "sensitive", by NNHP's definition, includes all species of concern; this includes candidates for Federal protection and species that are identified as "critically endangered" by the State, which in turn receive State protection. The plant species candidates for Federal protection are the Lavin's Egg Milk-Vetch (found in the Wellington Hills and the upper reaches of the Buckeye Creek basin) and the Tahoe Yellow-Cress (found along the east side of Lake Tahoe). The Lake Tahoe Benthic Stonefly is the one animal species that is a candidate for Federal protection and that the NNHP reports as being last spotted in 1962 just east of Lake Tahoe.

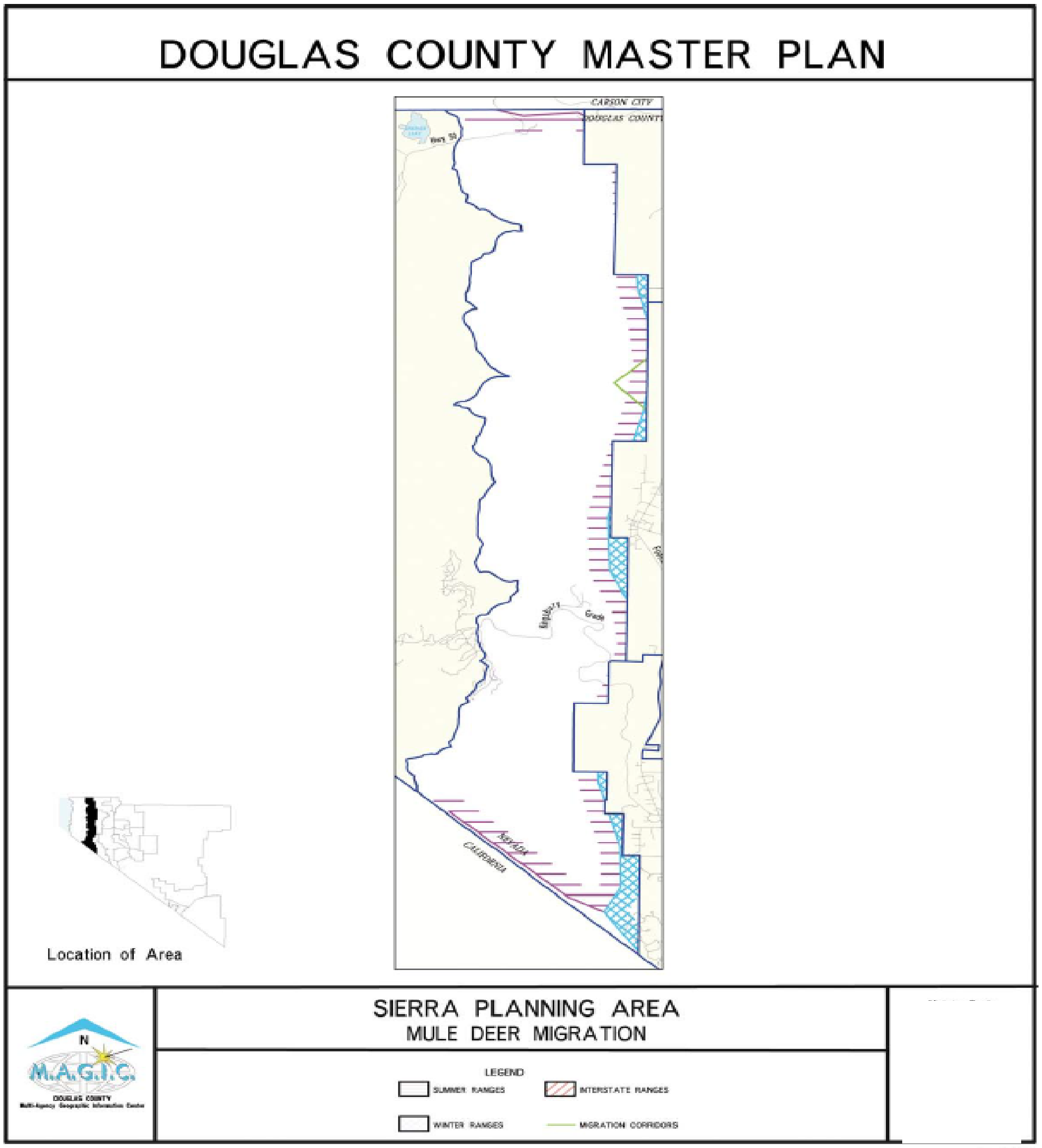
Habitat areas and migration routes have been identified for the mule deer. Maps 7.20 thru 7.22 depict the summer ranges, interstate regions, and migration corridors of the mule deer population of Douglas County. Identifying these critical habitat areas is necessary due to the impact of urban development on deer summer and winter ranges and on the migration routes between the two ranges. As urban development encroaches, these habitat areas are destroyed or become isolated; winter feeding areas and migration routes are also severely constricted.

The State of Nevada Park and Wildlife Bond Bill was passed to provide public support for programs dedicated to the preservation and protection of fish and wildlife resources and their habitats and also provides some $13 million to assist in accomplishing these objectives.

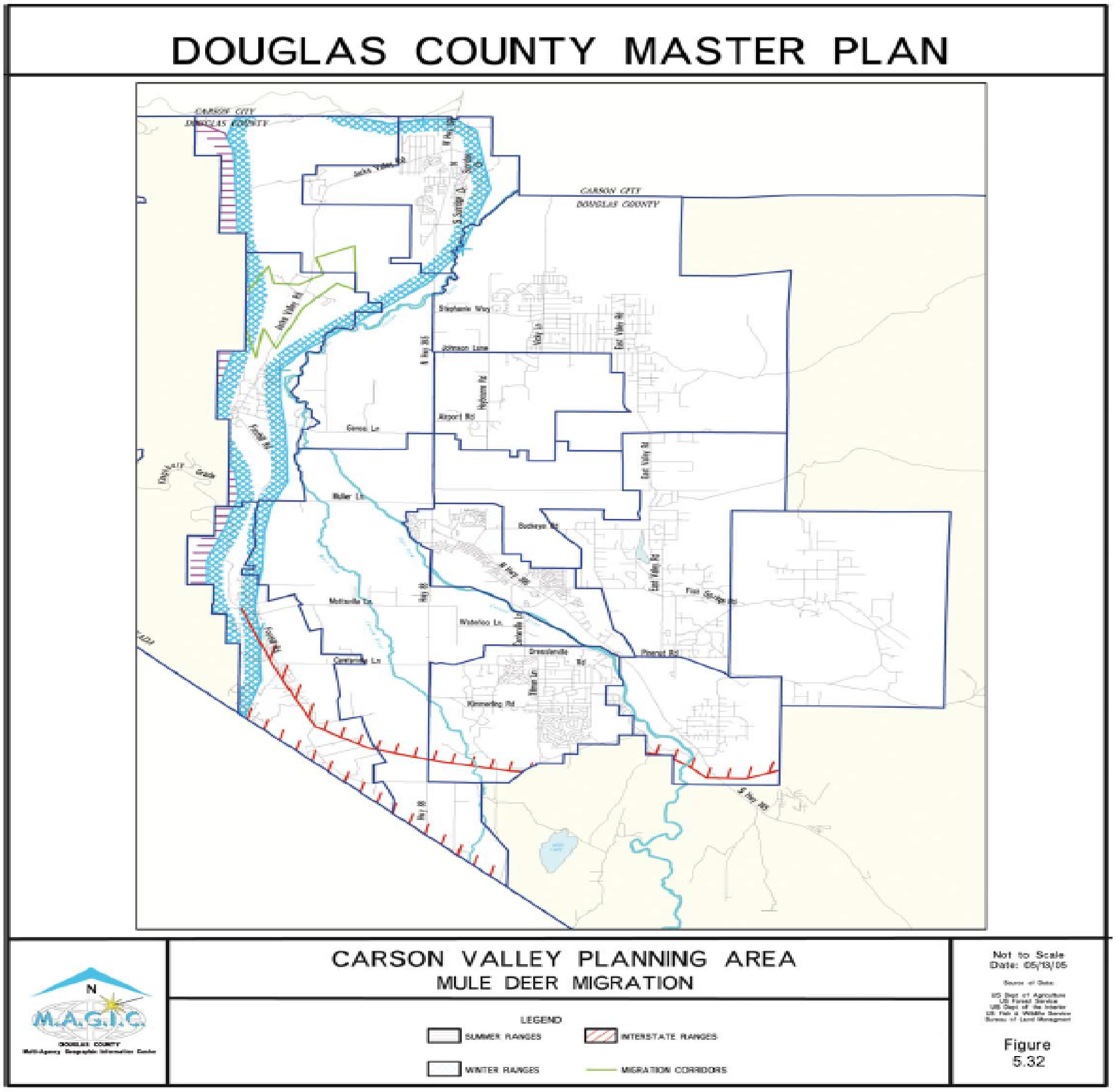
Douglas County is home to several sensitive plant and animal species. It is also part of the mule deer's critical habitat. Other wildlife species, while not endangered, contribute to the county's recreational opportunities and quality of life. Habitat of sensitive species, deer migration routes, and riparian habitats must all be considered as the County seeks to identify appropriate policies for future urban growth and for the management of those resources, which define or enhance the county's desired character.

Douglas County has many areas with thick vegetation generally associated with the riparian areas and areas of timber with heavy ground fuels. The fire fuel lands are areas that are very susceptible to fire dangers and provide significant habitat. Following the Angora Fire in Lake Tahoe, Douglas County adopted code provisions which require non flammable roofing materials be used throughout Douglas County.

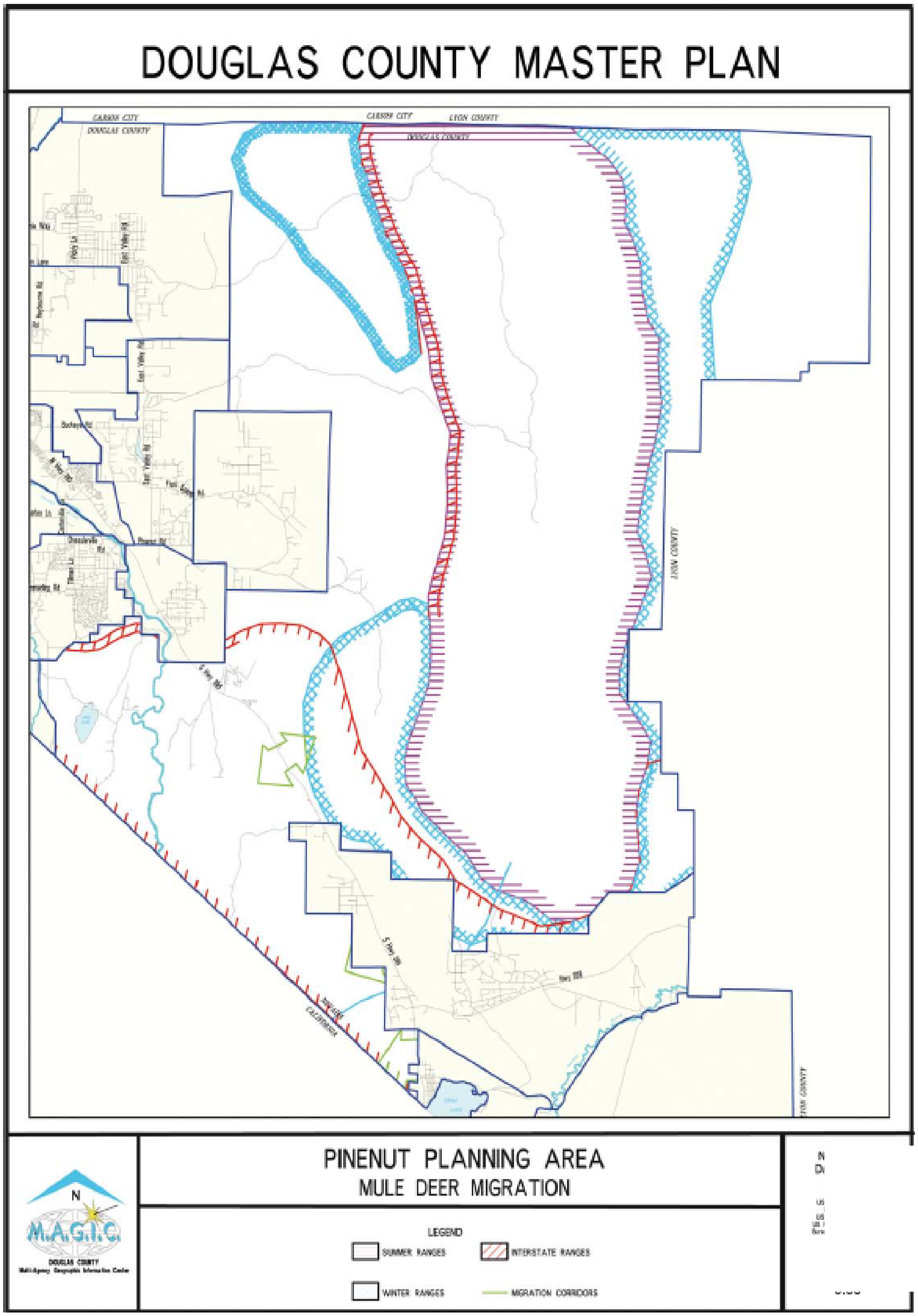
Map 7.20
Sierra Mule Deer Migration



Map 7.21
Carson Valley Mule Deer Migration



Map 7.22
Pinenut Mule Deer Migration



Energy

Sources

Many potential renewable energy resources exist in Douglas County that could be more fully utilized to minimize the use of conventional energy resources. These include “clean” energy sources such as solar, wind, and geothermal energy.

Given the financial and environmental costs associated with inefficient use of conventional energy and the increasing need for the United States to become energy-independent, the development of these “clean” energy resources and conservation methods should be of high priority.

The climate of Douglas County has been characterized as Continental, with moderately hot summers and moderately cold winters.

The most readily available form of “clean” energy in Douglas County is solar. “The sun shines 90 percent of the time possible in the summer and 66 percent in winter” (*Soil Survey of Douglas County Area Nevada,* U.S. Department of Agriculture Soil Conservation Service, 1984). This abundance of sunshine offers opportunities for utilizing both passive and active solar energy for water and space heating.

Passive solar energy generation involves the use of direct solar gain to convert natural sunlight into usable heat, to cause air-movement for ventilation or cooling, or to store the heat for future use. Passive solar technology can heat houses, non-residential buildings, and water, among other things. Passive solar buildings are easier to keep cool in the summer, as well. Design and orientation of structures is the key – passive solar does not require any additional or specialized electrical or mechanical equipment to make heating and cooling a structure more efficient.

For new construction projects and existing buildings that can be cost-effectively retrofitted to take advantage of direct solar gain, passive solar is the simplest way to achieve greater energy efficiency. Passive solar buildings require no additional energy to operate, have zero additional operating costs, are cheaper to maintain, and emit almost no greenhouse gases in operation. All new construction in Douglas County should be designed and built in a way to take advantage of passive solar technology.

Active solar energy generation involves the conversion of the sun’s energy into electricity or heat. This is most commonly accomplished with photovoltaic (PV) cells, also known as solar collectors, which create electricity. Systems that use pumps or fans are also classified as active solar technologies. The cost of purchasing and installing active solar is decreasing, and as more people begin to use this technology, its effectiveness and efficiency will continue increasing. In addition, there are incentive programs offered from time to time by power utilities and government agencies designed to spur growth in the active solar industry.

There are approximately 300 sunny days per year in Douglas County. Active solar can be fitted to new construction or retrofitted to existing structures to take advantage of this and decrease dependence on conventional energy resources. It may be a particularly attractive option for property owners who want to be more energy-independent but whose buildings cannot be cost-effectively retrofitted and/or reoriented to take advantage of passive solar technology.

Windmills used to be a very important part of life in Nevada. They were used to run well pumps and bring groundwater to the surface. Now, wind power may become popular again. Every year, the amount of wind energy generated state- and nation-wide increases. Turbines come in all shapes and sizes and can be used by all types of users, from large power utilities to the individual homeowner.

Wind power can be used to supplement conventional power generation, protect the environment, lower electricity costs, and foster greater energy independence. It should be noted, however, that wind power has its detractors: many people feel that wind generation creates excessive noise, presents dangers to people and property on the ground as well as birds in flight, and decreases the aesthetic appeal of the natural landscape.

Geothermal energy potential is the heat energy in the earth's crust which is created within the earth's molten interior. It can be tapped as steam or by injection of water to form steam.

Figure 7.11
Characteristics of Carson Valley Geothermal Waters

Name of Geothermal Feature	Temperature Range (°C)	Dominant Dissolved Chemicals
Walley's Hot Springs	58 - 71	NaSo4 (500 - 1000 ppm)
Hobo Hot Springs	46	NaSo4 (0 - 500 ppm)
Unnamed Indian Hill Spring	24 - 32	Na-HCO3 (0 - 500 ppm)
Saratoga Hot Springs	50	Ca-So4 (0 - 500 ppm)

Geothermal energy potential is present in the Carson Valley, primarily along the western fault line, incorporating the Genoa area and in the northern portion of the Valley, including Johnson Lane to the east. This geothermal energy has been identified as non-electricity producing, but it does have some potential for space and district heating (heating of several buildings connected through steam lines).

Geothermal water reaches the earth's surface in the areas of Walley's Hot Springs, Hobo Hot Springs, Saratoga Hot Springs, and Indian Hills Springs. Walley's Hot Springs, Hobo Hot Springs, and Saratoga Hot Springs have all been tapped for commercial purposes in the past, but Walley's Hot Springs is the only commercial hot spring at present.

The abundance of cool weather and the increasing population in Douglas County increase the importance of using solar and geothermal energy for heating. The sun provides a renewable non-polluting energy source for Douglas County. Techniques for supporting the use of solar energy include regulations and guidelines that promote passive solar design and protect solar access.

Besides solar, wind, and geothermal energy sources, another good energy "source" is conservation. Proper insulation of houses and non-residential structures reduces the need for heating and cooling on a continuing basis. Construction that uses environmentally-friendly materials such as straw bales, natural stone, rammed earth, and recycled/recyclable goods reduces resource use when structures are built and demolished.

Conservation can be accomplished on a larger scale through community design. An efficient house reduces energy use for the inhabitants of that house. An efficient community – one which is designed to minimize resource consumption – reduces energy use for the inhabitants of many houses. Efficient community design can involve location of the community near to services (which reduces the need to travel), compact development (which reduces infrastructure costs), provision of bicycle and pedestrian paths (which encourages walking and biking over the use of the automobile for visits and errands), reduction in roads and other impermeable surface (which provides better drainage and reduces the risk of flooding), efficient design of structures (which reduces resource consumption), and landscape design that requires little irrigation and uses local flora (which reduces water use, highlights indigenous plant species that look and are appropriate to the environment, and requires less-frequent replacement of landscape features).

Most sources of energy used in Douglas County are non-renewable. The efficient use of these resources must be maximized. Energy suppliers need to plan for the long-range development of the county in accordance with the Master Plan Goals and Policies to assure that ample and reliable energy will be available to consumers when needed. Because of the importance of energy to the quality of life and economic health of the county, energy consumption should be managed in an imaginative, innovative, and prudent fashion.

Noise

Noise pollution originates from a variety of sources in Douglas County. Major highways, the Douglas County Airport, and industrial areas can be primary sources. Mining and gravel operations are other sources of noise pollution.

Noise levels directly affect the suitability of land for various uses. Noise is an environmental factor generally paid little attention by the public. However, studies show that noise levels can have a significant impact on people's health and enjoyment of their surroundings.

Human response to noise varies according to the type of activity in which a person is involved. Noise levels are measured in dBA, the standard expression for "decibels" with a weighting to account for the sensitivity of the human ear. Seventy dBA[1] might be acceptable at a social gathering or a sporting event. However, it would be undesirable to relax or to carry on an important discussion at that level. Since high noise levels restrict certain types of human activity, each land use category has a naturally determined, fixed limit which cannot be exceeded if the land use is to maintain its proper function. This knowledge can be used to establish noise standards to protect the public.

LDN stands for Day/Night noise level, which weighs noise at night higher than daytime noise and uses within a numeric formula for average sound levels. An LDN of 70 dBA is equivalent to a person sitting 10 feet from a continuously operating vacuum cleaner all day and sleeping 30 feet away from it all night. A continuous sound level of 70 dBA will not permit normal conversation at a distance of 3 feet. Studies have shown that, at this level, the pupils of the eyes dilate and blood vessels constrict, causing increased arterial pressure, nervousness, fatigue, and hearing loss. Further, the body does not adapt to these physiological phenomena, even though a person may become "accustomed" to the noise.

Commercial and office use requires a fairly constant exchange of information and ideas, necessitating noise levels that will permit conversation (65 dBA maximum). Sixty-five dBA represents a noticeable reduction from the clearly unacceptable effects experienced at 70 dBA. Hearing loss is not a problem, although annoyance and activity interference occur regularly at this level.

Residential use is the most sensitive to sound because of interference with sleep and relaxation. Fifty-five dBA has been found to be an acceptable exterior residential noise level. Normal conversation is unimpaired, physiological and psychological reactions do not generally occur, task performance is nearly optimum, and annoyance is slight. However, noises at this level will awaken most people from sleep.

An exterior level of 60 dBA can be reduced to 50 dBA inside with windows open, or 45 dBA inside with windows closed. Forty-five dBA is considered an acceptable interior level and will not cause sleep interference for most people.

Separation of Noise-Sensitive Uses and Noise Generators

Careful coordination of land uses is a primary tool for minimizing the impacts of noise. Zoning and related setback requirements can be used to separate land uses that are sensitive to noise generators. Land uses sensitive to noises include residences, religious institutions, schools, hospitals, and some recreational uses. Noise generators include traffic, airports, and industrial activities.

The Minden-Tahoe Airport Master Plan, 2008, contains projections of noise contours, which should be reviewed when projects are proposed in the vicinity of the airport to mitigate noise concerns.

Mitigation of Off-Site Noise Impacts

In addition to separating noise generators from noise sensitive land uses, the impacts of noises can be reduced through a variety of structural techniques. Roadway noise can be mitigated by the use of sound walls, vegetative or structural buffers, building orientation, localized barriers, and insulation measures applied to affected buildings. The location of new roadways can dramatically affect noise levels. In general, industrial noise can be mitigated at the source through the use of sound walls, noise source muffling, buffering techniques, limits on hours of operation, and good site design. Construction is a temporary source of noise.

[2] Leg (24) represents an all day, 24-hour average noise level.