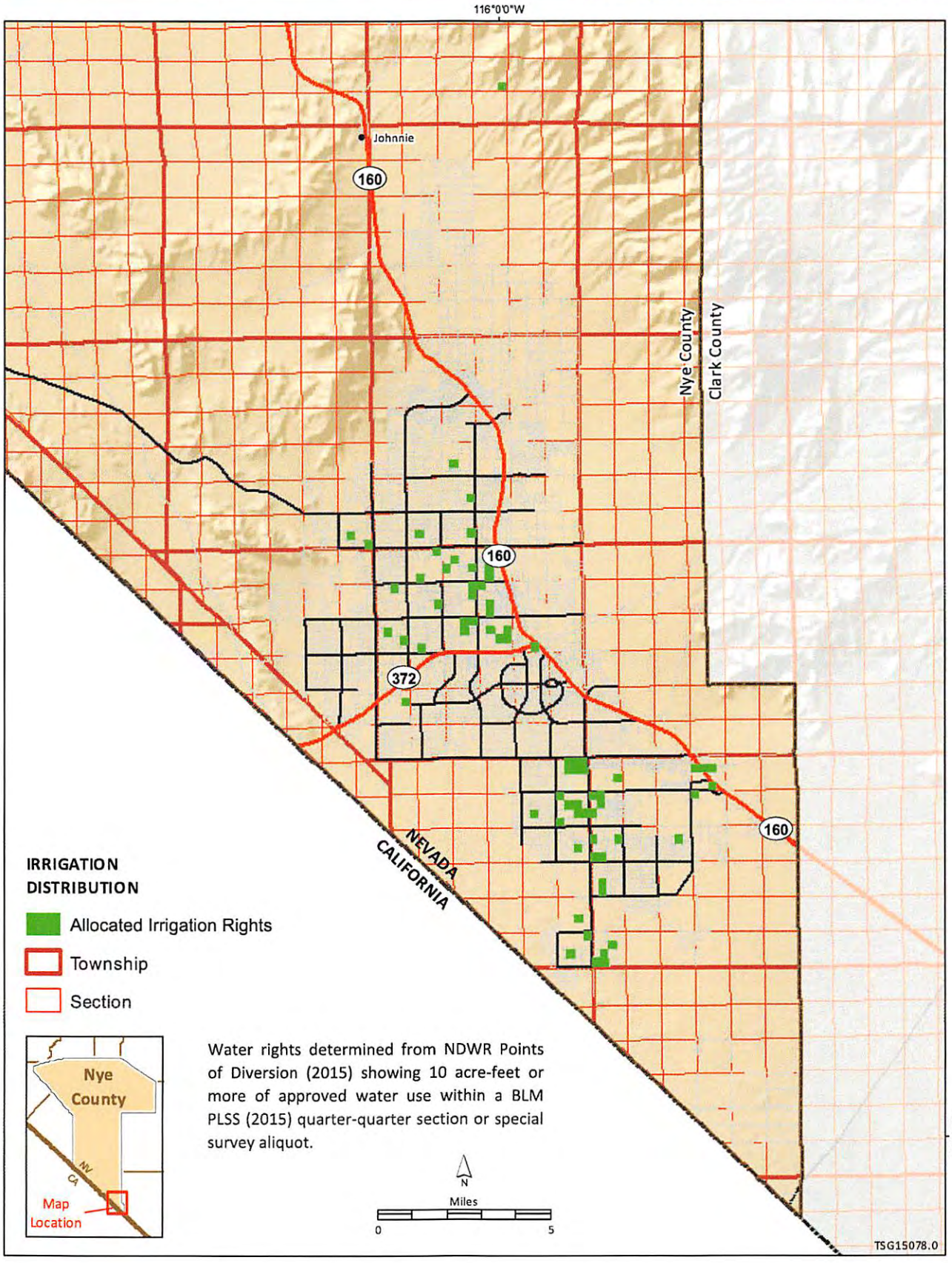


Figure 6-3. Distribution of Irrigation Water Rights in Pahrump Valley in April 2015.

Pahrump. The continued conversion of farmland to urban use will further reduce the water use concerns associated with agricultural land uses.

Environmentally Sensitive Areas - Unfortunately, some of the environmentally sensitive areas of Pahrump Valley have been affected by the activities of man. Bennetts Spring and Stump Spring have gone dry, although Manse Spring has recovered to historical levels. The natural habitat associated with these springs has been impacted and the native Pahrump Killifish had to be relocated by the U.S. Fish and Wildlife to a refuge to protect it from extinction.

The BLM and U.S. Fish and Wildlife have proposed several management actions aimed at reducing water use by federally-authorized projects on public lands including restricting and in some cases even prohibiting water development in support of the land use.

Water Supply Requirements

Increased groundwater withdrawals will be needed to meet the projected future growth in Pahrump. With a projected population of about 73,000 by the year 2060, the total demand for water will be about 23,000 AFY (Chapter 5). This estimate assumes continuing reductions in irrigation water use in the valley to the 2,000 AFY described in the GWMP, and a per capita water use rate of 268 gallons per day (including all domestic, municipal, and industrial uses). It is assumed that most of this water would be supplied by community water supply systems, with the remainder would be supplied by domestic wells.

Water Sources

Presently, the only source of groundwater in Pahrump Valley is the valley-fill aquifer. The perennial yield of this basin was recently increased by the State Engineer to 20,000 AFY in recognition of the estimated 8,000 acre-feet of groundwater outflow through the southeast valley into the California portion of the basin. This area is not presently developed and includes the Nevada portion of Basin 162 that is located in Clark County. The results of recent re-evaluations of water budgets in southern Nevada suggest that the perennial yield of Pahrump Valley could be higher, when recharge from RIBs, septic systems, and irrigation return flow credits are included.

If water use is not curtailed, then decline of the valley-fill aquifer will continue and will accelerate as growth continues. While there is a great deal of water stored in the upper valley-fill sediments, and this water is recoverable, there will likely be detrimental consequences as a result of continued overdraft of the basin. The consequences of overdraft include subsidence, higher well drilling and pumping costs, and degradation of water quality.

As discussed in Chapter 5, subsidence has already been documented in Pahrump Valley and there is active fissuring in a few areas. Subsidence can damage roads and utilities as well as structures, and costs can be substantial. The more the water table is lowered in the basin, the greater the potential for subsidence and the greater the costs associated with this phenomenon.

The costs associated with resetting pumps and re-drilling wells to tap the aquifer deeper will be incremental, but will be significant because of the numbers of wells that are likely to be affected. The potential for degradation of water quality as the aquifer is exploited to ever greater depths is

not known because of the lack of deep well data over much of the basin. If evaporite deposits (salt beds) are present at depth, then there may be severe limitations on water quality.

Several alternatives have been considered and are described in the Basin 162 GWMP. The importation of water to Pahrump from other basins in Nye County has been evaluated as a means to mitigate the past impacts of localized water level declines in the basin (Wichman, 2015). This alternative has been tabled indefinitely due to the estimated cost of implementation, and concern over the estimated project's proposal for groundwater pumping immediately south of and down-gradient from the contaminated groundwater of the NNSS. Unit costs for pipeline construction costs are well known, and pipeline construction comprises the majority of the estimated costs. Although concerns about contaminant migration are understandable, scientific studies and corrective active investigations conducted since 1998 under the authorities of the NDEP-issued Federal Facilities Agreement and Consent Order indicate that contamination will not reach any of the hydrographic basins south of the NNSS.

Conservation can reduce the demand for water. The GWMP illustrates how a reduction in the per capita water demand in Pahrump can reduce the projected demand for water dramatically. Conservation measures can include water reuse, smart landscaping, and watering, and low volume fixtures in residences. Water Utilities have implemented conservation plans. Two utilities are using RIBs to infiltrate treated effluents, and effluent reuse for golf course irrigation is already occurring. Smart landscaping and watering is best achieved through a program of public education. Low volume fixtures in residences are encouraged by building Master Plan and Development Agreements. One of the most effective conservation techniques, pricing, cannot be easily implemented in a community such as Pahrump where the numerous community water systems have rate structures regulated by the Public Service Commission.

The best approach to matching water sources with future demand is probably a combination of these alternatives. If conservation measures can significantly reduce demand, effluent reuse and recharge are maximized, and secondary recharge from irrigation is quantified, a balance between supply and demand may be achieved if the GWMP can actually result in the Pahrump Regional Planning District implementing effective growth control measures for Pahrump. This volume of pumping would probably be within the sustainable yield of the basin and, at a minimum, would lessen both the timing and severity of the adverse impacts of long-term overdraft of the basin. Water conservation is a proven method for achieving water savings and can be implemented through education, regulation, or pricing.

The legal availability of water, water system ownership and domestic well issues, land and environmental restrictions, and costs all constrain the feasibility of the options that are available for Pahrump. While it may be possible to drill deeper wells in the basin to help mitigate the adverse impacts of localized over-pumpage, any withdrawals from deeper zones would have to be done under existing water right permits, and no new permits will be issued.

The presence of more than 20 community water systems under different ownership also complicates the implementation of a solution. Similarly, domestic well owners would be reluctant to abandon their wells so that they could pay to join an existing utility. Studies are under way to

examine injection of water from artesian areas of the basin into those areas with the greatest rates of water level decline and those areas with the greatest potential for subsidence.

Recommendations

Based upon the current and projected water demands in Pahrump, the issues related to additional development and the constraints on that development, the following recommendations are made:

Continue implementing the recommendations of the GWMP.

Continue water level monitoring by the WLMP.

Continue nitrate monitoring.

Conduct a basin-wide water quality survey to identify problem areas and develop monitoring requirements.

Continue the dialogue with the DWR and federal agencies concerning the real and perceived impacts of water use in Pahrump Valley Basin 162.

6.6. RAILROAD VALLEY, CURRANT, DUCKWATER

Railroad Valley North and South **Perennial Yield: 77,800 acre-feet/year**

Combined Water Budget Parameters (acre-feet per year) from Table 3-7

Recharge	Inflow	Evapotranspiration	Outflow
67,000	24,000	85,000	1,000

Combined Water Rights Status (acre-feet per year rounded) from Tables 3-4 and 3-8

	CERT	Permits	VST
Surface Water	10,319	13,684	11,701
Groundwater	25,739	9,312	11

Note: All water right figures are approximate **CERT** = Certificated, **VST** = Vested

Assumptions

For the purposes of planning, the following assumptions were made:

1. **Oil and gas production may increase over existing levels but will not increase above historic levels.**
2. **The full agricultural productivity of the basin will be realized by 2060.**
3. **Expansion of the Duckwater Shoshone Reservation by over 31,000 acres in 2016 will increase water demand for residential and other tribal developments.**
4. **The Railroad Valley Wildlife Management Area will not increase in size.**

Water Resources Issues and Constraints

The primary water resources issues in Railroad Valley North and South are water availability and the protection of environmentally sensitive areas. The combined perennial yield of the two basins is nearly 78,000 acre-feet. Irrigation is the largest manner of use, followed by recreation. Current groundwater rights total slightly over 35,000 acre-feet (Figure 6-4), however pending applications for almost 96,000 acre-feet for municipal purposes filed by the Las Vegas Valley Water District have been re-assigned to the SNWA and remain Ready for Action. In the past, the SNWA had agreed to subordinate up to 30,000 acre-feet to users within the basin, however it is unclear whether or not that offer still stands. The presence of the wildlife management area and Railroad Valley Springfish habitat at two geothermal springs on the Duckwater Shoshone Reservation place constraints on the development of water in adjacent areas. Elevated levels of fluoride associated with volcanic rocks also occur in some parts of the valley.

The Duckwater Shoshone is primarily an agricultural community, drawing water from the largest geothermal hot spring located in the State of Nevada. This same hot spring, known as the Big Warm Spring, is home to the threatened species of the Railroad Valley Spring Fish. The Tribe has done mitigation to the critical habitat for the Railroad Valley Spring Fish in and near the Big Warm Spring; however, the swimming hole is still open to public use.

The Duckwater Shoshone reservation was expended in size in 2017 by over 31,000 acres from about 3,855 acres to about 35,086 acres. Although there are currently no firm plans, this expansion is expected to increase the future water demand on tribal lands to support additional residential and community facilities during the 50-year planning period.

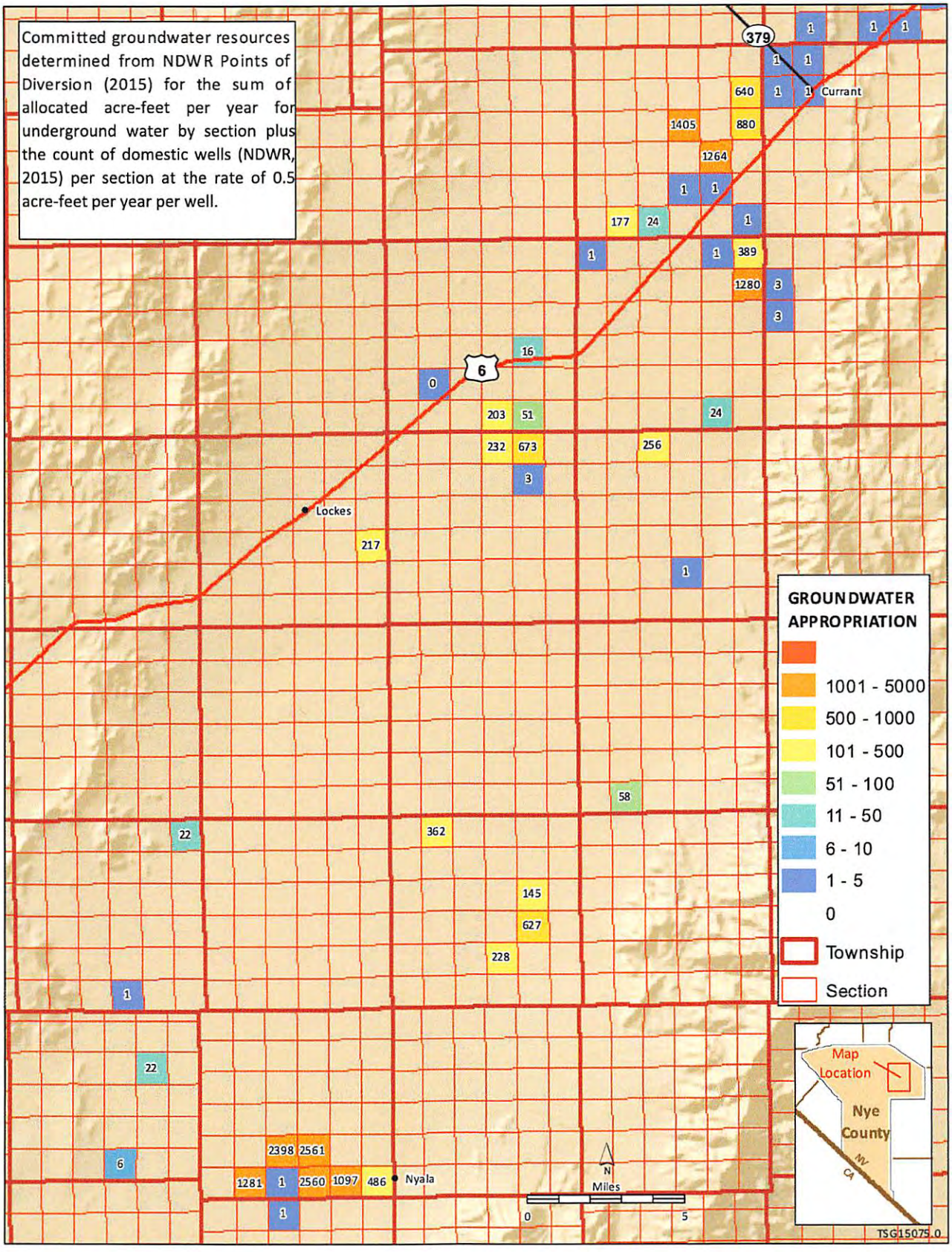


Figure 6-4. Distribution of groundwater appropriation in northern Railroad Valley from NDWR databases as of April 2015.

Water Supply Requirements

Existing water supplies are adequate to meet demands for quasi-municipal, mining, and industrial purposes. Growth of agri-business is expected and the demand for water should be met through existing water rights and applications. Since the 2004 WRP was issued, the State Engineer has denied the nearly 95,000 acre-feet of historic pending irrigation applications filed under the Carey Act and Desert Land Entry Act.

The SNWA applications that were filed in 1989 are still pending and should they be approved, the basin will be severely over-allocated, and the exportation of 98,000 AFY would result in significant water supply shortfalls. Spring flows and sensitive habitat would likely be impacted.

Water Sources

While surface water supplies are abundant, the pending SNWA applications restrict further development in most of the valley. Groundwater is the primary source of water; surface water provides limited supplies. While existing appropriations in Railroad Valley North and South are below the combined perennial yield, approvals of the pending SNWA applications would greatly over-allocate basin resources. The Railroad Valley Town Advisory Board passed a Resolution (2017-RRV-01) to address the pending SNWA applications. The Resolution states that if Nye County receives water rights through permits or applications as a result of the SNWA filings that said water rights permits or applications will be canceled or withdrawn, as applicable, so that the water is available for appropriation by the residents, land owners, and businesses in Railroad Valley. The Resolution, in its entirety, has been included in Appendix B.

Recommendations

Continue to monitor SNWA applications and vigorously protest the exportation of groundwater from Railroad Valley North to Clark County by the SNWA.

6.7. ROUND MOUNTAIN

Big Smoky Valley North (Round Mountain) Perennial Yield: 65,000 acre-feet/year

Combined Water Budget Parameters (acre-feet per year) from Table 3-7

Recharge	Inflow	Evapotranspiration	Outflow
65,000	0	64,000	0

Combined Water Rights Status (acre-feet rounded) from Tables 3-4 and 3-8

	CERT	Permits	RFA	VST
Surface Water	23,982	537	0	4,391
Groundwater	42,442	15,088	342	127

Note: All water right figures are approximate **CERT** = Certificated, **RFA** = Ready for Action **RFP** = Ready for Protest, **VST** = Vested RFA includes new water only.

Assumptions

For the purposes of planning, the following assumptions were made:

1. **Operations at Round Mountain Gold will continue through the planning period at current levels.**

Water Resources Issues and Constraints

The Big Smoky Valley-Northern Part has a perennial yield of 65,000 AFY and allocated groundwater rights of 57,000 acre-feet. Thus, additional groundwater resources are available to support future growth. The predominant uses for groundwater are irrigation, mining and milling. The most recent Crop Inventory conducted by DWR in 2013 estimated nearly 12,000 acre-feet of groundwater was pumped for irrigation uses (Perry and Davis, 2014). In 2014, mining, milling and domestic use accounted for nearly 7,700 acre-feet of groundwater pumped from the basin. Most of the pumpage occurs as mine dewatering, and nearly 4,000 acre-feet of the water pumped was returned to the basin though RIBs (Dixon, 2015). The key issues in Big Smoky Valley are the unpredictable future of the minerals exploration and development and naturally occurring concentrations of arsenic and fluoride in the groundwater.

Arsenic concentrations in groundwater exceed the standard of 10 ppb in several areas of the basin. The measured concentrations at Shoshone Estates (29 ppb) and the Smoky Valley RV Park (36 ppb) require treatment to meet the standard.

Water Supply Requirements

Round Mountain Gold Corp operates two large-scale open-pit mining operations and associated ancillary facilities in the Big Smoky Valley. The Round Mountain mine has been in continuous operation since 1976; the Gold Hill mine is located approximately 3 miles north of the Round Mountain operation and has been operating since 2011. Estimates of reserves suggest the operations will continue well into the future. Most of the workforce for the Round Mountain Gold mine resides in the Hadley subdivision. Existing supplies are adequate to meet the present demand for water. Water use by the two largest sectors, irrigation and mining, remain below their committed rights.

Water Sources

Existing water sources include both wells and springs. In general, areas of mineralization exhibit water quality constraints in terms of arsenic, fluoride, and metals. The Round Mountain PUC, which provides water to the Hadley Subdivision, has 445 residential and 35 commercial service connections, and serves an estimated 1,200 people. The distribution is served by two wells and storage tanks, and requires no treatment other than chlorination. Arsenic values in the two supply wells are well below the arsenic standard of 0.010 ppm. The Round Mountain PUC owns about 560 acre-feet of quasi-municipal water rights and is well positioned to serve its customers through the 50 year planning period. Carvers Mobile Home Park is located north of Round Mountain Mine and approximately 60 miles north of Tonopah. The drinking water at Carvers Mobile Home Park exceeded the arsenic standard. The Carvers water system has 80 residential connections, and serves approximately 150 people. In 2010, grant funds were used to purchase and install an Adedge Arsenic Treatment Unit at the Mobile Home Park. The Carvers' Café well meets the standard without treatment (NDEP, https://ndwis.ndep.nv.gov/DWW/).

Shoshone Estates Water Company (SEWC) located in Round Mountain had been on the State list of exempted utilities for the arsenic rule, but the exemption expired in 2010 and the system has not yet come into compliance. The Preliminary Engineering Report identified Point of Use treatment as the most cost effective treatment alternative. I observed in Devils Hole, the Supreme Court would order the Nevada State Engineer to take corrective action.

In 2016, unable to bring the water system into compliance, the system's Directors dissolved the SEWC. The Public Utilities Commission is reviewing management alternatives for this small non-profit utility. In September 28, 2016, the Public Utilities Commission granted a Petition and determined that Shoshone Estates should be placed into receivership. The Operator of the Mt. Charleston Water Company has expressed interest to take on management and operation of the Shoshone Estates Water System. Legal proceedings in this matter are still ongoing.

Arsenic treatment required for community water supplies is costly; engineering studies must be done on a case-by-case basis to determine appropriate treatment alternatives.

Recommendations

Continue to monitor water status of Shoshone Estates Water System performance and needs.

6.8. TONOPAH

Ralston Valley **Perennial Yield: 6,000 acre-feet/year**

Water Budget Parameters (acre-feet per year) from Table 3-7

Recharge	Inflow	Evapotranspiration	Outflow
5,000	3,000	2,500	5,500

Water Rights Status (acre-feet per year rounded) from Table 3-4 and 3-8

	CERT	Permits	RFA	RFP	VST
Surface Water	216	0	0	0	12
Groundwater	4,307	0	1,518	0	0

Note: All water right figures are approximate **CERT** = Certificated, **RFA** = Ready for Action **RFP** = Ready for Protest, **VST** = Vested RFA and RFP include new water only.

Assumptions

For the purposes of planning, the following assumptions were made:

1. **A full build-out of all private land in Tonopah will occur by the year 2060.**
2. **U.S. Air Force activities at the Nevada Test and Training Range will continue through the year 2060.**
3. **One or more commercial and/or industrial facilities will be sited at the Tonopah Airport.**
4. **Future designations of land for disposal by the BLM will be limited to those needed for specific community purposes such as landfills, air fields, roads, etc., and these disposals will only result in negligible additional demands for water.**

Water Resources Issues and Constraints

Ralston Valley has a perennial yield of 6,000 acre-feet and allocated groundwater rights of about 4,300 acre-feet, and pending applications for an additional 1,500 acre-feet for quasi-municipal use. The predominant groundwater use in the basin is quasi-municipal. Even with pending applications, there are adequate water resources to meet future demand.

Existing supplies and sources are adequate to meet current needs. The arsenic concentration of the Town's historic water supplies averaged 11 - 12 ppb, slightly above the standard above the 10 ppb standard. With arsenic concentrations in groundwater of approximately 12 ppb supplying eight wells and aging infrastructure, Tonopah Public Utilities (TPU) was faced with finding cost effective way to meet the new arsenic standard and remain sustainable.

Water Supply Requirements

Existing water rights are adequate to serve the population and the forecasted growth of the community. Water is available for appropriation to support future growth of the community. While water is available to support demands associated with industrial development at the airport, upgrades to the infrastructure will be needed to deliver water to the parcels. Tonopah Public Utilities owns certificated and permitted water rights in quantities adequate to serve their customers and allow for future expansion of the system. The Utility is the major water right holder in the Ralston Valley Basin and also owns water rights in Big Smoky Valley Tonopah Flat. The system is located in Ralston Valley but straddle the divide with Big Smoky Valley – Tonopah Flat.

The Utility currently has 1,416 connections serving a population of 2,593 people in 2014 (TPU, 2015). The system encompasses 32 square miles, including the well field and transmission lines, and is located in Lower Smoky and Ralston Valleys (TPU, 2015 [Water Conservation Plan]).

Water Sources

Water supplies for Tonopah are pumped from Ralston Valley. Although arsenic treatment was originally recommended, TPU decided that the short and long-term consequences of constructing and maintaining a water treatment plant would justify the additional cost to identify a new groundwater source. TPU contracted a hydrogeologic survey that included exploratory drilling in four strategic areas, test pumping, and water quality sampling. Ultimately, a test well in northern Ralston Valley approximately 4.5 miles north of the Rye Patch well field proved to have water of adequate quality and quantity. The facilities required to integrate the new well site into the existing system included constructing two new groundwater wells and 9.2 miles of new transmission main to the Rye Patch well field (http://ndep.nv.gov/bffwp/docs/water_lines_vol48_fall14.pdf). TPU has adequate water rights and infrastructure to meet future demands and is well positioned to serve its customers over the 50-year planning period.

Recommendations

Require industrial developers at the Tonopah Airport Industrial Park to prepare water demand forecasts

6.9. SURFACE WATER AND WATERSHED REQUIREMENTS

According to the Nevada Division of Wildlife, ten of Nevada "Top 100 Waters" are located in Nye County. The Hay Meadows, Adams McGill, Cold Springs, and Dacey reservoirs are all located at Kirch Wildlife Management area in the Nye County portion of White River Valley. Barley, Pine, and Mosquito Creek in the Monitor Range, the Upper Reese River and San Juan Creek in the Toiyabe Mountains, and Sportsmans Park Pond, about 12 miles north of Tonopah, provide prime fishing, hunting, and recreational opportunities, as well as water for livestock and ranching. Other important surface water occurrences include Amargosa River, the springs that form Ash Meadows, Little Currant Creek, Warm Springs, and Hot Creek in Railroad Valley, and the hundreds of springs, seeps, and streams in the County that provide important sources of water.

Surface Water Issues and Constraints

In Chapter 3, a number of surface water issues were identified:

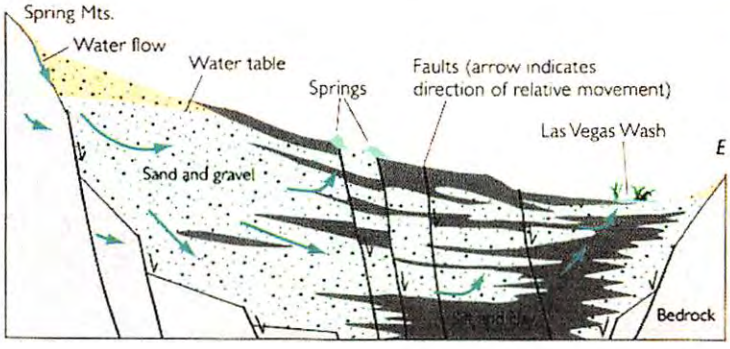
- **Promoting riparian area management and protection,**
- **Implement conservation measures in areas, where appropriate,**
- **Improving understanding of the relationships between surface and ground water uses,**
- **Maintenance of instream flows for recreation and wildlife,**
- **Reducing flood hazards and nonpoint source pollution**

The primary constraint with respect to surface water resources is the fact that most of the watersheds that provide the source water for streams and springs are under federal stewardship. As a consequence, Nye County has little participation in the development and implementation of management alternatives. More active participation by the County in the development of federal resource management plans would help ensure that the County's issues and concerns are addressed.

No interstate or intercounty surface water management issues have been identified for Nye County. Nonpoint source pollution includes surface water contamination from mining and construction activities, grazing, agriculture, sewage disposal, and naturally occurring salts and metals. With the continued growth of Nye County (and Nevada as a whole), increasing demands are being placed on recreational uses. The maintenance of instream flows is an issue for surface water for the Reese River, which has its headwaters in northern Nye County. The Amargosa River has short reaches of perennial base flow that have been declared Wild and Scenic are subject to additional protection. Finally, flooding in Pahrump Valley continues to be problematic. Nye County has approved a Flood Control Plan for the Pahrump Valley but lacks the fiscal resources to implement it.

Conservation of surface water sources is active at the wildlife management areas and Nye County is developing a habitat conservation plan to address concerns regarding the Amargosa River habitat at Beatty. As discussed previously, groundwater pumping has already reduced or eliminated spring discharge in the lower elevation portions of Pahrump Valley, although some areas are showing modest recovery. Figure 6-5 shows the impacts of historic groundwater overdraft in that basin on the discharge of springs. Some springs have ceased flow completely while other springs, such as Manse Spring have recovered to historical levels.

Figure 6-5. Effects of Groundwater Overdraft on Spring Discharge Rates.



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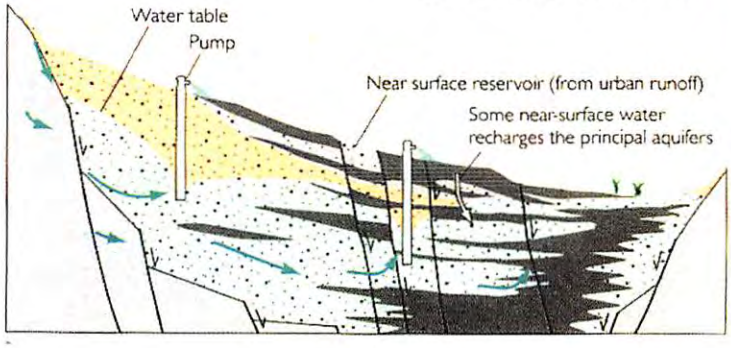
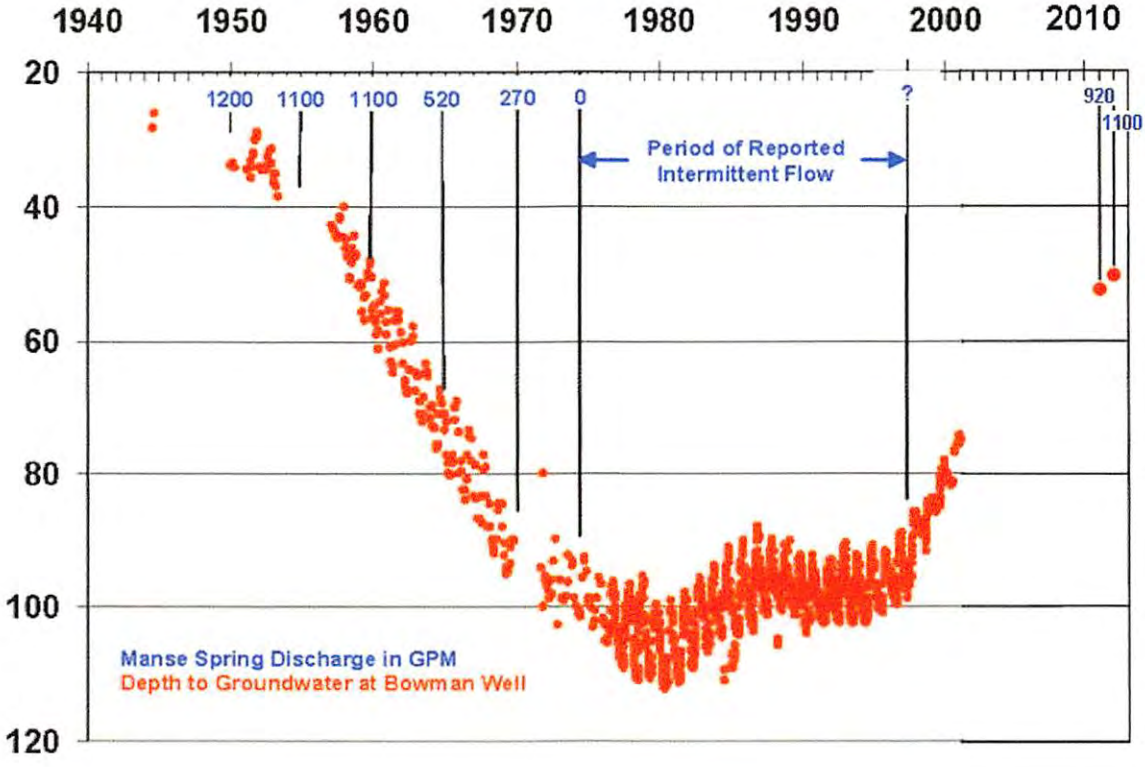




Management of Nye County's surface water resources at the watershed level requires a strategy that is applicable for various conditions and alternative development scenarios. As discussed in the 2004 WRP, the areas that have been needing protective measures such as Death Valley National Park, wildlife refuges, riparian and wetland habitats, existing and future public water supply sources have been identified. There is no single strategy that can perfectly fit all situations. Therefore, the strategy is outlined that is designed to be flexible and, with modification as needed on a case-by-case basis, provides a framework for the long-term management of the County's surface water resources.

The implementation of these setbacks and development of impairment criteria can help prevent the detrimental impacts of development that have already been observed in some areas of the County. While requirements are not legally binding requirements; Nye County may impose such requirements through development agreements. Rather, the criteria should serve as a planning guideline to ensure that any future water development in Nye County is not done to the detriment of the watersheds and ecosystems of the County.

There are several water related measures pending before the 2017 legislature. One important initiative would add language to existing water law to require the conjunctive management of water resources. Conjunctive management means that surface and groundwater resources, and the relationship between them within the State's hydrographic basins, would need to be considered in water resources decisions. This is consistent with goals and objectives of the Water Resources Plan and should be supported by the Nye County Water District.

Recommendations

The following recommendations are made with regard to surface water management:

Support conjunctive management language in the 2017 Legislative Session.

Maintenance of Spring Discharge Rates - Establish baseline data on the discharge rates and trends of selected springs in environmentally sensitive areas. The County should work with the Division of Water Resources, the University of Nevada system, the U.S. Geological Survey, other organizations, and developers to implement baseline data collection efforts.

Cooperate With Stakeholders - Consultations should continue with the State and Federal agencies that are stakeholders in Nye County.

Mitigate Adverse Impacts - Nye County should cooperate in the design and implementation of any mitigating actions, such as water rights dedication to offset impacts of the County's water resources.

6.10. MINING REQUIREMENTS

Assumptions

For the purposes of this plan, it is assumed that mining activities and their associated water use will increase slightly through the year 2060. Mining has been the one of the more volatile sectors of the County's economy. Fluctuations in gold, silver, and copper prices have created wide swings in population and employment. Over the next half-century, the pattern of population, employment, economic growth, and water use will likely change. While much uncertainty surrounds the political and technological forces that shape the mining industry, one important fact is certain: Nye County has a wealth of mineral resources, both metal and non-metal, available to be mined. When market conditions, policy, and technology converge to produce a favorable climate for mining, the mineral resources in the County will be developed and mined.

Water Supply Requirements

Water supplies are used throughout mining and post-mining reclamation operations. The quantities of water required depend primarily on the type of operation, whether or not milling and a town site are included, and the requirements for dewatering and reclamation. Typically, mining operations require from a few hundred to a few thousand AFY. Water use for any given mining operation are considered temporary, and usually lasts from a few years to a few decades.

Water Supply Sources

Water supplies in Nye County are generally ample for meeting the demand of future mining activities. As activities are usually in remote locales, water development for mining operations often requires the development of new water supplies from springs or wells. The availability of water within the vicinity of any given mining property varies depending upon the local hydrologic conditions, water chemistry, and environmental constraints. As any new mining is expected to occur on federal lands, environmental review will be performed under the National Environmental Policy Act to evaluate the potential impacts to water resources.

Feasibility of Alternatives

Historically, water availability has not been a binding constraint on the mining industry. In many areas of Nevada where reliable water supplies are absent, water has been conveyed via pipelines considerable distances to support mining and milling activities. Dewatering is still largely a technical issue although requirements for monitoring, treatment, and environmental mitigation now impose somewhat larger costs on these types of operations. The feasibility of the various alternatives for developing water for any given mining property can only be evaluated on a case-by-case basis. In general, mine dewatering is non-consumptive use, and much of the water is recharges in a downgradient area.

Recommendations

The following recommendations are made with regard to mining water use:

1. **Continue working with the mining industry in the management of the water resources of Nye County.**
2. **Facilitate cooperation between the mining industry and state and federal regulatory authorities in the development of water resources and the mitigation of past adverse impacts related to mining activities.**
3. **Continue to monitor water use and water trends in the mining industry.**

6.11. SELF-SUPPLIED DOMESTIC REQUIREMENTS

There are about 12,000 domestic wells in Nye County. However, with the exception of Pahrump Valley (about 11,100 wells), self supplied domestic water use is not large, on the order of almost 1,000 AFY. There are about 500 domestic wells in Amargosa Valley, and 119 wells in Big Smoky Valley. While there are hundreds of other domestic wells in the County, they are generally widely separated.

Water Supply Requirements

Water use for domestic purposes can vary widely depending upon the size of the household, individual habits and preferences, and area. Single domestic wells are entitled to pump up to two acre-feet of water per year but average actual usage in Nye County's most populous basins is estimated by the State Engineer since 2009 to be about 0.5 AFY.

Water Supply Sources

With the exception of Pahrump, there are ample water resources for domestic supplies throughout the portions of Nye County not served by public water supply systems. As described in the Nye County WSAI Report (GGI, 2013a), the depth, yield, water quality and estimated usage of domestic water wells varies from place-to-place. Monitoring of water quality in domestic wells is not required by regulation or statute. Because naturally-occuring nitrate, arsenic, and fluoride can have adverse health effects, well owners should test their water periodically to determine whether some type of treatment may be beneficial.

Feasibility of Alternatives

The alternative to self-supplied domestic wells is to expand utility infrastructure for public water supply systems. Public systems can be established by private entities under the requirements of the Public Service Commission and under the various Nevada laws and regulations governing public water supply systems. At present, a new public water supply system is being added in Pahrump by UICN to serve the expansion of Spring Mountain Motor Resort and Country Club. Growth along the proposed I-11 corridor also could result in the creation of new systems. Many types of development, such as a casino-resort or golf resort may also lead to the establishment of one or more new public systems. Any new public water supply must design, permit, and monitor in accordance with applicable regulations.

Recommendations

The following recommendations are made with regard to self-supplied domestic water:

Continue implementation of the Basin 162 Groundwater Management Plan.

Work with the NDEP Safe Drinking Water Bureau to keep Nye County's domestic water users informed regarding local water quality issues, and proper well sanitation methods and practices.

Cooperate with the Nevada Division of Water Resources in monitoring domestic water use and trends.

6.12. FEDERAL LANDS WATER REQUIREMENTS

With 98 percent of Nye County managed by federal agencies, there is a demand for water resources to meet the mission of each agency with stewardship over an area. As such, the water resource requirements for the continued management of federal lands in the County must be taken into account during the planning process.

Federal agencies, who in the past have found themselves at odds with each other's appropriative applications, have formed a Federal Water Users Group to better discuss water rights applications among the agencies. Additionally the Federal Water Users Group uses the forum to coordinate protests of non-federal water rights applications.

Water Supply Requirements

The demand for water to meet federal needs in Nye County has not been well defined. Federal water uses include preservation, conservation, wildlife management, construction, fire control, and quasi-municipal use. The direct demand for water to meet the infrastructure requirements for federal facilities in the county is not large, and in most cases is met. However, the demands placed on the water resources for environmental purposes are large and in some areas pose constraints on future water development.

Water Supply Sources and Issues

The water to meet federal water demands comes from numerous springs, streams, reservoirs, and wells. In recent years, an increased emphasis has been placed on the management and restoration of the water resources of springs, streams, and riparian areas. The U.S. Forest Service uses water resources of the Humboldt-Toiyabe National Forest. Water demand for facilities is minimal and the USFS holds appropriative rights in limited amounts. It is Forest Service policy to file a claim of reserved water rights (in the name of the United States) for all water needed to support instream flows on National Forest administered lands; none of the reserved rights have been adjudicated by the State Engineer.

The Bureau of Land Management is responsible for the management, use, and disposition of public lands. Present water use by the BLM is modest and it is not considered likely that any significant new supplies will be needed in the foreseeable future. Any lands that are designated for disposal (privatization) will have an associated, demand for water that is proportionate to the subsequent use of the land. Any developments on lands disposed by the BLM will have to obtain water rights in accordance with Nevada Water Law. Where water resources are over-allocated, then dedication or over-dedication of water rights could be required by County Ordinance.

The U.S. Fish and Wildlife Service is responsible for the management of key lands in Nye County and has regulatory authority to oversee activities and developments on federal lands and private lands for when threatened or endangered species or their habitats are present. Although, the National Park Service is responsible for management of Death Valley National Park. In this capacity, the Park Service has developed a well-defined water policy. The Park Service has protested more than 90 water right applications in Nye County including those filed by the County in basins on, or adjacent to the NNSS.

ratios of nitrogen to oxygen compiled by Kendall and McDonnell (1998), the Pahrump isotope data were plotted and compared to established ranges for precipitation, desert deposits, ammonia and nitrogen fertilizers, and soil nitrogen. Unfortunately, the established ranges of isotopic ratios for soil nitrogen, ammonia fertilizer, and rainfall also coincide in part or in total with the range for septic waste and manure, making it impossible to uniquely distinguish source on isotopic ratios alone.

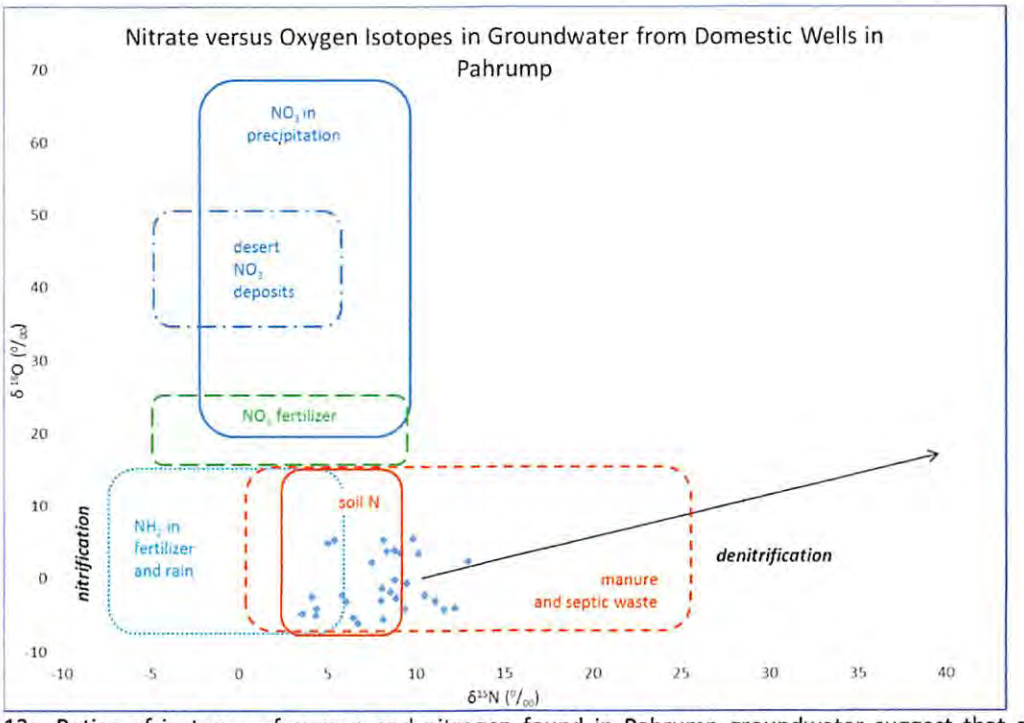


Figure 5-13: Ratios of isotopes of oxygen and nitrogen found in Pahrump groundwater suggest that areas of elevated and excessive nitrates are likely the result of past agricultural practices and existing greenspaces where fertilizers are applied.

While the isotopic data are inconclusive in establishing a unique source of nitrates, it is useful to compare the Pahrump data to similar datasets where nitrate sources are known. Wells (2012) used nitrogen-oxygen ratios to characterize groundwater contaminated by sewage effluents and septage. Plots of nitrogen-oxygen ratios presented by Wells (2012) showed that groundwater contaminated by effluents from up-gradient sewage lagoons had a much wider range of del 15 nitrogen values than those observed in the Pahrump data. Nitrogen values of the Wells' (2012) study plot between 10.0 and 22.0 0/00 compared to values of 3.0 and 12.0 0/00 found in Pahrump.

Wells (2012) also found the corresponding del 18 oxygen del values to be narrowly distributed between 3.0 and 8.0 0/00 compared to the wide range observed in the Pahrump Valley data, between -10.0 and 7.0 0/00. The isotopic ratios of groundwater contaminated with sewage effluents and domestic septage generally plotted in the manure and septic waste field nearer to the denitrification line, and Wells (2012) attributed those data points plotted in overlapping fields to sources other than manure and septic waste. This is in contrast to the Pahrump data where many of the data points cluster in the ranges of soil nitrogen and ammonia fertilizers. Those points

plotting exclusively within the manure and septic waste field may be derived from septic waste, and warrant further investigation.

Clark and Fritz (1997) summarized nitrogen-oxygen isotope ratios under a variety of conditions as reported by others. They found that while effluents and manure can have nitrogen values as low as 3.5 0/00, nitrogen values below 7.50 0/00 are reflective of ammonium fertilizers found in areas of agricultural land use. The clustering of the Pahrump isotope data suggests possible sources may be ammonium fertilizers and soil nitrogen. The absence of man-made compounds associated with sewage effluents and septage in wells exhibiting elevated nitrate concentrations further supports soil nitrogen and historic fertilizer uses as possible sources of nitrates in the Pahrump Valley. These results are consistent with the conclusions of previous studies and historic land uses.

The most recent nitrate sampling efforts in the Pahrump Valley found limited areas with nitrates concentrations at or above the Federal Drinking Water Standards. The NRS 445A.395 and the NAC 445A.955-9552 regulate discharges to groundwater to protect groundwater and prevent degradation of water quality. Based on measured concentrations in isolated parts of the Pahrump Valley, the NDEP designated the entire Pahrump Valley as a Nitrogen Restricted Area in 2009 (Lanza, 2009). Nitrogen restricted means that levels of nitrogen are at or approaching 10 milligrams per liter (mg/L) measured as total nitrogen in the groundwater or surface water. As a result of this designation, the NDEP requires that all non-domestic on-site septic disposal systems include nitrate treatment. Better definition of the areas of elevated nitrate concentrations could be used to require the footprint of the area requiring nitrate treatment. Klenke (2016) offered the following recommendations to better define the areas of elevated nitrates.

- Resample wells identified in historical reports with high or elevated nitrate levels to determine current nitrate levels;
- Sample wells in and around areas with high or elevated nitrates to better identify the magnitude and extent of the affected areas;
- Continue to sample new wells being added to the Volunteer Domestic Well Metering Program; and
- Sample in areas of the Pahrump Valley where nitrate data is lacking.

Resource Damages and Contaminant Migration at the Nevada National Security Site

The underground nuclear weapons testing areas at the NNSS are the most significant areas of groundwater contamination in the County, and the State of Nevada as well. In addition to the 23 million curies of tritium (2012 levels), which has a relatively short half-life of 12.5 years, there are 1.5 million curies of strontium (with a half-life of 28 years), and nearly 50,000 curies of very long half-lived radionuclides such as americium (458 years), plutonium (up to 24,400 years), and uranium (up to 4.4 billion years). This legacy of groundwater contamination has significantly reduced the water resources available for use in the County.

The maximum contaminant level for strontium in groundwater is only 8 picocuries per litre (pCi\L); 15 pCi\L for americium, plutonium, and uranium; and 20,000 pCi\L for tritium. Estimates of the quantity of groundwater necessary to dilute the activity levels remaining at the NNSS to drinking

water standards although somewhat reduced by radioactive decay since 2004, still remain staggering:

- About ~150 ***billion*** acre feet to dilute the 1.5 million curies of strontium to 8 pCi\L
- About ~25 ***billion*** acre feet to dilute the nearly 50 thousand curies of americium, plutonium, and uranium
- About ~1 ***billion*** acre feet to dilute the 23 million curies of tritium to 20,000 pCi\L

Alternately, the magnitude of contamination remaining at the underground testing areas on the NNSS can be estimated using a volumetric method:

(V)olume of contaminated water = (A)rea contaminated X (D)epth of contamination X aquifer (P)orosity

if A = 250 square miles = 160,000 acres
D = 300 feet
P = 0.10

then V = 4,800,000 acre feet

To estimate the value of the lost resource, assume water rights in Amargosa Desert have a fair market value of $1,000 per acre foot and water rights in Pahrump Valley have a fair market value of $7,000 per acre foot. Using an average value of $4,000 per acre foot, the dollar value of the groundwater resources that have been destroyed at the NNSS is estimated to be on the order of 19 billion dollars. Groundwater that otherwise could be developed for use in southern Nye County has been sacrificed for national security purposes. The Department of Energy has cited those same security concerns as the basis for protesting Nye County's water right filings on the NNSS.

Key questions with respect to the groundwater contamination at the NNSS are (1) availability and half-life of the radionuclides for transport in groundwater; and (2) the directions and rates of groundwater flow. While it is not Nye County's role to define the contaminant transport from the NNSS, it is nonetheless of paramount concern. The NNSA has been studying the groundwater contamination resulting from underground nuclear testing since 1998. Historically, Nye County's participation in these studies has been limited to interactions through DOE's Environmental Management Community Advisory Board (now called the NNSA Advisory Board). In 2015, however, Nye County received a grant from the NNSA to participate in the technical reviews of characterization and modeling studies of the Underground Test Area Corrective Action process. Through this same grant, Nye County is also responsible for sampling and analysis of tritium as part of the NNSA's ongoing Community Environmental Monitoring Program, which is discussed in the next section.

Groundwater Protection and Monitoring Measures

The protection of the quality of Nye County's water resources and drinking water supplies is of paramount importance. The primary groundwater protection issues include sources of potential contamination. Sources of contamination include both point sources such as leaking underground tanks, landfills, and mine tailings, and non-point sources which are diffuse sources that can

collectively cause contamination of surface water supplies. Examples of non-point sources include runoff from agricultural or feedlots, mining and construction activities, and urban areas.

Non-point source pollution is best addressed by implementing Best Management Practices (BMPs). BMPs are methods, measures or practices designed to prevent or reduce water pollution, including, but not limited to structural and nonstructural controls, and including both operation and maintenance procedures. BMPs are the most effective, practical means of preventing or reducing the amount of water pollution from non-point sources to a level compatible with water quality goals. Soil conservation, restoration of disturbed areas, proper planning, storage, and use of fertilizers, pesticides, herbicides and other chemical agents, wetland protection and enhancement, stabilization of tailings piles, and storm water treatment. The cost of implementing Best Management Practices can be an obstacle and some federal grant money may be available to help implement them on private land, however, matching funds must be provided, typically from local agencies, organizations, and landowners.

Potential point sources of groundwater contamination include the infiltration of irrigation water over cropland, livestock feed lots, septic systems, storage tanks, mines, business and industry, and solid and hazardous waste disposal sites. The Nevada Bureau of Health Protection Services has conducted groundwater vulnerability assessments of each of the public water supply systems in Nye County. These assessments surveyed each water supply well or spring and defined any sources of contamination are present within the vicinity of the water supply source. The Community Source Water Protection Plan identifies measures taken with each community to protect the wellhead and springworks areas from local sources of contamination.

In 2014, NNSA expanded its support of offsite community-based monitoring of wells in Nye County in response to the County's request to be involved. As a result, the Nye County Tritium Sampling and Monitoring Program was initiated in 2015. The DOE Environmental Management office issued a five-year grant to Nye County for this program to monitor tritium in wells downgradient from the NNSS. The grant supports annual sampling of 10 wells in the first year and up to 20 wells every year thereafter. In 2015, Nye County selected and sampled ten wells. Sample locations were selected based upon groundwater flow paths off of the NNSS, proximity of wells to downgradient communities and recommendations provided by Community Environmental Monitors. Five of these wells are previously established Nye County monitoring wells. Nye County coordinates with Desert Research Institute, with the Community Environmental Monitor Program Monitors, and with Nye County citizens.

Federal Land Use Issues

With 98 percent of Nye County under federal stewardship, there are a number of water management issues associated with federal management policies and practices. Although the various federal agencies generally use small amounts of water directly, federal actions, federal land withdrawals, and federal land management policies impose significant constraints on water resource development and management. Other provisions hinder use and development by imposing costly controls on private interests leasing federal lands for ranching, mineral or energy exploration, mining activity, power production from both renewable and non-renewable resources or other, private, business, or industrial uses. In recent years, the Interior and Agriculture agencies (BLM, USFWS, USFS) have adopted more unified policies aimed at protecting species habitat – most

recently the Sage Grouse – that highly restrict other uses, including the exploration for and development of water resources. The impacts are essentially the same as those Special Nevada Report findings discussed below. These policies and practices vary from agency to agency, resulting in additional constraints to long-term water resource planning efforts. The following section addresses the Nye County water supply issues created by the presence of the federal lands, and the federal management plans and policies that affect both the land and water resources.

Federal Water Use – The total federal water use in Nye County is more than 15,000 acre feet per year. Most of this amount, almost 13,000 acre feet, is permitted by the U.S. Fish and Wildlife Service for spring discharges at Ash Meadows. The Department of Energy/NNSA has appropriations totaling 353 acre feet of groundwater and claims a reserved right of 4,175 acre feet. The U.S. Air Force holds rights to almost 1,700 acre feet but actually uses only about 160 acre feet a year. The National Park Service claims a federal reserved right for lands within Death Valley National Park but has not quantified this claim. Water rights and water use by the Bureau of Land Management and U.S. Forest Service are small.

The U.S. Forest Service has stewardship over 1.9 million acres of land in Nye County comprising portions of the Humboldt-Toiyabe National Forest. In essence, the Forest Service serves as the steward for most of the major recharge areas in Nye County. Permitted water use by the Forest Service is negligible, however, like BLM, it asserts unadjudicated reserved rights to many streams in northern Nye County.

Federal Actions – Federal actions that have directly impacted the water resources of Nye County include operations at the NNSS and NTTR, and management policies being implemented or proposed by the three agencies in the Interior Department, the National Park Service, the U.S. Fish and Wildlife Service, and the Bureau of Land Management. The federal actions have also resulted in a number of direct and indirect impacts. These impacts are listed in Table 5-3 and include widespread resource damages at the Nevada National Security Site, significant reductions in resource availability, and the corresponding adverse socioeconomic impacts on the tax base, growth, and productivity of Nye County's economy.

Land Withdrawals – More than two million acres of land have been withdrawn for federal reservations in Nye County including 1,290,000 acres for the NTTR (formerly the Nellis Air Force Range), the NNSS (formerly the Nevada Test Site; 864,000 acres), Death Valley National Park (106,961 acres), the Ash Meadows National Wildlife Refuge (23,000 acres), and the Basin and Range National Monument. Additionally, the Fish and Wildlife Service has co-use of a large area of the Nevada Test and Training Range and wildlife management areas in Railroad Valley, and the U.S. Forest Service manages more than 1,940,000 acres of National Forests. Smaller areas have been set aside for Indian reservations. The continuing impacts of federal land withdrawals and land - designations on the water resources of Nye County are listed in Table 5-4.

The Special Nevada Report concluded that the withdrawal of land from public access and/or the purchase of water rights by the Departments of Defense and Energy has the greatest potential for adverse effects on Nevada. The water resources associated with withdrawn lands, were they available, would increase the economic growth potential of southern Nevada. The designation of lands for special management or as buffer zones around protected areas also has impacts on the

water resources of the County. Subsequent Bureau of Land Management policies and management direction in its RMPs include federal actions to file for water rights for water sources that are not federally reserved, and to protect riparian areas and habitat by not allowing projects that might be perceived to adversely impact the water table supporting those areas or spring flows. The implementation of these policies continues to reduce access to and thus the quantity of water available for other uses, and restricts the area available for future water supply development. Indirect impacts of these management policies include increased water costs, decreased tax revenues and tax base growth, and decreases in the long-term productivity of the affected lands.

Land Disposals – The reduction in some areas, and near elimination in others of previously available disposal land, while considerably reducing uncertainty of future demand for water, will severely restrict Nye County's economic future. If the lands were available to be developed, no new water will be appropriated as existing unused rights are purchased and dedicated in support of development. Given that Amargosa Desert is fully appropriated and Pahrump Valley is over-appropriated, additional disposals by federal agencies in these basins could beneficially contribute to basin management. Mitigation measures implemented by Nye County and the State, if applied consistently, can effectively help to reduce the beneficial use of over-allocated resources.

Interior and Agriculture Departments' Agencies

The BLM has stewardship over 6.7 million acres of land in Nye County and the administration of these lands is divided between four district offices. The four offices have each prepared resource management plans with different objectives, goals, and management direction with respect to water resources. In general, the BLM objectives are to maintain water quality, maintain or reduce salt yields, and ensure the availability of adequate water to meet management objectives including the recovery and/or reestablishment of special status species.

In recent years, multiple use of public lands has become increasingly more limited by the designation of special status lands. The Draft 2014 Resource Management Plan for the Southern Nevada District Office identifies a number of Areas of Critical Environmental Concern (or ACECs) in southern Nye County that comprise a total of almost 70,000 acres. The Draft RMP also identifies management actions to acquire water rights to support management decisions, deny projects that might adversely impact groundwater conditions in the vicinity of resting/nesting habitat, such as riparian areas and mesquite/acacia woodlands. In Northern Nye County, the White River Valley ACEC encompasses over 10,000 acres.

Water rights that are appropriated or purchased by the federal government, and/or any federal water right claims for the protection of ACECs will reduce the availability of water for non-federal uses. In basins that are already fully appropriated such as Pahrump Valley and Amargosa Desert, the overdraft will be exacerbated as the federal rights are added to the over-appropriated basins. In other areas along the Amargosa River near Beatty, protection of the Amargosa Toad and its riparian habitat had the potential to significantly hinder growth and development through land use restrictions and Toad's possible addition to the endangered species list. Cooperative efforts by federal agencies, the Nature Conservancy, Nye County, the Town of Beatty, and the Beatty General Improvement District worked to implement the Amargosa Toad Conservation Agreement that allows development for recreation and historic purposes while monitoring and protecting sensitive riparian habitat.

Another potential impact on water resources availability in Nye County results from the BLM's designation of land for disposal via public sale. BLM is considering amending their Draft RMP to eliminate nearly all disposal land in Amargosa Desert and greatly reducing available disposal land in Pahrump Valley. The BLM and other Interior agencies fear that additional water demand associated with land disposals could lead to over-draft of local groundwater basins and could potentially impact the Devils Hole Pupfish.

The Basin and Range National Monument was established by Proclamation in July 2015 by President Obama to preserve the objects of scientific and historic interest on the Basin and Range lands. These reserved Federal lands and interests in lands encompass approximately 704,000 acres in Nye and Lincoln Counties. All Federal lands and interests in lands within the boundaries of the monument are hereby appropriated and withdrawn from all forms of entry, location, selection, sale, or other disposition under the public land laws, from location, entry, and patent under the mining laws, and from disposition under all laws relating to mineral and geothermal leasing, other than by exchange that furthers the protective purposes of the monument. This proclamation does not alter or affect the valid existing water rights of any party, including the United States. This proclamation does not reserve water as a matter of Federal law.

In September 2015, the BLM issued a Record of Decision and Approved Resource Management Plan Amendments for the Great Basin Region including the Greater Sage-Grouse Sub-Regions of Nevada. In the Nevada and Northeastern California Greater Sage-Grouse Approved Resource Management Plan Amendment, 1,354,400 acres are designated as Acres of Greater Sage-Grouse Habitat. Of these 266,800 acres were designated as Priority habitat management area, 266,800 acres were designated as general habitat management area, and 770,700 acres were designated as other habitat management area. Designations of new water supplies in areas of Nye County designated as general habitat management areas will be complicated by additional restrictions imposed on land use.

The U.S. Fish and Wildlife Service manages the Ash Meadows National Wildlife Refuge, which has grown to include 23,000 acres of land. After several years of planning and construction, the new visitor center at Ash Meadows opened to the public on December 27, 2014. The new visitor center has increased visitation more than twofold in its first six months, attracting more locals and travelers than before. The state-of-the-art $10 million facility was funded through public land sales in the Las Vegas Valley.

Adjacent to Ash Meadows National Wildlife Refuge is Devils Hole, a spring pool that is part of Death Valley National Park. Devils Hole is essentially the surface expression of a cavern system in the limestone rocks of the area. The spring pool is the habitat for the Devils Hole Pupfish. On June 7, 1976, the U.S. Supreme Court ruled that state-permitted water withdrawals in the vicinity of Devils Hole must be limited to a level necessary to maintain water levels in Devils Hole above a determined level. This ruling followed a National Park Service appeal of a decision by the Nevada State Engineer to permit water withdrawals in the vicinity for irrigation purposes. In 2008, the State Engineer issued Order 1197 to further curtail pumpage in the Amargosa Farms area and within 25 miles of Devils Hole. As a consequence of the Court's ruling, subsequent National Park Service actions, and State Engineer's Orders, it is no longer feasible to obtain and develop new water rights for lands in the vicinity of Devils Hole.

Since the Court's ruling on Devils Hole, many endemic species at Ash Meadows have been identified resulting in an expanded area of protection. The U.S. Fish and Wildlife Service now owns more than 19,000 acre feet of surface water rights at Ash Meadows, an increase of 7,000 acre-feet since 2004. The federal government remains the single largest water right holder in the Amargosa Desert hydrographic basin. The protection of the wildlife values associated with Devils Hole and Ash Meadows has eliminated a large area up-gradient from Devils Hole and the refuge as a source of groundwater for other purposes.

The preferred use of water resources for wildlife demonstrates that wildlife values are higher than the value of agricultural productivity or residential development. In practice (at least in southern Nye County), this assumption appears to be valid. It has already been demonstrated that the wildlife values associated with Ash Meadows and Devils Hole are higher in social terms than the values associated with other types of uses. While these values benefit society as a whole, the cost of the policy that provides these benefits falls on a small fraction of society, in the case of Ash Meadows, the economy of Nye County. The farmer in Amargosa Valley may not increase his productivity so that another individual, organization, or society in general may enjoy the benefit of the preservation of Ash Meadows.

Nye County recognizes the need to preserve the important wildlife values at Ash Meadows and Devils Hole and is committed to working with the federal and state agencies to protect these values. However, it must be noted that preservation is not without a price. The cost to County includes the loss of productivity and associated revenues; the indirect benefits derived from the presence of these wildlife habitats do not offset the county's lost economic opportunities.

The National Park Service has not developed any water supplies in Nye County, but the impacts of Park Service policies and practices have had a demonstrable impact on water resource availability in the County. The Park Service has stewardship for Death Valley National Park which includes two areas in Nye County, the "Nevada Triangle" (an area of about 105,000 acres in Nye County and about 4,000 acres in Esmeralda County), and Devils Hole, an area of 40 acres located adjacent to the Ash Meadows National Wildlife Refuge. The National Park Service operates in accordance with a General Management Plan for Death Valley National Park that identifies a number of water resources issues including:

- Identify as a federally reserved water right all unappropriated water from any water source identified on federal lands within the boundaries of the park;
- Vigorously defend federally reserved water rights through the state of California administrative process and in proceedings pursuant to Nevada Water Law that may authorize groundwater withdrawals that may impact water sources to which federally reserved or appropriated water rights are attached; and
- Pursue acquisition of water rights within the park. (NPS, 2002)

In 1989, in response to concerns over Las Vegas Valley Water District filings, the National Park Service began protesting numerous water right applications within the Death Valley Flow System, which encompasses all of southern Nye County. Since the issuance of Order 1197 in the Amargosa Desert Basin, DOI agency protests of water right applications in southern Nye County have decreased significantly. Nonetheless, DOI actions taken to fulfill their management objectives have

had, and continue to have, a number of demonstrable impacts upon the availability of water resources in Nye County. The direct impacts of DOI actions on the water resources of Nye County include the loss of agricultural jobs and productivity, a decrease in the water available for other uses in the region of influence, increased costs in water right acquisitions, increased operational costs, and a decrease in the rate of growth of the agricultural sector of the County's economy.

Energy and Defense Departments' Agencies

The NNSA has stewardship over 864,000 acres withdrawn for testing nuclear weapons and other stockpile activities supporting our national defense. The DOE has identified the agency's policy and goals for management of the water resources on its NNSS EIS. As a matter of policy, the Department has committed to follow the principles of ecosystem management in the utilization of water resources. To implement this policy, four goals were defined:

- Maintain an adequate water supply for existing and new uses on the Nevada National Security Site while ensuring a long-term sustainable supply of water for the NNSS and the surrounding ecosystem.
- Maintain the quality of waters that are presently clean.
- Minimize the impact to groundwater quality should resumption of underground nuclear testing be required.
- Manage groundwater resources to maximize the availability of water while minimizing the impacts to human health and the environment from contamination remaining from underground nuclear testing.

As discussed in Chapter 3 the historic nuclear weapons testing program has rendered millions of acre- feet of groundwater unusable. Although it is unlikely that additional testing will occur in the future, and new groundwater contamination may occur as a result of recharge through the test cavity and collapse chimney structure. In the unlikely event that a nuclear test were to occur in the future, the NNSA has established the following limitations to minimize the environmental insult:

- Future tests would use previously used areas of underground nuclear testing.
- Minimize tests with the working point (depth of detonation) at or below the water table.
- Place working point no closer than two cavity radii from the regional carbonate aquifer.
- Tests must be sited more than 1,500 meters (4,921 feet) from the boundary of the NNSS where groundwater exits the facility boundary.
- The borehole beneath the working point must be plugged to a minimum of one cavity radius beneath the working point.

As discussed previously, the Department of Energy/NNSA conducts the Underground Test Area Project to address the groundwater contamination at the NNSS. This program is aimed at characterizing the nature and extent of contamination, and monitoring the groundwater from selected wells on and off of the NNSS. This work is conducted in consultation with the Nevada Division of Environmental Protection. Progress toward achieving the goals of the program has been made and studies are ongoing to evaluate closure and monitoring activities to be selected and implemented.

The widespread groundwater contamination at the NNSS poses a major conundrum to water resource planning. The NNSS groundwater contamination was a result of testing done with the full knowledge of the State of Nevada, the United States Congress, and the regulatory agencies charged with environmental protection. Nye County recognizes that the groundwater contamination is a consequence of national security needs and policies. Nonetheless, extensive water resource damage has occurred and has resulted in the loss of significant resources and associated socioeconomic values to the County.

The NNSS is not the only location in Nye County where nuclear weapons testing has been conducted. The Central Nevada Test Site, located about 60 miles east of Tonopah was the site of a single nuclear test conducted in 1968. The Department of Energy also conducted a series of safety experiments on the NTTR. These experiments destroyed nuclear weapons using chemical explosives and resulted in almost 3,000 acres of soils contaminated with plutonium, americium, and other radionuclides.

At the direction of the Secretary of Energy, the Department of Energy suspended its work on Yucca Mountain high-level nuclear waste repository in 2009. Nye County's policy of active engagement with respect to the repository program and conducted its own scientific investigations of a number of key repository related issues. These studies have helped to further define the groundwater conditions in the region hydraulically down gradient of the proposed repository site through the installation of a number of monitoring wells, the collection of aquifer test data, and routine sampling and analyses of key water chemistry parameters.

Should the YMP move forward in the future, Nye County has formally documented its concerns with regard to the repository on key Department of Energy decisions and is a certified participant on the Nuclear Regulatory Commission's Licensing Support Network. The major concerns with respect to water resources are:

- Transportation accidents and the potential for contamination of public water supplies along routes used to haul the radioactive wastes;
- The loss of land suitable for groundwater development because of the permanent withdrawal of land for the repository;
- Potential for contamination of groundwater resources in Jackass Flats and Amargosa Desert because of a cask handling problem or leakage from the repository; and
- The cumulative consequences of Yucca Mountain related impacts with those from other past, present, and reasonably foreseeable future actions by both the federal and private sectors.

The Nuclear Waste Policy Act and its amendments provide the legislative mandate for the mitigation of impacts, direct compensation to the host county, and equity offsets. The guarantee of permanent uncontaminated water supplies for southern Nye County should remain a cornerstone of any mitigation, compensation, or equity agreements between the federal government and the County should work on the Yucca Mountain Project resume.

The U.S. Air Force has withdrawn 1,290,000 acres in Nye County for military training and bombing practice. These lands are closed to ranching, mining, grazing, water resources development, recreation, and other purposes. Although the Air Force has adopted an integrated natural resources management plan, the plan that was prepared provides only limited information on surface resources and no plans, goals, or objectives are related to groundwater. The ongoing impacts of Air Force actions were identified in the Final Legislative EIS for the Renewal of the Nellis Air Force Range Land Withdrawal (USAF, 1999), and the Special Nevada Report (SAIC, 1991). The Special Nevada Report identified the cumulative impacts associated with actions taken by the U.S. Air Force, the U.S. Navy, and the U.S. Department of Energy in compliance with the Military Lands Withdrawal Act of 1986.

Actions taken at the NTTR have resulted in: the dispersal of more than 40,000 tons of explosion debris, residues, and contamination (depleted uranium, beryllium, and explosive products) on alluvial fans and playas; the disposal of solid wastes, paint products, solvents, batteries, and petroleum products in landfills, pits, and explosive ordnance disposal pits; leaks from underground storage tanks; and the consumption of water in support of mission related activities.

According to historic reports, the dispersion of explosion debris may have resulted in the contamination of groundwater. The amount of groundwater that may have been contaminated as a result of these by products is not known and cannot be estimated on the basis of existing studies. Similarly, insufficient studies have been done to allow the definition of contamination that may have resulted from land filling of wastes, the operation of explosive ordnance disposal facilities, or leaking tanks. According to the final contamination report for the Final Legislative EIS for the Renewal of the Nellis Air Force Range Land Withdrawal (USAF, 1999), three sites in Nye County were found to have surface soils contaminated with arsenic and beryllium.

Subsequent evaluations indicated that contamination of surface soils is known to occur but the potential for groundwater contamination from this source is discounted because of the "low precipitation, high evaporation, generally low solubility of the contaminants of concern, and the considerable depth to groundwater across most of the range". This more recent study identified two categories of contamination on the NTTR, ordnance residues and operations and maintenance spills. The study concluded that there was little potential for the contaminants to migrate vertically downward to an aquifer.

There have been impacts on the water resources of Nye County associated with the withdrawal of the lands that now comprise the Nevada Test and Training Range. These withdrawals have effectively removed large areas of Nye County from future development. There are areas on the range where groundwater resources could be developed however, their development is inconsistent with the mission of the facility and such development is considered at best to be highly unlikely. As a consequence, the water resources that would otherwise be available to Nye County have been withdrawn as well as the land. In the Special Nevada Report, the analysis of the effects of the land withdrawals noted that:

> "The withdrawal of land from public access and/or the purchase of water rights by DOD and DOE has the greatest potential for effects on Nevada. ... The water resources associated with these lands could, if they exist and were available, play an important role in the continued growth of southern Nevada."

Possible mitigating measures identified in the Special Nevada Report included the provision of access for water resources evaluation and development (if possible and consistent with mission requirements); assistance in water resources evaluation on withdrawn lands; the provision of rights-of-way for water transmission facilities where such action would not limit, constrain, or deny the purpose of the withdrawal; and considering opportunities to cooperate with local agencies to enhance water supply sources and programs.

The appropriations associated with the U.S. Air Force-related water withdrawals reduce the legal availability of water in the basins and flow systems in which they occur, and are additive to the appropriations of all water right owners in the region of influence. Although the U.S. Air Force water right holdings in Nye County are appreciable (1,700 acre feet), the actual quantity of water being used is small, about 130 to 160 acre feet per year. The direct impacts of water use in support of U.S. Air Force actions are limited and include the localized effects of water withdrawals in the vicinity of water supply wells. The U.S. Air Force has recently announced plans to renew and expand its existing land withdrawal. Tables 5-3 and 5-4 show the impacts of these federal actions and withdrawals.

Table 5-3. Impacts of Federal Activities and Actions

Agency	Actions	Direct Impacts	Indirect Impacts	Significance
Department of Energy National Nuclear Security Administration	NNSS Operations Past Actions; Implement EIS/ROD	Contamination of subsurface; physical damage to aquifers; water level perturbations; increased recharge down chimneys.	Contamination of recharge; removal of contaminated areas from future water development.	Significant resource injuries and constraints on water development.
U.S. Air Force	NTTR Update RMP Operations Past Actions	Surficial contamination; water level perturbations.	Increased water demand in employment centers.	Not significant.
Bureau of Land Management	Past Actions; Implement Resource Management Plan	Reduced water availability; increased over-appropriation of Amargosa Valley; restricted area for development; increased water demand.	Increased water costs; decreased tax revenues; decreased long-term productivity of private lands; decreased tax base growth; increased overdraft of Pahrump Valley.	Significant increased demand for water and overdraft in Pahrump and over-appropriation in Amargosa Valley.
National Park Service	Past Actions; Implement General Management Plan	Reduced water availability; increased over-appropriation of Amargosa Valley; restricted area for development; increased appropriation time; increased appropriation cost; increased water demand.	Increased water costs; decreased tax revenues; decreased long-term productivity of private lands; decreased tax base growth; increased overdraft of Pahrump Valley.	Significant losses of long-term productivity of private lands; increases in costs of obtaining water rights; decrease in tax revenues to County.
U.S. Fish & Wildlife Service	Past Actions	Reduced water availability; increased over-appropriation of Amargosa Valley; decreased long-term productivity.	Increased water costs; decreased tax revenues.	Significant losses of long-term productivity and tax revenues to County.
U.S. Forest Service	Land Use Plans	Reduced water availability; decreased long-term productivity	Increased water costs; decreased tax revenues.	Significant losses of long-term productivity and tax revenues to County.

Table 5-4. Cumulative Impacts From Federal Land Withdrawals and Public Land Use Designations

Agency	Withdrawal or Designation	Direct Impacts	Indirect Impacts	Significance
Department of Energy	Nevada National Security Site Land Withdrawal (864,000 acres ±) Central Nevada Test Area	Restricted area for development.	Reduced water availability; increased water costs.	Significant reduction in water availability
U.S. Air Force	Nevada Test and Training Range Withdrawal (1,290,000 acres ±)	Restricted area for development.	Reduced water availability; increased water costs.	Significant reduction in water availability
Bureau of Land Management	42,044 acres designated for disposal; 80,000 acres designated as Areas of Critical Environmental Concern; Designation of the Basin and Range National Monument	Reduced water availability; increased over-appropriation of Amargosa and Pahrump Valleys; restricted areas for development; increased water demand; restricted areas for mineral exploration.	Increased water costs; decreased tax revenues; decreased long-term productivity of private lands; decreased tax base growth.	Significant increased demand for water and overdraft in Pahrump and increased demand in Amargosa Valley.
National Park Service	Death Valley National Park Land Withdrawals (106,961 acres)	Reduced water availability; increased over-appropriation of Amargosa Valley; restricted area for development; increased water demand.	Increased water costs; decreased tax revenues; decreased long-term productivity of private lands; decreased tax base growth.	Significant losses of long-term productivity of private lands, and decreased tax revenues to County.
U.S. Fish & Wildlife Service	Ash Meadows National Wildlife Refuge (23,000+ acres in Ash Meadows and land at Railroad Valley Wildlife Management Area and co-use of Nevada Test and Training Range lands)	Reduced water availability; increased over-appropriation of Amargosa Valley; decreased long-term productivity.	Increased water costs; decreased tax revenues.	Significant losses of long-term productivity and tax revenues to County.
U.S. Forest Service	Lands designated as National Forests (1,942,983 acres)	Reduced water availability; decreased long-term productivity	Increased water costs; decreased tax revenues.	Significant losses of long-term productivity and tax revenues to County.

Conservation and Preservation Measures

Groundwater conservation is a key issue with respect to future water supply in the Pahrump Valley and groundwater preservation is a key issue related to the protection of environmentally sensitive areas in Amargosa Desert and Oasis Valley in the south, and Railroad Valley, and White River Valley in the northern part of the County.

Conservation measures have been established to reduce the per capita demand for water in Pahrump and help mitigate the overdraft of the basin. Established conservation measures include zoning restrictions, building requirements for water conserving fixtures and appliances, education, and pricing of water supplies to encourage low water use. Zoning is continuing to mature in Pahrump, and is in its early stages in Amargosa Valley where it may be years before restrictions on landscape and landscape features are considered. In Pahrump, the Draft GWMP provides a detailed program for implementing and enforcing conservation that could help reduce per capita water rates. Because there is no single water purveyor in the valley and there are so many domestic water well users, the approach to conservation through pricing is likely to be of only limited success.

Public education offers the most effective method to "get the word out". While the NCWD has budgeted about $7,000 in 2016 – 2017 for water education (conservation), more work is needed in this area. As of this writing conservation measures for new construction proposed in the Basin 162 GWMP and supported by the Pahrump Regional Planning Commission, have been brought to the BoCC, but have not yet been heard. The Southern Nye County Conservation District continues to work with the school district in educating the public about water conservation measures.

The continued viability of healthy fish and wildlife conditions are of particular benefit to the northern basins of Nye County. Communities in this region are dependent in part upon the revenues generated through recreational fishing and hunting. Nye County's continued involvement in the development of management plans for wildlife refuges, habitat conservation plans for specific areas or species, and resource management plans by the various federal agencies will help to insure that future generations of Nye County's citizens will be able to enjoy the natural (and often unique) wildlife in the County while still having the opportunity to engage in recreational fishing and hunting.

The preservation of water quantity and quality at wildlife refuges and national parks is considered essential to their stewards, and recent management proposals have increased land use conflicts throughout Nye County. While Nye County recognizes that the goals of preservation in these areas are mandated by federal law, these federal water management policies continue to erode economic opportunities of multiple use. Nye County has fostered increased cooperation between the County, its citizens, and the federal agencies with stewardship over environmentally sensitive areas. As examples of these efforts the County has:

- Worked with and contributed funding to the DOI agencies on the Death Valley Regional Groundwater Flow System Numerical Modeling workshops;

- Worked with the BLM to mitigate the impact of recreation and water use on sensitive habitat in the Amargosa River near Beatty, and stands of natural mesquite bosques in Pahrump Valley; and

- Worked with the National Park Service to mitigate the impacts of water development on Devils Hole and Death Valley National Park by hosting and participating in Devils Hole workshops.

A spring pool at Ash Meadows. Photo Credit: Tom Buqo

Chapter 6 – COMMUNITY AND BASIN WATER ISSUES

Previous chapters discussed the water resources and the prevalent resource management issues on a county-wide basis. In this chapter, the current status of water supplies, water resource issues, and future needs are presented for the communities of Amargosa Valley, Beatty, Belmont and Gabbs, Manhattan, Pahrump, Railroad Valley-Currant, Round Mountain-Hadley Subdivision, and Tonopah. Other rural areas such as Carvers, as described as well. Access to water resources, and water issues related to the federal lands that make up most of the county are summarized. For the communities, the existing water uses and trends, future demands, water availability, special management areas, and management objectives are described and discussed. Next, the water supply requirements and issues at the basin level are discussed with respect to mining and milling, federal lands, and watershed maintenance and protection. Specific management alternatives are identified and discussed, and recommendations made for developing specific County policies with respect to water resources management.

Discussions with Water District Governing Board members and staff were an important element in identifying the local issues of concern. Draft copies of this plan were distributed for public review and comment, and public meetings were held at various locations in the county to obtain useful input from the citizens and organizations of Nye County. Comments and questions received during the public comment period were used to revise the Public Draft. Where appropriate, changes were made to the text, figures, and tables, and incorporated into the final WRP Update.

The 2011 Comprehensive Master Plan laid out extensive goals and objectives for the management of Nye County's waste resources. To achieve these planning goals, the County must balance the water resource needs for continued economic growth and the needs of the natural environment.

Water use to support the continued growth that is expected over the coming decades need not adversely impact springs, riparian areas, and associated wildlife habitat that require protection. With proper water planning and management, Nye County can improve its overall economic well being while maintaining environmentally sensitive areas and recreational values. Perhaps more importantly, the County can ensure that its future generations have adequate water supplies to meet the demands without adverse environmental effects.

Nye County has only limited authority to impose constraints on the management of water resources within its boundary. This authority resides with the State of Nevada, primarily the State Engineer and Nevada Division of Water Resources through Nevada Water Law. A review of the forefront issues such as basin over-allocation, localized drawdown, and long-term over-pumpage, indicate that water law, or the exercise of administrative options, has not evolved quickly enough to either prevent, or effectively mitigate the adverse effects of these problems in some cases. Existing water law lacks the tools needed by the State Engineer to effectively resolve many of the existing water conflicts. It is important that Nye County and the Nye County Water District continue to work with the State Engineer, as well as the Legislative Committee on Water Resources in the development of new legislative tools to aid in resolving the County's water resource conflicts. It is also critical that the County continue to engage and coordinate with the numerous federal agencies that manage the vast majority of land in Nye County.

6.1. AMARGOSA VALLEY AND CRYSTAL

Amargosa Desert Basin **Combined Perennial Yield of Basins 225 thru 230: *24,000 acre-feet/year***

Water Budget Parameters (acre-feet per year) from Table 3-7

Recharge	Inflow	Evapotranspiration	Outflow
600	44,000	24,000	19,000

Water Rights Status (acre-feet per year rounded) from Tables 3-4 and 3-8

	CERT	Permits	VST
Surface Water	21,375	3,630	2
Groundwater	20,940	6,379	0

Note: All water right figures are approximate **CERT** = Certificated, **VST** = Vested.

Assumptions

For the purposes of planning, the following assumptions were made:

1. **The existing undeveloped private land in Amargosa Valley and Crystal is adequate to accommodate residential growth through 2060.**
2. **Future designations of land for disposal by the BLM will be eliminated, or will be limited to those needed for specific community purposes such as landfills, roads, etc., and these disposals will only result in negligible additional demands for water.**
3. **Agricultural operations will remain at current levels or decline; no new agricultural through 2060.**
4. **The U.S. Air Force will continue operations at Nevada Test and Training Range and the NNSA will continue operations at the Nevada National Security Site. Water use at these federal facilities may increase slightly over current levels but will exceed historic use.**
5. **There will be one new mining operation or expansion in the Amargosa Desert.**
6. **At least one new renewable energy power plant will be constructed in the Amargosa Desert.**
7. **No further expansions of Death Valley National Park will occur and no additional buffer zone will be established around the existing Park boundary.**
8. **The Amargosa Valley Science and Technology Park (AVSTP) near the Lathrop Wells intersection will be completed.**
9. **Four marijuana cultivation facilities will be established.**

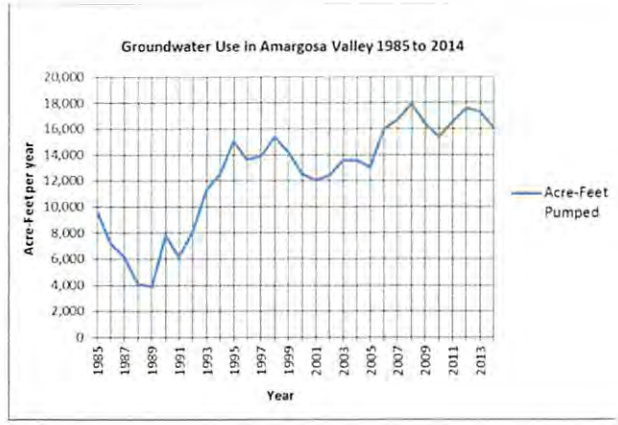
Water Resources Issues and Constraints

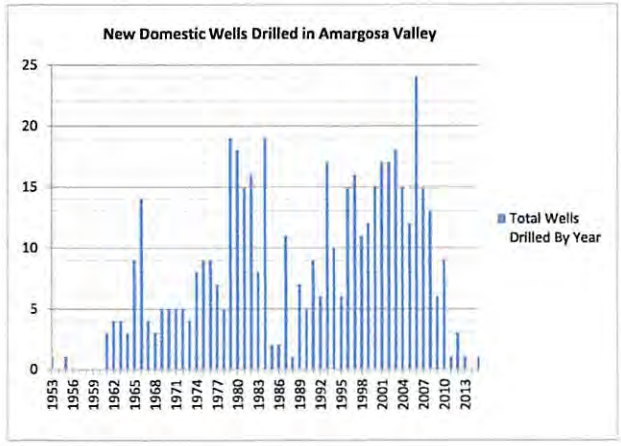
Water resource issues and constraints in Amargosa Desert include a number of factors related to water quantity and use, and the protection of environmentally sensitive areas. Water resources in the vicinity of Lathrop Wells intersection are high in naturally occurring arsenic and require treatments to meet the drinking water standard. The Town of Amargosa Valley is located downgradient from the U.S. Ecology facility and the Nevada National Security Site.

The small rural community of Crystal is located in the Amargosa Desert basin northeast of Devils Hole and the Ash Meadows National Wildlife Refuge. Water is supplied to homes by domestic wells, and a few businesses operate public water supply systems. Issuance of new water rights, as wells as applications to change point of diversion, are constrained by the Nevada State Engineer's Curtailment Order 1197, which includes the community in its entirety. Water level data have

shown, however, that pumping wells to the west of the gravity fault have no effect on water levels in the carbonate aquifer that is home to the Devils Hole Pupfish.

Water Quantity and Use – While the existing allocated groundwater rights of about 26,000 acre-feet exceed the published perennial yield of 24,000 acre-feet; actual water use in the basin is far less. Total pumpage in 2015 was 16,000 acre-feet, nearly 2,000 acre-feet less than the high of nearly 18,000 acre-feet in 2008. Irrigation water use was at 13,000 acre-feet in 2014. Commercial and industrial water use has fluctuated significantly over the last decade between 1,000 and 4,700 AFY, but has remained steady since 2013 at about 1,800 AFY. Quasi-municipal use has remained fairly constant at slightly less than 300 AFY, while municipal use increased from 0 in 2000 to 160 AFY in 2015. Residential water use has grown only slightly over the last decade. In 2000, an estimated 378 acre-feet were used for domestic purposes; using a rate of 1 acre-foot per well. Between 2000 and 2013, 124 new domestic wells were drilled in the basin, or an average of 9 wells per year. Even with additional wells domestic use in 2015 was calculated at 269 acre-feet due to the State Engineer's revised pumping rate of 0.5 AFY.





Environmentally Sensitive Areas - Spring pools at Ash Meadows provide the vital source of water and habitat for a number of threatened and/or endangered species, as well as numerous other fishes, birds, and mammals. The protection of Ash Meadows and Devils Hole from the impacts of water withdrawals in the basin remains a key issue in Federal water planning for Amargosa Valley.

In 2010, the USFWS diverted creek flows in Carson Slough away from a private church ministry located in the Ash Meadows National Wildlife Refuge. The USFWS cited the need to preserve endangered species, including the Ash Meadows speckled dace that inhabit the refuge. On Nov. 4, the DWR ordered the federal agency to cease diversion of water through the ministry's parcel after the investigation found several USFWS violations of the terms of the ministry's water permits. The diversion also resulted in repeated flooding of the church's property. According to the order from the state, the U.S. Fish and Wildlife Service must return the water to its "historic path" traversing the church property, within 90 days, or face administrative fines up to $10,000 per day until corrective action is taken.

The federal government has denied any liability for the flooding and has argued that the ministry had no rights to the water that had traversed its property. While the order from the DWR verified

the ministry's vested water rights were violated, the ministry continues to suffer "significant damage and constitutional violations."

Failure to take corrective action will result in the matter being referred for additional action available to the State Engineer. Possible penalties for noncompliance can include payment of an administrative fine not exceeding $10,000 per day for each violation, replacement of not more than 200 percent of the water used, and payment of the costs of the proceeding, including investigative costs and attorney's fees. The case is currently pending in the U.S. Court of Federal Claims (Pahrump Valley Times, 2016). As of April 2017, the illegal diversion constructed by the USFWS has not been removed, and the ministry continues to suffer as a result of the loss of their water supplies.

While there is no question that the 1968 historic groundwater withdrawals in the immediate vicinity of Ash Meadows and Devils Hole resulted in unacceptable water level declines and spring discharge reductions, these withdrawals have ceased. Since that time, water levels in numerous wells in the basin have been monitored by Nye County, the U.S. Geological Survey, and others as part of studies related to Yucca Mountain and the Nevada National Security Site. Areas of concentrated groundwater pumpage in Amargosa Farms Area of the Amargosa Desert Basin has resulted in only localized drawdown. Figure 6-1 shows the long-term water level trends in Amargosa Desert. Although some water level declines have occurred around the pumping centers in the Amargosa Farms area, water levels over most of the basin have either remained stable or risen over the last two decades. In the environmentally sensitive area of Ash Meadows (and Devils Hole), water levels have increased since the cessation of pumping in the late 1970s and have recovered to their pre-pumping levels at several monitoring wells. In the northwest part of the basin, water levels have remained fairly constant over the last decade even though water use in the basin and its upgradient tributary basins has increased. Water levels continue to decline in the agricultural areas of the basin, reflecting the higher agricultural productivity and the transition of the water levels in the area to a new state of equilibrium as groundwater is recovered from transitional storage.

In response to continued protests filed by federal agencies of new and change applications, which allege potential for impacts on Devils Hole and the springs discharging in Death Valley National Park, in 2008, the State Engineer issued Curtailment Order 1197 for the Amargosa Desert Basin prohibiting the issuance of any new water rights and approval of any change applications within 25 miles of Devils Hole, with minor exceptions.

There is no scientific data on the Devils Hole water level or spring discharge rates in Death Valley as a result of the agricultural pumping centers in the Amargosa Farms area. If dramatic declines in water levels in the Amargosa Farms area were to occur, agricultural economics and the total thickness of the alluvial aquifer would dictate that pumping levels not be lowered to a depth below 500 feet. Even if this were to occur, the hydraulic heads in the area would still be about 1,800 feet above those in Death Valley. Further, the alluvial aquifer, the only aquifer used for irrigation, is isolated from the regional carbonate aquifer that supplies the springs in Death Valley by several thousand feet of clay-rich Tertiary sediments. Finally, should significant water level declines be observed in Devils Hole, the Supreme Court would order the Nevada State Engineer to take corrective action.

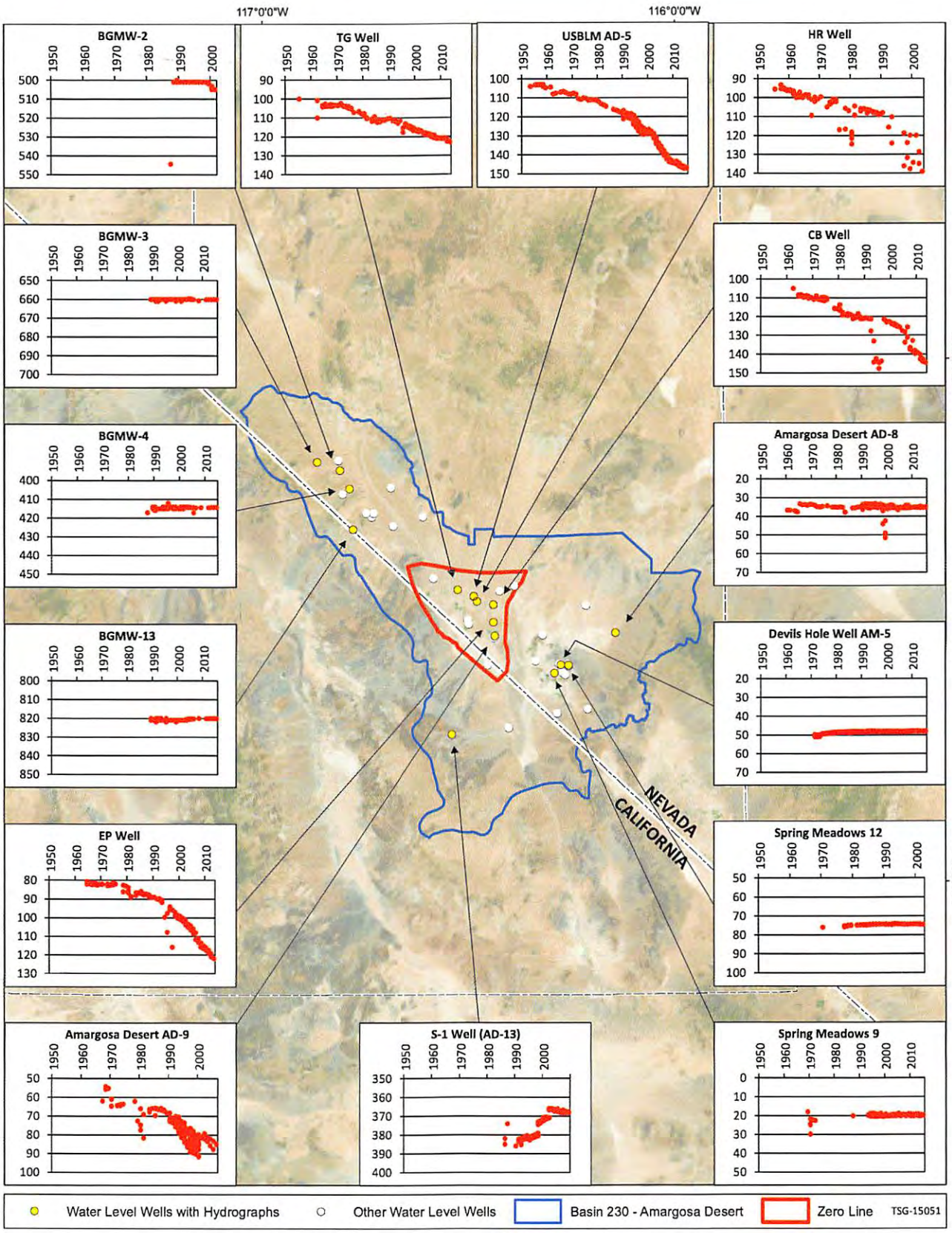


Figure 6-1. Long-Term Water Level Trends in Amargosa Desert. Zero Line is the boundary of the area of water level decline. Y-axis shows 50 foot interval depth to water. Water levels from USGS National Water Information System (March, 2015).

Water Supply Requirements

Groundwater will be needed in the future to provide for the expected new growth in renewable energy development and marijuana cultivation. The likely reduction in agricultural and dairy production will help to offset this new demand.

Future water demand for mining purposes is assumed through the development of one new mining property in the basin outside the area addressed in Order 1197 over the planning period. As water development for such an operation is likely to be moderate (1,000 AFY or less), temporary in duration, and in a remote location, it should be possible to develop the necessary water without detriment to existing or future water right holders or the environment.

It is likely that some agricultural water rights will continue to be converted to other uses to support growth of the community of Amargosa Valley. Conversion of irrigation to quasi-municipal or domestic use will help to reduce the over-allocation through the mandatory dedication and relinquishment of water rights during the development permitting process. Assuming that the future demand for water for irrigation will not exceed the 15,000 acre-feet of current demand, the total projected demand for all uses is 26,000 AFY with a consumptive use of about 22,000 acre-feet.

Water demand for renewable energy and marijuana cultivation is not expected to increase overall water demand in the Amargosa Desert. Water rights for these projects will be purchased from the existing irrigation rights, and converted and moved in accordance with the restrictions imposed by Order 1197. Water level declines in Amargosa Valley are centered on the existing agricultural pumping centers. Most of the basin water levels outside of agricultural areas are unaffected.

Water Sources

As described in Chapter 5, there is currently debate as to whether existing groundwater sources are adequate to provide for the current and future needs for the next fifty years based on the current committed water resources and established perennial yield value of 24,000 acre-feet. Several of Department of Interior agencies have asserted that the Amargosa Desert Basin is over-allocated and over-pumped, however groundwater withdrawals do not exceed the basin's established perennial yield. Water level monitoring in the basin shows only localized drawdown around agricultural pumping centers, as would be expected. No valley-wide water level decline has been observed.

The Amargosa Desert Basin is only slightly over-allocated (27,000 acre-feet committed versus perennial yield of 24,000 acre-feet); it is not over-pumped (24,000 acre-feet perennial yield versus 16,052 acre-feet pumped including domestic wells). Measures by Nye County to curtail parceling through BOCC-approved Area Plans and Land Division Ordinances are expected to contribute to the success of limiting the creation of new private parcels available for development and ensuring that all new parcels created will have dedicated water rights to account for future residential and domestic uses.

Curtailment Order 1197 issued by the Nevada State Engineer have virtually eliminated the approval of new permits and has limited the scope of change applications. The threat of litigation by federal agencies over the Devils Hole Pupfish continue to influence state water policies in this region. Nonetheless, to ensure the success of these mitigation measures, Nye County and the DWR should continue to track, monitor, and report committed water rights, pumpage, and water levels to

ensure continuing the trend of reducing committed groundwater resources through time. If it appears basin pumpage will exceed the perennial yield, Nye County should consider implementing additional measures, such as requiring the over-dedication of water rights for commercial and industrial uses.

All surface waters (springs) in the Amargosa Desert remain fully developed or appropriated for wildlife purposes; this will continue to impose a binding constraint on any other future development of surface water. Future groundwater development is constrained by both environmental and water quality considerations. Because of its location up gradient of Ash Meadows and Devils Hole and within the area of Curtailment Order 1197, it is unlikely that large-scale development in the Crystal area will occur. As noted in previous sections, access restrictions at Nevada National Security Site and the Nevada Test and Training Range impose severe constraints on the development of new water supplies in areas north of Highway 95 where unappropriated water resources exist. Similarly, the designation and expansion of new Areas of Environmental Concern by the BLM in the recently proposed RMP imposes future constraints on the location of water supply wells near these areas. In 2009, a 26-mile stretch of the Amargosa River in California was declared a Wild and Scenic River and is subject to special protection. On the Nevada side, Carson Slough in Amargosa Valley was deemed eligible for inclusion in the National Wild and Scenic River in the 1998 Las Vegas Field Office RMP, the 2014 Public Draft RMP determined it is no longer suitable for inclusion.

Recommendations

Based upon the current and projected water demands in Amargosa Valley, the issues related to additional development and the constraints on that development, the following recommendations are made:

Continue Tritium monitoring.

Continue groundwater level monitoring.

Continue to coordinate planning with local and federal water users, and the Nevada Division of Water Resources.

Continue to require dedication and relinquishment of water rights for future domestic uses for each new parcel created.

Continue the dialogue with the Department of Interior agencies (National Park Service, Fish and Wildlife Service, and BLM) concerning the establishment and results of mitigation measures implemented in the basin.

6.2. BEATTY – OASIS VALLEY

Oasis Valley **Combined Perennial Yield of Basins 225 thru 230:** ***24,000 acre-feet/year***

Water Budget Parameters (acre-feet per year) from Tables 3-7

Recharge	Inflow	Evapotranspiration	Outflow
1,000	2,500	2,000	1,500

Water Rights Status (acre-feet per year rounded) from Tables 3-4 and 3-8

	CERT	Permits	VST
Surface Water	1,908	2,130	1,558
Groundwater	1,246	50	0

Note: All water right figures are approximate **CERT** = Certificated, **VST** = Vested

Assumptions

For the purposes of planning, the following assumptions were made:

1. **A full build-out of all private lands in Beatty will occur by the year 2060.**
2. **The U.S. Air Force will continue operations at Nevada Test and Training Range.**
3. **Mining operations will continue at current levels.**
4. **Three industrial or warehousing facilities will open operations near the Beatty airport.**
5. **Future designations of land for disposal by the BLM will be limited to those needed for specific community purposes such as landfills, air fields, roads, etc., and these disposals will only result in negligible additional demands for water.**
6. **Substantial marijuana cultivation/processing facilities will be developed near the Beatty Airport.**

Water Resources Issues and Constraints

The significant water issues in Beatty involve the naturally occurring levels of arsenic and fluoride in the groundwater. In the past, fluoride has been managed by blending water from various sources. The groundwater sources for the Beatty Water and Sanitation District (BWSD) averaged less than 20 parts per billion (ppb) of arsenic after blending but exceeded the primary drinking water standard. Beatty's main production well, Well EW-4, exceeded the maximum contamination level for arsenic and Beatty operated under an arsenic exemption extension until January 2011. In 2009, the BWSD received a grant to construct central treatment for the removal of arsenic. The selected technology was coagulation/filtration with chemical addition. The total project cost was almost $3 million with $2,910,000 provided in state and federal funds in a principal forgiveness loan.

Water Supply Requirements

The BWSD has adequate water rights and wells to meet projected future demands. Total groundwater use in 2011 was estimated to be about 233 acre-feet, or 24 percent lower than the quantity pumped in 2004. At present, there are 450 service connections serving approximately 1,024 residents. Water use is estimated in the WSAI Report (GGI, 2013a) at 233 AFY based in the current number of service connections.

The BWSD water distribution system is sized for approximately three times the current population and therefore, will not need to be expanded with expected growth. The Nye County WSAI Report (GGI, 2013a) provides detailed description of individual system components and needs. BWSD received a Community Development Block Grant in 2011 to create a master plan including utility mapping, environmental assessments and a capital improvement plan.

Water Sources

The BWSD relies upon six water supply sources, Wells 1, 2, and 3, the Summit Well, the Indian Springs Well, and Well EW-4 for its potable water supplies. Well #1, the Summit Well, and the Indian Springs Well all meet safe drinking water standards. The groundwater at Well EW-4, which is located in Amargosa Desert Basin 230, had elevated concentrations of arsenic that exceed standards, and fluoride concentrations that are slightly over the drinking water standard.

Water treatment was identified as the only option to ensure compliance with the new arsenic standard. The construction of the treatment unit began in April 2010. A Hungerford and Terry coagulation-filtration treatment system was installed in a new facility near the BWSD's existing booster station. The treatment uses sodium hypochlorite oxidation of the arsenic in the water and ferric chloride for coagulation prior to filtering. An automated system was installed to assist in system control and data collection. The BWSD completed the project, and hosted an open house on March 16, 2011. Visitors enjoyed tours provided by the water system operators and the design engineer (http://ndep.nv.gov/recovery/beatty_arra.html, 8/12/16).

Existing sources are adequate to meet projected future demand. Past constraints imposed by environmental concerns over several species of concern have been addressed through a multi-party conservation agreement between government, private, and public parties.

Recommendations

None

6.3. GABBS

Gabbs Valley **Perennial Yield: 5,000 acre-feet/year**

Water Budget Parameters (acre-feet per year) from Tables 3-7

Recharge	Inflow	Evapotranspiration	Outflow
5,000	0	>3,700	0

Water Rights Status (acre-feet per year rounded) from Tables 3-4 and 3-8

	CERT	Permits	VST
Surface Water	205	0	217
Groundwater	11,914	7,263	108

Note: All water right figures are approximate **CERT** = Certificated, **VST** = Vested

Assumptions

For the purposes of planning, the following assumptions were made:

1. **Industrial mining activities will continue at current levels during the planning period.**
2. **One new moderately sized gold mine will be developed and operated during the 50-year planning period.**
3. **The proposed expansion of the Fallon Naval Air Station land withdrawal will eliminate the potential for future oil development and will restrict future geothermal development.**

Water Resources Issues and Constraints

Water resources issues and constraints in Gabbs include those related to water quantity and water quality issues. Groundwater in the area has elevated fluoride and arsenic concentrations.

Water Quantity and Use

The Gabbs Valley has a perennial yield of 5,000 AFY. Permitted, certificated, and vested groundwater rights totaled 19,285 AFY in 2015. Of that total, nearly 9,000 acre-feet are for mining and milling, a temporary use. The 9,000 acre-feet of irrigation rights are in the adjacent counties.

The Gabbs water system owns 234.34 AFY in municipal and quasi-municipal water rights and 361.98 AFY in milling, mining and domestic rights. The water system has a total of 140 active service connections, which includes 125 residential, 14 commercial and the school with irrigated ball fields. The population served by the water system is estimated to be 282 people. Prior to 2005, the community per capita water use was 800 gallons per day. Since that time, increased funding has been used to successfully find and fix system leaks. Because the proportion of water use by the school and commercial users is relatively high, the community per capita water use rate for Gabbs is 531 gallons per capita (GGI, 2013a).

Water Supply Requirements

The Gabbs Water system has sufficient water rights and with the new improvements will have sufficient water production of good water quality to supply a population increase of approximately

200 people. The system will need to continue its current policy of line and valve replacement and leak detection.

Several oil and gas exploration leases and geothermal projects have been proposed and approved northwest of Gabbs. Based on the locations of these projects, BLM indicates that there is little potential for operations or water demand of these projects impact to Gabbs water supplies (GGI, 2013a), should they go forward.

Water Sources

The Town of Gabbs water system, which is operated by Nye County Public Works, has one production well, one emergency well, and a new production well that was constructed and connected to the system in 2012. The emergency well has higher fluoride concentrations but can be used as a system back-up well. The newly constructed production well has acceptable concentrations of fluoride and arsenic and is capable of supplying all the water required for the water system demand.

The new well, located ½ mile southwest of the existing well, and the pipeline connecting the wells to the system, SCADA system and chlorination injection system were installed and became operational in 2012. The existing Well 1 is maintained as a back-up well; water from this well can be blended with the new well to meet demand and maintain water rights. A second project for re-lining the 500,000 gallon storage tank was funded through a Community Development Block Grant in 2012.

The Fallon Naval Air Station is proposing to expand its land withdrawal into Nye County very near the Town of Gabbs. If the proposed land withdrawal expansion occurs, the federal oil and gas, and geothermal leases discussed above will likely be cancelled, and those areas withdrawn from access for exploration for all resources, including water.

Recommendations

None

6.4. MANHATTAN – BIG SMOKY VALLEY TONOPAH FLAT

Big Smoky Valley Tonopah Flat (Manhattan) Perennial Yield: 6,000 acre-feet/year

Combined Water Budget Parameters (acre-feet per year) from Table 3-7

Recharge	Inflow	Evapotranspiration	Outflow
12,000	2,000	6,000	8,000

Combined Water Rights Status (acre-feet rounded) from Tables 3-4 and 3-8

	CERT	Permits	RFA	VST
Surface Water	8,379	1,020	0	1,205
Groundwater	17,106	6,951	322	0

Note: All water right figures are approximate **CERT** = Certificated, **RFA** = Ready for Action **RFP** = Ready for Protest, **VST** = Vested RFA includes new water only.

Assumptions

For the purposes of planning, the following assumptions were made:

1. **Up to four new concentrating solar power towers will be constructed and developed during the 50-year planning period.**

Water Resources Issues and Constraints

The Big Smoky Valley-Tonopah Flat Basin has a perennial yield of 6,000 AFY and allocated groundwater rights of 23,000 acre-feet. The predominant uses for groundwater are mining, milling, and irrigation. The basin has less than 50 domestic wells. Although the basin is significantly over-allocated, almost 60 percent of the allocated rights are for mining and milling, which are generally considered temporary use by the State Engineer. Almost all but 1,000 AFY of the approximately 4,200 AFY of surface water rights are certificated or vested. The predominant uses of surface water are irrigation and stock watering.

Water Supply Requirements

The Manhattan Town Water system owns adequate water rights to serve their current customers and a future population increase, should it occur. The NDEP Drinking Water Branch website (https://ndwis.ndep.nv.gov/) lists Manhattan Town Water as having 101 service connections; the system is currently serving a population of 40 people. In 2016, Nye County certificated 14.608 acre-feet of the permitted 16.82 acre-feet water rights, and moved the remainder of the permitted rights to the back-up well. The 2011 per capita use was calculated in the WSAI report (GGI, 2013a) to be 72 gallons per day including some commercial use.

The Crescent Dunes Solar Energy Project, has a permit for about 600 AFY of industrial water rights for energy production, but expects to use less than the permitted amount. Recent press releases indicate that the company intends to pursue permits for an additional 10 towers. The WRP Update assumes 4 additional towers will be approved. Additionally, Round Mountain Gold and other mining exploration projects may expand in the near future, which could increase population in the Town of Manhattan. The water system operator indicated that the system does not have any major maintenance requirements in the near future.

Water Sources

The Manhattan Town Water public water supply system is located in the mountains between Smoky and Ralston Valleys. Water is supplied from one drilled well using a submersible pump. Aboveground storage consists of a 250,000 gallon water tank. The system is fully chlorinated. Manhattan Town Water put a new well into service in 2010 that has an arsenic concentration below the drinking water standard; the old well, which exceeds the arsenic standard, has been designated as an emergency backup well. The system has been upgraded to include a new water tank and replacement of all major transmission and distribution lines.

Recommendations

Monitor renewable energy projects and revise water demands, as necessary.

6.5. PAHRUMP

Pahrump Valley		Perennial Yield: 20,000 acre-feet/year			
Water Budget Parameters (acre-feet per year) from Table 3-7					
Recharge	Inflow	Evapotranspiration		Outflow	
22,000	0	10,000		13,000	
Combined Water Rights Status (acre-feet rounded) from Tables 3-4 and 3-8					
	CERT	**Permits**	**RFA**	**RFP**	**VST**
Surface Water	3,061	4,240	0	0	2,085
Groundwater	16,367	36,533	2,978	0	0

Note: All water right figures are approximate **CERT** = Certificated, **RFA** = Ready for Action **RFP** = Ready for Protest, **VST** = Vested RFA and RFP include new water only.

Assumptions

For the purposes of planning, the following assumptions were made:

1. **Water rights will continue to be relinquished and dedicated at rates of two to three times the expected use for support of land subdivision or new development.**
2. **Land disposal by the BLM will be limited to those needed for specific community purposes such as landfills, air fields, roads, etc.; these disposals will not increase water rights allocations in the basin.**
3. **The Nevada State Engineer will not allow new water to be appropriated.**
4. **Irrigated agricultural will continue to decline and will be a minor component of total water use, about 2,000 AFY, by the year 2060.**
5. **Water for commercial development will be provided by utilities, or will be provided through changes to existing valid water rights.**

Water Resources Issues and Constraints

Water resource issues and constraints in Pahrump include those related to both water quantity and water quality issues. Chapter 5 provided detailed discussions of these issues. Pahrump's issues are typical of basins where rapid urbanization of former agricultural land is changing the nature and distribution of water withdrawals and the types of contaminant threats to the water resources.

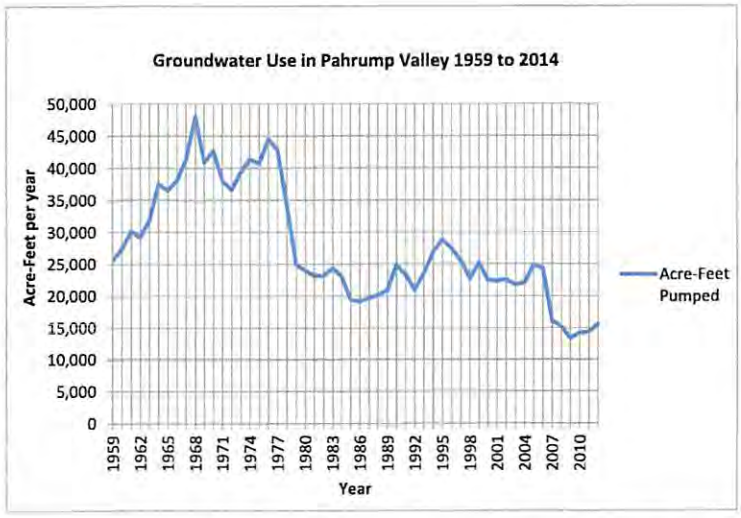
Water Quantity and Use

Accepted perennial yield values for the Pahrump Artesian Basin have ranged from a low of 12,000 acre-feet to the recently revised estimate of 20,000 acre-feet. The perennial yield is pumped from different layers or units within the alluvial aquifer. The alluvial aquifer is comprised of a variety of sediments that include highly transmissive gravel units - one in the fan and the other underlying the shallow, unconfined, fine-grained sediments of the valley floor. The shallow, fine-grained valley fill aquifer receives very little natural recharge; most recharge to this shallow unit is the moisture derived from infiltration from irrigation water and septic systems.

Deeper gravel units of the alluvial aquifer that underlay the valley between 500 and 850 feet are fed by recharge from Mount Charleston snowpack, and runoff through connectivity with fan gravels located higher up in the valley. Further from the fan margins, the lower gravel unit probably

receives upward leakance of higher pressure water through structural features, and allows some hydraulic communication with the deeper regional lower carbonate aquifer.

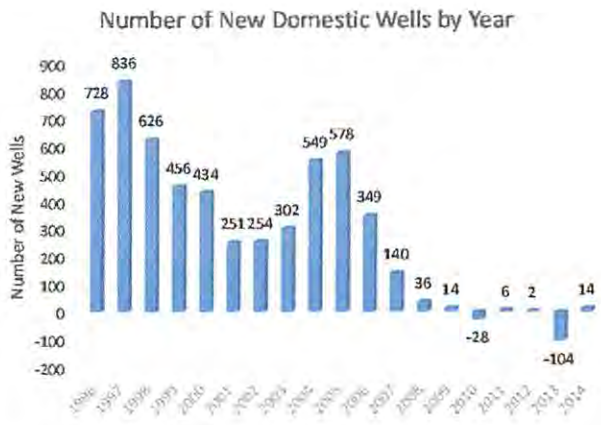
From the 1950s to the 1970s, artesian wells developed in the lower gravel unit were used to irrigate cotton and other crops. By 1967, 47,000 acre-feet of groundwater were being withdrawn for agricultural use from the deeper gravels primarily through artesian wells. This irrigation water provided significant recharge to the shallow, unconfined unit through secondary infiltration. As described in Chapter 3, water levels in the deeper gravel unit began declining in the 1980s, and many of the larger springs, like Manse, began to see decreased discharge, and some stopped flowing completely.



The graph (right) shows groundwater use in Pahrump Valley from 1959 to present. Irrigation pumpage accounted for nearly all water use until 1975. By 1980, agricultural cotton production had ceased and total basin pumpage decreased from 48,000 acre-feet to 25,000 acre-feet. From 1980 through 2004, annual groundwater pumpage averaged about 23,000 acre-feet. Since 2004, annual pumpage has continued to decline. Decline in usage since 2004 is partially due to the DWR reduction in the 2009 and subsequent years Pumpage Inventory Report of the average domestic well usage figure from 1.0 AFY to 0.5 AFY. The average annual pumpage for 2011 thru 2015 was 14,600 acre-feet.

Changes in historic pumpage trends in the Pahrump basin have resulted in the water levels observed today. During the periods of heavy agriculture, pumpage was predominantly from the deeper gravel aquifer, and artesian heads in the area declined dramatically through the 1980s, while increasing the water levels in the shallow aquifer. With the decline of agriculture, heads in the deeper gravel aquifer gradually recovered, and artesian conditions and spring flows returned in many areas of the valley. With the reduction of agricultural irrigation, however, the largest source of secondary recharge to the shallow fine-grained aquifer was substantially reduced.

With urbanization in the 1990s, several areas in the Pahrump basin experienced a dramatic increase in the number of shallow, domestic wells completed in the upper fine-grained unit of the alluvial aquifer. As the number of domestic wells increased, rate of declines observed in the fine-grained unit also began to increase. Continued pumpage of the shallow fine-grained aquifer will draw down water levels at increasing rates in those sections with high densities of domestic wells.



The graph (at right) shows the number of new wells drilled by year. Since 2008, the total number of domestic wells in Pahrump Valley has remained relatively steady at about 11,000. The number of new domestic wells drilled from year to year was highly variable, but some trends are apparent during the last 20 years (1996 to 2016). In 1996, domestic well drilling was nearing its peak, which occurred in 1997 with 836 new domestic wells reported. By 2010, the Pahrump Valley saw a net reduction of 28 domestic wells with 12 new wells drilled, and 40 existing wells plugged. The number of new wells increased dramatically as national economic conditions from 2001 and 2005 fueled growth and development, but domestic well drilling rates did not surpass those seen in the late 1990s. In 2006, the number of new wells began to decline as growth slowed, and by 2008, only 36 new domestic wells were drilled. From 2009 through 2014 less than 15 new domestic wells have been drilled annually reflecting the slow economic recovery, as well as a shift in housing trends from large rural estate lots served by domestic wells, to subdivisions served by public water supply systems.

Figure 6-2 shows the count and distribution of domestic water wells in the Pahrump Valley. Several sections in the basin where the number of domestic wells equals or exceeds 100 wells per square mile, with the highest domestic well density reported by DWR (2015) at 437 wells per square mile. These areas with a high density of shallow domestic wells are where the most rapid rate of decline is observed.

Water Quality - Currently, the overall quality of the groundwater in Pahrump is quite good. As discussed in Chapter 5, the lack of community-wide sewage treatment, the 11,000 existing septic systems, and the potential for an additional 8,000 septic systems all point to the vulnerability of the valley-fill aquifer to contamination by nitrates. There are 33 sections of land in Pahrump with more than 100 septic systems in each section. Of these, ten sections have more than 200 septic systems. The vulnerability of the groundwater under these areas to nitrate contamination depends upon the type of soils, the depth to groundwater, and the practices of the individual septic system owners.

To determine if contamination from septic systems is occurring, using historical sampling data, a set of wells should be identified and sampled on a regular basis. Groundwater samples should be analyzed for the analytes of concern including nitrates, e. coli, sulfates, chlorides, and selected waste water compounds. Based upon the results of the sampling and analyses, a limited number of wells should be selected for annual monitoring.

The infiltration of water applied over irrigated areas back to the water table is another potential source of contamination. Since the heyday of cotton production, the acreage of irrigated land in Pahrump Valley has declined steadily. The distribution of irrigated land in 2015 is shown on Figure 6-3 and is now largely restricted to areas in the west central part of the basin and southern

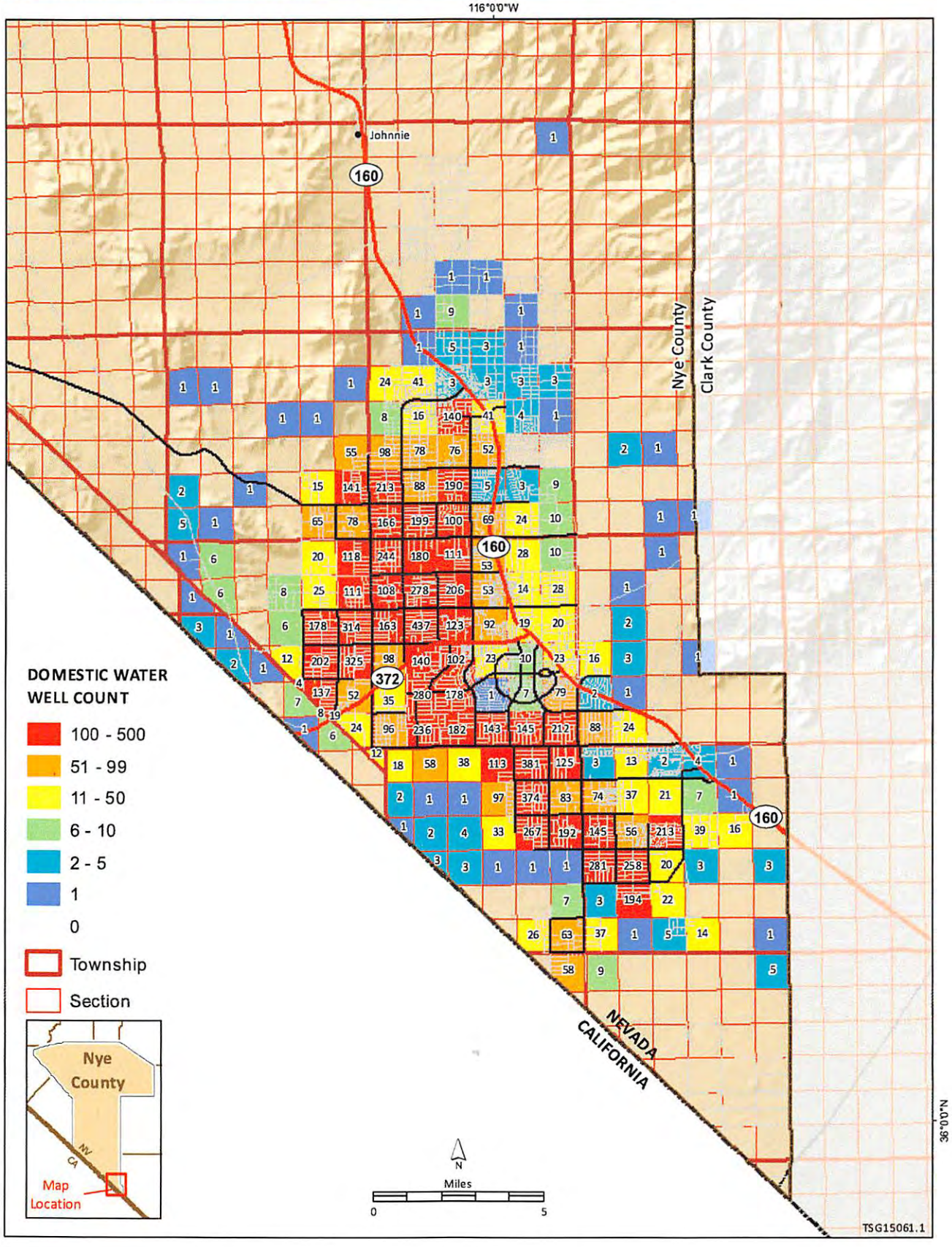


Figure 6-2. Count and distribution of domestic water wells in Pahrump Valley from NDWR Well Log Database as of April 2015.

The support of the DWR staff and the Nevada State Engineer were instrumental in the update of the WRP. The DWR timely provided a great deal of the data and information presented in this plan. Informational briefings, presented and discussed with the State Engineer and his staff contributed to the update of the WRP.

The Division of Water Planning created by legislation in 1977, was incorporated into the Division of Water Resources in 2000 shortly after completion of the State Water Plan in 1999. The DWR remains responsible for water management and planning, conservation plans, planning assistance to local governments, and development of the State Water Plan.

It is the policy of Nye County to comply fully with Nevada Water Law and its implementing regulations, to encourage business and industry to comply fully with applicable regulations, and to foster a spirit of cooperation between the regulatory agencies and all of the stakeholders in Nye County. Nye County believes that sound long-term planning and management of the development and use of County's water resources is in the best interest of both the County and the State.

Federally Mandated Programs

The State Environmental Commission (SEC) an 11-member board acts as a quasi-judicial and quasi-legislative board for adoption and approval of federally mandated environmental programs and regulations. The SEC is responsible for developing water quality standards for specific water bodies within the State. The SEC also approves new or revised regulations related to Nevada's Water Pollution Control laws and regulations at NRS Chapter 445A and NAC 445A by acting on petitions proposed by the NDEP. Rulemakings may address new or revised environmental standards, adopt certain federal regulations, approve new permitting fees, incorporate federally required plans, and other functions necessary for the proper adoption, execution and implementation of federal and state laws and regulations.

Federal laws, regulations, and policies establish standards for clean water, controlling growth in flood plains, and protecting the environment. While each of these goals is beneficial and consistent with the long-term goals and values held by Nye County and its citizens, the immediate impact of the mandates is often limiting. Some of the provisions of these many levels of regulation impose requirements that are costly for the County or the towns within the County to implement, often at the cost of reducing or eliminating discretionary programs that benefit the citizens of the area.

Clean Water Act

The Clean Water Act is a federal law enacted to prevent pollution of surface waters. The Act was established to "restore the chemical, physical, and biological integrity of the nation's waters." It requires that states establish standards for surface water quality, provides federal funding for sewage treatment plants, and sets goals of zero toxic discharges to, and realization of "fishable" and "swimmable" surface waters. The Clean Water Act also mandates a regulatory system for reporting of hazardous spills to surface waters, as well as a wetlands preservation program.

The NDEP has been delegated limited authority to implement programs of the Clean Water Act. The enforceable provisions of the Clean Water Act, including permit programs for the National Pollution Discharge Elimination System and technology-based effluent standards for point sources of pollution, are retained and implemented by Environmental Protection Agency (EPA) Region IX.

NDEP enforces surface water quality standards, and also implements and enforces federally mandated programs for the management of non-point sources of pollution, ensures the use of best management practices, and offers construction grants through a program to build or upgrade sewage systems.

Additionally, the State of Nevada has adopted regulations for State programs to implement the provisions of the Clean Water Act and Nevada Water Pollution Control laws. Nevada's Water Pollution Control laws, contained in Chapter 445A of the Nevada Revised Statutes, establish several non-federal water pollution control programs. These programs, implemented by the NDEP, include programs for issuing Water Pollution Control Permits with zero-discharge performance standards, and State Ground Water Permits for infiltration basins, land application of treated effluents, large septic systems, and industrial facilities.

It is Nye County's policy to cooperate and comply fully with state and federal regulatory programs of the Clean Water Act and the Nevada Water Pollution Control Laws, to encourage business and industry to comply fully with applicable regulations, and to ensure that the County's surface water resources are clean and free from pollution. Additionally, the County supports the use of the State Environmental Commission's Handbook of Best Management Practices for all activities that have the potential to degrade surface waters.

Safe Drinking Water Act

The Safe Drinking Water Act is the primary federal law enacted to protect underground sources of drinking water from pollution, and to ensure the quality of drinking water delivered at the tap. The Act established a program for setting primary and secondary standards for drinking water, a permit program for waste and hydrocarbon injection wells, and mandated a program of wellhead protection practices. The Nevada Water Pollution Control Act authorizes the State Board of Health to promulgate standards for tap and bottled drinking water.

Authority to implement the various programs of the Safe Drinking Water Act has been granted by the EPA to the NDEP Safe Drinking Water Branch. The State Board of Health has promulgated standards for over 100 contaminants in drinking water, consistent with federal standards. NDEP implements permitting programs for public suppliers of tap and bottled water, which include routine sampling and monitoring of public water supplies to demonstrate compliance with drinking water standards. This includes implementation of EPA's more stringent standard for arsenic levels, which has caused compliance challenges for some of Nye County's small public water supply systems. NDEP also implements a permit program for domestic septic systems to ensure underground water supplies are adequately protected. Industrial wastewater treatment systems, and waste and enhanced mineral and hydrocarbon recovery injection wells, are permitted through the NDEP.

The Safe Drinking Water Act's wellhead protection program is implemented by NDEP, in cooperation with the partners of the Nye County Community Source Water Protection Team. Members include Nye County departments, the Water District, State agencies, Towns, utilities, and local water supply systems. In May 2012, Nye County Source Water Protection Team completed the Community Source Water Protection Plan for Public Water Supply Systems in Nye County, Nevada with funding and technical assistance from NDEP. Elements of the wellhead protection

program include delineating the wellhead protection area, identifying potential pollution sources within the wellhead protection area, defining constraints on siting of new wells, contingency planning and emergency response, and defining roles of state and local governments and water purveyors. The 2012 Plan combined and incorporated the numerous community wellhead protections plans developed and implemented between 2004 and 2009. Local governments support and participate in wellhead protection programs.

It is the policy of Nye County to cooperate and comply fully with state and federal regulatory programs of the Safe Drinking Water Act as implemented through the Nevada Water Pollution Control Laws. Nye County encourages business and industry to comply fully with applicable regulations, to ensure that the County's public drinking water supplies are clean and free from contamination.

Endangered Species Act

The purpose of the Endangered Species Act (ESA) is to ensure that any action, administrative or real, does not unduly jeopardize the continued existence of an endangered or threatened species, or cause the destruction or adverse modification of a critical habitat. With respect to the water resources of Nye County, the ESA provides protection not only to threatened or endangered species, but also to the water resources that support the habitat for these, and other sensitive species. There are a number of threatened and endangered bird species, and a fish species that has been relocated to protect it from extinction, as well as sensitive species and species of concern.

The ESA is administered by the USFWS. In Nye County, the USFWS administers permits on private land, and BLM requires implementation of USFWS mandated mitigation measures on public lands through terms and conditions imposed in land use authorizations. In addition to protections afforded by the ESA, the State of Nevada has a number of statutes administrated by the Division of Wildlife that govern the protection of imperiled species. The State has a listing of sensitive plant and wildlife species that have been designated as State-protected species.

It is the policy of Nye County to work cooperatively with federal agencies to comply with the ESA, and all State laws and regulations governing wildlife. Nye County encourages all of its citizens, visitors, and businesses to comply fully with these laws and regulations.

5.2. WATER RESOURCE AND SUPPLY ISSUES

In Chapter 3, a number of key water supply issues were identified. These issues can be grouped as:

Issues related to growth:

- **Managing areas of concentrated pumpage that are contributing to areas of localized water level declines in Pahrump and Amargosa, and related subsidence impacts in Pahrump;**
- **Over-allocation of Pahrump Basin and other basins, and the potential for a future shortfall of groundwater supplies;**
- **Over-allocation and potential over-allocation of groundwater rights in several Nye County basins and potential impacts;**
- **Potential for water exportation from Railroad Valley by the Southern Nevada Water Authority; and**

- **Development of existing parcels in the Pahrump Basin would allow growth, requiring up to three to four times more water than the current perennial yield.**

Issues related to Water Quality:

- **Management of naturally occurring arsenic and fluoride in drinking water supplies in several Nye County communities;**
- **Management of areas with elevated levels of residual nitrates from naturally-occuring sources and historic land uses, and development of measures to protect basin water supplies in areas at risk for elevated nitrates; and**
- **Impairment of quality of groundwater resources on the Nevada National Security Site and the Central Nevada Test Area, and potential for off-site migration of radionuclides, primarily tritium.**

Land Use issues related to Federal Planning Initiatives:

- **Land use restrictions posed by the presence of threatened, endangered and special status species; and**
- **Emerging federal policies to further restrict water use for projects on public lands, and development on private lands.**

Effects of Drought and Climate on Water Supply Issues

Many of the water supply issues identified above are exacerbated by drought and climate-change related phenomena. Drought related impacts are expected to be felt more severely in the northern areas of the County where surface water resources are present. The agricultural operations that rely on surface water appropriations for irrigation will continue to require supplemental supplies from groundwater, resulting in an increased, but unpredictable demand on groundwater resources.

The impacts of drought and climate-related factors, although beyond human control, can be lessened through adoption of various measures and practices. Conservation measures have been adopted by utilities, public water systems, and other entities as required by the NRS, and various measures are in process County-wide as discussed at the end of this Chapter.

5.2.1 Growth-related Water Supply Issues

Pahrump Valley

The Pahrump Artesian Basin, home to Nye County's largest town, faces several water resources challenges now and in the near future. All of the challenges and the adverse effects of leaving them unaddressed, can be summarized as (1) areas of concentrated pumpage of the shallow aquifer as a result of the high density of domestic wells; (2) the over-allocation of water rights in the basin; and (3) approved future development in excess of the perennial yield. These issues are being addressed on several fronts by the Nye County BoCC, the NCWD, and the State Engineer who are all actively involved in addressing the elements of the problem for which they have authority. In this section, the water resource issues facing Pahrump are presented in light of projected growth and water demands developed in Chapter 4 for Nye County.

Most of the growth projected for Nye County over the next half-century is expected to occur in Pahrump Valley. Of the 88,000 County residents projected by the year 2060, about 73,000 are projected to reside in Pahrump. For the purposes of planning, it is assumed that agriculture and

parks will decline to a low of 2,000 acre-feet per year (GWMP, 2015). Using the per capita water demands calculated in Chapter 4, the total water demand in Pahrump by the year 2060 will probably be about 19,500 acre-feet per year for domestic/residential purposes. Assuming development of one new golf course, five hundred acres of public parks, a four-year college facility, continued expansion of the hospitality industry, growth in medical marijuana cultivation, and a new general aviation airport and related commercial development, total water use is projected to be about 22,750 acre-feet per year by the year 2060. While the projected use (Chapter 4) is around 30 percent greater than the reported 2014 usage of 15,550 acre-feet per year, it is only a few thousand acre-feet over the perennial yield. Based upon these estimates, the shortfall projected by the year 2060 may not be as great as previous estimates suggested in WSAI Report and the 2004 WRP.

The effects of groundwater overdraft in Pahrump Valley have already been well documented and include the lowering of static and pumping water levels, reductions or elimination of spring discharges, and subsidence. Between the mid 1940s and late 1960s, groundwater withdrawals from deeper gravel/aquifers in the basin increased from 10,000 acre-feet per year to a peak of 47,100 acre-feet in 1968. During this period, the static groundwater level declined as much as 100 feet in some portions of the basin and the flow of Manse Spring dropped from three cubic feet per second to less than one cubic foot per second. By the mid-1970s, discharge at Manse Springs was seasonal. In 1986, the U.S. Geological Survey published the first study of groundwater depletion in Pahrump Valley and developed a numerical model of the basin (Harrill, 1986). The results of this model indicated that continued pumping of the valley-fill aquifer at a rate of about 42,000 acre-feet per year for 65 years would result in additional water level declines of as much as 30 feet in the central portions of the basin to more than 50 feet along the base of the Pahrump and Manse alluvial fans, the alluvial fans along the western slopes of the Spring Mountains.

Photo 9. Typical domestic wellhead Photo credit: Tom Buqo, 2006

The Pahrump Master Plan Update approved in 2014 reduced the projected maximum population for the Pahrump Valley from over 500,000 people to around 330,000 people, assuming a 100 percent build-out of the approved land parcels and subdivision development agreements, and current zoning. This is between three and four times the population that can be supported by the basin's perennial yield. Thus, the a slow growth rate alone will not resolve a future water supply shortfall that will occur with a 100 percent build-out, unless growth control coupled with water conservation standards are adopted and implemented.

Since 2004, a number of scientific studies have contributed to better understanding of the water resources of the Pahrump basin:

- Development of a Groundwater Flow Model of Pahrump Basin, Nye County, Nevada and Inyo County, Nevada, by Lise Comartin, 2009 The Desert Research Institute;
- Administrative Groundwater Model for Pahrump Basin by Glorieta Geosciences, Inc., 2013;
- Nye County Water District Water Supply Appraisal Investigation Report by Glorieta Geosciences, 2013;
- Assessment of Selected Springs and Wells in the Pahrump Valley and Western Spring Mountains, Nye County, Nevada by Glorieta Geosciences, 2013;
- Hydrologic, Hydrostratigraphic, and Climate Assessment of the Pahrump Basin by J. F. Leising, 2015;
- Modeling Assessment of Pahrump Valley, Nevada by Rybarski, S., S. Rajagopal, G. Pohll, and K. Pohlmann, Desert Research Institute, 2016; and
- Estimated Effects of Water Level Declines in the Pahrump Valley on Water Well Longevity by John Klenke, 2017.

As a result of historic water withdrawals, groundwater levels have declined over a large portion of the valley. The hydrographs in Figure 5-1 show the history of water level declines and rises in Pahrump Valley for the period 1940 through 2015. This figure shows the long-term water level measurements taken by the U.S. Geological Survey at nine wells and supplemental water level data from the Division of Water Resources.

As can be seen from Figure 5-1, there are two basic trends in water levels in the basin, 1) on the fan, declining water levels until about 1980 followed by a rise in water levels over the last two decades, and 2) a general decline in water levels over much of the valley floor during the entire period of development. A reduction in pumping rates since peak withdrawals in 1969 and a number of wet years in the 1980s and 1990s have generally reversed the water level declines along the toe of the alluvial fan in the eastern part of the valley floor. In this area, the groundwater levels have risen by as much as 45 feet from their historic lows in the late 1970s and early 1980s.

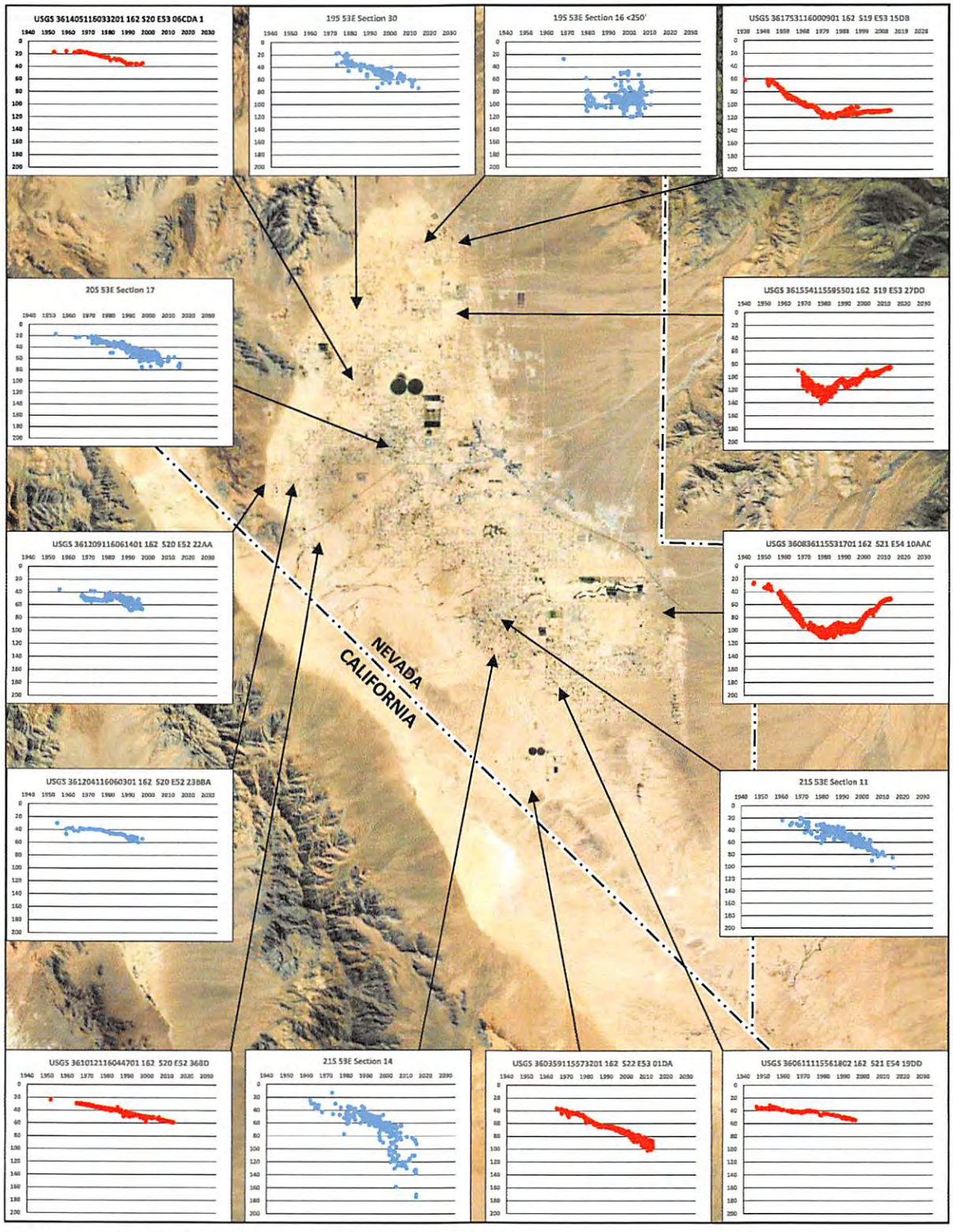


Figure 5-1. Long-term Water Level Trends in Pahrump Valley.

Notes: Charts shown for specific locations for USGS long-term water level monitoring wells (red).
Charts shown for specific sections with high densities of water wells (blue).
Depth to water in feet shown on Y axis on all graphs.
X axis varies depending on period of record.
Y axis varies depending on water level variation.
Data from U.S. Geological Survey and Nevada Division of Water Resources.

Water levels have continued to decline, however, over the central, southern, and western lowland portions of the basin. The proliferation of domestic wells in some sections of the valley has resulted in faster water level declines in the shallow aquifer. Figure 5-2 shows the long-term water level trends in a six square mile area in the southern part of Pahrump where more than 900 wells have been drilled, along with projected water level trends through the year 2030. The majority of withdrawals occurred in the north-central and southern portions of the community. In general, the water levels in this area declined between 40 and 50 feet between 1960 and 2015. These data suggest that future wells will have to be drilled deeper, and thousands of primarily domestic wells will have to be deepened or replaced in some sections of southern Pahrump. Monitoring of water levels in high well density areas of Pahrump should continue to better define the rates of decline.

The Water Level Measurement Program (WLMP), originally established in 1999 to monitor water levels in basins in the vicinity of Yucca Mountain has been overseen by the NCWD since 2014. The WLMP collects water levels across the Pahrump Valley on a regular basis and maintains 17 years of measurements in a water level database. The WLMP program has been reporting water levels, and trends in the water table wells in Pahrump Valley for many years. The areas of water level decline in the Pahrump Valley have been defined using the WLMP water level data (Klenke, 2017).

Klenke (2017) used data and maps from the WLMP to examine the longevity of existing shallow wells, primarily domestic wells, in areas of measured and sustained water table declines. Water level data were used to create maps of the potentiometric surface and the rates of water level change (decline and rise). A total of 116 control points comprising 83 monitored wells and 33 springs were gridded to develop the current potentiometric map, or starting point, which corresponds to water levels normalized to July 7-15-2015 (Figure 5-3), and a map showing the distribution of rate of water level changes, including both declines and rises (Figure 5-4). The study considered the current rates of withdrawal and decline, and did not take into account anticipated increases in future demand. Using an assumption of linear rates of decline, Klenke constructed maps to depict the predicted potentiometric surfaces at 20 years (7-15-2035) and 50 years (7-15-2065) into the future.

Klenke's method produced four types of results 1): a cumulative frequency plot of "failing" wells versus time, 2); predicted potentiometric surfaces, 3); maps showing predicted well "failures" by section at 20 and 50 years in the future, and 4) maps showing predicted depths-to-water.

Four sets of predictions were developed by varying the height above bottom-of-screen, or *well submergence,* which is the distance above the bottom of the well screen where the declining water table elevation would cause the well to fail pumping. The 10-, 20-, 30- and 40- foot distances above the bottom-of-well screen elevation were used to simulate the range of likely well submergences that would exist at well failure. The cumulative frequency plot predicts the number of wells that will "fail" through time based on the distance of the water table above the screens or submergence. Klenke's plot shows predictions as a percentage of the total of 9774 wells used in this analysis (Figure 5-5). The range of submergences used in the 2017 analysis was 10-, 20-, 30-, and 40- feet, with standardized time frames of 20 years (in 2035) and 50 years (in 2065).

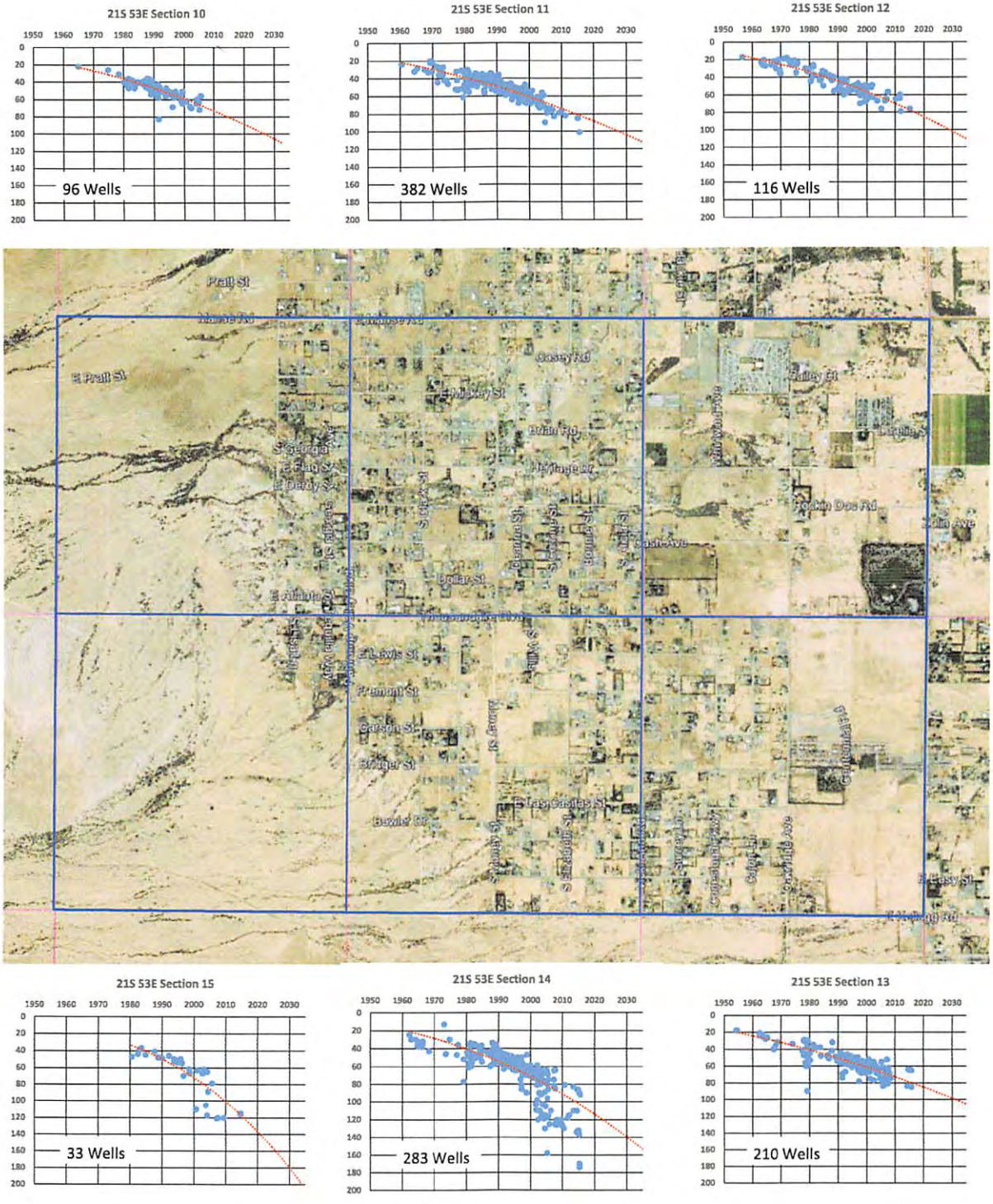


Figure 5-2. Long-term Water Levels for 1,120 Water Wells in six sections in Southern Pahrump.

Notes: Water level data is from the Nevada Division of Water Resources Well Log data base.
Water levels are those reported by the well driller at the time the well was completed.
Neither the Division of Water Resources nor Nye County attest to the validity of the data presented on these charts.
Dashed red lines are power function trendline projections of water level trends.

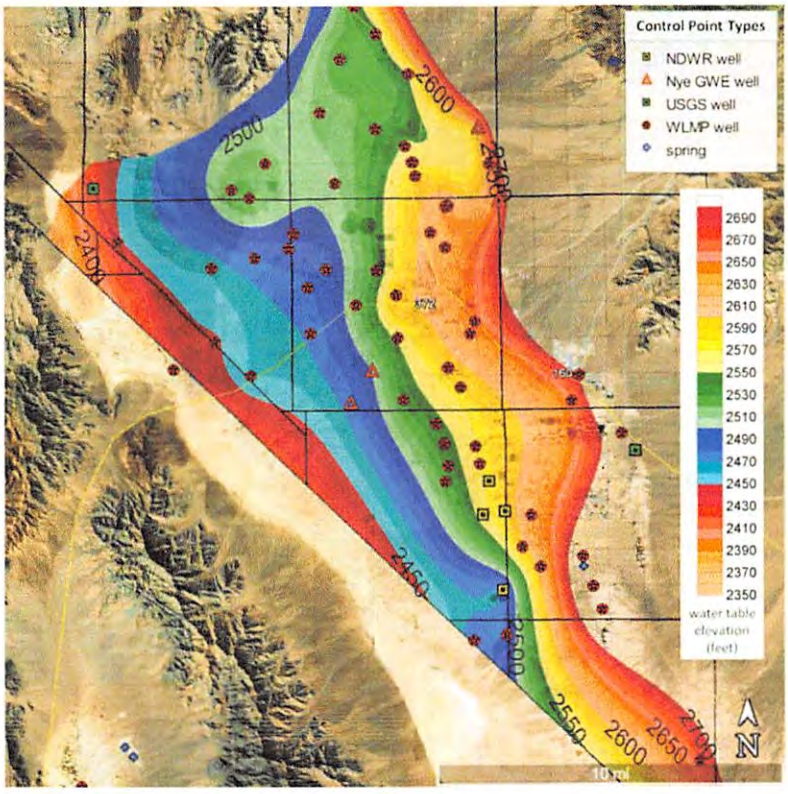


Figure 5-3. Potentiometric map showing water table elevations across the Pahrump Valley for the starting "current" potentiometric surface map (7-15-2015). Control point wells and springs used to create the potentiometric surface are shown. From Klenke 2017.

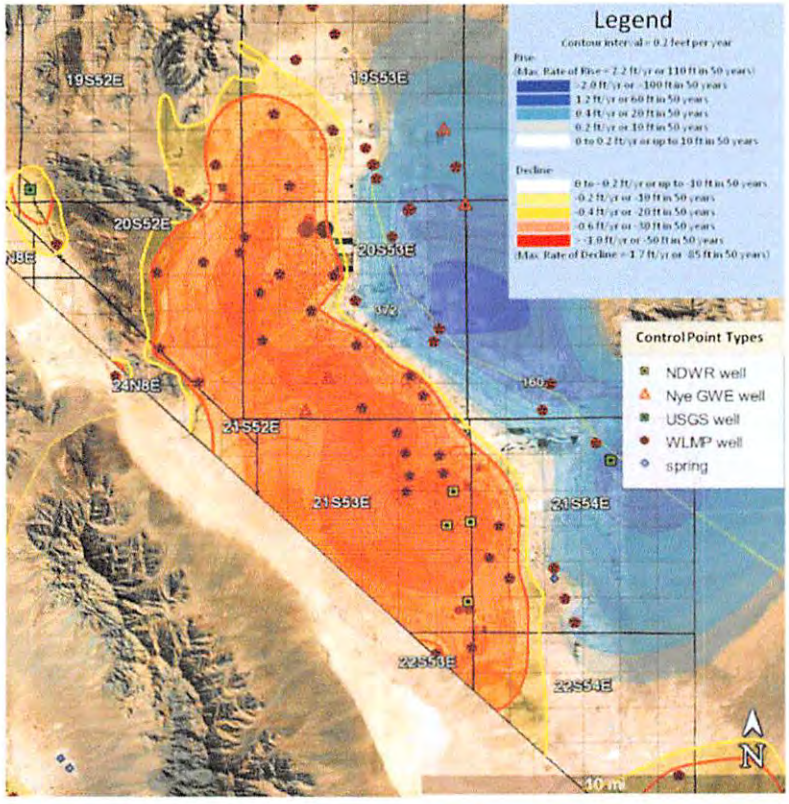


Figure 5-4. Contour map showing the areal distribution of predicted rates of water table elevation change. The area enclosed by the yellow polygon with an average rate of decline of ≥ 0.2 ft/yr is the Area of Appreciable Decline, and bounds the aerial extent analysis. The area enclosed by red polygon with a greater average rate of decline of ≥ 0.5 ft/yr is the Area of Rapid Decline. From Klenke, 2017.

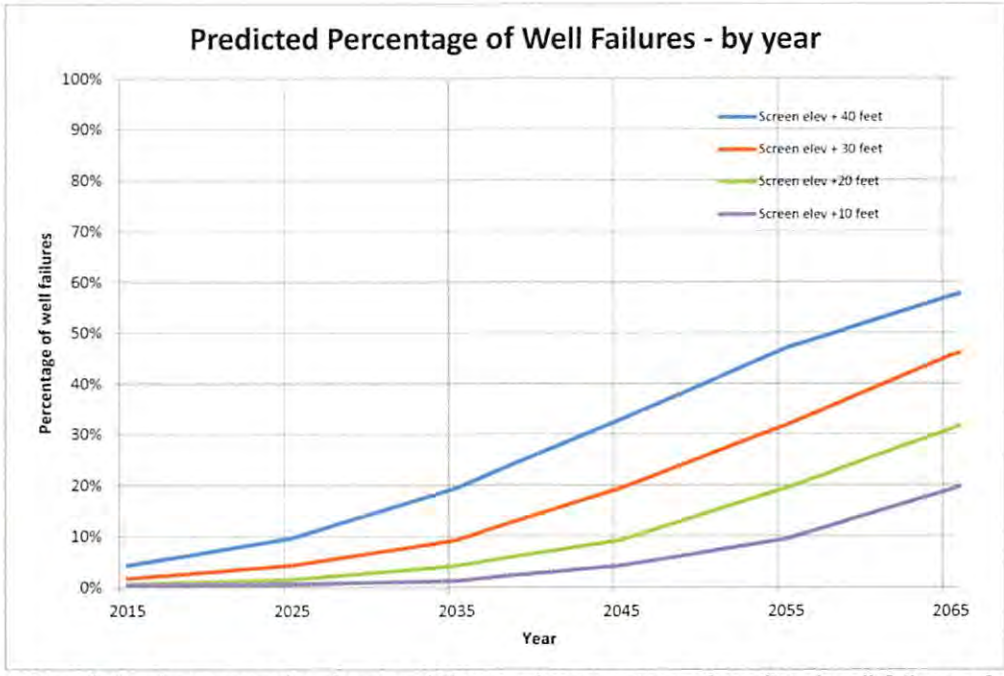


Figure 5-5. Cumulative frequency plot showing difference in percentage of predicted well failures of the 9,774 wells within the Area of Appreciable Decline over the next 50 years based on well submergence. The colored lines represent the four submergences of 10-, 20-, 30- and 40-feet above the bottom of well screen elevation considered.

The data and simulations were used to create maps showing the number of wells predicted to "fail" in each section at the 20-year and 50-year time projection. Figures 5-6 and 5-7 are Klenke's (2017) maps of number of "failed" wells by section. The study predicted that 438 wells will "fail" by 2035, with the number of failed wells estimated to reach 3,085 by 2065.

The future consequences of continued localized over-pumpage of the shallow valley-fill aquifer will probably include increased pumping and well drilling costs as water levels in wells decline, and water quality degradation as minerals are concentrated. Perhaps, most importantly, subsidence of the land surface through the compaction of dewatered sediments will continue to occur. Harrill (1986) estimated that more than two feet of subsidence occurred between 1962 and 1975 over an area of about eight square miles, and more than one foot of subsidence had occurred over an area of more than 40 square miles. Continued pumping of the shallow aquifer by domestic wells continues to cause subsidence over areas of the valley. Problems associated with similar subsidence in the Las Vegas Valley and elsewhere have included damage to building foundations and slabs, fissuring, shearing of well casings, and extensive damage to roadbeds, and are discussed in the following section.

Population forecasts for Pahrump based on the 2014 Master Plan suggest that the demand for water will increase as the buildout of up to 8,500 parcels and over 19,000 approved subdivision lots occurs. If left unchecked, the currently observed rates of annual water level decline over a broad area of the basin, with time and increased pumping can be expected to accelerate. The Basin 162 Groundwater Management Plan details the issues and outlines a range of possible actions that could be taken to address over-allocation and help to bring the basin back into balance.

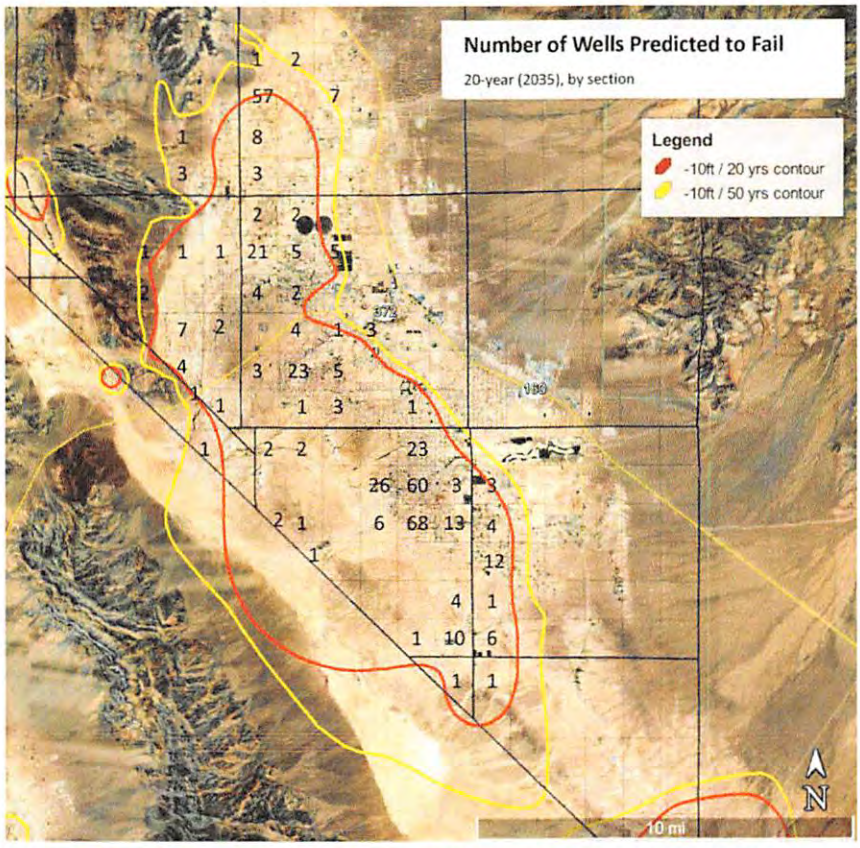


Figure 5-6. Locations of the 438 wells predicted to "fail" by 2035 using the 20 foot submergence alternative. The 10-foot decline contour for 20 years is shown in red, and for 50 years in yellow.

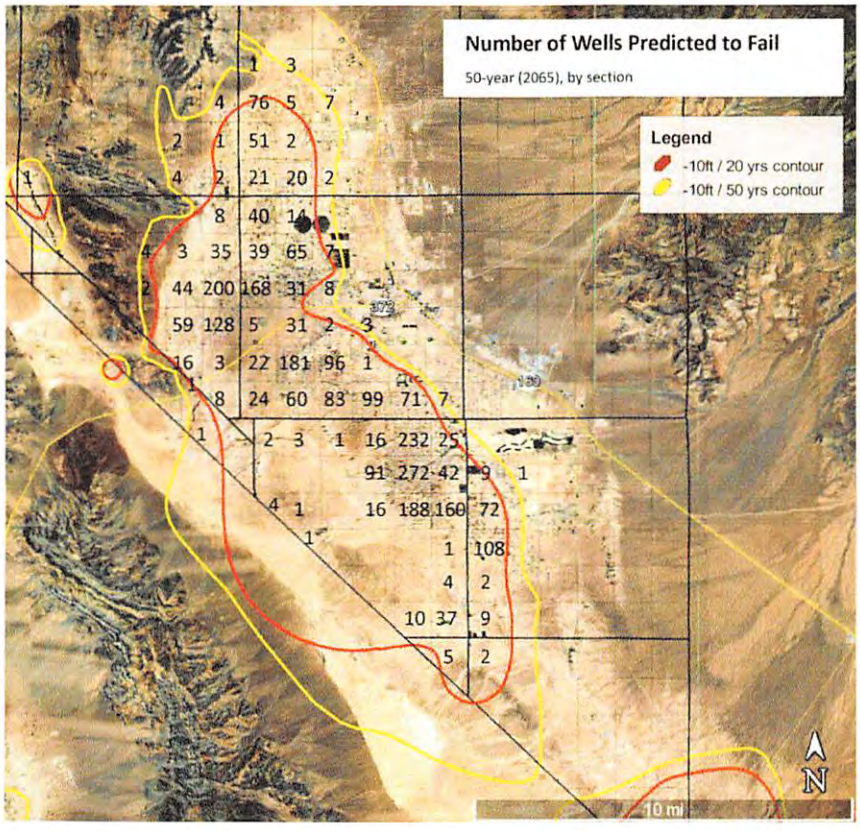


Figure 5-7. Locations of the 3,085 wells predicted to "fail" by 2065 using the 20 foot submergence alternative. The 10-foot decline contour for 20 years is shown in red, and for 50 years in yellow.

Subsidence

Land subsidence, fissuring and sink holes have been documented in the Pahrump Valley. The USGS found that aquifer-system compaction, hydro-compaction, and natural compaction are among the principal causes of subsidence (http://water.usgs.gov/ogw/pubs/fs00165/). Several studies have been undertaken by Nye County and others to investigate the cause or causes of subsidence in the valley, and to establish measures to mitigate the associated hazards. These measures include enacting codes to require adequate geotechnical characterization to ensure that construction in susceptible areas addresses and mitigates any geotechnical hazards.

Utley (2004) used satellite based radar imagery to evaluate subsidence in Pahrump Valley. By comparing radar images taken months or years apart, it is possible to identify areas where subsidence or uplift is active. Subsidence fringes were identified around a "bowl" in southern Pahrump. Subsidence features occur on the fringes of the bowl.

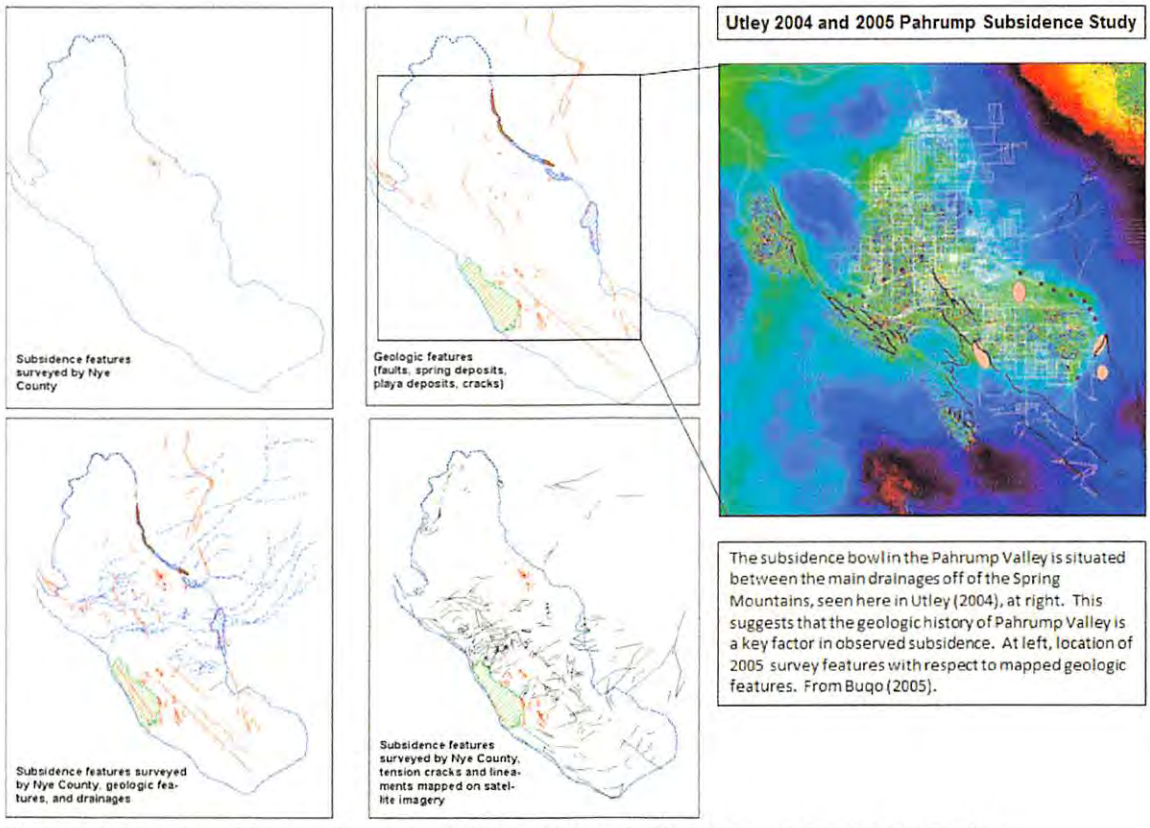
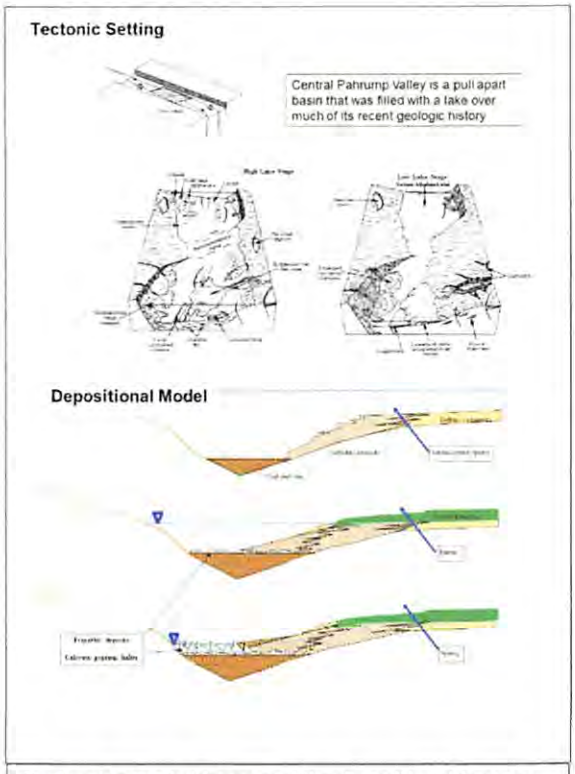


Figure 5-8 Overview of findings from Utley's 2004 and Buqo's 2005 Pahrump Subsidence Studies.

Nye County has conducted two subsidence studies. The first study conducted in 2005 by Buqo, County staff, and contractors (Buqo, 2005a) sought to better define the extent and nature of subsidence in Pahrump. The second study, done by Klenke and Howard (2013), expanded the areas of known subsidence in the Pahrump Valley through field reconnaissance. The study team surveyed the locations of subsidence features; evaluated available geologic information; evaluated water level information and water level declines; and considered possible causes of and factors

contributing to subsidence. Possible contributing factors considered included: Water table decline, hydro-collapsible soils, drainage, poor compaction, tectonic and geologic setting.



Regional tectonic history and the depositional features of the Pahrump Valley are factors that contribute to and help to explain the locations of observed subsidence features. From Buqo (2005).

Figure 5-9: Tectonic and depositional influences on observed subsidence areas.

Both tectonic setting and geologic history of the Pahrump Valley are likely contributing factors to locations of subsidence. Located in a pull-apart basin, the valley was filled with a lake during much of its recent geologic history. These resulting lacustrine deposits included clays, muds, and evaporite deposits. The USGS has found in aquifer systems that include semi-consolidated silt and clay layers (aquitards) of sufficient aggregate thickness, long-term ground-water-level declines can result in a vast one-time release of "water of compaction" from compacting aquitards, which manifests itself as land subsidence. Groundwater declines can trigger other mechanisms that also contribute to subsidence including dissolution of certain lacustrine deposits, e.g., evaporites, which can result in dissolution, vertical fracture and increased surface water infiltration. These mechanisms can lead to piping, potholes, sinkholes, and other observed subsidence features.

Buqo (2005a) noted that soil types should be a significant contributing factor in the occurrence of subsidence. The 2013 study found evidence of subsidence in several soil types (Nopah Loam, Haymont very fine sandy loam, Besherm clay loam); these soils comprise most of the soil types that occur in the Pahrump Valley, and some of the features identified as sinkholes and fissures, may in fact reflect localized soil properties (e.g., hydro-collapsible) rather than subsidence.

Field surveying with a research grade GPS was conducted in April and May 2005 in areas with known damage. Soil types were verified and features were photographed and classified. More than 200 features were mapped, including sinkholes up to 35 ft diameter. The study reviewed published geologic and soils maps, and literature on subsidence, collapsible soils, and the geology of Pahrump.

In evaluating the data, the authors classified geologic units, considered areas of water level decline, and other factors that could contribute to observed subsidence. Based on these assessments, they evaluated models for subsidence and delineated subsidence zones. They found that while subsidence occurs in areas underlain by one of three water-sensitive geologic units, the geologic

units are more widely distributed than the observed subsidence features. The observed extent of subsidence is more limited, suggesting other factors in addition to soil type are present.

Water table decline in areas of heavy withdrawals is thought to be a significant factor contributing to subsidence. On some areas of the valley floor, water levels have declined 40 ft to 60 ft since the early 1950s. Although the water table has dropped over a large area in the valley, observed subsidence has occurred in limited areas within the area of water-level decline. If water table decline was the only factor, then subsidence features would be observed only in the areas of water level decline and would likely be more distributed within that area.

MAPPED GEOLOGIC DEPOSITS		SUBSIDENCE SIGNIFICANCE
Qbg eolian and alluvial silt and mud		Direct evidence of subsidence includes fissuring, and potholes. Thin-bedded to massive with no soil development
Qbf sandy silt, clayey silt, and clay		Extensive areas of subsidence and damaged structures. Irrigation/ponded water can result in severe fissuring and piping and, in some cases, catastrophic collapse
Qbe Unit F sandy silt, clayey silt, and clay		Direct evidence not observed but soils are collapsible. As water table declined, evaporites were dewatered. Subsequent dissolution by recharge may cause collapse.

Mapped geologic deposits and the significance of observed subsidence and soil collapse features observed during 2005 Nye County Subsidence Field Study. From Buqo (2005a).

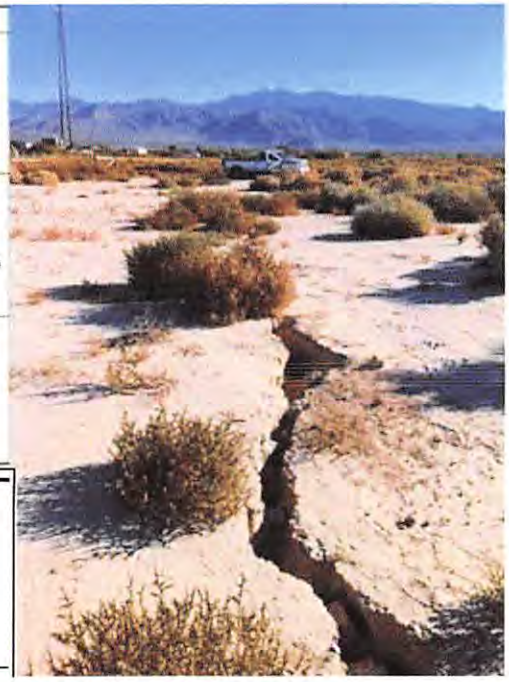


Figure 5-10: Classification of mapped geologic deposits and subsidence features from 2005 Nye County Study (Buqo, 2005a).

The 2013 Nye County reconnaissance study conducted by Klenke and Howard in 2013 (Klenke, 2016a) expanded the known areas of subsidence to the central and western portions of the Pahrump Valley. Subsidence related features were photo-documented and catalogued. Figure 5-11 shows the distribution of features that cluster in both central Pahrump Valley near Nevada Highway 372 and Red Rock Drive, and in the northwestern part of the valley. The 2013 Nye County study did not find as extensive fissuring and sinkholes as were observed in the area of earlier 2005 study. This may be due in part to the vehicle-based reconnaissance survey methods used in the 2013 study, but is more likely a result of some areas oberved in the 2005 study area being subsequently regraded.

The 2013 study found an open fissure just to the south of Homestead and Dandelion that was not identified in the 2005 study. Since it is unlikely that the 2005 survey, which focused on the area immediately to the north, would have missed a feature this large – an approximately 100' long fissure – it is probable this particular subsidence feature has been expanding over time. Additional

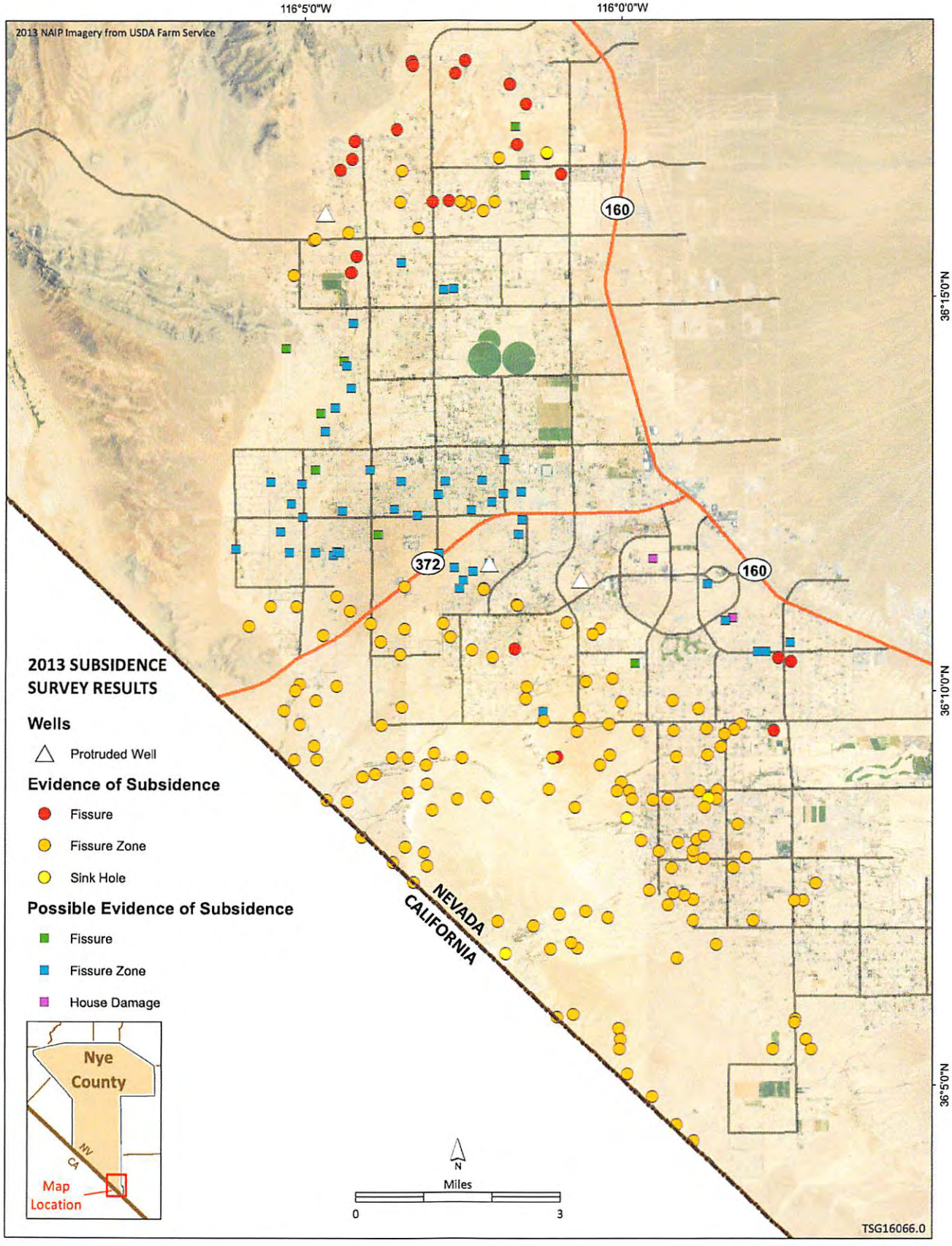


Figure 5-11. Evidence of subsidence from a field reconnaissance survey conducted in 2013 by the Nye County.

features were identified in areas of known Cenozoic faulting, such as edges of mesas, washes containing mesquite bosques, and edges of the valley where alluvium is juxtaposed against bedrock, as it is in the extreme west and northwest. This suggests either reactivation of faulting, or propagation of surface fissures along zones of weakness associated with Cenozoic faults that were not actually reactivated, are also contributing to observed subsidence-like features.

Comparing the locations of features to the 11-year water level change map indicates the southern fissure is an area of declining water levels, while the main area of interest in the 2005 study at Homestead and Dandelion is now in an area of rising water levels. This suggests that the subsidence in the Homestead and Dandelion area, if due solely to water declines, should no longer be active. A high elevation view of the Pahrump Valley showing the location of all subsidence features and the 11-year (2004 to 2005) Water Level change map shows that nearly all subsidence features occur within areas of water level decline (Klenke, 2016a).

Aquifer compaction due to groundwater withdrawals is probably the main cause of subsidence in the Pahrump Valley (Klenke, 2016a). Other factors, including vulnerable soil types that are the result of geologic history and extensional tectonic features have created an environment that is susceptible to impact by man's activities, as well as natural hydrologic processes. Thus, there are several factors including past and future irrigation practices, vertical changes in soil properties, and water level declines within the soil column that may contribute to subsidence and collapse in the Pahrump Valley.

All locations surveyed in the 2013 Field Study were recorded using a handheld GPS to ensure that revisiting and reevaluating these features could be easily accomplished in future studies. In future studies, satellite imagery could be used to better define subsidence. Update of the Utley report could be accomplished using InSAR imagery and resurveying the high-accuracy GPS locations. Previously established GPS network control points could be reoccupied and used to better define susceptible areas. The information would have other applications as well including providing refinements to Nye County flood control plans.

In 2005, Nye County completed its review and evaluation of subsidence problems, and reviewed proposals for various mitigating measures. By decision of, and at the direction of the BoCC, the Public Works Department developed a County Ordinance to require geotechnical testing of soils as part of the building permit process. County staff held workshops with the affected community including home-owners, realtors, developers, builders, and engineers. The BoCC passed County Ordinance in 2006 to require soil testing and characterization to protect the community from the risks posed by subsidence-related geotechnical hazards.

Pahrump Basin 162 Groundwater Management Plan

In 2011 the Nevada State Legislature passed into law Assembly Bill 419. Part of AB 419 discusses the submittal and approval (by the State Engineer) of a GWMP. Components of the plan are tailored to present and future conditions for a basin's unique physical character and demographic attributes such as available water supply versus present and future demands existing population and growth potential, physical geologic and lithologic conditions, land available for development, types of uses, permitted water rights, domestic well density, production well locations, water utility availability, economic factors and other conditions. Components of a GWMP include a variety of

actions and/or state and local regulations to force groundwater withdrawals to balance with the available groundwater supply.

To address the issue of over appropriation the Nye County Board of Commissioners, in concert with the Division of Water Resources, formed an advisory committee in January 2014 to make recommendations for a GWMP. The committee met from January 2014 to September 2015 to discuss the over-allocation of the basin, held public meetings and workshops, considered options, collected information and recommended many elements and actions to be included in the GWMP pursuant to AB419. The State Engineer and/or his staff attended most of the meetings and workshops to advise the GWMP Committee and Water District staff of the tools that are available under existing Nevada water law. DWR staff remains involved in the effort to assist in drafting a final GWMP for the community of Pahrump and the larger Hydrographic Basin 162. After much consideration, discussion, and debate, the committee identified the following items which form the foundation for a GWMP.

- Aggressive water education;
- Adopt a water conservation plan;
- Water importation;
- Require meters on new domestic wells;
- Limit new domestic well entitlements to 0.5 AFA;
- Educate domestic well owners regarding the option to supplement their water usage with permitted water rights;
- Construct rapid infiltration basins (RIB) and/or recharge basins;
- Aquifer Storage and Recovery;
- Allow utilities to put in backbone infrastructure with Public Utilities Commission approval to reach more lots;
- Create incentives to voluntarily connect to public water systems;
- Conservation Credit Program for water rights;
- Investigate existing and future development agreements and implement changes with the goal to require water mitigation; and
- Growth Control.

In addition to preparing the GWMP, Nye County and the NCWD have completed a number of measures to address the water supply shortfalls and over-allocation in the Pahrump Basin including:

- Master planning to include water efficient development standards;
- A mandated program of water rights dedication, over dedication and relinquishment;
- Geologic mapping of portions of Pahrump Valley;
- Geophysical surveys of the basin including gravity and low-altitude aeromagnetic surveys;
- Development of a water level baseline beginning in 1999;
- Study to evaluate cost and feasibility water importation to Pahrump Valley;
- Coordination with the Division of Water Planning and Division of Water Resources; and
- Development of the Basin 162 Groundwater Management Plan and implementation of selected recommendations.

Basin over-allocation and the potential future shortfall of groundwater supplies

The Pahrump Hydrographic Basin is one of the most over-allocated basins in Nevada, and has the highest density of domestic wells of any basin in the State. Total permitted water appropriations currently exceed 60,000 acre-feet, and under current water law estimated entitlement could be as high as 17,000 acre-feet per year. However, the State Engineer's estimated domestic well use of 0.5 acre-feet per year could result in the withdrawal of an additional 4,250 acre-feet with no future parceling. Based on available information from the Planning Department it is estimated that currently approved Development Agreements in the Pahrump Valley could accommodate up to an estimated additional 66,000 people, at full buildout. Using the 1.5 percent annual growth rate from Chapter 4, Pahrump will achieve that population by about 2050. At that point, groundwater withdrawals from the basin will consistently exceed the perennial yield.

In order to address such basin issues the NRS 534.120 authorizes the State Engineer to make rules, regulations and orders when groundwater is being depleted in designated area; including placing restrictions on certain wells. To implement this part, subsections of NRS 534.120 allow the State Engineer to require the dedication of any type of appropriative water right to a city, county, or their designee or, the relinquishment of such water rights directly to the State Engineer for any newly created parcel proposed to be served by a domestic well to ensure a sufficient supply of water for each new parcel. Water rights offered for relinquishment must be valid and in good standing. Once relinquished, the water right returns to the basin (the source), the status of the water right is changed by the State Engineer to *RELINQUISHED*, and compliance with permit milestones – also known as permit maintenance – is no longer required.

Both dedication and relinquishment ensure that appropriated water rights will be available for the newly created parcels to account for the domestic and residential use that will occur. Unlike relinquishment, however, managing a dedicated water right does not relieve the holder of permit maintenance, which can become time consuming and costly as the number of dedicated rights increases. For this reason, the Nye County Water District Governing Board recommended that Nye County relinquish its dedicated water rights to the State Engineer, and require that future dedicated water rights to be relinquished directly to DWR. Thus, Nye County no longer maintains dedicated water rights but instead requires water rights in support of new parcels that will be served by domestic wells to be relinquished directly to the State Engineer. These relinquished water rights are said to revert "back to the basin" to be managed by the State Engineer. The status of the right is changed to Relinquished, and the Manner of Use to Domestic. The annual duty of the relinquished right is deducted from total allocation of its prior manner of use category (Irrigation, Commercial, etc.), and it remains "on the books" for future domestic use and accounted in the basin's total appropriations.

The water rights dedication and relinquishment requirements to support future domestic use on newly created parcels in the Pahrump Valley are found at Nye County Code 16.28.170: Parcel Map Procedure. Additional measures approved by the Nye County Water District Governing Board on July 27, 2015 members would require new commercial or industrial projects to submit conservation and landscaping plans, and water rights mitigation plan. The NCWD asked that staff review codes, policies and procedures and bring recommendations for possible adoption to provide the best management practices, stewardship, protection and conservation of the Pahrump Basin.

Pursuant to NRS 534.120, when land to be parceled and served by domestic wells is within a Water Service District's service area and it is the intent of the service district to provide water service, Nye County Code identifies the Water Service District as the entity to receive dedicated water rights. Water rights are transferred to a service district or utility in an amount determined by the district or utility. The quantities of water required by utilities for dedication have been established by the State Engineer.

The quantity of water rights to be transferred for new lots or parcels created in a Utility's service area is currently based on the following Dedication Requirements; lots and parcels that can demonstrate compliance with a Water System District's Conservation Plan (i.e., water use restrictions implemented) may be eligible to receive an incentive, as demonstrated below:

Lot Size	Dedication Requirement
All lots without water use restrictions	1.12 acre-feet annually
Greater than 11,200 square feet	1.12 acre-feet annually
6,800 to 11,200 square feet	(square feet/10,000) acre-feet annually
Less than 6,800 square feet	0.68 acre-feet annually

When land is being subdivided for other than single family residential use, sufficient water rights are determined in accordance with NAC specified allowances, which are based on the numbers and types of fixtures to be constructed.

To date, the dedicated water rights associated with parcels in utility service areas remain under active permits, require permit maintenance, and are not relinquished to the State Engineer. While these rights are dedicated for use on the residential lots they are intended to serve, the long timelines associated with development and proof of beneficial use make difficult to account and allocate the water use on residential subdivision lots served by utilities and public water supply systems. This makes basin accounting problematic as it is not possible to quantify water use on a lot or parcel without proof of beneficial use because neither the quantity in beneficial use, nor the unused or excess water that returns to the source, can be determined. In 2016, the Nye County Water District Governing Board requested that the State Engineer disallow changes to the place of use of any previously, currently, or future excess dedicated water rights to ensure that they are not moved to support new development. The State Engineer is considering issuance of an Order to address this request.

County ordinances require more water be dedicated for a parcel than is expected to be used. Nevada Water Law entitles domestic wells to withdraw up to 2 acre-feet of groundwater per year, however, estimates by the State Engineer based on satellite and aerial imagery analysis, and data from metering, strongly suggest that domestic wells in Pahrump use an average of 0.5 acre-feet per year. The current dedication rate of 3 acre-feet per parcel can be said to "over-dedicate water" over both the maximum entitlement amount of 2 AFY, and the estimated usage of 0.5 AFY. The relinquished water rights that are excess of the actual usage will never be used beneficially and in fact return to the basin. Until recently, there were no reliable estimates of the total quantity of water rights dedicated to account for future domestic and residential use. The Nye County Water District undertook a review to resolve the quantity of dedicated water rights and to established an

accurate accounting of the number of parcels, and the dedicated and over-dedicated water rights recorded in the Pahrump Basin. The Water District Study used estimated usage rates of 0.324 AFY for single family dwelling served by water supply systems, and 0.5 AFY for domestic wells. Subtracting the total estimated parcel/lot usage from the total dedicated rights produced an "excess dedication amount." The preliminary value of the "excess dedicated amount" was determined to be 11,484 AFY, or nearly 11,500 AFY of water rights "on the books" that will not be beneficially used.

Table 5-2, below is Table 3 from the GWMP that will be adjusted to reflect the quantities of dedicated and excess dedicated water rights. Water District Studies are also underway to quantify the recharge and return flow credits that could potentially be available from irrigation return flow, rapid infiltration basins, and septic systems during the 50-year planning period.

Table 5-2: Adjustment of over allocation by crediting reuse, recharge and over dedication of water rights.

PAHRUMP HYDROGRAPHIC BASIN	
PERENNIAL YIELD	20,000 AF
OVER ALLOCATION	50,166 AFY
REUSE CREDIT POTENTIAL	TBD AFY
RECHARGE CREDIT POTENTIAL	TBD AFY
OVER DEDICATION POTENTIAL – SUBDIVISIONS	TBD AFY
OVER DEDICATION POTENTIAL – DOMESTIC WELLS	TBD AFY
*ADJUSTED OVER ALLOCATION	TBD AFY
*Adjusted over allocation: 1.) Credits reuse and recharge water as usable water. 2.) Significantly reduces the over allocation total by accounting for over dedicated water rights (existing + future should be included). 3.) 1 and 2 combined would be subtracted from the 50,166 over allocation figure.	

From the Pahrump Basin 162 Groundwater Management Plan STAGE ONE Version Oct. 16, 2015.

These numbers will help to guide future water management decisions and will be a measure of the success of these mitigative actions.

These measures enacted by Nye County through BoCC-approved Area Plans and Land Division Ordinances are expected to help reduce the over-allocation of water rights in Pahrump and Amargosa Valleys. The measures, once implemented, reduce existing water rights allocated for irrigation and other uses by dedicating those rights for future residential use. Such measures may be considered in other Nye County basins that are over-allocated. Following a recently passed resolution by the Nye County Water District Governing Board, new planning ordinances are being considered that could require relinquishment of commercial or other water rights in an amount equal to or greater than amounts proposed to be placed into beneficial use as condition of planning approval.

Regardless of whether a dedicated water right is through a utility or relinquished to the State Engineer, the priority date runs with the water right. This means that a water right dedicated for

domestic use at a given parcel retains the priority date of the original dedicated right, and is not dependent upon when the owner actually drills the well and proves beneficial use. Thus, in areas where designations as Critical Management Areas fail to resolve over-pumpage problems, adjudications based on priority date will favor users whose domestic wells have dedicated rights with the most senior priority dates.

Currently the only Nye County basins requiring water rights dedication and relinquishment are Pahrump Valley and the Amargosa Desert Basin. Although several other Nye County basins are over-appropriated, the State Engineer has not required nor supported enactment of proposed Nye County ordinances for the dedication or relinquishment of water rights in those basins. Thus, Nye County codes requiring water rights dedication or relinquishment apply only in Amargosa Valley and Pahrump.

Circumstances could evolve in the Amargosa Desert basin, which is slightly over-allocated at 26,000 acre-feet versus a perennial yield of 24,000 acre-feet, which would result in a slight over-pumping of the basin. Pumpage in the basin is at nearly 18,000 acre-feet per year, including about 500 domestic wells, and there are a number of private parcels available for future additional build-out. Measures to mitigate the over-allocation have already been implemented. The quantity of water rights required to be relinquished to the State Engineer to account for future water use associated newly created parcels and lots in Amargosa Valley is currently 2 acre-feet per parcel (Nye County Code 16.20.190 Development Standards). The State Engineer Water Rights Database (June 30, 2016) on the DWR website shows 4.04 acre-feet of water rights in Amargosa Valley relinquished in support of new parcel maps. To date, there are no utilities offering water service in the Amargosa Valley.

Water Exportation and Multi-County Management Issues – The potential exportation of water from Nye County to serve the ever increasing demand for water in the urban areas of Clark County remains an issue with regard to water supply allocation. As a result in 1989, water filings by the Las Vegas Valley Water District (now SNWA), for about 95,000 acre-feet of water rights in Railroad Valley (both North and South hydrographic basins) remain ready for protest. The applications were filed to develop groundwater in rural areas of Nevada and convey the water to metropolitan Las Vegas. The applications in Hot Creek Valley were subsequently dropped, but the SNWA's applications for Garden and Coal Valleys, in basins shared with White Pine and Lincoln counties remain.

The water right filings raised strong concerns regarding the impact of the proposed water withdrawals on the quality of life, economies, and ecosystems of the targeted basins. The SNWA applications were protested by more than 1,000 individuals and entities, including Nye County, which expended considerable time and funds reacting to the filings. SNWA and the affected counties agreed to work cooperatively to address specific issues related to the applications.

In addition to applications by other entities to export water from Nye County basins, many of the basins in Nye County are shared with other counties, and some are shared with California. Basins that lie in multiple jurisdictions can complicate water planning efforts. For example, DWR data for many of Nye County's shared basins (Chapter 3, Table 3-8) show pending applications in several basins that, if approved, will result in over-allocation. The CNRWA continues to support Nye as well

as other counties efforts in formulating legal positions and policies needed to address these issues in the shared basins of the Central Hydrographic Region.

5.2.2 Water Quality and Environmental Issues

In Chapter 3, a number of key water quality related issues were identified.

- Naturally occurring arsenic and fluoride in groundwater in several Nye County Communities
- Elevated concentrations of nitrates in Pahrump Valley from historical practices and natural sources; nitrate management restrictions, and potential for future contamination from septic systems
- Contamination of groundwater resources beneath the Nevada National Security Site, and potential for migration of contaminants off of the Nevada National Security Site

Naturally Occurring Arsenic and Fluoride

The geology in many parts of Nye County that has provided a wealth of mineral resources has also set the stage for naturally-occurring groundwater contamination. Groundwater in aquifers associated with volcanic and evaporite deposits have elevated concentrations of naturally occurring arsenic and fluoride in the central and northern parts of Nye County. Since these aquifers may also be used to supply drinking water wells, the potential for contamination of drinking water is an important concern. The WSAI Report (GGI, 2013a) investigated the naturally occurring ground water contaminants arsenic and fluoride for each community water system in Nye County; other naturally occurring contaminants such as uranium and radon, which are not well characterized in Nye County, were also briefly addressed.

Arsenic levels in groundwater have been problematic for water systems throughout Nye County. Beatty Water and Sanitation District, Manhattan Town Water, Tonopah Public Utilities, Carvers Smokey Valley RV & MHP, Shoshone Estates Water Company, and other community systems have undertaken engineering studies and/or completed system improvements to bring community water supplies into compliance with the deadlines of the revised arsenic standard. Of these, the Beatty Water and Sanitation District and Carvers Smokey Valley RV & MHP installed arsenic treatment systems in 2010 and since then have had no exceedances of the arsenic standard. Manhattan Town Water installed a new well in 2010 with an arsenic concentration below the standard, and the old well is designated as an emergency backup. Tonopah Public Utilities has sited and drilled two new production wells that have acceptable arsenic concentrations below the standard. The Shoshone Estates Water Company in Round Mountain has completed Preliminary Engineering Review (PER) to identify a treatment strategy. The PER concluded the best approach would be the installation of point-of-use treatment, however, these recommendations have not yet been implemented, and the system is not yet in compliance. The status of the water system is further discussed in Chapter 6.

Fluoride concentrations in Gabbs' prior water well were above the standard, but a new well completed in 2011 has a lower, acceptable concentration. Beatty blends water from different wells to keep the fluoride concentration below the drinking water standard (GGI, 2013a). No other fluoride issues have been identified.

While the maximum concentrations of naturally-occurring contaminants are regulated by the NDEP for water delivered through public supply systems, these concentrations in domestic, irrigation, and

industrial supply wells are usually unregulated. The basin with the highest concentration of domestic wells, Pahrump Valley, is not affected by the presence of naturally-occurring arsenic and fluoride.

Elevated Nitrates in the Pahrump Valley

Nitrates (NO3) are an essential source of nitrogen (N) for plants. Nitrogen occurs naturally in soils, rainfall, and desert deposits, or it can be introduced into the environment by the use of nitrogen and ammonium fertilizers, the decomposition of plants and animal wastes, and disposal of human waste from septic systems and water wastewater treatment facilities. All of these sources can contribute to nitrate contamination of ground water.

The water supplies for Pahrump Valley are derived from a single source, the valley-fill aquifer. The valley-fill aquifer comprises a thick sequence of gravels, sands, and clays, and may have volcanic units and/or evaporate deposits at depth. The ability of these different materials within the aquifer to transmit water varies widely. Underlying the valley-fill aquifer (and cropping out in the mountains on either side of the basin) are rocks of Paleozoic age that include multiple carbonate aquifers. Under natural (pre-development) conditions there was also appreciable discharge within Pahrump Valley to numerous springs and wetland areas. Today, many of the springs are dry and the wetlands are almost entirely gone.

Both aquifers receive their recharge from precipitation that falls within the basin boundaries; the deep infiltration occurs in the mountain ranges that bound the margins of the valley, with the vast majority of this recharge derived from the on the east side of the valley from the Spring Mountains. The percolating water flows down through bedrock fractures and eventually moves into the valley-fill deposits. From there the groundwater moves through the paths of least resistance and flows predominantly southwestward under the valley. The final discharge point of this water is not known with certainty but hydraulic gradients exist toward both the Ash Meadows region of the Amargosa Desert and a discharge area in the vicinity of Tecopa, California (Buqo 2004).

The other source of recharge is derived from the infiltration of water used for irrigation and domestic purposes. This influx of water is referred to as secondary recharge and is a primary concern from the water quality point of view. The infiltration from the irrigation of farmland, parks, baseball fields, and even lawns can result in groundwater contamination with fertilizers, herbicides, and pesticides. The infiltration of septage effluents from domestic septic systems can also be a source of groundwater contamination.

There are presently more than 11,000 domestic water wells located in Pahrump Valley and most of the lots with domestic wells also have domestic septic systems. About 33 square miles in the lowland portions of the basin have septic system densities of more than 100 per square mile. Commercial establishments, which have larger septic systems, already include nitrate treatments, as required by the NDEP nitrogen restriction.

In addition to these existing septic systems, there is the potential for a great number of new domestic septic systems in the basin as the community of Pahrump continues to grow. Given the number of existing lots, there could be an additional 8,000 or more individual septic systems in the Pahrump Valley by the year 2060. While the larger subdivisions use package treatment works or

other engineered treatment, the high number of domestic septic systems, poses a significant potential for groundwater contamination that must be addressed and monitored.

In Pahrump, various studies have been conducted over the years to characterize the distribution of nitrates and establish the source or sources of elevated nitrates. Klenke (2016b) summarized and presented the data collected by these studies. His compilation shows that the aerial distribution of high nitrate concentrations across the Valley is still not well defined. While data collected to date suggest the areas of high concentrations are very localized, a consistent and systematic approach to defining the boundaries of these areas has yet to be undertaken. Figure 5-12 is a preliminary nitrate distribution map compiled from historical studies (Klenke, 2016b), which are summarized in this section.

Groundwater sampling in the early 1970's established the presence of excessive and elevated nitrates and broadly identified the areas of elevated nitrate concentrations. Historic nitrate values from 1964 through 2003 were reported sporadically by DOE in environmental baseline studies conducted by the nuclear testing and nuclear waste programs. DOE's sampling found two isolated occurrences of high nitrates in water supplies in rural parts of the valley, associated with livestock and wildlife watering areas. In 2005, Buqo reviewed several sources of nitrate data including historic nitrate levels from water quality analyses conducted by the Nevada Division of Health State Laboratory, results of the Southern Nye County Conservation District 2005 study, and water quality characterization for the Artesia Sewage Treatment facility, Buqo (2005b). Various nitrate analyses were also included in studies conducted from 2010 through 2015 by the Nye County Water District, the Nye County NWRPO and Glorieta Geosciences, Inc. The USGS studies provided data on a number of groundwater contaminants from wells of opportunity.

The earliest known nitrate investigation in Pahrump Valley was conducted in 1974 in support of litigation. Rosse, an Engineer with the Nevada Bureau of Environmental Health (and later with NDEP) conducted large-scale sampling of over 200 wells in the agriculturally developed areas of the Pahrump Valley to collect data on nitrate levels. His survey, which included wells in 29 sections, found nitrates present in shallow wells (less than 200 feet) at concentrations of up to 35 mg/L in areas of the valley associated with agriculture, and deeper wells (greater than 350 feet) had nitrate concentrations approaching 24 mg/L. At least 21 of the wells sampled had nitrates in excess of the Drinking Water Standard of 10 mg/L.

Rosse's 1975 letter to the Chairman of Nye County Board of Commissioners, outlined testimony given in a case before the Fifth District Court that found elevated nitrate levels in Pahrump Valley groundwater. The elevated nitrate levels were attributed to the agricultural application of ammonium fertilizers; the fertilizers had contaminated the upper, unconfined aquifer making it unsuitable for human consumption. Rosse's letter also cautioned that wells penetrating the deeper aquifer needed to be adequately isolated from the upper aquifer to prevent the spread of contamination. He noted that *community water supply systems* (emphasis added) would need to treat drinking water to the reduce nitrate concentrations to meet the applicable U.S. Public Health Service (now EPA) Drinking Water Standard for nitrate. No remedy was offered for potential exposure from the domestic wells, which totaled fewer than 500 at the time (1970 Pumpage Inventory; DWR, 1970). Additionally water quality standards were applicable to public water systems and not to domestic wells.

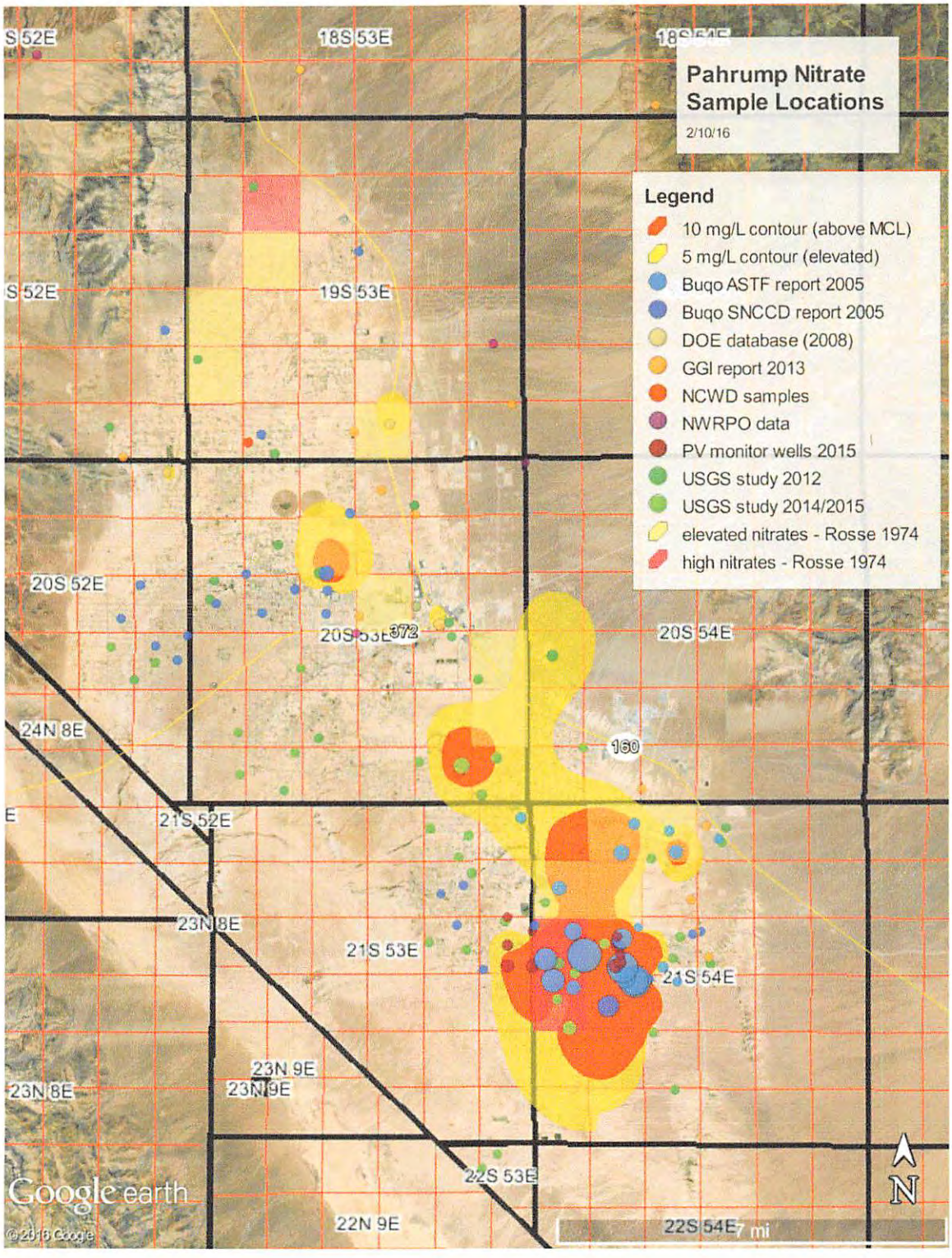


Figure 5-12. Preliminary nitrate distribution map including data from Rosse's 1974 report. Twelve sections highlighted in yellow indicate elevated nitrate areas, and three sections highlighted in magenta indicate high nitrate areas. From Klenke (2016b).

In 2005, the Southern Nye County Conservation District (Buqo, 2005c) conducted a study to investigate two areas in Pahrump considered to have the highest potential for groundwater contamination by nitrates. These two areas included neighborhoods with relatively high density of domestic wells and associated high density septic systems. The northern study area is bounded by Mesquite Avenue on the north, State Highway 372 on the south, Blagg Street on the east, and Bannavitch Street on the west encompassing approximately 12 square miles. According to DWR records, more than 2,400 domestic water wells had been drilled in the area through August 2001. The second study area, located in the southwest part of the valley encompassed nearly 8 square miles bounded by Gamebird Road on the north, Turner Boulevard on the south, Homestead Road on the east, and Pahrump Valley Boulevard on the west. Records of the DWR indicated that more than 1,100 domestic wells had been drilled in the second area.

These two most densely developed areas of Pahrump were sampled, and the results found no evidence of elevated or excessive nitrates in groundwater beneath areas with a high density of septic systems. The study also examined presence and concentration of other indicators of septic contamination including total dissolved solids, and phenols. These other indicators of septic contamination were absent, as well. Buqo (2005c) concluded that no evidence exists to suggest that the current distribution of elevated nitrates are associated with septic systems.

Prior to permitting and constructing RIBs, Pahrump Utilities Company, Inc. contracted Buqo (2005b) characterized groundwater conditions beneath and down-gradient of the proposed RIB facility. Based on this study and others, Buqo (2005b) concluded that, *"Nitrates [in the southern portion of the Pahrump Valley] are probably related to the Pleistocene lake in Pahrump Valley, specifically the decay of vegetation in bog and marsh deposits adjacent to the shoreline."* This suggests that soil nitrogen may be a source of the observed nitrate values in some areas. Buqo's sampling results also found that *"the groundwater down gradient of the proposed facility was naturally brackish with total dissolved solids concentrations of more than 2,000 ppm, sulfate concentrations of more than 1,000 ppm, and nitrate concentrations of more than 200 ppm, all well above the respective drinking water standards for these parameters..."* Thus, the treated effluent proposed for disposal would not degrade the existing groundwater quality.

In 2012, the USGS conducted a pilot study that sampled for nitrates in 20 wells, most of them domestic. Two of the 20 wells sampled had nitrates above the drinking water standard. From 2014 to 2015, the USGS sampled an additional 27 wells and resampled 4 wells from the pilot study. In all, a total of 37 unique wells were sampled to investigate possible sources of nitrates; three of the wells sampled had nitrate concentrations above the Federal Drinking Water Standard of 10 mg/L, and two additional wells had elevated nitrated concentrations above 5 mg/L but below the standard of 10 mg/L.

To further investigate the source of observed nitrates, the 2014/2015 USGS study also looked for the presence of wastewater-related compounds, or simply "manmade compounds" that are found in domestic septage or wastewater treatment effluents. The USGS tested for the presence of 46 compounds in 27 wells, and 32 wastewater-related compounds in 4 additional wells. Three of the selected compounds are commonly associated with human wastewater: caffeine, and two other conservative pharmaceutical compounds. None of these compounds were detected in any of the wells that were sampled. In all, there were 30 *detections* of wastewater–related compounds, only

five of those detections were at quantifiable levels; the others were so low that sample concentrations could only be estimated.

Water quality and chemistry analyte data (e.g., arsenic, fluoride, total dissolved solids, chloride, sulfates, etc,) are usually measured in the parts per million (ppm). Environmental data from samples collected to measure man-made wastewater contaminants must be detectable at much, much lower concentrations, usually in the parts per billion range. Because environmental data can be detected at the part per billion range; it is important to implement quality control measures to ensure and document a sample's integrity. Quality control measures include collection of field blanks, laboratory method spikes, and the use of other controlled sampling measures to establish that contamination has not been inadvertently introduced during sampling or the laboratory handling. Quality control data were not available for the USGS data set so no conclusions can be drawn regarding data quality.

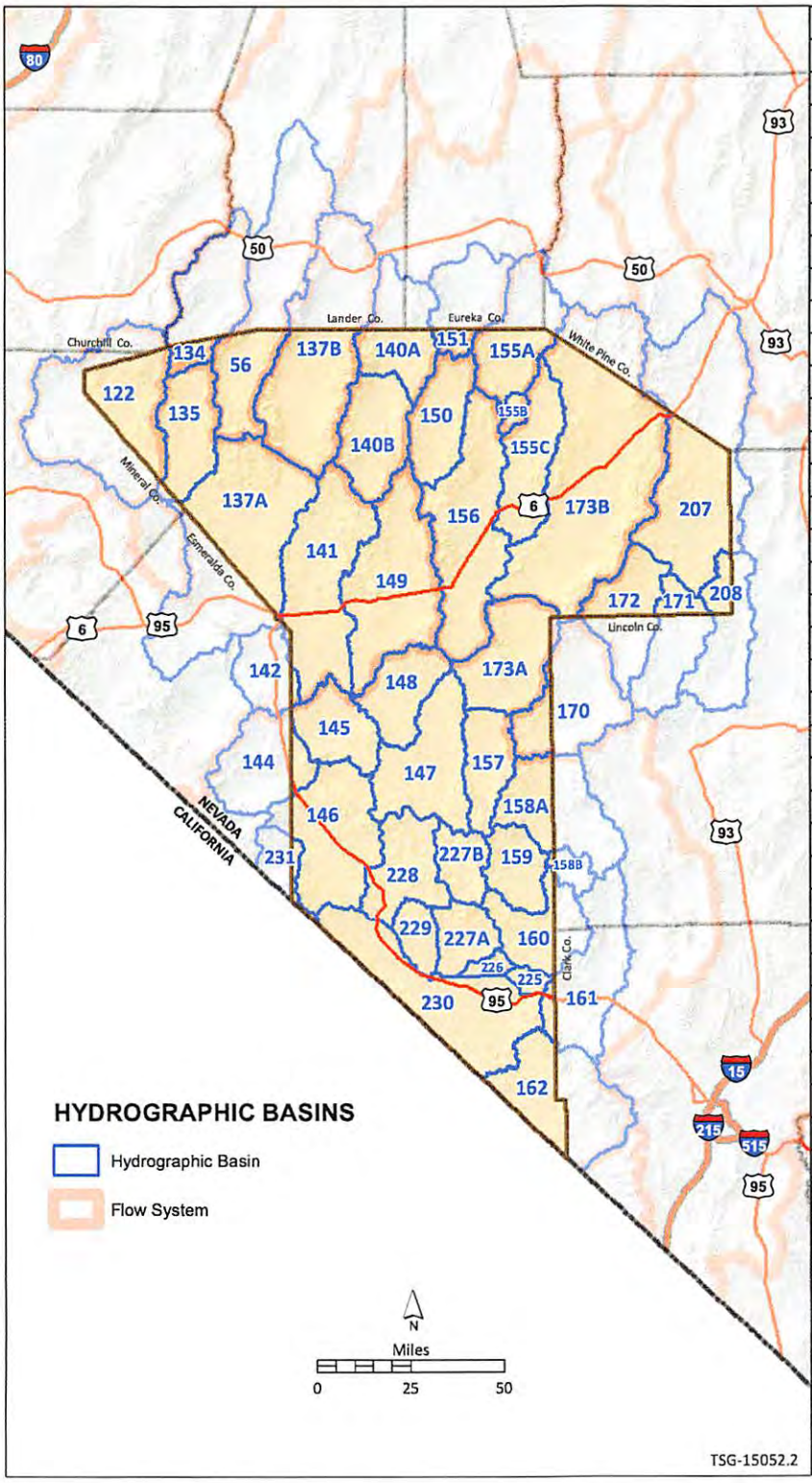
Environmental data to assess the source and magnitude of contamination in groundwater are ideally collected using a gridded sample, or alternatively random sample. In reality data sets are frequently neither. The data set of contaminants in groundwater in the Pahrump Valley is neither gridded nor random, but instead is considered a *biased* sample because data can only be collected at locations where water wells already exist. Additionally, to determine if such low concentrations are real and not a statistical anomaly requires resampling of the wells through time to confirm the presence of a contaminant at such trace levels. Because the USGS data set has only one set of observations for each well sampled, neither temporal nor statistical comparisons can be made.

The following generalizations can be made, based on the USGS data wastewater compounds dataset:

4 wells were tested for 32 wastewater compounds (4x32 observations).
27 wells were tested for 46 wastewater compounds (27x46 observations).

In all there are a total of 1,370 observations. Of the 1,370 observations, 30 of the values were non-zero. Of these 30 non-zero observations, 18 were at the instrument limit, and 12 were "non-zero" detections that were not quantifiable because the contaminant was present below the instrument's quantitation limit. The 30 observed detections occurred in 13 wells of the 31 wells sampled, and were distributed as follows: six wells had one detection; two wells had two detections; one well had three detections; two wells had four detections; and one well had five detections. Thus, slightly over 50 percent of the detections are accounted by slightly more than 10 percent of the wells. This suggests that if the detections are found to be real (i.e., if the results are reproducible), then the contaminant sources are localized, rather than a basin-wide problem. The 30 detections represent 21 different compounds; the only compounds to occur more than once were the chemical constituent found in mothballs, and by-products of well disinfection and cleaning. Again it is emphasized that all 30 wastewater-related compounds detected were well below regulatory standards and levels of concern.

In addition to sampling for the presence of nitrates, wastewater compounds, and general hydrochemical parameters, the second phase of the USGS nitrate study also measured and plotted the ratios of specific isotopes of oxygen and nitrogen to try to establish the source of nitrate. Using



No.	Basin Name
56	Upper Reese River Valley
122	Gabbs Valley
134	Smith Creek
135	Ione Valley
137A	Big Smoky Valley - Tonopah Flat
137B	Big Smoky Valley - Northern
140A	Monitor Valley - Northern
140B	Monitor Valley - Southern
141	Ralston Valley
142	Alkali Spring Valley
144	Lida Valley
145	Stonewall Flat
146	Sarcobatus Flat
147	Gold Flat
148	Cactus Flat
149	Stone Cabin Valley
150	Little Fish Lake Valley
151	Antelope Valley
155A	Little Smoky Valley - Northern
155B	Little Smoky Valley - Central
155C	Little Smoky Valley - Southern
156	Hot Creek
157	Kawich Valley
158A	Emigrant Valley - Groom Lake Valley
158B	Emigrant Valley - Papoose Lake Valley
159	Yucca Flat
160	Frenchman Flat
161	Indian Springs Valley
162	Pahrump Valley
170	Penoyer Valley
171	Coal Valley
172	Garden Valley
173A	Railroad Valley - Southern
173B	Railroad Valley - Northern
207	White River Valley
208	Pahroc Valley
225	Mercury Valley
226	Rock Valley
227A	Fortymile Canyon - Jackass Flats
227B	Fortymile Canyon - Buckboard Mesa
228	Oasis Valley
229	Crater Flat
230	Amargosa Desert
231	Grapevine Canyon

Figure 3-13. Hydrographic Basins of Nye County. There are 44 hydrographic basins wholly or partially located within Nye County's boundary. Only about 20 of the basins are wholly within the County boundaries, and of these, eight are located entirely on federal lands withdrawn from all forms of public entry. The remaining 23 basins are shared with eight other Nevada counties and two counties in California. Political subdivision of hydrographic basins and federal agency land access rules can hamper water planning efforts.

Table 3-7. Water Budget Parameters in acre-feet per year for the Basins in Nye County

Basin Name	Basin No.	Recharge	Inflow	Evapotran-spiration	Outflow	Perennial Yield Current	Perennial Yield Prior
Alkali Spring Valley*	142	100	5,500	400	5,000	3,000	
Amargosa Desert	230	600	44,000	24,000	19,000	24,000[1]	24,000[2]
Antelope Valley (Eureka & Nye)*	151	**17,000**	**500**	**4,000**	**13,500**	4,000	
Big Smoky Valley - Northern Part*	137B	65,000	0	64,000	0	65,000	
Big Smoky Valley - Tonopah Flat*	137A	12,000	2,000	6,000	8,000	6,000	
Cactus Flat	148	600	0	0	300	300	
Coal Valley*	171	2,000	8,000	Minor	10,000	6,000	
Crater Flat	229	220	1,500	0	1,700	24,000[1]	1,000
Emigrant Valley/Groom Lake Valley*	158A	3,200	0	0	3,200	2,800	
Emigrant Valley/Papoose Lake Valley*	158B	<10	0	0	<10	<10	
Fortymile Canyon/Buckboard Mesa	227B	1,400	5,800	0	7,200	24,000[1]	4,000
Fortymile Canyon/Jackass Flats	227A	900	7,200	0	8,100	24,000[1]	4,000
Frenchman Flat*	160	100	33,000	0	33,000	100	
Gabbs Valley*	122	5,000	0	>3,700	0	5,000	
Garden Valley*	172	10,000	0	2,000	8,000	6,000	
Gold Flat	147	3,800	0	0	3,800	1,900	
Grapevine Canyon*	231	50	500?	Minor	400	1,000	400
Hot Creek Valley	156	**5,800**	**0**	**5,000**	**800**	5,500	
Indian Springs Valley*	161	10,000	22,000	Minor	32,000	500	
Ione Valley*	135	8,000	0	1,300	2,000	2,500	
Kawich Valley	157	3,500	1,000	0	4,500	2,200	
Lida Valley*	144	500	200	0	700	350	
Little Fish Lake Valley	150	**9,700**	0	**9,700**	**0**	10,000	
Little Smoky Valley Central Part	155B	200	0	0	200	100	
Little Smoky Valley Northern Part*	155A	4,000	Some	1,900	1,000	5,000	
Little Smoky Valley Southern Part	155C	1,400	Some	0	Some	1,000	
Mercury Valley	225	250	16,000	0	17,000	24,000[1]	8,000
Monitor Valley Northern Part*	140A	6,300	2,000	2,000	6,000	8,000	
Monitor Valley Southern Part	140B	15,000	0	9,200	2,000	10,000	
Oasis Valley	228	1,000	2,500	2,000	1,500	24,000[1]	
Pahroc Valley*	208	2,200	40,000	0	42,000	21,000	
Pahrump Valley*	162	22,000	0	10,000	13,000	20,000	12,000[3]
Penoyer Valley (Sand Spring Valley)*	170	4,300	0	6,400	0	4,000	5,000
Railroad Valley Northern Part*	173B	**61,000**	**24,000**	**85,000**	**0**	75,000	50,000[4]
Railroad Valley Southern Part*	173A	6,000			1,000	2,800	
Ralston Valley*	141	5,000	3,000	2,500	5,500	6,000	
Rock Valley	226	30	17,000	0	17,000	24,000[1]	8,000
Sarcobatus Flat*	146	1,200	1,300	3,000	500	3,000	
Smith Creek*	134	12,000	0	6,600	0	10,000	
Stone Cabin Valley	149	5,000	0	2,000	3,000	2,000	
Stonewall Flat*	145	100	Some	0	200	100	
Upper Reese River Valley*	56	37,000	0	37,000	500	37,000	
White River Valley*	207	38,000	39,000	37,000	40,000	37,000	
Yucca Flat	159	700	0	0	700	350	
					County Total	364,500	

* Shared Basins

[1] Combined total for Basins 225 through 230 (DWR website Basin Summary August 26, 2015).

[2] Scott et al (1971) reported a value of 34,000 acre-feet.

[3] The State Engineer's 1987 curtailment order (955) notes that the USGS estimates Pahrump's perennial yield to be 19,000 acre-feet, while the NSE estimates it to be lower on the order of 12,000 afa.

[4] 50,000 combined total of 173A and 173B.

Source: Scott et al 1971; Nichols 2000 (in bold); DWR website Basin Summaries August 2015.

"pre-development" conditions. A basin's water budget is in balance if the groundwater recharge from all sources equals the total discharge. Recharge to the groundwater system in each basin is derived primarily from the precipitation that falls above an elevation of about 6,000 feet above mean sea level. In the northern part of the County, the bulk of the recharge over the County occurs over the Toiyabe Range, Toquima Range, Hot Creek Range, and Grant Range. Lesser recharge in the north is distributed over the White Pine Range and Shoshone Mountains (Figure 3-2).

In the southern part of the County, little recharge is derived from precipitation that falls over the County. Rather, as noted previously, the aquifers in Pahrump Valley and Amargosa Valley are recharged primarily by precipitation over the Spring Mountains and Sheep Range in Clark County. The quantity of recharge that is contributed each year is not known. Reconnaissance level estimates of recharge have been developed based on estimates of discharge, climate data, and the topography of the landscape. In addition to this natural recharge, activities by man can result in additional recharge to the groundwater reservoir, a process referred to as secondary recharge. Secondary recharge occurs where water infiltrates to the water table from irrigated cropland or pastures; leakage from canals, ditches, and natural stream channels; and even from septic systems. Secondary recharge can total several thousand acre-feet per year in some basins. A study sponsored by the NCWD is currently underway to quantify the secondary recharge in the Pahrump basin.

Groundwater flows from the upland recharge areas to discharge areas at springs and areas where shallow groundwater is discharged to evapotranspiration. The largest areas of evapotranspiration in Nye County are in Railroad Valley and Big Smoky Valley. Lesser but still significant evapotranspiration occurs in Amargosa Desert and Little Fish Lake Valley. Significant natural discharge from springs once occurred in Pahrump Valley but has been diminished over the last five decades by groundwater development from wells. There is still considerable uncertainty, however, in these water budgets, and a greater understanding of both recharge and discharge is needed to help guide water resources evaluations and planning in the region.

Groundwater Quantity and Availability

Nye County has significant groundwater resources but they are not well defined. The perennial yields listed in Table 3-7 offer a first order approximation of how much water can actually be drawn on an annual basis. As water development occurs and changes in water levels are observed, the State Engineer may revise perennial yield estimates as additional data provide better understanding of the basin budget and dynamics. Until more complete information on basin groundwater budgets are available, the existing perennial yield values of the State Engineer continue to serve as the basis for planning.

In 2015, the State Engineer adjusted the perennial yield of the Pahrump Artesian basin upward from 12,000 acre-feet to 20,000 acre-feet in Order 1252, based on the results of numerous hydrologic studies. Although the change suggests that current pumpage is below perennial yield, the State Engineer considers Pahrump Artesian Basin to be in need of special management, based on the current level of allocation and historic pumpage. The recently approved GWMP, discussed in Chapter 5, identifies numerous measures that are being implemented to better define the basin budget, address the over-allocation, and establish a range of viable alternatives to mitigate areas of over-pumpage.

The perennial yield of the Amargosa Desert includes the yields of its tributary basins, most of which are located on the NNSS. The basins include Mercury Valley, Rock Valley, Jackass Flats, Crater Flat, Buckboard Mesa, Oasis Valley and Amargosa Desert Basins. The total perennial yield assigned by DWR is 24,000 acre-feet. This value is significantly lower than the estimate of 40,000 acre-feet suggested by Buqo in the 2004 WRP. Buqo's 2004 estimate was based on assigning non-zero evapotranspiration values to areas of bare soil with shallow groundwater in the Amargosa Desert that were previously considered to be zero. Applying a non-zero evapotranspiration value produces 16,000 acre-feet of evapotranspiration in the Amargosa Desert Basin budget. Further study is needed to determine whether or not evapotranspiration occurs on bare soils in Amargosa Desert and if so, the magnitude of its contribution to the basin budget and perennial yield.

Determining the quantity of water available within Nye County is further complicated by the fact that only 16 of the 43 hydrographic basins are wholly situated within the County. In the north, Nye County shares two hydrographic basins with Churchill County, three basins with Lander County, three basins with Eureka County, and three basins with White Pine County. On the east, seven basins are shared with Lincoln County and three basins are shared with Clark County. On the west, two basins are shared with Mineral County and six basins are shared with Esmeralda County. To the south, in California, Nye County shares three basins with Inyo County.

Because the development in the rural counties of Nevada and California that share hydrographic basins has been minor, there has not been conflicts in the past over groundwater commitments and use. This situation may change, however, as growth is expected to occur across the entire region, and a number of entities are looking at the water resources of the shared basins as sources of water for exportation to urban areas. As in the past, water development in Clark County could result in direct competition with Nye County, and development in Nye County may result in direct competition with Inyo County interests for the shared but limited groundwater resources.

In recent years, the federal demand for water resources to support its various missions has increased competition for Nye County's water resources. Several Interior Department agencies, including the BLM, National Park Services, Fish and Wildlife Service, and the USDA's Forest Service continue to propose numerous measures that will substantially restrict the future development and use of groundwater on public lands for federally-authorized uses (i.e. grazing, commercial power production, etc.). At the same time, Federal agencies continue to acquire state-issued rights to support wildlife habitat and riparian areas. Federally held surface water rights in Nye County account for nearly 29,000 acre-feet per year of certifications, permitted, decreed, and vested rights. Federal Interior and Agriculture agencies also assert additional unadjudicated claims of 7,000 acre-feet of reserved surface water rights, and an unquantified annual duty with a combined seasonal diversion rate of nearly 25 cfs from these sources.

It is expected that most of these federal claims of reserved rights would not meet the standards of adjudication were the administrative process to occur. The Nevada State Engineer has countered attempts by federal agencies to hold the water rights required to support the federal land uses they permit, and has held that the permittee is in fact the appropriate owner of the water rights. Nye County will continue to resist federal efforts to overstep State Water Law, and the limited authorities granted to the County.

Data on Departments of Defense and Energy water use is readily available. Air Force water use at the NTTR complies with Nevada water law, and is reported on DWRs website. Annual NTTR pumpage from wells located in Nye County averaged 155 acre-feet during the period from 2000 to 2014. The DOE/NNSA asserts federally reserved water rights at the NNSS up to the historical maximum use (4,175 AFY) and does not comply with Nevada Water Law except as a matter of comity. Although, water use on the NNSS is not reported to DWR, the USGS/DOE Cooperative Studies in Nevada website lists monthly current and historical pumpage data by well for all wells on the NNSS at https://nevada.usgs.gov/doe_nv/.

The estimated committed groundwater resources in Nye County are large. Table 3-8 identifies water rights by status in each basin and Table 3-9 lists the committed water rights by type of use. The values shown are estimates based on DWR data. As of August 2015, nearly 360,000 acre-feet of groundwater have been committed in the basins that are located wholly or partially in Nye County. The valleys with the largest committed groundwater resources are Pahrump Valley with over 60,000 acre-feet committed, Big Smoky Valley - Northern Part with about 57,000 acre-feet committed, Upper Reese Valley with about 37,000 acre-feet committed, White River Valley with over 35,000 acre-feet committed, Railroad Valley Northern Part with over 31,000 acre-feet committed, Amargosa Desert with almost 28,000 acre-feet committed, Big Smoky Valley - Tonopah Flat with almost 24,000 acre-feet committed, Gabbs Valley with over 19,000 acre-feet committed, Penoyer Valley with about 15,000 acre-feet committed, and Stone Cabin Valley with about 11,000 acre-feet committed. As expected from Table 3-8, most basins in Nye County saw an increase in groundwater allocation since 2004. In this same period, the Pahrump Artesian Basin (162) and Alkali Spring Valley (142) saw substantial decreases in groundwater allocations, each in excess of 11,600 acre-feet per year.

In addition to the water resource commitments shown in Table 3-8, there are large water right filings in some basins that are ready for action by the Nevada State Engineer. In all, applications are outstanding for slightly more than 200,000 acre-feet in the basins that are located wholly or partially in Nye County (as of August 2015). Most of these pending applications are from the Southern Nevada Water Authority and originated with the Las Vegas Valley Water District's 1998 plans to export water from Nye County and other rural Nevada counties to metropolitan Las Vegas. The Las Vegas Valley Water District originally filed 32 groundwater applications with points of diversion in Nye County. Some of these applications have been withdrawn but the remaining applications, totaling more than 172,000 acre-feet in Railroad Valley (North), Garden Valley, Coal Valley, and Indian Springs Valley, with the status of "ready for protest".

Since publication of the 2004 WRP, which presented 1999 data, many of the longstanding applications for large allocations of water rights have been processed by the State Engineer. Numerous applications associated with Carey Act and Desert Land Entries have been denied in many Nye County basins. Permits were denied on more than 95,000 acre-feet of applications pending in Railroad Valleys North and South, 14,000 acre-feet in Big Smoky Valley North, 13,760 acre-feet in Hot Creek Valley, 7,680 acre-feet in Monitor Valley South, 2,560 acre-feet in Smith Creek Valley, and 640 acre-feet in Ione Valley. Prior filings by the Nye County Board of County Commissioners from February 2000 totaling over 33,000 acre-feet per year in the basins of the

Table 3-8. Status of Underground Water Rights in acre-feet in Nye County Basins Through August 2015

Basin Name	Basin No.	Vested	Applied For	Ready for Action[1]	Permitted	Relinq-uished	Certifi-cated	Total Allocated[2]	Total Demand[3]
Alkali Spring Valley*	142			†1,448.00	1,329.32		578.10	1,907.42	3,355.42
Amargosa Desert	230		1,300.00	†2.0	6,378.67	2.02	20,939.78	27,320.47	28,622.47
Antelope Valley (Eureka & Nye)*	151				1,300.00		1,763.00	3,063.00	3,063.00
Big Smoky Valley - Northern Part*	137B	127.35		†342.00	15,088.38		42,442.01	57,657.74	57,999.74
Big Smoky Valley - Tonopah Flat*	137A		20.88	†322.00	6,950.65		17,106.34	24,056.99	24,399.87
Cactus Flat	148				178.77		69.41	248.18	248.18
Coal Valley*	171			†33,071.16			63.80	63.80	33,134.96
Crater Flat	229				491.03		190.33	681.36	681.36
Emigrant Valley/Groom Lake Valley*	158A						12.32	12.32	12.32
Emigrant Valley/Papoose Lake Valley*	158B						11.78	11.78	11.78
Fortymile Canyon/Buckboard Mesa	227B								
Fortymile Canyon/Jackass Flats	227A		4.60				17.22	17.22	21.82
Frenchman Flat*	160								
Gabbs Valley*	122	107.88		†500.00	7,262.78		11,914.21	19,284.87	19,784.87
Garden Valley*	172			†11,583.75	489.85		553.60	1,043.45	12,627.20
Gold Flat	147				361.98		29.34	391.32	391.32
Grapevine Canyon*	231						12.43	12.43	12.43
Hot Creek Valley	156	23.17			613.90		2,553.47	3,190.54	3,190.54
Indian Springs Valley*	161			†32,000.00	68.92		1,322.03	1,390.95	33,390.95
Ione Valley*	135				50.00		136.20	186.20	186.20
Kawich Valley	157						22.74	22.74	22.74
Lida Valley*	144				197.66		61.25	258.91	258.91
Little Fish Lake Valley	150				7,870.44		24.86	7,895.30	7,895.30
Little Smoky Valley Central Part	155B				17.92		2.23	20.15	20.15
Little Smoky Valley Northern Part*	155A	2.00		1,280.00	17.92		5,053.65	5,073.57	6,353.57
Little Smoky Valley Southern Part	155C				34.72		17.00	51.72	51.72
Mercury Valley	225								
Monitor Valley Northern Part*	140A						280.78	280.78	280.78
Monitor Valley Southern Part	140B	101.03			4.00		454.55	559.58	559.58
Oasis Valley	228				50.00		1,245.98	1,295.98	1,295.98
Pahroc Valley*	208				8.96		29.98	38.94	38.94
Pahrump Valley*	162		252.17	2.00	36,533.15	7,289.85	16,366.52	60,189.52	60,443.69
Penoyer Valley (Sand Spring Valley)*	170			†8,687.64	2,604.21		12,478.44	15,082.65	23,770.29
Railroad Valley Northern Part*	173B	10.71		95,568.00	9,289.61		21,830.31	31,130.63	126,698.63
Railroad Valley Southern Part*	173A				22.40		3,908.62	3,931.02	3,931.02
Ralston Valley*	141			1,518.00			4,307.33	4,307.33	5,825.33
Rock Valley	226								
Sarcobatus Flat*	146				2,288.28		1,107.14	3,395.42	3,395.42
Smith Creek*	134			†3,840.00			1,915.57	1,915.57	5,755.57
Stone Cabin Valley	149	73.93			6,401.07		4,504.18	10,979.18	10,979.18
Stonewall Flat*	145						11.78	11.78	11.78
Upper Reese River Valley*	56			3,311.39	16,048.15		20,944.07	36,992.22	40,303.61
White River Valley*	207			3,282.47	13,577.04		21,988.10	35,565.14	38,847.61
Yucca Flat	159								
							County Totals	359,538.17	557,874.23

† Points of diversion and place of use for these pending allocations are not in Nye County portion of the basin.

* Shared Basins

[1] **Includes only new appropriations. Updated March 22, 2016.**

[2] **Total Allocated = Vested + Permitted + Certificated + Relinquished**

[3] **Total Demand = Vested + Applied For + Ready for Action (new appropriations) + Permitted + Relinquished + Certificated**

Source: Division of Water Resources Files database August 2015. The values are preliminary and intended to be used for planning purposes only.

Table 3-9. Summary of Committed Underground Water Rights in acre-feet by Manner of Use for Nye County Basins as of August 2015

Basin Name	Basin No.	Domestic	Com-mercial	Industrial	Mining & Milling	Stock	Irrigation	Wildlife	Recrea-tion	Municipal	Quasi-Municipal	Power	Environ-mental	Con-struction	Other	Total
Alkali Spring Valley*	142				1,486.23	29.43	16.29			328.00						1,859.95
Amargosa Desert	230	21.38	2,212.65	400.00	1,911.49		21,580.94	9.42		431.79	752.78					27,299.07
Antelope Valley (Eureka & Nye)*	151					157.54	2,905.64									3,063.18
Big Smoky Valley - Northern Part*	137B	21.38	50.38		15,469.94	149.40	38,957.83		0.27		2,602.83				46.46	57,277.11
Big Smoky Valley - Tonopah Flat*	137A	23.63		607.88	14,611.26	918.48	7,795.94			58.95	20.84			20.00		24,033.35
Cactus Flat	148					5.06					243.12					248.18
Coal Valley*	171					63.80										63.80
Crater Flat	229			61.38	619.98											681.36
Emigrant Valley/Groom Lake Valley*	158A					12.32										12.32
Emigrant Valley/Papoose Lake Valley*	158B															0.00
Fortymile Canyon/Buckboard Mesa	227B															0.00
Fortymile Canyon/Jackass Flats	227A					17.22										17.22
Frenchman Flat*	160															0.00
Gabbs Valley*	122		996.00		9,038.60	276.76	8,670.80			234.34	61.38			7.00		19,284.88
Garden Valley*	172			4.76		52.28	986.41									1,043.45
Gold Flat	147					11.26					380.06					391.32
Grapevine Canyon*	231					12.43										12.43
Hot Creek Valley	156	1.99		21.70	605.79	153.41	2,401.20				6.44					3,188.54
Indian Springs Valley*	161	1.38	7.64				124.10			798.00	459.82					1,389.56
Ione Valley*	135				15.09	56.80	61.47		2.84		50.00					186.20
Kawich Valley	157					22.74										22.74
Lida Valley*	144	3.62	167.96		29.96	27.68					29.70					255.30
Little Fish Lake Valley	150					24.86	7,870.44									7,895.30
Little Smoky Valley Central Part	155B					20.15										20.15
Little Smoky Valley Northern Part*	155A					135.89	4,937.68									5,073.57
Little Smoky Valley Southern Part	155C					51.72										51.72
Mercury Valley	225															0.00
Monitor Valley Northern Part*	140A					105.66	175.12									280.78
Monitor Valley Southern Part	140B				442.22	111.80					5.55					559.57
Oasis Valley	228		5.52		0.87	2.21	74.60		50.00	1,162.78						1,295.98
Pahroc Valley*	208					38.94										38.94
Pahrump Valley*	162	7,291.45	1,198.14	161.64	10.00	4.70	12,439.97		490.53	30,671.13	7,854.97			67.00		52,898.08
Penoyer Valley (Sand Spring Valley)*	170		64.20			87.71	12,390.73				2,540.01					15,082.65
Railroad Valley Northern Part*	173B		2.00	71.90	805.37	171.98	28,085.18		1,993.97		0.24					31,130.64
Railroad Valley Southern Part*	173A					245.54	3,676.51								8.96	3,931.01
Ralston Valley*	141			7.86		134.19	7.16			4,121.93	36.19					4,307.33
Rock Valley	226															0.00
Sarcobatus Flat*	146				162.34	76.02	2,631.80			500.00	25.26					3,395.42
Smith Creek*	134				42.53	44.71	1,828.33									1,915.57
Stone Cabin Valley	149	2.42				277.30	9,516.87				1,182.58					10,976.75
Stonewall Flat*	145					11.78										11.78
Upper Reese River Valley*	56				608.21	142.55	35,698.68			43.98	498.79					36,992.21
White River Valley*	207		4.64			478.39	34,972.24		16.07		73.80			20.00		35,565.14
Yucca Flat	159															0.00
	Totals	7,367.25	4,709.13	1,337.12	45,859.88	4,132.71	237,805.93	9.42	2,553.68	38,350.90	16,824.36	0.00	0.00	114.00	55.42	351,752.55

* Shared Basins

Source: Division of Water Resources Files database August 2015. These values are preliminary and intended to be used for planning purpo

NTTR and NNSS were denied because of land access restrictions; appeals are pending on two applications as of January 2016.

The Nye County Water Resources and Summaries Reports (Wichman, 2014, 2016) describe the health of each basin in Nye County based on available water resources, Orders and Rulings of the State Engineer, the published perennial yield, total existing appropriations, and total pending applications as of 2013. Based on information in the Water Resources and Summaries Report, as updated with data from DWR (March 2016), groundwater allocations (total vested rights, permits, certificates, and relinquished rights) exceed the perennial yield in twelve (12) basins: Amargosa Desert, Big Smoky Valley – Tonopah Flat, Emigrant Valley/Papoose Lake Valley, Gabbs Valley, Indian Springs Valley, Little Smoky Valley Northern Part, Pahrump Valley, Penoyer Valley, Railroad Valley Northern Part, Railroad Valley Southern Part, Sarcobatus Flat, and Stone Cabin Valley. The demand for water, defined as the sum of existing rights and applications that are ready for action exceeds, the perennial yield in four additional basins: Coal Valley, Garden Valley, Upper Reese River Valley, and White River Valley. In each of these basins, the quantity of water already allocated has the potential to result in groundwater withdrawals that exceed the perennial yield, leading to critical management area designation by the State Engineer. While highly unlikely in most areas of Nye County, areas such as Pahrump, and Amargosa Valley, and Diamond Valley in neighboring Eureka County, demonstrate how local conditions can change unexpectedly and abruptly to radically alter historic settlement and development trends.

Groundwater Quality

With the exception of the areas used for underground nuclear testing on the NNSS, the general quality of the groundwater in Nye County is suitable to marginally suitable with limited exceptions based on specific location and proposed beneficial uses. Naturally occurring fluoride and uranium concentrations in areas of Oasis Valley, Gabbs Valley, and Crater Flat exceed drinking water standards. The total dissolved solids concentration of groundwater in very limited portions of Alkali Spring Valley, Big Smoky Valley, Gold Flat, Monitor Valley, Railroad Valley (North and South), Sarcobatus Flat, and Stone Cabin Valley that are located beneath or near playas (dry lake beds) exceed state or federal drinking water standards. In these basins, the total dissolved solids are elevated because of the natural process of salt buildup by evaporation in areas of shallow groundwater discharge. Passage of a more stringent Federal Primary Drinking Water Standard for arsenic in 2002, lowering it from 50 to 10 parts per billion, required community water systems in Beatty, Tonopah, Hadley, and Manhattan to treat existing sources, or to locate and develop new compliant ground water sources. Community systems such as Shoshone Estates in Round Mountain continue to work toward achieving compliance. These issues are discussed further in Chapters 5 and 6.

The potential for groundwater nitrate contamination from septic systems, agriculture, and natural sources continues to be a concern in the Pahrump Valley. Elevated nitrate concentrations have been reported, and are likely attributable to several sources. Studies by Rosse (1975), Buqo (2005c), USGS (2012), and others have identified elevated nitrate levels in certain areas of the valley. Additional studies to further define the areas of concerns as well as the potential sources are needed (i.e., natural, agricultural, septic systems), and are discussed in Chapter 5.

In addition to naturally occurring contaminants, the activities of man have resulted in the contamination of significant volumes of groundwater in Nye County. First and foremost, is the remaining radioactivity on the NNSS. About 250 square miles at this facility are contaminated with radioactivity as a result of historic underground nuclear weapons testing. Testing was conducted in six hydrographic basins (Yucca Flat, Frenchman Flat, Gold Flat, Kawich Valley, Oasis Valley, and Buckboard Mesa); Figure 3-14 shows the locations of the underground nuclear testing areas and the possible paths that this contamination might take. Flow paths are based upon a regional numerical model prepared by the U.S. Department of Energy/National Nuclear Security Administration as part of its ongoing investigations of the underground testing areas. According to NNSAs accepted model, radionuclide contamination in the groundwater underlying the NNSS may migrate off of the facility toward the communities of Beatty and Amargosa Valley, and ultimately to the regional discharge areas in California in Death Valley and southernmost Amargosa Desert. The NNSA's Underground Test Area program continues to characterize and monitor the movement along these pathways. In 2008, tritium was detected in groundwater samples collected in Oasis Valley Basin just outside of the NNSS boundary. The NNSA has stepped up characterization in this area to better understand this groundwater pathway. Figure 3-15 shows measured tritium concentrations on and down gradient of the NNSS.

In 1996, DOE/NNSA estimated that more than 295 million curies of radioactivity remained in the deep subsurface at the NNSS, of which an estimated 112 million curies are under or within 100 meters (328 feet) of the water table. In 2001, scientists at Los Alamos and Lawrence Livermore National Laboratories estimated the underground source term beneath the NNSS, decay-corrected to September 23, 1992, to be about 132 million curies (Bowen et al. 2001). Of the 132 million curies, approximately 95 percent (125 million curies) was estimated to be tritium, which has a half-life of about 12.3 years. As of September 2012, radioactive decay has reduced the tritium component of the underground source term to about 23 million curies (DOE/NNSA, 2013).

While the majority of the radiologic contamination is tritium, a number of longer-lived radionuclides of concern are also present in appreciable quantities. Specific radionuclides of concern in the current residual inventory include isotopes of americium (11,500 curies), plutonium (37,000 curies), strontium (1,497,450 curies), and uranium (1,200 curies). These radionuclides exhibit half-lives ranging from 28.8 years for strontium to 4.4 billion years for some uranium isotopes. The daughter isotopes that result from the decay of these radionuclides, especially neptunium and technetium, are also a concern. A consequence of the nation's nuclear weapons testing program has been the contamination of an estimated five million acre-feet or more of groundwater in Nye County. For all practical purposes, the water resources under the testing areas have been impacted as a result of nuclear testing and are lost to the County in perpetuity.

An additional area of potential radionuclide contamination from nuclear testing occurs outside the boundaries of the NNSS at the Central Nevada Test Area in northern Nye County. This area was the site of a deep underground one megaton nuclear test conducted in 1968. Initially, based on hydrologic conditions, radionuclide transport was not expected to occur until the pre-test water level recovered. Results from post-shot drilling identified outflows, which suggested that transport is occurring. Long-term monitoring of wells in the area by the NNSA's Environmental Restoration Program has not detected contamination related to nuclear testing. Information can be found on the NDEP website at https://ndep.nv.gov/cnta/LTHMP.html.

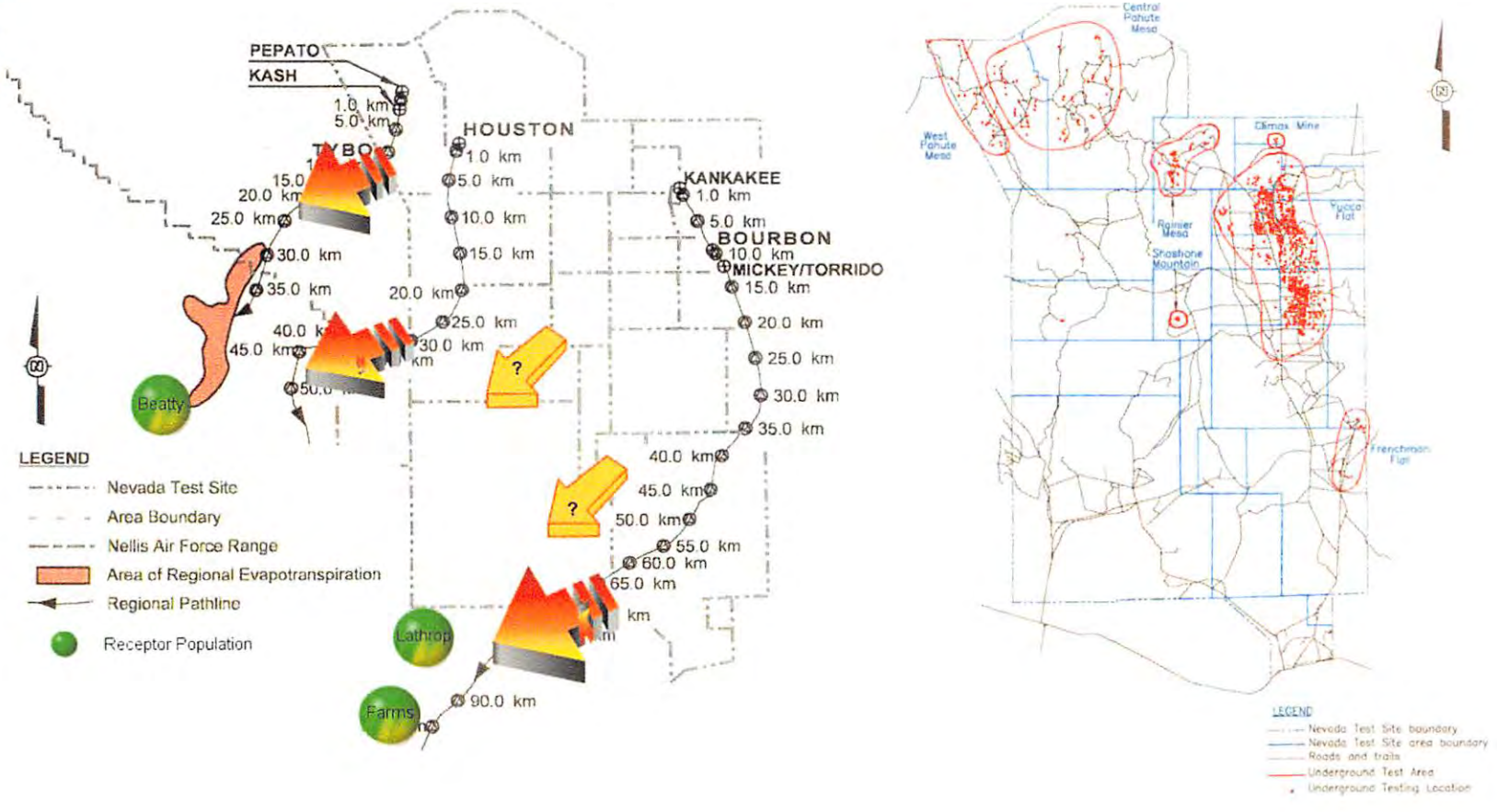


Figure 3-14. Location of underground nuclear tests at the Nevada National Security Site (Nevada Test Site), and regional paths for contaminant transport.

Source: Modified from U.S. Department of Energy, 1997, Regional Groundwater Flow and Tritium Transport Modeling and Risk Assessment of the Underground Testing Area, Nevada Test Site. The northwest boundary of the Nevada National Security Site has changed since these maps were originally published.

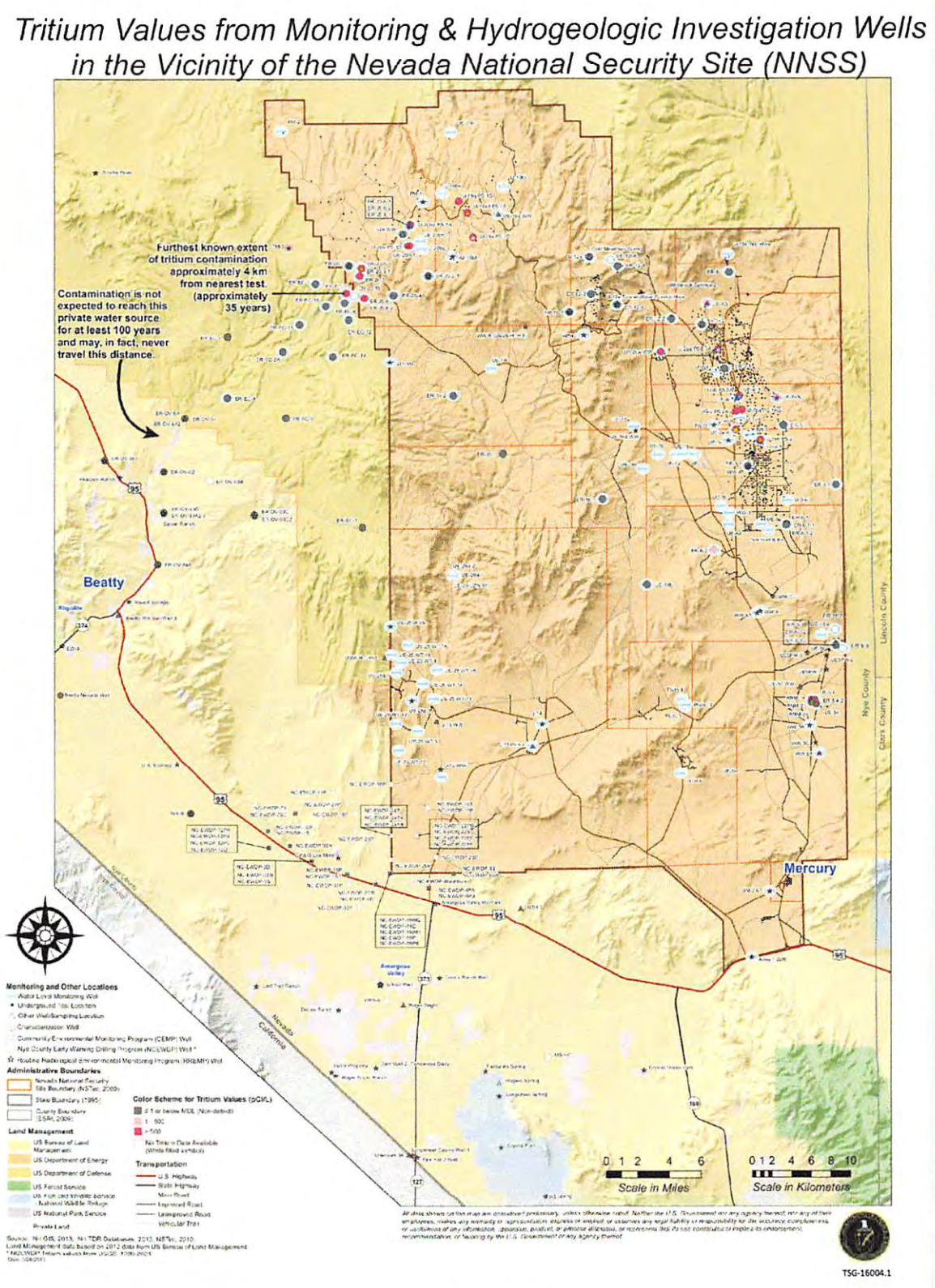


Figure 3-15. Tritium values in the vicinity of the Nevada National Security Site from a presentation by the Nevada Division of Environmental Protection (May 2013).

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Radionuclide contamination in Nye County is not limited to only the NNSS. In the 1980's tritium contamination was detected in the unsaturated zone underlying portions of the U.S. Ecology radioactive and hazardous waste site near Beatty. The release was related to the disposal of wastes with a total activity of about 715,000 curies were emplace at the site (in the 1960's and 1970's). Elevated activities of gross alpha, gross beta, and tritium were detected in groundwater sampled from on-site monitoring wells since about 1973, but significantly decreased from the maximum levels detected in the early 1980s. Wells along the site boundary continue to monitor groundwater beneath both the active and closed disposal sites.

In October 2015, an industrial fire occurred at the closed State-controlled low-level radioactive waste site area adjacent to US Ecology's active Hazardous Waste Disposal Site. Metallic sodium disposed in trenches in the 1970's, encountered water from a heavy precipitation event, and the heat generated by the sodium water reaction ignited the combustible metal, resulting in a fire. The fire burned until the next day when the source of fuel was exhausted. No releases of radioactivity were detected (State Fire Marshal, 2015).

In response to this incident, the Nevada Division of Public and Behavioral Health's Radiation Control Program is working with a Technical Advisory Group to develop a scope of work for a contract for remedial work at the closed low-level waste site. The scope of work will likely include a review of historical records and documents, and additional field investigations to fill any data gaps.

The work will likely address the potential for possible contaminant releases to the general environment: in groundwater and surface water, as well as in air, soil, plants, and animals. Information regarding the ongoing and planned activities including the Division of Public and Behavioral Health and NDEP Action Plan (2016), can be found on the DPBH website on the Radiation Control Program tab at http://dpbh.nv.gov/Reg/RPM/Beatty_LLRW/.

Photo 6. View overlooking Beatty Low-Level Radioactive Waste Site Photo credit: Nevada Division of Public and Behavioral Health

3.6. SUMMARY

Based on information presented in this Chapter, the key issues related to the groundwater resources of Nye County can be summarized as follows:

- **The presence of areas of concentrated pumpage that are contributing to areas of localized water level declines in Pahrump and Amargosa, and related subsidence impacts in Pahrump;**
- **Over-allocation of Pahrump Basin, the Amargosa Desert Basin, and the potential future shortfall of groundwater supplies;**
- **Over-allocation and potential over-allocation of groundwater rights in several Nye County basins and potential impacts;**
- **Proposed water exportation from Nye County basins by the Southern Nevada Water Authority from Railroad Valley;**
- **Naturally occurring arsenic, fluoride, and radionuclides in the groundwater in several Nye County communities;**
- **Management of areas with elevated levels of residual nitrates from naturally-occuring sources, historic land uses, and measures to protect basin water supplies in areas with risk for elevated nitrates;**
- **Impairment of quality of groundwater resources on the Nevada National Security Site and the Central Nevada Test Area, and potential off-site migration of radionuclide contamination;**
- **Land use restrictions posed by the presence of threatened, endangered and special status species; and**
- **Emerging federal policies to further restrict water use for projects on public lands, and development on private lands.**

In addition to these key issues, there are concerns regarding the poor understanding of the physical and legal water availability in terms of perennial yield, effects of groundwater withdrawals, and the interactions between the surface water and groundwater regimes. Other emerging issues include growth and water availability in over committed basins, need for conservation planning, drought protection, wastewater reuse, and aquifer management.

Chapter 4 – WATER DEMAND TRENDS AND FORECASTS

This chapter presents information on water in Nye County, and on the trends that create the demand. First, the historic water use is summarized from several sources. Next, the baseline domestic demand for 2015 is estimated, and current and future trends are considered. Finally, the time-phased demand for water based on activity in various sectors of the County's economy are estimated and discussed, based on currently available data from several sources.

4.1. HISTORIC USE AND TRENDS

Although water rights data have become readily available, data on actual water use in Nye County and Nevada as a whole are lacking. Estimates of past water use in Table 4-1 from the State Water Plan, the 2004 WRP, the 2013 DWR Nevada Statewide Assessment of Groundwater Pumpage, and other sources demonstrate the disparity in water use estimates for Nye County.

Table 4-1. Nye County Historical Water Use

Category	1985[1]	1990[1]	1995[1]	2004[2]	2010[3]	2013[4]	% of 2013 Total
Domestic	2,756	2,767	5,130	3,150	5,784	6,123	5.83%
Commercial	358	1,904	784	800	NR	1,911	1.82%
Industrial	370	22	0	NR	673	176	0.17%
Mining and Milling	4,940	7,505	7,057	8,000	35,476	21,415	20.40%
Livestock	538	739	739	800	493	1,851	1.76%
Irrigation	79,598	49,511	60,233	60,000[5]	23,460	62,648	59.67%
Wildlife and Recreation	NR	NR	NR	2,289	NR	2,284	2.18%
Public Use and Losses	148	426	1,378	NR	NR	NR	-
Municipal	NR	NR	NR	10,500	NR	5,963	5.68%
Quasi-Municipal	NR	NR	NR	NR	3,363	2,560	2.44%
Power	0	0	0	0	NR	0	0.00%
Other	NR	NR	NR	48	NR	55	0.05%
Total	88,708	62,874	75,321	85,587	70,750[5]	104,986	100%

All numbers in acre-feet per year. NR = Not Reported

[1] From Nevada State Water Plan (1999). Domestic includes public water supply systems. Totals included surface water use.
[2] From 2004 Nye County Water Resources Plan. 60,000 is total of estimated 12,000 AFY from surface water, and 48,000 AFY from groundwater.
[3] From USGS Circular 1405 (Maupin et al., 2014). Reported values include groundwater sources only. Quasi-municipal reported as public-supplied domestic.
[4] Totals from Nevada DWR Assessment of Groundwater Pumpage for 2013; irrigation not adjusted for supplemental use.
[5] Total value listed is from USGS Circular 1405 (Maupin et al., 2014); total of all reported categories sums to slightly less.

The historic data compiled in Table 4-1 illustrate the uncertainty in water use figures and point to the need for more robust measuring and reporting if accurate assessments of basin health are to be made. Although there is a great variation in the values between the sources, a few trends can be observed. Since at least 1985, agriculture has consistently accounted for nearly 60 percent of Nye County's water use, and mining and milling for about 20 percent. The total of domestic, quasi-municipal, and municipal uses account for only about 15 percent of the County's water use. Values reported were compiled primarily from federal sources and are significantly different across all

categories from the state-reported values. The 2013 groundwater pumpage estimates from the Nevada State Engineer are believed to be the most robust.

4.2. CURRENT WATER USE

Water use figures for Nye County are not known precisely and can only be estimated on the basis of the available information. The majority of current water use falls into five broad categories: public water supply systems, domestic wells, mining, agriculture (farming, livestock, and dairies), and commercial/industrial use. Together, agriculture and mining account for 80 percent of all groundwater use in Nye County (King, 2014). Recent developments in renewable energy have increased industrial water use. The estimates of current water use were derived by updating water use figures to current populations and conditions using information from the Nevada Division of Water Resources and the Governor's Office for Economic Development. The values given are estimates based upon the best information available and are suitable for planning purposes.

Public Water Supply Systems

According to the records of the Nevada Division of Environmental Protection, Drinking Water Branch *Nevada Drinking Water Information System*, there are 90 active water supply systems, and one pending water supply system in Nye County, as of October 1, 2015. These systems account for about 8 percent of Nye County's groundwater pumpage. NDEP permits three types of water systems in Nye County. Community water systems are those that serve at least 15 service connections used by year-round residents, or regularly serve 25 year-round residents. Currently in Nye County, there are 25 active Community water systems. Transient Non-Community water systems regularly serve at least 25 non-residential individuals during 60 or more days a year. In 2015, there were 43 active and 1 pending Non-Community water systems in Nye County. Non-Transient, Non-Community water systems serve at least the same 25 non-residential individuals during 6 months of the year; there are 21 active Non-Transient, Non-Community water systems in Nye County. Tables 4-2a, b, and c identify the active and pending community, transient non-community, and non-transient non-community Public Water Supply Systems (PWSs) in Nye County.

Table 4-2a. Active Community Public Water Supply Systems in Nye County

Number	Name	Number	Name
NV0002558	AMARGOSA WATER COMPANY	NV0000063	GABBS WATER SYSTEM
NV0005033	ANCHOR INN MHP	NV0000165	MANHATTAN TOWN WATER
NV0000009	BEATTY WATER AND SANITATION DISTRICT	NV0000920	MOUNTAIN FALLS WATER SYSTEM UICN
NV0000362	BIG FIVE PARK	NV0005067	MOUNTAIN VIEW MHP UICN
NV0000369	BIG VALLEY MHP	NV0000926	PAHRUMP UTILITY COMPANY INC
NV0002538	C VALLEY MHP	NV0000402	PLEASANT VALLEY
NV0000408	CALVADA MEADOWS UICN	NV0002571	RANCHO VISTA 4
NV0000218	CARVERS SMOKEY VALLEY RV AND MHP	NV0004074	ROUND MOUNTAIN PUC
NV0002554	CHIPMUNK RETREAT	NV0005028	SHOSHONE ESTATES WATER CO INC
NV0005032	COUNTRY VIEW ESTATES UICN	NV0005066	SUNSET MHP
NV0000831	DESERT MIRAGE HOMEOWNERS ASSOCIATION	NV0000237	TONOPAH PUBLIC UTILITIES
NV0000300	DESERT UTILITIES	NV0000270	UTILITIES INC OF CENTRAL NEVADA
NV0002552	ESCAPEE CO OP OF NEVADA		

Table 4-2b. Active Transient Non-Community Public Water Supply Systems in Nye County

Number	Name	Number	Name
NV0000828	AMARGOSA PARK	NV0002147	NDOT BIG SMOKEY ROADSIDE PARK RP807NY
NV0000811	AMARGOSA VALLEY VFW POST 6826	NV0002146	NDOT LATHROP WELLS ROADSIDE PARK RP801NY
NV0002141	AREA 51 DEATH VALLEY TRAVEL CENTER	NV0000943	NDOT SUNNYSIDE ROADSIDE PARK RP810NY
NV0003010	BAILEYS HOT SPRINGS	NV0004099	NEVADA TEST SITE AREA 12
NV0005038	BEATTY RV PARK	NV0004098	NEVADA TEST SITE AREA 25
NV0002151	BERLIN ICHTHYOSAUR STATE PARK	NV0001105	ORCHARD VALLEY MARKET
NV0000405	CARBERRY SQUARE	NV0004018	PAHRUMP FIRE STATION BLM
NV0002140	CARVERS CAFE	NV0005034	PAHRUMP RV PARK
NV0002555	CHAMPIONS	NV0001094	PATCH OF HEAVEN
NV0003060	CHERRY PATCH LOVE RANCH	NV0001096	SANDERS WINERY
NV0004085	CHICKEN RANCH	NV0000820	SHADY LADY RANCH
NV0000385	COYOTE CORNER III	NV0003074	SHORT BRANCH
NV0002565	COYOTE CORNER MARKET	NV0002598	STAGESTOP RESTAURANT
NV0002196	DESERT CENTER PLAZA	NV0000829	SULLIVANS PUB
NV0000923	ELKS LODGE PAHRUMP	NV0003035	THE HUBB
NV0000155	FORT AMARGOSA RV PARK	NV0000340	THE MAVERICK
NV0000918	HORIZON MARKET III	NV0000386	TOWER PIZZA
NV0002143	IONE WATER SYSTEM	NV0000827	TUMBLEWEED TAVERN
NV0000833	LJ S MARKET	NV0002575	VALLEY BAR
NV0000917	LOW LOW LIQUOR CIGARETTES AND GOODIES	NV0002556	VFW PAHRUMP POST 10054
NV0005019	MABELS BAR	NV0000946	WHOS DUNES
NV0002142	MOOSE LODGE 808	NV0000846	ALIANA (Pending)

Table 4-2c. Active Non-Transient, Non-Community Public Water Supply Systems in Nye County

Number	Name	Number	Name
NV0002190	AMARGOSA ELEMENTARY SCHOOL	NV0001122	ROUND MOUNTAIN GOLD HILL WATER SYSTEM
NV0003061	AMARGOSA SENIOR CENTER	NV0002535	ROUND MOUNTAIN SMOKY VALLEY MINE
NV0005037	AMARGOSA TOWN COMPLEX	NV0005036	SHERI'S RANCH
NV0001095	CEDAR PASS WATER SYSTEM	NV0001093	SPRING MOUNTAIN MOTOR SPORTS RANCH
NV0000834	LAKESIDE CASINO AND RV PARK	NV0000804	TOLICHA PEAK ELECTRONIC COMBAT RANGE
NV0005068	LDS CHURCH PAHRUMP WARD	NV0000823	TONOPAH CONSERVATION CAMP NDOC
NV0000871	LONGSTREET INN AND CASINO	NV0005002	TONOPAH ELECTRONIC COMBAT RANGE O AND M
NV0000360	NEVADA TEST SITE A23 AND 6	NV0005001	TONOPAH TEST RANGE AREA 10 INDUSTRIAL
NV0004067	NORTHWEST ACADEMY	NV0004068	TONOPAH TEST RANGE MANCAMP
NV0002152	NYE COUNTY COMPLEX	NV0003014	TONOPAH TEST RANGE SITE 6
NV0003036	PAHRUMP SENIOR CENTER INC		

Very few of the public water supply systems in Nye County are publicly owned; nearly all are privately owned and operated. In Pahrump, for example, there are more than 20 public water supply systems, none of which are publicly owned.

The State Water Plan totaled the quantity of water supplied by public water supply systems and estimated the percentage of the population served as 68 percent of the total. In the 2004 WRP the water demand calculations, the percentage served was assumed to remain constant for the 50-year planning period. Review of post-1999 data found that the percentage of Nye County's population served through public water supply systems is much lower than 68 percent, but is increasing with time, and as population increases. To test this assumption, data from the NDEP Drinking Water Branch website was used to determine the population served by public water supply systems in 2010 and 2015, which were 19,160 and 20,707, respectively. Comparing the population served by PWSs to the total County population for those years (46,202 and 47,319) yields values of 41.47 percent and 43.75 percent served by PWSs in 2010 and 2015, respectively. Two conclusions can be drawn from this short period of record: the population served by PWSs (1) is probably not constant through time; and (2) has increased at a cumulative rate of 2.3 percent over five years.

Domestic Water Wells

As of October 2015, the total number of domestic water wells in Nye County was 12,022. Water use from domestic wells accounts for about 6 percent of Nye County's groundwater use. Pahrump accounts for nearly 11,135 of the domestic wells drilled in Nye County. By 2004, between 600 and 700 new wells were being drilled in Pahrump each year. That number began dropping in 2004, and by 2012, more wells were plugged (40) than drilled (12). Through 2014, new wells were being drilled at rates of 2 to 15 wells per year. There are about 500 domestic wells in Amargosa Desert in the communities of Amargosa Valley and Crystal; the approximately 400 remaining domestic wells are scattered throughout Nye County's other basins.

The Nevada State Engineer estimates self-supplied domestic water use at 0.5 acre-feet per year in his annual pumpage inventory for Pahrump and Amargosa basins, and 1.0 acre-foot per year for others in Nye County. Assuming this rate and a total of 12,000 domestic wells at the beginning of 2015, the corresponding water use is estimated to be approximately 6,000 acre-feet per year. However, if the rate of 2 acre-feet per year per domestic well (as allowed by the Nevada Water Law) is used, then total domestic water use is 24,000 acre-feet per year. In most areas of the County, the difference between the two rates is of little consequence as the total use from domestic wells in most basins is less than 500 acre-feet per year. The potential demand associated with the increasing number of domestic wells has become significant in Pahrump Valley, however, and will become increasingly problematic if not aggressively addressed. It is estimated that there could be as many as 8,500 additional domestic water wells drilled in Pahrump Valley if full build-out occurs and no basin-wide solution is developed. With the existing domestic wells and the projected new wells, the total demand for domestic self served water could range from a low of 9,750 to a high-of 39,000 acre-feet per year depending upon the pumpage rate assumed.

Mining

Mining accounts for 20 percent of Nye County's groundwater use. The primary mining companies in Nye County are located in Big Smoky Valley, Gabbs Valley, Amargosa Desert, and Crater Flat. The largest mining operation is Round Mountain Gold in Big Smoky Valley. This mine produced 314,886

ounces of gold and 636,564 ounces of silver production in 2013. The second largest operation is the Premier Services's magnesite/brucite mine at Gabbs which produces magnesium oxide; production figures are confidential, but the plant is rated for 150,000 tons per year. The Sterling Mine located in Crater Flat produced 7,500 ounces of gold in 2013. Lhoist North America (formerly IMV) produces specialty clays and calcium borate from their operations in Amargosa Desert and produced 20,000 tons of sepiolite, saponite, and bentonite clays in 2013. Production at the Manhattan Gulch Mine, which produces gold and silver was not reported. Other metal, clay and commodity mines/mills which operate sporadically, were not reported (NBMG, 2014).

Water use by the mining industry has increased over the last 15 years. The 1999 State Water Plan listed water withdrawals for mining in Nye County at 4,940 acre-feet in 1985 and 7,695 acre-feet in 1995. From 1995 to 2004, combined surface and groundwater water use for mining and milling increased to nearly 38,000 acre-feet per year. In 2013, mining and milling operations used about 21,000 acre-feet of groundwater. At large open pit mines, much of the groundwater pumped is associated with pit dewatering and returned to the basin via rapid infiltration basins (Dixon, 2015) and thus is not a consumptive use.

Although minerals exploration activity continues in Nye County, new mining operations and their locations cannot be predicted with certainty. Currently, activity in the vicinity of Tonopah, Manhattan, and Round Mountain is particularly encouraging. Appendix A includes map data developed by the Nevada Bureau of Mines and Geology that shows the locations of mineral exploration and mining activity in Nye County. For planning, it is assumed that two new mining operations will start over the next 50 years but these new ventures will probably be offset by two mine closures elsewhere in the County. Thus, groundwater use by the mining industry is expected to increase only slightly over the planning period to a total annual rate of about 25,000 acre-feet. Because mining operations are typically located in remote areas, are of temporary duration, and the water use is recognized as a preferred use, it can be assumed that the water demand for any new operations will be met on a case-by-case basis. It is also assumed that adequate water supplies will be available to support temporary development for mining.

Photo 7. Tonopah Mining Park Museum. Photo Credit: Thomas Buqo, 2009

Photo 8. Amargosa Valley alfalfa field. Photo credit: TerraSpectra Geomatics.

Agriculture, Livestock, and Dairies

Agriculture is a significant part of Nye County's economy and the largest water user in Nye County accounting for over 60 percent of groundwater use. The contribution of the agricultural sector of the economy continued to increase during the last decade even though the land in agriculture, the number of farms and average farm size, and the total irrigated acreage have declined. In 2012, Nye County had 198 farms; more than 60 percent of these farms were small – between one and 49 acres. Nye County's total market sector output for agricultural products, including employment was just over $52 million. Farming of other crops, livestock production, and dairy cattle and milk production account for 95 percent of total agricultural sales. Nye County's largest food manufacturing industries are fluid milk and butter, and coffee and tea. Appendix A includes map data that show the areas of agriculture production in Nye County as of 2013 (Nevada Department of Agriculture, 2014).

Both surface water and groundwater are used for irrigation and livestock although actual surface water is not tracked by DWR. The total acreage of irrigated farm and pasture land has declined, several factors suggest slight increases in irrigation water use are likely over the planning period. In 2004, of the 60,000 acre-feet of total agricultural water withdrawals, 48,000 acre-feet were groundwater and 12,000 acre-feet were surface water. Total agricultural water use for 2013, including both irrigation and stock watering was reported by King (2014) to be 65,000 acre-feet per year from groundwater only. Should drought conditions in northern Nye persist, groundwater pumpage will increase to make up for shortfalls in surface water supplies, in a quantity that cannot be predicted.

Although agricultural use of groundwater increased dramatically since 2004, by an estimated 12,000 acre-feet per year, it is expected to increase only slightly in northern Nye County over the coming decades. In northern Nye County, an estimated 20 new pivots are expected to come into

operation by 2060. In Pahrump Valley, agricultural lands continue to give way to urbanization but may continue to irrigate small tracts. In the late 1990s, large tracts of farmland in Pahrump Valley were subdivided and developed for residential and commercial uses. By 2013, less than 3,500 acre-feet of groundwater was pumped in Pahrump Valley to cultivate about 800 acres of land. In Amargosa Valley, approximately 2,700 acres were irrigated in 2013 with 15,000 acre-feet of water. Irrigated land in Railroad Valley totals about 7,000 acres but only about 5,000 acres are under cultivation in any given year and most of the irrigation source water is surface water rather than groundwater.

Thus, agricultural production in Nye County will likely remain level for the short term, but is expected to increase in the future, even as new federal land management policies and DWR curtailment conservation measures are implemented in several Nye County basins. This trend is projected to cause the demand for groundwater to remain increase slightly in northern valleys as the cost of agricultural business in neighboring states increases.

There is uncertainty in the quantity of water used each year for agricultural and livestock production in Nye County. The actual acreage under irrigation in any given year is not reported or tracked in many basins. The Nevada Division of Water Resources conducts crop inventories in two basins, Upper Reese Valley, and Big Smokey Valley Northern Part. Pumpage inventories are conducted in four basins, Pahrump Valley, Amargosa Valley, Penoyer Valley, and Indian Springs Valley. Agricultural production can vary depending upon the individual farmer's crop plan and market conditions. The consumptive use rates for the crops grown in the County also varies. The irrigation efficiency can also be quite variable reflecting the soil characteristics, seasonal rainfall, the type of crop, the manner of irrigation, the preparation of the cropland, and the cost of the water in terms of electricity and waterworks.

According to the 2013 Nevada Agriculture Analysis and Opportunities (Nevada Department of Agriculture, 2014), the County's livestock industry had approximately 30,500 head of cattle and sheep in 2007, or about 9,000 fewer animals than in 1987. This trend suggests that livestock production in Nye County, which has remained stable for more than a decade, may be declining. Nonetheless, water withdrawals for livestock purposes are assumed to remain constant at a rate of 1,800 acre-feet per year into the foreseeable future. The bulk of this demand will be met from surface water and springs, and the remainder from supplemental groundwater pumping.

The dairy industry continues to be a key economic sector in southern Nye County, and leads Nevada in milk production. Three dairies owned by Rockview Farms - Ponderosa Dairies 1, 2, and 3 in Amargosa Valley - house nearly 12,000 cows and 5,200 calves. Several thousand cows at the Pahrump Dairy located in Pahrump Valley were moved to Amargosa Valley in 2010. According to *An Economic Analysis of the Food and Agriculture Sector 2015: Nevada's Counties*, Nye County's dairy industry had a total output in 2015 of almost $9.3 million (Minnesota IMPLAN Group, Inc., 2014).

Nye County's dairies do not produce enough feed to meet their demands, and have had a beneficial impact on the agricultural production of the region. For every dollar spent on labor, the dairies spend seven dollars on supplies and services, with much of these spent on feed grown within the region. The Ponderosa Dairy has increased their feed production, as have several farmers in

Amargosa Valley. Much of the water use by the dairy industry is included within the estimates for commercial water use.

Federal Water Use

Federal agencies acquire and use water in manners that are different from other Nye County water users. For example, land management agencies, such as the BLM, USFS, and USFWS manage vast tracts of land in Nye County that are held in public trust by the United States and managed by these federal agencies for their natural resource values and opportunities. The agencies, taken together, typically hold tens of thousands of acre-feet of water rights to maintain water for wildlife, critical habitat for special status species, and for the maintenance of instream flows. For example, the USFWS holds nearly 20,000 acre-feet of water rights in the Amargosa Desert Basin, with a perennial yield of 24,000 acre-feet, this appropriation represents nearly 75 percent of the available water resources of the basin.

Other agencies, such as the DOD and DOE, are mission oriented and require extensive land withdrawals from the public domain to accommodate the high-hazard operations that are conducted there. These military and other defense-related operations are not generally water intensive and require relatively minor quantities of water to support personnel (quasi-municipal) and mission-related (industrial) purposes. The extensive land withdrawals necessary for their activities, however, prevent access to precious groundwater resources. In Nye County, DOD has historically acquired water rights for the NTTR through the State's administrative process. Thus, DOD demand can be quantified like any other sector by totaling permits, certificates, vested rights, applications, etc. The DOE, now the NNSA, asserts federal reserved water rights in support of the mission-related activities on the NNSS (formerly the Nevada Test Site); NNSA's water use is discussed in greater detail, below.

The primary federal water use in Nye County is at the NNSS (DOE), the Tonopah Test Range (DOD), NTTR, and in Amargosa Valley and Railroad Valley for wildlife conservation (USFWS). Historically, actual water use by the DOI's USFS and BLM has been small by comparison. While the quantity used is minor, recent land use plans issued by these agencies include extensive federal management actions intended to reduce, restrict, or eliminate authorized land uses that require water use. The U.S. Park Service does not use water in Nye County but has become a significant factor in water resource planning as a result of the mitigative measures required to be implemented for the protection of Devils Hole and Death Valley National Park. These federal policies and actions impose severe constraints on types and locations of potential development on federally managed lands. Appendix A includes map data that show federal land use constraints affecting Nye County.

National Nuclear Security Administration - The NNSA operates three water supply systems at the NNSS. Six permitted water supply wells are pumped into a system of storage tanks, sumps, and distribution systems over portions of the 1,375 mi^2 facility. The groundwater is withdrawn from six hydrographic basins (Mercury Valley, Yucca Flat, Frenchman Flat, Buckboard Mesa, Jackass Flats and Gold Flat). In its 2013 NNSS EIS, the NNSA continued to assert sovereign immunity from State Water Law for water needed to support the purpose of the land withdrawal (i.e., the site mission). The agency semi-quantified this implied water right in its 1996 Nevada Test Site EIS and 1998 Nevada Test Site RMP by establishing "annual duties" based on historic pumping rates. Water is

used for quasi-municipal and industrial purposes, and current use is less than 365 acre-feet, well below historic demand. Table 4-3 summarizes NNSS water withdrawals in 2014 by basin. Table 4-4 summarizes the maximum annual pumpage on the NNSS by basin.

Table. 4-3. 2014 Groundwater Withdrawals from active wells

Well	Basin	Gallons	Acre-feet
UE-16d	159	21,070,137	64.66
WW-4	160	7,188,943	22.06
WW-4A	160	38,594,572	118.44
WW-5B	160	40,741,794	125.03
WW-5C	160	13,100	0.04
Army 1 WW	225	4,475	0.014
J-12 WW	227A	1,657,500	5.09
J-14 WW	227A	1,178,085	3.62
WW-8 (30-2031 ft)	227B	7,732,299	23.73
	Totals:	**118,180,905**	**362.684**

Active Well WW-C1, Basin 159 - last pumpage reported in 2012 at 9,118,313 gallons, or 27.98 acre-feet.

Table. 4-4. Maximum Historical Pumpage

Basins	Use AFY
Mercury Valley	428
Yucca Flat	912
Frenchman Flat	1,664
Buckboard Mesa	524
Jackass Flats	277
Gold Flat	426
Kawich Valley	425
Total	**4,656**

Metered data from NSTec water-production report, available from USGS/DOE Cooperative Studies in Nevada.

U.S. Department of Defense - The U. S. Air Force operates water supply systems on the NTTR and the Tonopah Test Range. The Air Force has 32 water rights in Nye County for springs and surface water sources totaling 368.55 acre-feet and has 15 groundwater appropriations in Nye County totaling 1,488.93 acre-feet, slightly less than reported in 2004. Although the U.S. Air Force water right holdings in Nye County are appreciable, the actual quantity of water is small. From 2000 through 2004, metered water use at seven water supply wells in Nye County ranged from 121.5 to 179.9 acre-feet per year. Water use at the NTTR and Tonopah Test Range have been relatively flat since 1995 at an average rate of 155 acre-feet per year.

National Park Service - The National Park Service (NPS) has no water rights in Nye County but asserts a federally reserved right to all unappropriated water from any water source identified within the boundaries of Death Valley National Park. This assertion of federal right includes the portion of Death Valley National Park, including Devils Hole, that is within Nye County (about 107,000 acres). Although the NPS has not developed any water supplies in Nye County, the impacts of the NPS and other DOI agencies' policies and administrative actions continue to have a significant impact on water resource availability in the County. These impacts are discussed in detail in Chapter 5.

Bureau of Land Management – The public lands in Nye County, comprising nearly 11,380,000 acres, are administered by four different BLM Districts. Although water use *on* BLM land was considered in the 2004 WRP, actual water use *by* the BLM was not evaluated. The agency holds a total of 2,407 acre-feet of surface and groundwater rights in the County in widely spread locations, primarily for wildlife, stock watering, quasi-municipal, and other purposes. Existing and proposed management direction mandates that BLM not only determine water demands for meeting management objectives and filing for appropriative water rights in accordance with the Nevada Water Law, but

also that BLM assert federally reserved rights in various circumstances, "as applicable". BLM currently asserts federally reserved rights to 2,135 acre-feet of surface water in Nye County. Newly proposed management directions focus on preserving mesquite and acacia woodlands, riparian areas, and all other areas containing any wildlife, wilderness, scenic, historic, or cultural values and disallowing projects that BLM perceives might adversely impact the water table that supports these areas. Thus, while the actual use of water resources is small, the effects of land use policies are making access to state-controlled water on federally-controlled public lands increasingly difficult.

U.S. Fish and Wildlife Service - The USFWS holds extensive surface water rights in Amargosa Valley for the conservation of numerous endemic species at Ash Meadows. The USFWS currently holds 62 permitted and certificated water rights totaling about 19,389 acre-feet, making it the largest single water right holder in the Amargosa Desert basin, and in Nye County. The USFWS does not plan to file for new water rights but will likely continue to purchase rights to spring discharge at Ash Meadows as willing sellers come forward.

U.S. Forest Service - Historic water use by the USFS was not evaluated in the 2004 WRP. The agency holds 6,760 acre-feet of permitted and vested surface water rights in the County in widely spread locations for wildlife, fire control, recreation, and other purposes. No new water demands have been identified for the 1.9 million acres of USFS lands in Nye County.

4.3. FORECASTED FUTURE DEMAND 2010 THROUGH 2060

In this section, the forecasted water demand in Nye County through the year 2060 is presented and discussed. Given the forecast for significant population growth in the western region of the United States, and related potential for economic opportunities, it is assumed that population growth in Nye County will continue to increase gradually but steadily if economic factors remain favorable. Pahrump's proximity to the Las Vegas Metropolitan area is assumed to continue to influence growth in southern Nye County, and the majority of Nye County's population will continue to reside in the Pahrump Valley. Population growth in other Nye County communities is expected to be relatively stable, and largely urban/suburban in nature.

The process that was used in developing this forecast mirrors the method outlined in the Nevada State Water Plan for linking water forecasts with the socioeconomic forecasts, and used in the 2004 WRP. This process involved the following steps:

1. The population was projected using the 1999 State Water Plan projections, which extend to 2020, and applied a constant 1.5 percent annual growth rate through 2060. The selection of the 1.5 percent annual growth rate was based on census trends and projections, economic forecasts, and assumptions for each sector of the economy, as discussed in Chapter 2.

2. The population forecasts were multiplied by the per capita water use rates for public water supply systems and self-supplied domestic wells. Per capita water use rates for Nye County were taken from studies by the USGS, the Nye County Water District, the GWMP, and the Pahrump Master Plan Update and are consistent with those developed by Kuver (2016a). The results are presented in Table 4-5 and serve as the baseline domestic water demand forecast for Nye through the year 2060.

3. The water demand to serve future development and related development-induced population growth were estimated for the various modes of development discussed in Chapter 2. Direct and indirect employment values for each mode of development were taken from state reports, industry publications, federal environmental impact reports, and other published sources. The induced population for each development mode was calculated to determine the total development-related population over the baseline population projected in step 1.

4. The total population above baseline was multiplied by the per capita rates for commercial and industrial employment (from the 1999 State Water Plan) to project the total employment-induced water demand. The operational water demands were estimated from publicly available documents including reports by various State of Nevada and federal agencies (e.g., Nevada Bureau of Mines and Geology, Office of Economic Development, BLM, Bureau of Reclamation, U.S. Geological Survey). The results are presented in Tables 4-6a and b.

5. The water demands associated with the various modes of development were time-phased, that is, the various developments are assumed to occur over the course of the 50-year planning period, rather than simultaneously. Some modes of development are projected to occur more than once during the planning period (i.e. five renewable energy facilities, four new oil wells, etc.). The projected timing of each mode of development is based on judgement and is meant to be used only for planning purposes. The results are presented in Table 4-7.

6. The baseline demand was added to the time-phased demand for various modes of development to forecast the water demand in Nye County through the year 2060. The results are also presented in Table 4-7 and shown in the adjacent graph.

The forecast projects that by the year 2020, the total demand for water in Nye County will be at 112,000 acre-feet, or about 10 percent higher than the State Water Plan estimate of 102,000 acre-feet. In contrast, the 2004 WRP projected a total 2020 water demand of 166,000 acre-feet, nearly 62 percent higher than the State Water Plan projection. Differences in the forecasts result from using different assumptions about the economic future of Nye County, including different annual growth rates for population projections, and the expected modes and extent of development during the planning period. A comparison of the 2015 projection of 108,000 acre-feet to the State Engineer's 2013 reported groundwater pumpage of 105,000 acre-feet suggests that the results are reasonable. The basis for the assumptions that lead to the revised 2016 forecasts is discussed below for each sector of the economy.

Total Municipal and Industrial Water Use

In the absence of water use data, the State Water Plan (1999) projected that 13,000 acre-feet would be needed by 2020 to supply water for domestic, commercial, industrial, and thermoelectric uses while the 2004 WRP projected an estimated 33,000 acre-feet per year. By comparison, this 2016 update projects 16,500 acre-feet for those same uses. The differences result from (1) the variation in population projections used, and (2) the per capita rates for domestic self- and publicly-supplied categories, which have been revised downward based on data available since the 1999 Water Plan and 2004 WRP were issued.

Table 4-5. Projected Future Domestic Baseline Water Demand

NDWP-Modified Population Forecasts Projected at 1.5% Growth Rate							All Other Uses Held Constant		
Domestic Use							Other		Total
Population Projection				Domestic Water Demand			All Other Uses (constant)		
Year	Population	Population served by PCR	PCR GPD	Demand by PCR GPD	Total GPD	Total AFY	PU, C&I AFY	Other AFY	Baseline Demand AFY
2010	41,185	17,079	268.0	4,577,172	9,012,676	10,095	4,400	88,800	103,295
		24,106	184.0	4,435,504					
2015	45,471	19,898	268.0	5,332,664	10,038,096	11,244	4,400	88,800	104,444
		25,573	184.0	4,705,432					
2020	48,684	22,443	268.0	6,014,724	10,843,068	12,146	4,400	88,800	105,346
		26,241	184.0	4,828,344					
2025	52,446	25,384	268.0	6,802,912	11,782,320	13,198	4,400	88,800	106,398
		27,062	184.0	4,979,408					
2030	56,500	28,646	268.0	7,677,128	12,802,448	14,341	4,400	88,800	107,541
		27,855	184.0	5,125,320					
2035	60,866	32,259	268.0	8,645,412	13,909,100	15,580	4,400	88,800	108,780
		28,607	184.0	5,263,688					
2040	65,570	36,260	268.0	9,717,680	15,110,720	16,926	4,400	88,800	110,126
		29,310	184.0	5,393,040					
2045	70,638	40,687	268.0	10,904,116	16,415,100	18,387	4,400	88,800	111,587
		29,951	184.0	5,510,984					
2050	76,097	45,582	268.0	12,215,976	17,830,736	19,973	4,400	88,800	113,173
		30,515	184.0	5,614,760					
2055	81,978	50,990	268.0	13,665,320	19,367,112	21,694	4,400	88,800	114,894
		30,988	184.0	5,701,792					
2060	88,314	56,963	268.0	15,266,084	21,034,668	23,562	4,400	88,800	116,762
		31,351	184.0	5,768,584					

Domestic Per Capita Rates (PCR) gallons per day (GPD)	
Public Water Supply Systems[1]	268.0
Domestic Well Self Supplied[2]	184.0

Groundwater Use By Category for 2013 (modified from King, 2014)	AFY
Domestic (Self-Supplied)	6,100
Commercial & Industrial (C&I)	2,100
Agriculture	65,000
Mining	21,000
Public Use (PU)	2,300
Public Water Supply Systems	8,500
Total Use	105,000

[1] From the WSAI Report (GGI, 2013). Includes commercial and industrial services.

[2] Based on DWR's value of 0.5 afy per domestic well, and U.S. Census Bureau's value of 2.42 persons per household.

Assumptions:

A. Percentage of domestic use from public water supply systems was calculated to be 41.47% for 2010, and 43.76% for 2015 using NDEP Drinking Water Branch data (2010 and 2015). This 2.3% rate of increase observed between 2010 and 2015 is applied to each 5-year interval average pumpage beginning with 46.1% in 2020.

B. Commercial and Industrial uses are combined with Public Use for a total baseline value of 4,400 afy.

C. Other groundwater use is baselined at 88,800 afy: 21,000 afy for mining; 65,000 afy for agriculture; and 2,800 afy for federal uses at the NNSS, Ash Meadows, and NTTR.

Table 4-6a. Population Impacts of Various Modes of Development

Mode of Development	Minimum Direct Employees	Maximum Direct Employees	Minimum Indirect Employees	Maximum Indirect Employees	Minimum Population Over Baseline	Maximum Population Over Baseline
Golf Resort	50	75	37	55.5	224	337
Federal Facilities and Lands	40	600	30	444	181	2,694
Agricultural expansion (2,600 acres)	0.6	1	0.5	0.74	2.8	4.5
Non-farming agribusiness	50	75	37	55.5	224	337
Renewable Energy Facilities (110 MW) (5)	175	225	129.5	166.5	786	1,010
Tourism growth (5% per year)	500	750	370	555	2,245	3,367
Stateline/I-11 related expansion	250	300	185	222	1,122	1,347
Oil wells (4)	80	120	59.2	88.8	359	539
New mine operation/expansion (2)	1,000	1500	740	1110	4,489	6,734
Marijuana Cultivation Facilities (20)	1,000	1,500	740	1,110	4,489	6,734
Four-year college (1)	100	150	74	111	449	673
Airport development	15	20	11.1	14.8	67	90
Other industrial development	300	500	222	370	1,347	2,245

Per Capita Rates (gallons per day)

Commercial	82.4
Industrial	82.4

Population Over Baseline =
Direct + Indirect + Induced Population

Induced Population =
(Direct + Indirect) x 2.58

Table 4-6b. Projected Future Water Demand for Various Modes of Development

	Employment Minimum Water Demand Over Baseline		Employment Maximum Water Demand Over Baseline		Non-Employment Water Use		Total Minimum Water Demand Over Baseline		Total Maximum Water Demand Over Baseline	
Mode of Development	mgd	afy	mgd	afy	mgd	afy	mgd	afy	mgd	afy
Golf Resort	0.02	21	0.02	31	1.07	1,200	1.09	1,221	1.09	1,231
Federal Facilities and Lands	0.01	17	0.22	249	0.31	350	0.32	367	0.53	599
Agricultural expansion	0.001	1	0.001	1.6	8.92	10,000	8.92	10,000	8.92	10,000
Non-farming agribusiness	0.02	21	0.03	31			0.02	21	0.03	31
Renewable Energy Facilities (110 MW) (5)	0.06	73	0.08	93	4.02	4,500	4.08	4,573	4.10	4,593
Tourism growth (5% per year)	0.18	207	0.28	311			0.18	207	0.28	311
Stateline/I-11 related expansion	0.09	104	0.11	124	1.07	1,200	1.16	1,304	1.18	1,324
Oil wells (4)	0.03	33	0.04	50	0.01	16	0.04	49	0.05	66
New mine operation/expansion (2)	0.37	414	0.55	622	2.68	3,000	3.05	3,414	3.23	3,622
Marijuana Cultivation Facilities (20)	0.37	414	0.55	622	0.36	400	0.73	814	0.91	1,022
Four-year college (1)	0.04	41	0.06	62	0.33	1,250	0.37	1,291	0.39	1,312
Airport development	0.01	6	0.01	8	0.89	1,000	0.90	1,006	0.90	1,008
Other industrial development	0.11	124	0.18	207	0.45	500	0.56	624	0.63	707

mgd = million gallons per day; afy = acre feet per year; MW = megawatt; Non-farming agribusiness = Agricultural related businesses e.g. equipment sales and service, fertilizer suppliers, etc.

Assumptions:

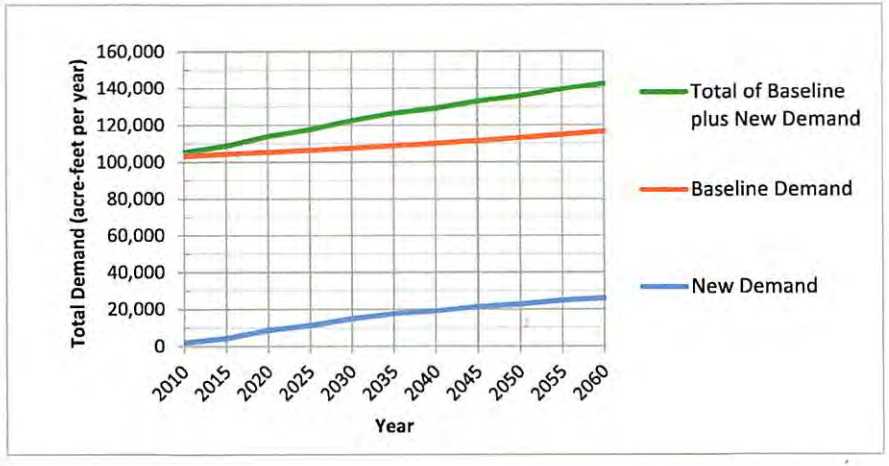
1. Golf course use assumes a rate of 4 acre-feet/acre from Lyman, 2012, plus 1 acre-foot/acre of effluent re-use for a total application rate of 5 acre-feet/acre used in the GWMP (2015).
2. Stateline area expansion assumes small casino and RV park similar to Longstreet Inn and similar Interstate Corridor Commercial development.
3. Water use at campus assumes 5 acre-feet/acre times 250 acres.
4. Projections assume agriculture will increase by 20 pivots, or about 10,000 acre-feet through 2060. Associated Employment Demand is lost in rounding error. Non-farming agribusiness is assumed to increase with development of marijuana cultivation and remain constant thereafter.
5. Induced population rate from Buqo and Baughman, 1999.
6. Deep oil well horizontal and directional hydrofacturing rate 2.5 to 3.5 AFY/well from DOI-BLM-NV-B000-2015-0001-EA.
7. Airport assumes commercial and industrial development at the Tonopah, Beatty, and Gabbs Airports. Of the forecasted total use of 1,008 AFY over the planning period, 672 AFY is allocated at Tonopah Airport, and 168 AFY each for Beatty and Gabbs Airports.

Table 4-7. Projected Maximum Future Water Demands - Baseline Plus New Development

Year	Golf Resort afy	Federal Facilities afy	Ag afy	Ag-Bus afy	Renewable Energy afy	Tourism afy	Stateline and I-11 afy	Oil wells afy	Mining afy	Marijuana Cultivation afy	College afy	Airport afy	Other afy
2010						157			1,811				
2015			1,008	11	918	172			1,811	51			382
2020	1,231	199	2,016	21	918	187	147	16.5	1,811	255	1,312	168	382
2025	1,231	299	3,024	25	1,836	202	294	16.5	1,811	510	1,312	336	382
2030	1,231	399	4,032	31	1,836	219	441	33	3,622	766	1,312	504	534
2035	1,231	499	5,040	31	2,754	233	588	33	3,622	1,022	1,312	672	534
2040	1,231	599	6,048	31	2,754	249	736	49.5	3,622	1,022	1,312	840	534
2045	1,231	599	7,056	31	3,672	264	883	49.5	3,622	1,022	1,312	1,008	707
2050	1,231	599	8,064	31	3,672	280	1,029	66	3,622	1,022	1,312	1,008	707
2055	1,231	599	9,072	31	4,593	295	1,177	66	3,622	1,022	1,312	1,008	707
2060	1,231	599	10,080	31	4,593	311	1,324	66	3,622	1,022	1,312	1,008	707

Year	Baseline Demand afy	New Demand afy	Total Demand afy
2010	103,295	1,968	105,263
2015	104,444	4,353	108,797
2020	105,346	8,664	114,010
2025	106,398	11,279	117,677
2030	107,541	14,960	122,501
2035	108,780	17,571	126,351
2040	110,126	19,028	129,154
2045	111,587	21,457	133,044
2050	113,173	22,643	135,816
2055	114,894	24,735	139,629
2060	116,762	25,906	142,668

afy = acre-feet per year



Mining

Both the State Water Plan (1999) and the 2004 WRP projected mining water use to remain flat at 8,000 acre-feet per year through 2020. Review of historical records indicate that mining related water demand increased to 21,000 acre-feet per year by 2015, an increase of slightly more than 1,000 acre-feet per year. Mining has been, and continues to be, a volatile sector of the County's economy. Fluctuations in gold, silver, and other mineral prices create wide swings in employment and population. Nye County has considerable proven mineral reserves and resources for several metals and non-metal resources. Further exploration could identify new deposits not yet identified, and exploration is active. For the purposes of calculating water demand, this plan assumes that three new mining projects will occur over the foreseeable future. This includes the expansion of Round Mountain Gold that occurred in 2010. One of these projects will be offset by closure of one existing mining operation. The additional demand for water associated with the new mine is estimated at 1,811 acre-feet per year beginning in 2030. Because of the many unpredictable factors in forecasting the mineral industry, the use could be appreciably higher. However, as mining and milling use is typically temporary (five to 40 years), occurs in isolated locations, and is a preferred use under Nevada Water Law, it is assumed that water will be available to support the mining industry.

Oil and Gas

In 2015, the BLM offered over 250,000 acres of oil and gas leases in Nye County, the majority of which are located in the BLM's Battle Mountain District. The future water demand forecast assumes at least four new deep oil wells will be drilled and developed during the 50-year planning period. The water demand calculation assumes that directional and/or horizontal hydro-fracture stimulation will be necessary during well development.

Agriculture

While not as dramatic an increase as reported by the State Water Plan and the 2004 WRP, the 2016 projections suggest that growth in the agriculture sector will remain relatively flat in the near term, but will increase slightly over the 50-year planning period. Thus even if agricultural water use increases only slightly as use in other economic sectors increases, at the currently projected annual growth rate of 1.5 percent per year, agriculture will continue to account for at least 50 percent of all water use in Nye County through the year 2040.

Renewable Energy

Appendix A includes map data compiled by the Nevada Bureau of Mines and Geology that show geothermal resource potential in Nye County. Although BLM recently offered over 250,000 acres of geothermal lease parcels in Nye County in 2015, the DWR shows no pending applications for geothermal resource development. Thus, a future related water demand is not specifically considered, however, future water demand for other uses could accommodate future geothermal development, should it occur.

Appendix A includes map data compiled by the Nevada Bureau of Mines and Geology that show the areas of solar and wind energy potential in Nye County. The development and advancement of renewable energy technology was not foreseen in the State Water Plan or the 2004 WRP. Since 2007, several technological advances, and new federal mandates and policies, have given rise to the potential for large scale development of renewable energy power generation facilities. Several

technologies have been proposed, each facing different challenges. The solar tower boiler technology with molten salt storage has been successfully sited, constructed, and is now operating at the 110 MW Crescent Dunes facility north of Tonopah.

Water-cooled solar trough technology has had limited success in southern Nevada due to the high temperatures that must be overcome, and the scarcity of water supplies. Although hybrid cooling technologies could reduce water demand, no solar trough facilities have been successfully sited in Nye County. Water use is not a consideration in the implementation of photovoltaic technology due to its low water demand; one 15 MW photovoltaic Community Solar Project operated by the Valley Electric Association was completed in Pahrump in 2016. There are several potentially viable applications proposing various technologies pending on federal lands, and limited sites available for development on private land within the County. Based on these and the current planning horizon, the future water demand calculation assumes one additional 110 MW facility will be constructed every ten years over the period of the plan (i.e., a total of five facilities including Crescent Dunes).

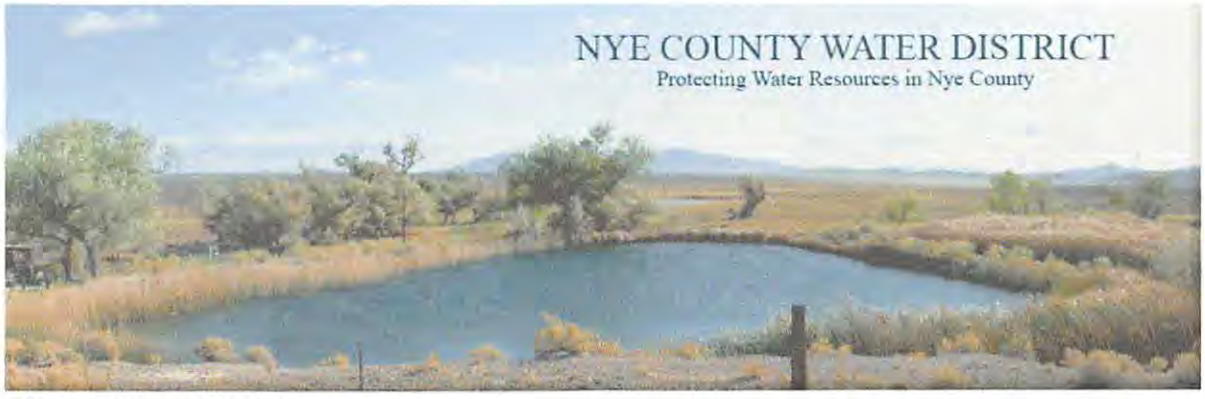
Federal Water Users

The State Water Plan did not distinguish federal water use from other sectors as is done in this plan. The 2004 WRP assumed that federal water use would remain constant at 17,000 acre-feet per year including the 12,600 acre-feet of spring discharge appropriated by the U.S. Fish and Wildlife Service to sustain the wildlife habitat at Ash Meadows, and about 3,400 acre-feet per year of water use at the NTTR and NNSS. In contrast, based on existing and expanding mission requirements and emerging federal land management policies, this plan assumes that water use by federal agencies will increase slightly during the 50-year planning period.

4.4. SUMMARY

Using the population projections developed in Chapter 2, and updated values for per capita water use, the baseline future water demand was calculated from 2010 through the year 2060. Historic economic trends, and current information on the status of land, land use applications, and actions pending in the Nye County Planning Department were used to estimate new future water demand by various modes of development during the 50-year planning period. The projected development was time phased, and added to the baseline use to project the total future water demand. As a result of the different economic conditions, and availability of additional data over a longer period of record, the total future demand projections in this plan are significantly lower than those projected by the 2004 WRP.

The projections of future water demand developed and presented in this chapter compare favorably with the most recent reported pumpage by the State Engineer (King, 2014). There is considerable uncertainty in the estimates presented in this plan. Water use estimates and future demand calculations must be reviewed and updated periodically to consider and address the unforeseen changes in economic conditions.



Nye County Water District

Chapter 5 – WATER MANAGEMENT AND PLANNING ISSUES

The potential for growth and development in Nye County over the next 50 years must take into account future changes that are beyond prediction. The economic collapse of 2008 demonstrates how unpredictable the future can be. All sectors of the Nye County economy are subject to changes in market conditions, policies, and technology that are decided and controlled on regional, national, and global levels. These factors could change the economic outlook, population, employment patterns, and water use forecasted in the County by the year 2060. Thus, there are numerous factors associated with planning, development, and management of the water resources that exist that are beyond Nye County's control.

The NCWD was created by Nevada Legislature in 2007 pursuant to Chapter 542 of the Nevada Revised Statutes under Selected Special and Local Acts. The Nye County Water District Act grants the District broad authorities with respect to all aspects of water management. The powers extend to the acquisition, storage, sale and distribution of water and water rights. The Water District maintains this authority through a wide range of powers, including the ability to sell, lease, purchase, construct, and operate lands, property, and water rights for any water related benefit. In order to carry out these powers, the District has the authority to hire employees, enter contracts, assume costs and expenses, levy taxes, and to sue and be sued.

In addition to administrative authorities, the District may enter upon any land for reasons pertaining to necessary improvements, surveys, maintenance, construction, supplementation, and delivery or storage of water. In cooperation with the State of Nevada, the federal government, and its agents, affiliates, and applicable laws, the Act ensures the district's power to conserve and reclaim water, appropriate or transfer water and water rights, import water, and restrict water usage in cases of emergency. The District may be funded or granted financial assistance to perform these functions.

Certain Water District actions require approval from a majority of the BoCC through conditions of the Act. Under these terms, the BoCC-appointed governing Board of the Water District is permitted to adopt ordinances, rules, regulations, and bylaws deemed fit for the management and operations of water for the District. With BoCC approval, the District may also exercise the power of eminent

domain, in or outside of the service area, to acquire property or water rights necessary to fulfill the powers of the District and its ability to provide adequate water service.

In summary, the Nye County Water District Act empowered the Water District to engage in the actions necessary to conduct the business of the Water District in serving the community of Nye County, and resolve the myriad of water resource issues facing Nye County. This chapter provides an overview of the laws and regulations that govern water development, use and protection, and the water supply and environmental issues that must be considered in developing a long-term resource management strategy for the County.

5.1. REGULATORY FRAMEWORK

While the water resources of Nye County occur within the boundaries of the County, the County itself has limited authority over the use of those resources. In this section the major state and federal laws that must be taken into consideration are briefly identified and discussed.

Nevada Water Law

Nevada Water Law governs the administration of the waters of the State of Nevada. The Nevada Department of Conservation and Natural Resources is the branch of State government responsible for management of water resources and the Division of Water Resources, directed by the Nevada State Engineer, is responsible for the allocation of the public waters of the State, administering the law. The State Engineer's actions and decisions are bound by the water law and the implementing regulations in the Nevada Administrative Code (Table 5-1).

Table 5-1 Nevada Water Law and implementing Regulations

Nevada Revised Statutes Title 48—WATER	
Chapter 532	State Engineer
Chapter 533	Adjudication of Vested Water Rights; Appropriation of Public Waters
Chapter 534	Underground Water and Wells
Chapter 534A	Geothermal Resources
Chapter 535	Dams and Other Obstructions
Chapter 536	Ditches, Canals, Flumes and Other Conduits
Chapter 537	Navigable Waters
Chapter 538	Interstate Waters, Compacts and Commissions
Chapter 539	Irrigation Districts
Chapter 540	Planning and Development of Water Resources
Chapter 540A	Regional Planning and Management
Chapter 541	Water Conservancy Districts
Chapter 543	Control of Floods
Chapter 544	Modification of Weather
Nevada Administrative Code	
Chapter 532	State Engineer
Chapter 533	Adjudication of Vested Water Rights; Appropriation of Public Waters
Chapter 534	Underground Water and Wells
Chapter 534A	Geothermal Resources
Chapter 535	Dams and Other Obstructions
Chapter 538	Colorado River Commission of Nevada
Chapter 548	Conservation

IN THE SUPREME COURT OF THE STATE OF NEVADA

TIM WILSON, P.E., Nevada State Engineer, DIVISION OF WATER RESOURCES, DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES,

Appellant,

vs.

PAHRUMP FAIR WATER, LLC., a Nevada limited-liability company; STEVEN PETERSON, an individual; MICHAEL LACH, an individual; PAUL PECK, an individual; BRUCE JABEOUR, an individual; and GERALD SCHULTE, an individual,

Respondents.

Case No. 77722

JOINT APPENDIX
Volume VII of XIV, pages 1480–1615

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DATE	DOCUMENT DESCRIPTION	VOLUME	PAGE NOS.
10/12/18	Answering Brief filed by State Engineer	XIV	4910–4945
12/10/18	Ex Parte Motion for Order Shortening Time on Motion for Stay of Order Granting Petition for Judicial Review and Reversing State Engineer's Amended Order No. 1293A Pending Appeal	XIV	5474–5476
09/05/18	Letter from Court & Memorandum of Temporary Assignment (Steven Kosach)	XI	3628–3629
12/18/18	Letter from Nye County Clerk to Nevada Supreme Court re: submittal of appeal packet	XIV	5496–5497
09/18/18	Memorandum of Temporary Assignment (Steven Elliott)	XIV	4906
08/22/18	Memorandum of Temporary Assignment (William Maddox)	I	34–35
12/10/18	Motion for Stay of Order Granting Petition for Judicial Review and Reversing State Engineer's Amended Order No. 1293A Pending Appeal on Order Shortening Time	XIV	5461–5473
12/10/18	Notice of Appeal filed by State Engineer	XIV	5442–5460
08/17/18	Notice of Appeal of Nevada State Engineer Amended Order 1293A	I	1–14
01/02/19	Notice of Entry of Order (Denying Motion for Stay)	XIV	5530–5539
12/07/18	Notice of Entry of Order (Granting Petition for Judicial Review)	XIV	5427–5441

DATE	DOCUMENT DESCRIPTION	VOLUME	PAGE NOS.
09/11/18	Notice of Transmittal of Record on Appeal	XI	3630–3631
09/11/18	Opening Brief filed by Pahrump Fair Water, LLC, *et al.* ("PFW")	XI	3634–3655
12/18/18	Opposition to Motion for Stay of Order Granting Petition for Judicial Review	XIV	5498–5508
12/27/18	Order Denying Motion for Stay	XIV	5525–5529
12/06/18	Order Granting Petition for Judicial Review	XIV	5417–5426
08/31/18	Order Granting Stipulation and Order Regarding Briefing Schedule	XI	3622–3624
08/22/18	Order of Recusal (Robert Lane)	I	31–33
10/29/18	Order Setting Hearing	XIV	4946–4947
09/11/18	Peremptory Challenge of Judge (Steven Kosach) filed by State Engineer	XI	3632–3633
09/04/18	Peremptory Challenge of Judge (William Maddox) filed by PWF	XI	3625–3627
08/17/18	Petition for Judicial Review	I	15–30
11/08/18	PowerPoint Presentation by PFW re: Petition for Judicial Review	XIV	5137–5185
11/08/18	PowerPoint Presentation by State Engineer re: Petition for Judicial Review	XIV	4988–5136
12/27/18	[Proposed] Order Denying Motion for Stay filed by PFW	XIV	5515–5524

DATE	DOCUMENT DESCRIPTION	VOLUME	PAGE NOS.
12/10/18	[Proposed] Order Granting Motion for Stay of Order Granting Petition for Judicial Review and Reversing State Engineer's Amended Order No. 1293A Pending Appeal filed by State Engineer	XIV	5483–5493
11/26/18	[Proposed] Order Granting Petition for Judicial Review filed by PFW	XIV	5402–5416
11/26/18	[Proposed] Order Granting Petition for Judicial Review filed by State Engineer	XIV	5378–5401
12/10/18	[Proposed] Order Shortening Time on Motion for Stay of Order Granting Petition for Judicial Review and Reversing State Engineer's Amended Order No. 1293A Pending Appeal filed by State Engineer	XIV	5477–5482
11/01/18	Reply Brief filed by PFW	XIV	4955–4987
12/20/18	Reply in Support of State Engineer's Motion for Stay of Order Granting Petition for Judicial Review and Reversing State Engineer's Amended Order No. 1293A Pending Appeal	XIV	5509–5514
12/12/18	Request for Submission of Ex Parte Motion for Order Shortening Time	XIV	5494–5495
09/21/18	Request to Set Hearing Date (re: Petition for Judicial Review)	XIV	4907–4909
10/31/18	Stipulation and Order for Extension of Time (re: Reply Brief)	XIV	4948–4954

DATE	DOCUMENT DESCRIPTION	VOLUME	PAGE NOS.
08/30/18	Summary of Record on Appeal and Bates-stamped pages SE ROA 1–3574	I–XI	36–3621
09/11/18	Supplemental Record on Appeal and Bates-stamped pages SROA 1–1245 filed by PFW	XI–XIV	3656–4905
11/08/18	Transcript (re: Oral Arguments on Petition for Judicial Review)	XIV	5186–5377

RESPECTFULLY SUBMITTED this 15th day of February, 2019.

AARON D. FORD
Attorney General

By: /s/ James N. Bolotin
JAMES N. BOLOTIN
Deputy Attorney General
Attorney for Appellant, State Engineer

CERTIFICATE OF SERVICE

I certify that I am an employee of the Office of the Attorney General and that on this 15th day of February, 2019, I served a copy of the foregoing JOINT APPENDIX, by electronic service to:

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/s/ Dorene A. Wright

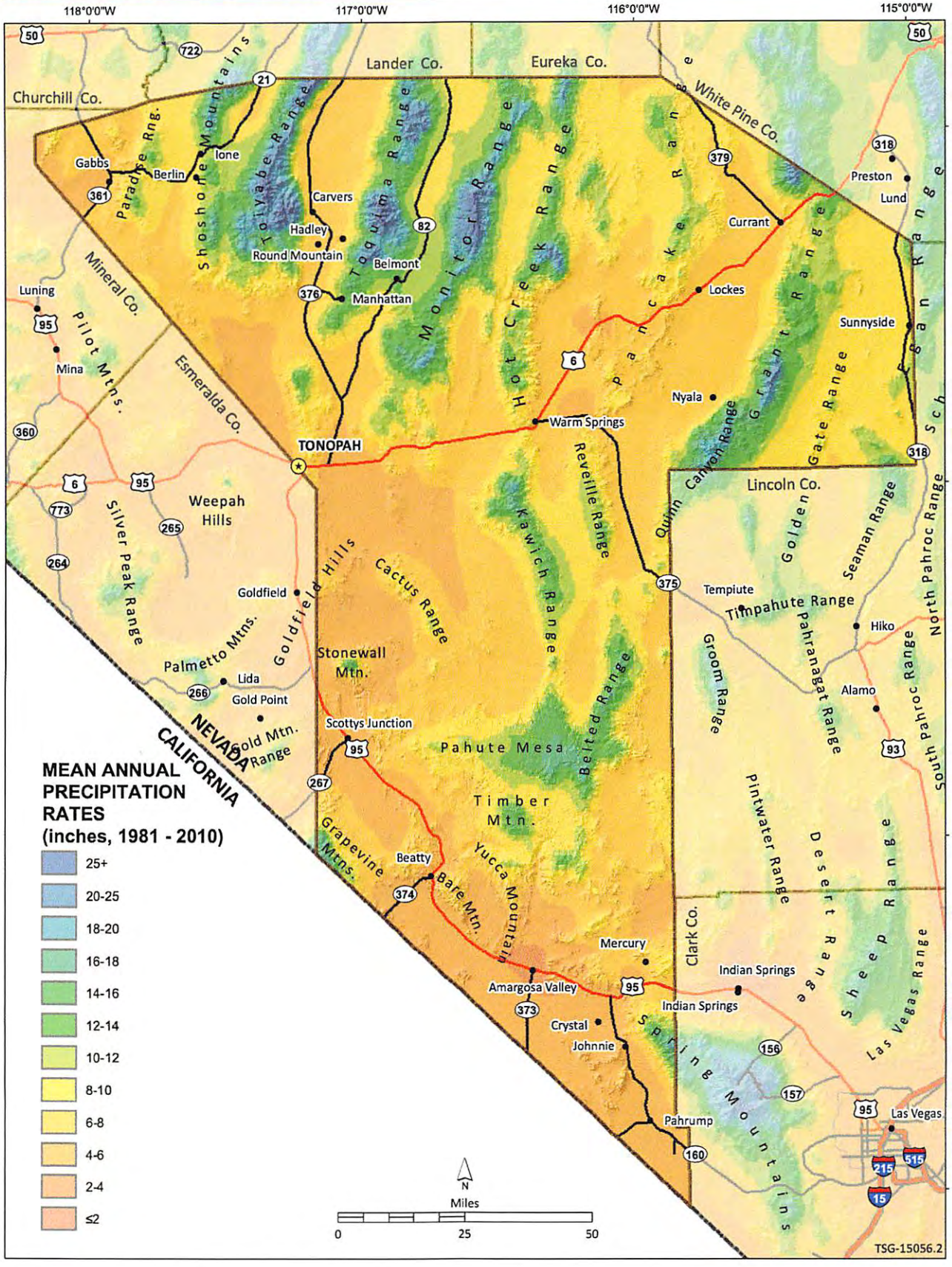


Figure 3-2. Nye County mean annual precipitation rates in inches for the period 1981-2010 (NRCS PRISM).

Emergency Operation Center, which may be activated should drought reach Stage 3, Drought Emergency.

In a mid-latitude, dry climate like Nye County's, the average potential evaporation rate exceeds the average annual precipitation, with actual average evaporation ranging from 51 to 72 inches. Figure 3-3 shows the average calculated evaporation throughout Nevada. On an annual basis, as much as 90 to 95 percent of the total annual precipitation is lost through evaporation and transpiration; only an estimated 5 to 10 percent recharges the groundwater regime. Most recharge occurs in the northern part of the County where precipitation rates are higher and evaporation rates are lower.

Climate Change

On April 10, 2007, Governor Jim Gibbons signed an executive order that created the Nevada Climate Change Advisory Committee (Committee). The executive order directed the Committee to propose recommendations by which Greenhouse Gas (GHG) emissions can be further reduced in Nevada. Climate change refers to any significant change in measures of climate, such as temperature, precipitation or wind, lasting for decades or longer. The term is also widely used to describe the impact on the environment from the emissions of GHGs (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perflouorocarbons, and sulfur hexafluoride) and is often used interchangeably with the term "global warming."

The Governor assembled the Committee from public agency personnel, private industry representatives, interest groups, and the public at large. The Committee reviewed policies and impacts related to climate change in Nevada, and consulted experts from the fields of energy transmission, wind energy, water resource issues, and geologic carbon sequestration. The Governor's Nevada Climate Change Advisory Committee Final Report (2008) delineates the potential impacts and offered recommendations to address climate change in Nevada. Scientists agreed that impacts will become more widespread throughout the west as a result of climate change. The report summarizes impacts of climate change on public health, water, wildfire, agriculture, and air quality.

The Governor's report concluded that climate change will significantly impact water resources in Nevada by increasing drought conditions in the southern part of the state. The report also predicted that Colorado River basin will see less precipitation overall in the future, and a greater percentage will be as rain rather than snow. Metropolitan Las Vegas obtains over 90 percent of its drinking water from the Colorado River; a decline in the river will present challenges to maintaining municipal water supply and could again put pressure on Southern Nevada Water Authority (SNWA) and other metropolitan water districts to tap the water resources in Nye and Nevada's other rural counties.

Less snowfall and more precipitation as rain in the Sierra Nevada will increase the likelihood of area flooding, and lessen summertime reserves. Decreased water reserves could lead to forest and wildland fires with the potential for greater intensity and devastating consequences. The report also notes that these changed conditions may lead to the disappearance of some native species of fauna and increased invasive weed species. The agriculture sector and recreation opportunities in Nevada could also be negatively impacted with less water available for irrigation and diminishing instream flows and reservoir levels. Such climate change–related impacts can be expected to affect

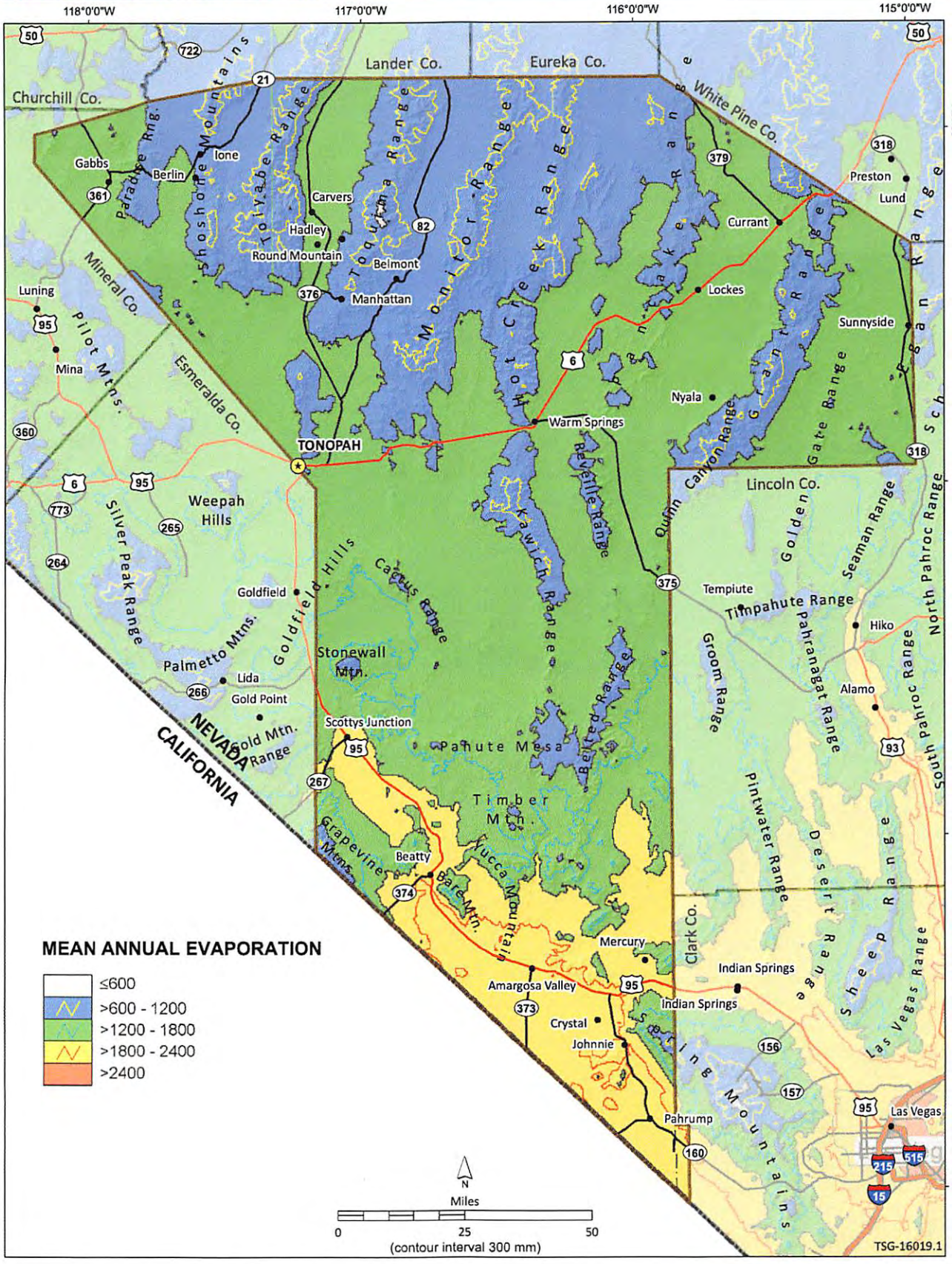


Figure 3-3. Potential evaporation rates in Nye County (From Shevenell, 1999).

Nye County as the environments ability to capture and store precipitation is reduced. While these impacts are expected, and changes in climate parameters can be measured, the longer term effects on water resources are not easily separated from similar impacts resulting from other causes.

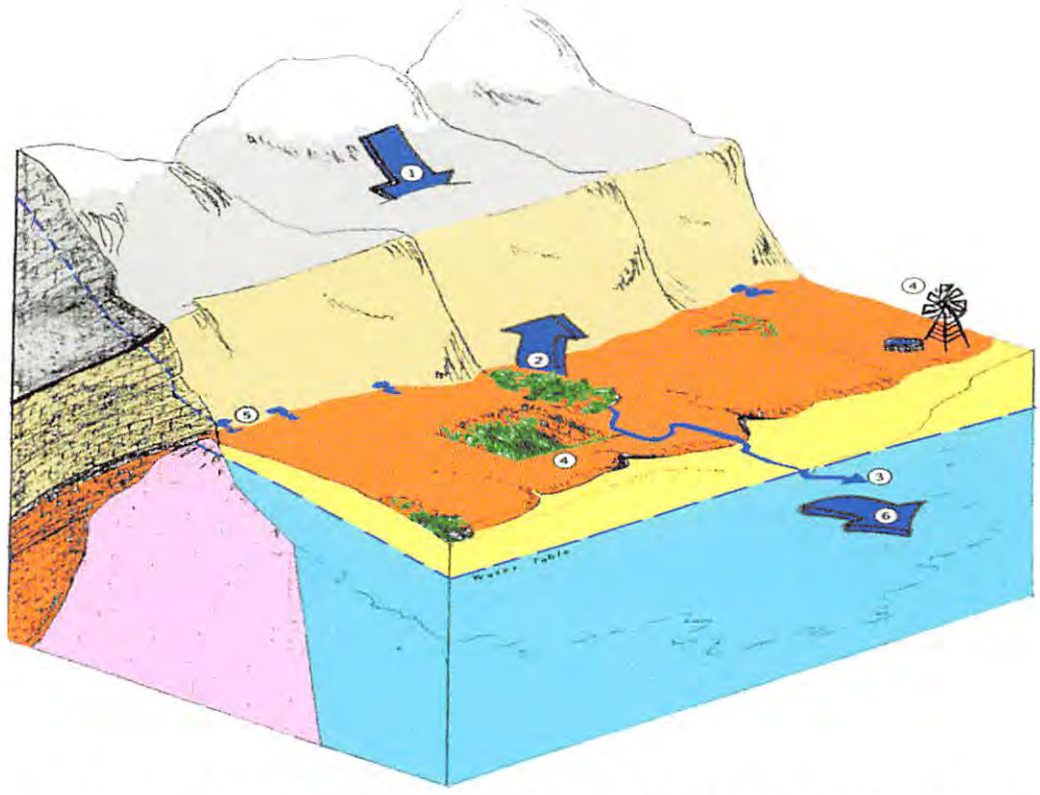
3.4. SURFACE WATER RESOURCES

Although Nye County has no major lakes, reservoirs, or rivers, there are important surface water resources in many locations. Surface water flows are important sources of irrigation water in the agricultural areas such as White River Valley. Groundwater that discharges at the surface as springs is also an important source of surface water resources. Many springs in Nye County have been developed for irrigation, livestock watering, municipal and domestic water supplies, and the mining industry. Surface water resources of Nye County are also used for recreational purposes including fishing, hunting, boating, swimming, camping, picnicking, and relaxation. Finally, wildlife cannot thrive without a dependable source of water, and the springs, streams, and lakes in Nye County support the habitat for many desirable species.

The federal government owns or asserts reservation of a number of spring and surface water rights in many Nye County basins. In some basins, like the Amargosa Desert, Supreme Court or other judicial decisions have continued and quasi-quantified these federally-reserved water rights. These are in addition to the appropriated vested rights acquired through purchase or the administrative process. While the federal agencies have protested and appealed the State Engineer, the decisions of the State Engineer remains the authority in state water rights matters.

All of the surface water resources (and groundwater resources, as well) are derived from the precipitation that falls over the County or adjacent recharge areas. Figure 3-4 is a conceptual representation of the interrelationships between the precipitation that falls over the mountainous areas and the surface and groundwater regimes. In this section, information is presented on the surface water resources of Nye County and the issues associated with their protection and use.

Photo 4. Snow on the Toiyabe Range. Photo Credit: Tom Buqo, 2006



1. The water resources of Nye County originate predominantly as the rain and snow fall over the upland areas in the County and adjacent areas. Rain and snowmelt run off into the channels and into the fractures in the rock. Some of this water is consumed by the plants and some in□ltrates downward to the water table, a process known as *recharge*. Most of the recharge occurs at elevations above 6,000 feet.

2. The streams in Nye County are important water resources. The streams are fed by runoff from the mountains and by springs that discharge in the upland areas. The streams often support riparian areas and wildlife. Along the mountain front, additional recharge occurs through the channels that drain the upland areas. The vegetation that is supported by the streams and springs consume a considerable amount of water through *evapotranspiration*.

3. Surface water □ows year round in some springs and streams, but the amount of □ow is often quite variable. Following the snowmelt in the late spring, there is usually a surge of discharge in the streams and springs that drain the mountain areas. This surge of □ow is also referred to as *rejected recharge* as it represents the excess water that the rocks are not able to take in. Streams fed by springs with seasonal □ow may dry up completely in the dry months. Streams and springs that □ow year round are called *perennial* and seasonal □ows are referred to as *ephemeral*.

4. The water that is used by man for irrigation, stockwater, and quasi-municipal purposes is not completely consumed. Water stored in ponds and irrigation canals leaks back into the groundwater system. Some portion of the irrigation water (about 25 percent) in□ltrates back into the ground. Even domestic septic systems return a small quantity of water back into the ground. Collectively, the in□ltration of water from these sources is called *secondary recharge*. Secondary recharge can be a large component of the water budget in basins where irrigation is widespread.

5. Spring lines often occur where geologic controls such as faults or contacts are present. These controls cause groundwater to rise to the surface and discharge. Some of the more water-rich basins of Nye County have spring lines that are tens-of-miles long.

6. In most basins, the water that recharges the aquifers ultimately □ows from up-gradient basins to down-gradient basins. Basins that are hydraulically linked in this manner are referred to as □*ow systems*.

Figure 3-4. Conceptual hydrogeologic model for Nye County.

Lakes

The number and locations of Nye County's lakes and reservoirs have changed slightly since 2004. Table 3-1a lists the 19 lakes and reservoirs which are currently listed in the Nevada DWR database, and Table 3-1b lists reservoirs associated with mining activities. The largest reservoirs in Nye County are located in White River Valley at the Wayne Kirch Wildlife Management Area (Adams-McGill Reservoir, Hay Meadows Reservoir, and Tule Field Reservoir). This wildlife management area remains popular and is widely fished for rainbow trout, black bass, and other game fish. In addition to their importance for fish, these reservoirs also provide habitat for a number of bird species, including Western Snowy Plover, Long-billed Curlew, and White-faced Ibis. Temporary reservoirs and ponds are used in mining for storage of process water and mineral de-watering operations. Figure 3-5 shows the lakes and reservoirs in Nye County, including temporary reservoirs associated with mining operations. Sites shown are current as of April 2015.

Table 3-1a. Lakes and Reservoirs of Nye County. (From the Nevada DWR Dam Records, April 2015)

Lake or Reservoir	Hydrographic Basin	Basin	Surface Area (acres)	Maximum Storage Capacity (acre-feet)
Adams-McGill Reservoir	White River Valley	207	>791	4,040.0
Angleworm Ranch	Railroad Valley/Northern	173B	2.0	8.0
Angleworm West Dam	Railroad Valley/Northern	173B	4.0	20.0
Cold Springs	White River Valley	207	305.0	1,210.0
Crystal Marsh Lower Dam	Amargosa Desert	230	130.0	400.0
Crystal Marsh Upper Dam	Amargosa Desert	230	20.0	50.0
Crystal Springs Dam	Amargosa Desert	230	157.0	2,300.0
Dacey Dam	White River Valley	207	214.9	783.7
Dam C	Amargosa Desert	230	69.5	618.0
Echo Canyon Dam Nye	Railroad Valley/Northern	173B	80.0	300.0
Hay Meadow Dam	White River Valley	207	203.0	1,120.0
Lake No 2	Amargosa Desert	230	-	10.0
Lake No 3	Amargosa Desert	230	-	1,200.0
Lake No 4	Amargosa Desert	230	79.1	650.0
Lake No 5	Amargosa Desert	230	-	3,000.0
Lake No 6	Amargosa Desert	230	27.5	300.0
Lake No 7	Amargosa Desert	230	-	300.0
Lake No 8	Amargosa Desert	230	-	450.0
Manzonie Dam	Railroad Valley/Northern	173B	23.0	240.0
Old Place Dike #3	White River Valley	207	43.0	57.0
Segura Dam	Antelope Valley	151	5.0	24.0
Seyler Reservoir	Big Smoky Valley/Tonopah	137B	30.0	350.0
Spring Meadows Lake #1	Amargosa Desert	230	-	300.0
Sunnyside Dam	White River Valley	207	882.1	4,040.0
Tule Field Dam	White River Valley	207	80.0	507.0
Whipple Reservoir	White River Valley	207	30.0	60.0

Table 3-1b. Mining Related Reservoirs in Nye County. (From the Nevada DWR Dam Records, April 2015)

Mining Related Pond/Reservoir	Hydrographic Basin	Basin	Surface Area (acres)	Maximum Storage Capacity (acre-feet)
Bullfrog Evaporation Pond	Amargosa Desert	230	14.8	80.9
Equatorial Tonopah Phase I Leach Event Pond	Big Smoky Valley/ Tonopah Flat	137B	4.8	65.0
Imvite Reservoir	Amargosa Desert	230	1.0	10.0
Paradise Peak Tails	Gabbs Valley	122	230.0	8,300.0
Reward Event Pond	Amargosa Desert	230	3.0	32.0
RMG Cell B TSF	Big Smoky Valley/Northern	137B	353.0	28,450.0
RMG Goldhill Event Pond	Big Smoky Valley/Northern	137B	3.0	32.6
RMG Goldhill Process Pond	Big Smoky Valley/Northern	137B	2.0	19.7
RMG Gravity Plant Sediment Decant Pond	Big Smoky Valley/Northern	137B	2.0	45.1
RMG Lower Storage Pond	Big Smoky Valley/Northern	137B	1.4	19.0
RMG South 48 Hour Event Pond	Big Smoky Valley/Northern	137B	1.5	17.3
RMG South Dedicated Event Pond 5	Big Smoky Valley/Northern	137B	2.6	39.0
RMG South Leach Pad Event Pond 4	Big Smoky Valley/Northern	137B	2.0	38.0
RMG South Process Pond	Big Smoky Valley/Northern	137B	1.5	17.2
RMG South Process Pond #2	Big Smoky Valley/Northern	137B	2.3	30.1
RMG South Storm Event Pond #1	Big Smoky Valley/Northern	137B	1.8	24.8
RMG South Storm Event Pond #2	Big Smoky Valley/Northern	137B	2.3	35.5
RMG South Storm Event Pond #3	Big Smoky Valley/Northern	137B	2.5	40.0
RMG Upper Fire Pond	Big Smoky Valley/Northern	137B	2.3	31.0
RMG Upper Storage Pond	Big Smoky Valley/Northern	137B	1.8	19.0
RMG West Ded Event Pond	Big Smoky Valley/Northern	137B	0.0	45.0
RMG West Dedicated Leach Event Pond	Big Smoky Valley/Northern	137B	4.4	65.8
RMG West Dedicated Pad Phase II Process Pond	Big Smoky Valley/Northern	137B	3.1	47.0
RMG West Dedicated Pad Phase II Storm Pond	Big Smoky Valley/Northern	137B	3.1	47.0
RMG West Dedicated Pad Process Pond	Big Smoky Valley/Northern	137B	2.9	41.9
RMG West Dedicated Pad Storm Pond	Big Smoky Valley/Northern	137B	2.3	32.0
RMG West Storm Pond #3	Big Smoky Valley/Northern	137B	5.0	61.0
RMG West Tailings Dam	Big Smoky Valley/Northern	137B	226.0	28,816.0
RMG West Tails Storm Pond	Big Smoky Valley/Northern	137B	4.1	49.8
RMGC North Rib	Big Smoky Valley/Northern	137B	20.0	60.0
RMGC South Rib	Big Smoky Valley/Northern	137B	37.0	143.6
Sierra Tails	Gabbs Valley	122	14.1	70.0
Tenneco Mill Pond	Amargosa Desert	230	5.0	72.0

RMG = Round Mountain Gold

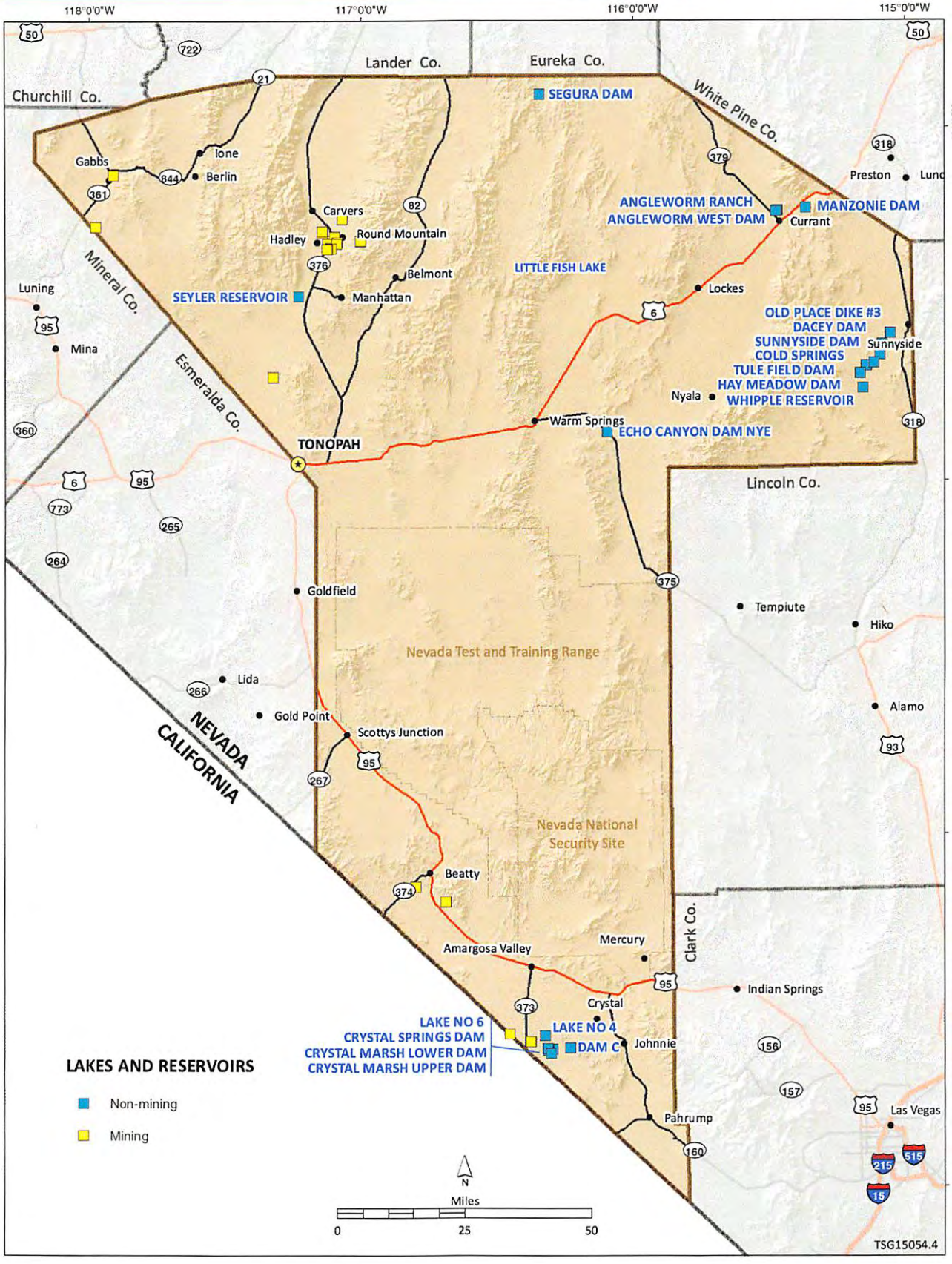


Figure 3-5. Nye County lakes and reservoirs from Nevada Division of Water Resources (2015) dam database.

Streams

Although there are no major rivers in Nye County, there are many streams that drain the upland areas. These streams derive their flow from three main sources: spring discharges, groundwater discharge along the stream channels, and snow melt.

The streams of Nye County provide the aquatic habitat for many types of fishes, including two types of trout (rainbow and brook), native species such as the Railroad Valley Springfish and Railroad Valley Tui Chub, and many other types of fishes. The primary streams that contain game fish populations are Cherry Creek, Cottonwood Creek, Deep Creek, Hooper Canyon Creek, Pine Creek, and Troy Canyon Creek.

The streams also support extensive riparian and wetland areas. According to BLM documents, there are at least 20 streams in Nye County that support more than 25 miles of riparian habitat. The riparian areas of Nye County provide not only habitat for the fishes listed above and other aquatic species, they provide nesting for a number of bird species including the White-faced Ibis and a number of important raptors including the Bald Eagle, Ferruginous Hawk, and several species of owls.

Figure 3-6 shows the location of stream discharge measurement sites for the U.S. Geological Survey (USGS) National Water Information System. The USGS publishes historic discharge records for the 17 gaging stations listed in Table 3-2. The discharge rates for most of these streams are seasonal with peak flows following the spring snow melt in the upland areas. USGS spring monitoring in Nye County decreased dramatically in the late 2000s when the DOE's Yucca Mountain Project was defunded. Currently, only five surface water sites in Nye County (including Grapevine Spring) are monitored by the USGS.

From 2012 to 2013, the Nye County Nuclear Waste Repository Project Office (NWRPO) and Glorieta Geoscience, Inc. (GGI) completed a preliminary sampling of selected springs and nearby wells in the Pahrump Valley. The purpose of the study was to provide baseline geologic, geomorphic, geochemical, and hydrologic data for the springs, and to evaluate the recharge and flow characteristics using general and isotope geochemistry (Drakos and Hodgins, 2013).

Photo 5. View overlooking Peterson Reservoir. Photo Credit: Tom Buqo, 2006

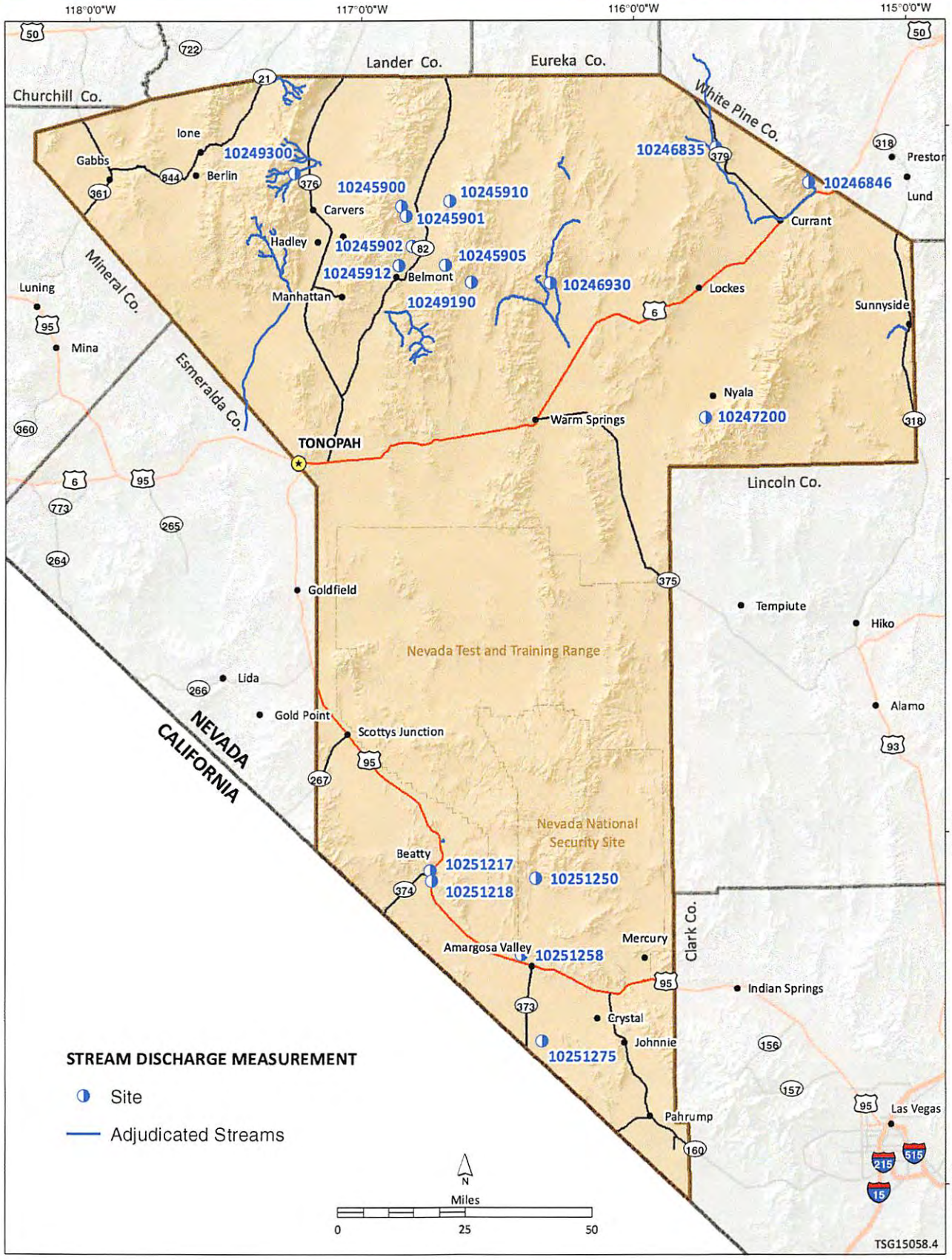


Figure 3-6. Nye County stream discharge measurement sites from USGS National Water Information System (2015).

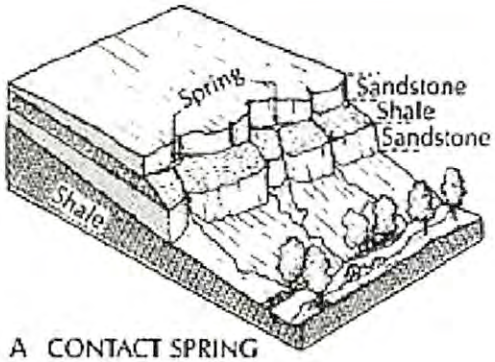
Table 3-2. Selected Stream Discharge Measurements in Nye County (Source: U.S. Geological Survey)

Station Name	USGS ID #	Basin	Period of Record	Range in Mean Annual Discharge (cfs)	Maximum Discharge (cfs)	Minimum Discharge (cfs)
Pine Creek Near Belmont	10245900	140B	1977-present	5.77 to 13.8	340	0.24
Mosquito Creek Near Belmont	10245910	140B	1977-1982, 1983-present	2.41 to 7.87	119	0.04
South Twin River Near Round Mountain	10249300	137B	1965 - present	2.40 to 20.1	510	0.35
Andrews Creek Near Belmont	10245901	140B	1998	not available	10	0.18
Corcaran Creek Near Belmont	10245902	140B	1998	not available	1.2	0.6
Barley Creek Near Belmont	10245905	140B	1998	not available	89	2.6
Morgan Creek Near Belmont	10245912	140B	1998	not available	3.1	0.61
Big Creek Near Warm Springs	10247200	173B	1991-1994	1.70 to 2.19	22	0.05
Amargosa River at Beatty	10251217	228	1993-1996	0.63	1000	0.12
Amargosa River at Highway 95	10251218	230	1963-1968, 1991-1995	0.46 to 1.72	16000	0
Fortymile Wash at Narrows, NTS (NNSS)	10251250	227A	1983-1996	0.00 to 0.69	3000	0
Fortymile Wash Near Amargosa Valley	10251258	230	1983-1996	0.00 to 0.49	1430	0
Carson Slough at Ash Meadows	10251275	230	1983-1996	0.59 to 1.59	689	0
Big Warm Springs Near Duckwater	10246835	173B	2007-present	not available	27	12
Little Currant Creek Near Currant	10246846	173B	1964-1981, 1983-1986, 1990-1994	3.32 to 9.65	366	0
Willow Creek Near Warm Springs	10249190	149	1977-1992	1.16 to 5.91	92	0
Sixmile Creek Near Warm Springs	10246930	156	1967-1968, 1984-1991	0.67 (1985-1991)	104	0

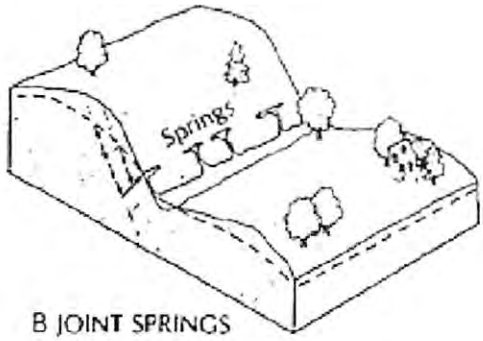
cfs = cubic feet per second

Springs

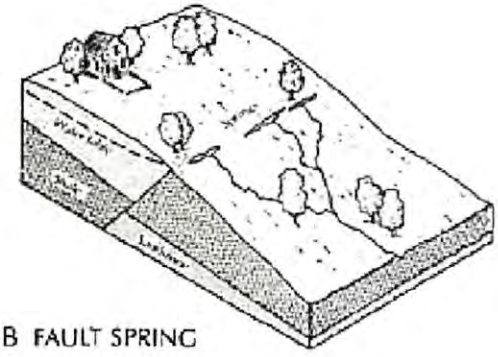
Nye County is fortunate to have hundreds of springs that support a number of uses including ranching, mining, and wildlife management. Springs occur wherever groundwater intercepts the land surface and discharges water to the surface water regime. Figure 3-7 is a conceptual illustration depicting the different types of springs in Nye County. Table 3-3 summarizes available data on the larger springs (discharge 450 gallons per minute or greater) including their elevations, maximum and minimum discharge rates, and most recent measurement date. Figure 3-8 shows the locations of Nye County's large springs. There also are numerous springs located on the access-restricted NTTR and NNSS that are not shown on Figure 3-8. Information on these springs can be found in the Final Integrated Natural RMP for Nellis Air Force Base / Creech Air Force Base / Nevada Test and Training Range (2010), and the NNSA Final SWEIS for the NNSS (2013).



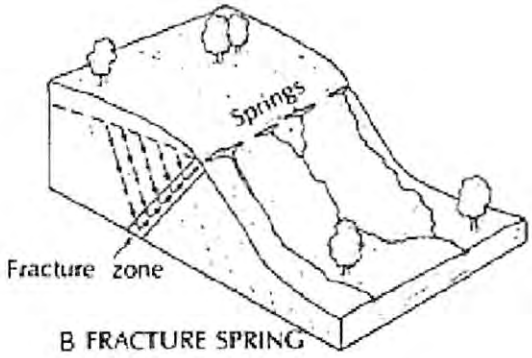
A CONTACT SPRING



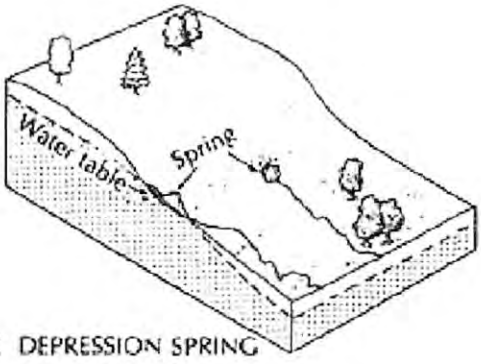
B JOINT SPRINGS



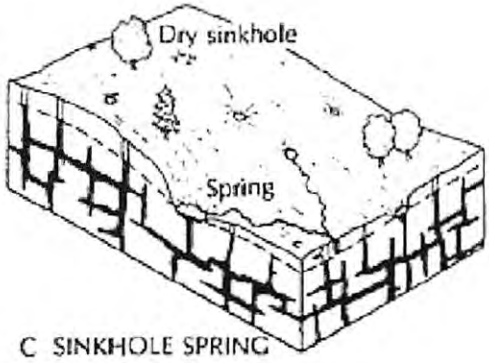
B FAULT SPRING



B FRACTURE SPRING



C DEPRESSION SPRING



C SINKHOLE SPRING

A. Contact Spring - This type of spring occurs where permeable rocks such as limestone come into contact with less permeable rocks such as shale. These types of springs occur throughout Nye County.

B. Structural Spring - This type of spring occurs where faults, joints, or fractures provide an avenue for water to reach the land surface. Structural springs are widespread in Nye County in the mountainous areas.

C. Depression Spring - This type of spring occurs where the land surface is below the water table. Depression springs are common in the lowland areas of Nye County and are sensitive to the impacts of water withdrawals.

Figure 3-7. Types of springs in Nye County. After Fetter, 1988.

Table 3-3. Major Springs in Nye County (greater than 450 gpm Discharge)

Basin	Spring Name	Elevation (ft)	Maximum Discharge (gpm)	Minimum Discharge (gpm)	Latest Discharge Measurement (gpm)
137B	Darroughs (?) Hot Spring	5,600	1,001		1968[1]
140A	Diana's Punch Bowl	6,715	467		1964[1]
140A	Potts Ranch Spring	6,615	467		1964[1]
156	Hot Creek Spring	5,540	759	220	1969
162	Bennetts Springs[2]	2,680	3,350	0	1963
162	Manse Springs [3]	2,776	2,700	0	2011
173B	Big Spring	4,820	741	130	1998
173B	Blue Eagle Springs	4,765	2,653	1,490	2000
173B	Little Warm Spring	5,590	1,611	202	1994
173B	Big Warm Spring	5,605	10,323	2,024	2007
173B	Hay Corral Spring	4,770	601	157	1994
173B	Reynolds (?) Spring	4,770	588	215	1994
207	Hot Creek Spring	5,225	9,829	494	2006
207	Butterfield Spring	5,320	1,872	844	2015
207	Flag Spring #1	5,290	1,566	691	2015
207	Flag Spring #2	5,280	1,633	224	2015
207	Flag Spring #3	5,290	1,643	548	2015
207	Moon River Springs	5,220	2,320	1,643	1990
207	Emigrant Springs	5,480	1,396	337	1994
230	Fairbanks	2,250	2,401	1,095	2011
230	Crystal Pool	2,195	3,824	2,168	2014
230	Big Spring	2,240	1,418	512	2015
230	Roger's Spring	2,275	956	135	1997
230	Jack Rabbit Spring	2,300	799	498	1998
230	Longstreet Spring	2,310	1,041	352	1997
230	Point Of Rocks (Kings Spring)	2,350	2,132	687	1998

gpm = gallons per minute

[1] Only one measurement was taken at this location.

[2] Discharge at Bennetts Spring was estimated at 3,350 gallons per minute in 1875. In 1940 the discharge was measured at 2,540. By 1956, the discharge had dropped to 1,238 gallons per minute and by 1959, the spring was dry.

[3] Manse Spring was estimated 2,700 gallons per minute in 1875, 1100 gallons per minute in 1958-1960 and has been dry during the summer months since 1975 with seasonal discharge occurring through at least 1976. Monitoring resumed in 2011 after Manse Spring began flowing around 2004. Current flows are estimated at 1,000 to 1,200 gpm (Drakos and Hodgins, 2013).

The most significant springs in Nye County are located at Ash Meadows National Wildlife Refuge, located east of the Town of Amargosa Valley. More than 30 springs and seeps discharge to the land surface at the refuge including Fairbanks Springs, Rogers Springs, School Spring, Point of Rocks Springs, Jackrabbit Springs, Big Spring, Bole Springs, and Grapevine Spring. The refuge was established in 1984 to protect the spring-fed wetlands that support more than 25 plant and animal

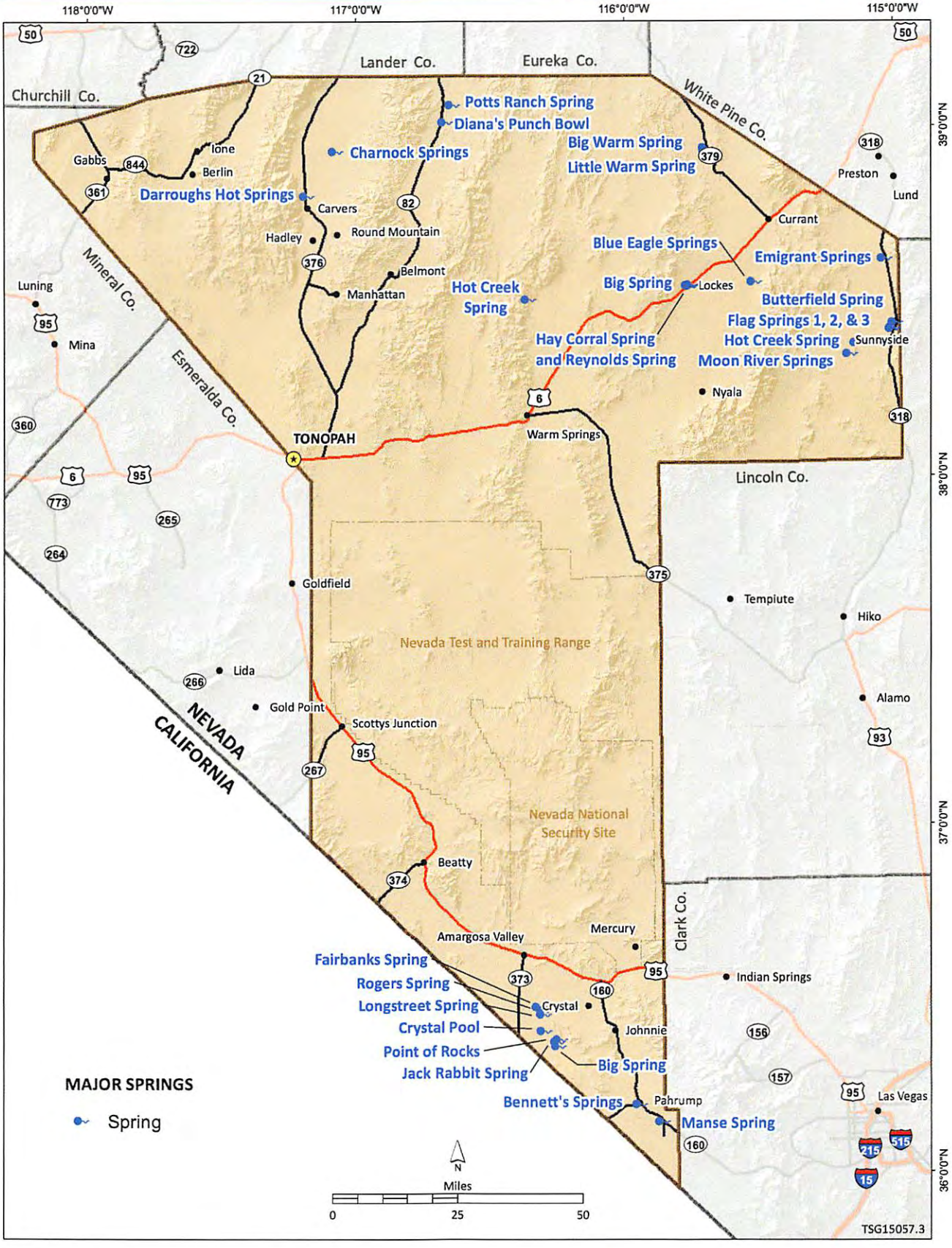


Figure 3-8. Major springs (greater than 450 gpm discharge) in Nye County from USGS National Water Information System (2015).

species found nowhere else in the world. Ash Meadows is touted by the U.S. Fish and Wildlife Service as having the highest concentration of endemic species in North America.

Water Quality

The quality of Nye County's surface water is in compliance with the Clean Water Act of 1972. Surface water quality is subject to impacts from human activities and natural causes. The vulnerability assessments conducted for public water supply systems did not identify any contamination of surface water drinking sources in the County.

Committed Resources

The total quantity of surface water resources in Nye County is difficult to quantify and the quantity of committed resources is not known with precision. Table 3-4 shows the status of surface water rights for Nye County basins obtained from the Nevada Division of Water Resources. In some cases, these data have not been supplementally adjusted, and may include supplemental water rights that are used with groundwater rights or with multiple points of diversion. There have been no calls for the filing of proof of vested rights in most basins in Nye County with the exception of Reese River Monitor Valley. The notes on Table 3-4 provide additional caveats regarding the accuracy of the estimates.

In total, approximately 209,000 acre-feet per year of surface water rights are allocated in the basins that are wholly or in part located in Nye County. An additional 1,100 acre-feet of applications are currently ready for action. Of the nearly 208,000 acre-feet of surface water rights allocated, almost 80 percent are in only eight basins: about 29,000 acre-feet in Big Smoky Valley Northern Part; almost 11,000 in Big Smoky Valley Tonopah Flat; about 25,000 acre-feet in Amargosa Valley; about 29,000 acre-feet in Monitor Valley Southern Part; about 9,300 acre-feet in Pahrump Valley; over 35,000 acre-feet in Railroad Valley Northern Part; almost 19,000 acre-feet in Upper Reese River Valley; and about 34,000 acre-feet in White River Valley. The bulk of the applications and applications that are ready for protest or action are also limited to a few basins - Big Smoky Valley, Alkali Spring Valley, and Hot Creek Valley.

Actual vested surface water rights and their use is not measured or reported. A vested water right cannot be lost to non-use, although in limited circumstances could be lost to abandonment. In general, it is assumed that all appropriated surface water will be placed in beneficial use. Shortfalls in surface water supplies that occur because of low flow are supplemented by groundwater pumpage, as specified by permit. Thus, actual surface water is used to the extent it is available to meet the allocation. Basins with available data in the period 2004 to 2015 show surface water appropriations declines in many of the Nye County's shared basins. The largest declines occurred in the Amargosa Desert, Pahrump Artesian Basin, and Indian Springs Valley (Basins 230, 162, and 161, respectively). Increases in surface water appropriations were greatest in the northern County, with the largest increase (nearly 16,000 acre-feet per year) occurring in portions of Reese River Valley that are located outside of Nye County. Because surface water allocation data was incomplete when the 2004 Water Resources Plan was prepared, several of the basins are labeled "no data" because no comparison is possible.

Table 3-4. Status of Surface Water Rights in acre-feet in Nye County Basins Through April 2015

Basin Name	Basin No.	Vested	Certificated	Permitted	Applied For	Ready for Action/ Protest	Reserved	Total Allocated[1]	Total Demand[2]
Alkali Spring Valley*	142		21.73					21.73	21.73
Amargosa Desert	230	2.24	21,374.84	3,631.30				25,008.38	25,008.38
Antelope Valley (Eureka & Nye)*	151	10.83	344.15				180.82	535.80	535.80
Big Smoky Valley - Northern Part*	137B	4,390.89	23,982.06	537.00			201.63	29,111.58	29,111.58
Big Smoky Valley - Tonopah Flat*	137A	1,204.74	8,379.01	1,020.00			147.86	10,751.61	10,751.61
Cactus Flat	148		208.03					208.03	208.03
Coal Valley*	171	22.40						22.40	22.40
Crater Flat	229		8.70				2.24	10.94	10.94
Emigrant Valley/Groom Lake Valley*	158A		28.38					28.38	28.38
Emigrant Valley/Papoose Lake Valley*	158B								
Fortymile Canyon/Buckboard Mesa	227B								
Fortymile Canyon/Jackass Flats	227A		4.36					4.36	4.36
Frenchman Flat*	160		4.36					4.36	4.36
Gabbs Valley*	122	217.30	204.62				6.72	428.64	428.64
Garden Valley*	172	554.80	727.29	6.72				1,288.82	1,288.82
Gold Flat	147		32.35					32.35	32.35
Grapevine Canyon*	231								
Hot Creek Valley	156	373.24	2,117.53	53.25			431.79	2,975.80	2,975.80
Indian Springs Valley*	161		2.21					2.21	2.21
Ione Valley*	135	329.66	194.41				53.77	577.83	577.83
Kawich Valley	157		90.44					90.44	90.44
Lida Valley*	144		2.18					2.18	2.18
Little Fish Lake Valley	150	40.02	279.44				138.84	458.30	458.30
Little Smoky Valley Central Part	155B		30.44					30.44	30.44
Little Smoky Valley Northern Part*	155A		378.07				453.95	832.02	832.02
Little Smoky Valley Southern Part	155C		71.40	79.57				150.97	150.97
Mercury Valley	225								
Monitor Valley Northern Part*	140A	878.61	71.39				13.44	963.44	963.44
Monitor Valley Southern Part	140B	23,207.43	5,674.65				40.33	28,922.40	28,922.40
Oasis Valley	228	1,558.12	1,908.37	2,129.50			28.36	5,624.35	5,624.35
Pahroc Valley*	208								
Pahrump Valley*	162	2,085.00	3,061.40	4,240.29				9,386.69	9,386.69
Penoyer Valley (Sand Spring Valley)*	170		11.99	9.05			2.19	23.23	23.23
Railroad Valley Northern Part*	173B	11,701.38	10,107.36	13,684.24			69.52	35,562.51	35,562.51
Railroad Valley Southern Part*	173A		211.81				86.62	298.43	298.43
Ralston Valley*	141	11.56	216.32				110.94	338.82	338.82
Rock Valley	226								
Sarcobatus Flat*	146		73.59					73.59	73.59
Smith Creek*	134		218.00					218.00	218.00
Stone Cabin Valley	149	797.88	835.11	6.72			49.42	1,689.13	1,689.13
Stonewall Flat*	145		57.36				2.24	59.60	59.60
Upper Reese River Valley*	56	17,477.20	1,311.92					18,789.12	18,789.12
White River Valley*	207	13,917.77	20,122.78	130.26				34,170.81	34,170.81
Yucca Flat	159		52.47					52.47	52.47
							County Totals	208,750.15	208,750.15

* Shared Basins

[1] **Total Allocated = Vested + Certificated + Permitted + Reserved**

[2] **Total Demand = Vested + Certificated + Permitted + Applied For + Ready for Action/Protest + Reserved**

Source: Division of Water Resources Files database April 2015. The values are preliminary and intended to be used for planning purposes only.

Table 3-5 summarizes the surfaces water appropriation by type of use. Agriculture (irrigation and stock water) is the largest user of surface water in Nye County accounting for a combined total nearly 153,000 acre-feet per year. Wildlife accounts for nearly 25,000 acre-feet with the majority of the rights held by the US Fish and Wildlife Service at the Ash Meadows Refuge in the Amargosa Desert. Mining, considered a temporary use, used about 16,000 acre-feet in 2015.

In 1985, surface water accounted for 47 percent of total water use in the County, reflecting their ease of access and application to beneficial use. By 1990, surface water use had dropped to 13 percent of the total water use in Nye County as groundwater development and pumpage increased. Presently surface water, which accounts for almost 37 percent of the committed water resources in Nye County, is used primarily for agriculture and wildlife.

Surface Water Issues

Drought is the foremost factor affecting surface water resources. Extended drought reduces precipitation, resulting in a reduction and sometimes complete loss of streamflow as baseflows decline. Drought will continue to reduce the availability of surface water supplies to support agricultural and ranching sectors. In addition to the negative economic impacts, drought will complicate the protection of spring and stream discharge rates, the management and use of riparian areas, and the maintenance of surface water quality.

In addition to the effects of drought, spring and stream discharges in Nye County may be reduced by diversions for beneficial use (a permitted activity), drought (a natural condition), or the effects of groundwater pumping that is located too near to surface water bodies. Figure 3-9 shows how springs may be affected by groundwater pumping. The potential for impacts on springs depends upon the proximity of the pumping, the hydraulic characteristics of the aquifer, and the magnitude and duration of pumping.

Beneficial use of surface water has been hampered by federal land use policies and decisions. Federal land management agencies such as BLM and USFS have adopted policies and decisions aimed at constraining, or in some cases, eliminating water use associated with federally authorized land use and disposals. Historic impacts on springs in Pahrump Valley are well documented. Discharge at Bennett Spring was measured at 3,350 gallons per minute (7.5 cfs) in 1875, and more than 2,500 gallons per minute (5.6 cfs) in 1940, but was dry by the end of 1959. At Manse Spring discharge dropped from a historic high of 2,700 gallons per minute (6.09 cfs) in 1885 to 1,400 gallons per minute in 1940, and was dry during the summer months by 1975. In 2004, Manse Spring began to flow again, reflecting wetter than normal climatic conditions and a decrease in agricultural water withdrawals in the vicinity of the spring. Most recent discharge measurements from Manse Spring were conducted by Nye County in May and October, 2011; measured discharges were approximately 900 gpm (2.0 cfs) (USGS NWIS, 2016). The prior reduction of spring discharges in Pahrump Valley resulted in the loss of the endemic Pahrump Killifish, as well as other fish species that depended on the spring pools for habitat.

A significant issue affecting northern Nye County is the use and management of riparian areas. Figure 3-10 shows conceptualized model of the ecologic processes at work in a healthy riparian area. The use and management of riparian areas on public lands continues to be a source of increased awareness and conflict. Livestock and wildlife, including wild horses and burros, can

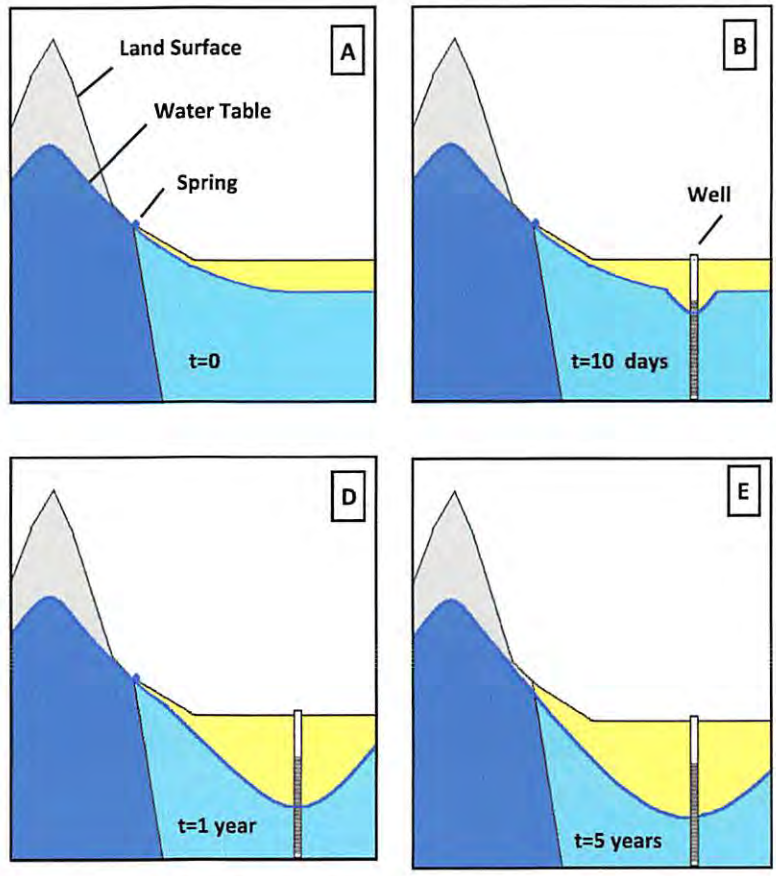
Table 3-5. Summary of Committed Surface Water Rights in acre-feet by Manner of Use for Nye County Basins as of April 2015

Basin Name	Basin No.	Domestic	Com-mercial	Mining & Milling	Mining, Milling & Dewatering	Stock	Irrigation	Irrigation DLE	Wildlife	Recrea-tion	Municipal	Quasi-Municipal	Power	Storage	Other	Total
Alkali Spring Valley*	142			18		4										22
Amargosa Desert	230			258		22	5,055	27	19,293	207		2			145	25,008
Antelope Valley (Eureka & Nye)*	151					95	260								181	536
Big Smoky Valley - Northern Part*	137B			8,185		760	12,268						6,697	1,000	202	29,112
Big Smoky Valley - Tonopah Flat*	137A		8	6,425	1,020	926	2,278			1					94	10,752
Cactus Flat	148					12	196									208
Coal Valley*	171					22										22
Crater Flat	229					9									2	11
Emigrant Valley/Groom Lake Valley*	158A					28										28
Emigrant Valley/Papoose Lake Valley*	158B															0
Fortymile Canyon/Buckboard Mesa	227B															0
Fortymile Canyon/Jackass Flats	227A					4										4
Frenchman Flat*	160					4										4
Gabbs Valley*	122	18		58		150	196								7	411
Garden Valley*	172	18				73	1,197									1,271
Gold Flat	147					32										32
Grapevine Canyon*	231															0
Hot Creek Valley	156			41		1,983	893	40							19	2,976
Indian Springs Valley*	161					2										2
Ione Valley*	135			127		355				15					80	578
Kawich Valley	157					77			13							90
Lida Valley*	144					2										2
Little Fish Lake Valley	150					165	154								139	458
Little Smoky Valley Central Part	155B					30										30
Little Smoky Valley Northern Part*	155A					139	239								454	832
Little Smoky Valley Southern Part	155C					120			31							151
Mercury Valley	225															0
Monitor Valley Northern Part*	140A					653	297								13	963
Monitor Valley Southern Part	140B	2		24		1,073	26,509	1,274		1					40	28,921
Oasis Valley	228	53		12		18	4,280			50		83			28	4,471
Pahroc Valley*	208															0
Pahrump Valley*	162			90		21	5,595			1,425	1,680			575		9,387
Penoyer Valley (Sand Spring Valley)*	170					23										23
Railroad Valley Northern Part*	173B			442		500	31,948	2,611							61	35,563
Railroad Valley Southern Part*	173A					298										298
Ralston Valley*	141			9		171	48								111	339
Rock Valley	226															0
Sarcobatus Flat*	146					64	10									74
Smith Creek*	134						218									218
Stone Cabin Valley	149			16		791	882									1,689
Stonewall Flat*	145					57									2	60
Upper Reese River Valley*	56					1,176	16,642	971								18,789
White River Valley*	207					258	28,520		5,392			2				34,171
Yucca Flat	159					52										52
	Totals	91	8	15,707	1,020	10,173	137,684	4,922	24,729	1,698	1,680	87	6,697	1,575	1,578	207,559

* Shared Basins

Source: Division of Water Resources Files database April 2015. These values are preliminary and intended to be used for planning purposes only.

Figure 3-9. Potential Effects of Groundwater Withdrawals on Spring Discharge Rates.



A. Prior to pumping, the natural hydrologic system is in balance with flow from recharge areas over the mountains to discharge areas along the valley axis or out of the basin via underflow. Where the water table intercepts the land surface, groundwater discharges to the surface as springs.

B. With the onset of pumping, water levels are lowered in the vicinity of the production wells. The amount of water level decline that will occur depends upon a number of factors, including the pumping rate and duration, and the ability of the underground aquifers to store and transmit groundwater. If more than one production well is present a pumping center may develop where the cones of depression of each well begin to overlap.

C. With continued pumping, the area over which declines occur begins to expand outward from the pumping well or wells.

D. As water withdrawals continue over time, the area of influence of the wells begins to approach the edges of the valley-fill aquifer (or the geologic structure) controlling the spring. Spring discharge rates may begin to decline.

E. The effects of long-term withdrawals can expand beyond the valley-fill aquifer and can reduce or eliminate the natural discharge of springs. Springs have dried up in this manner in a number of Nevada basins including Las Vegas Valley, Pahrump Valley, and Clayton Valley. Wetlands and habitats associated with the springs may also be eliminated or significantly reduced in size.

trample vegetation and overgraze forage in riparian areas. Livestock and wildlife may impact water quality in riparian areas by disturbing the soils and increasing erosion. Wildlife may be trapped and drowned in troughs and spring developments. Water diversions for irrigation may impact instream flows.

Livestock production is an important economic sector in northern Nye County. The ranching industry, in accordance with Nevada Water Law, has the right to divert water from streams and springs and to withdraw groundwater for irrigation. The potential effects of cattle on riparian areas cannot be entirely discounted, and, if not properly managed, livestock grazing can adversely impact the sporting and tourism industries that also provide important sources of revenue to the County. Impacts from grazing have been greatly reduced as grazing allotments are being restricted and closed. Further by requiring appropriate management practices, the effects of livestock grazing on riparian areas have been minimized.

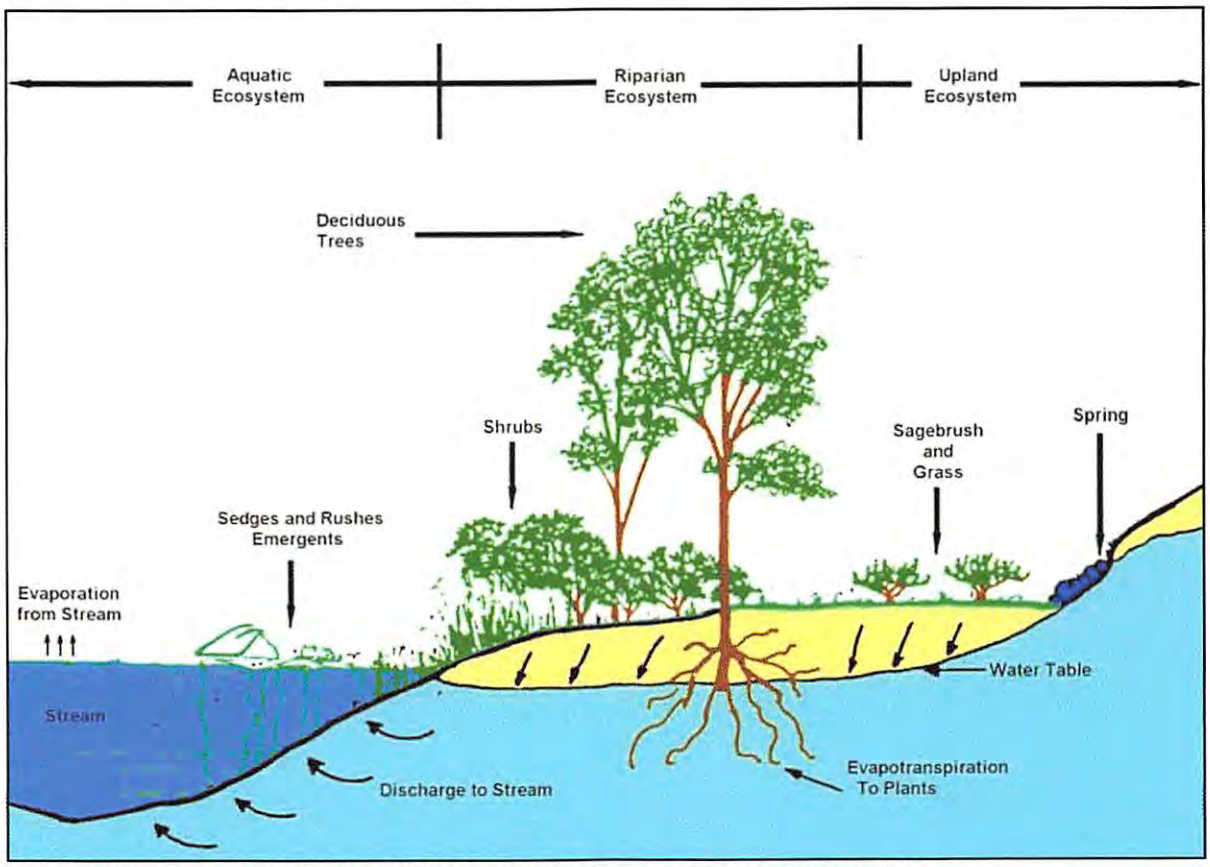


Figure 3-10. Conceptual model of ecological processes in a riparian area. From Buqo (2004).

In a related issue, thousands of "wild" horses and burros roam Nye County's public lands and sometimes the private lands, as well (www.blm.gov, accessed 2016; Wild Horse and Burro Facts). These large animals, originally introduced by the European settlers and later the gold miners, were afforded Congressional protection in 1971 by the Wild Free-Roaming Horses and Burros Act, which requires BLM to actively manage the herds at appropriate levels. Another federal law, FLPMA, requires BLM to manage public lands under the principles of "multiple use and sustained yield,"

thus livestock grazing and wildlife habitat are managed along with free-roaming horses and burros. When BLM develops land use plans, FLPMA requires that wild horses and burros be considered for their *resource value* on par with cultural, historic, wildlife, and scenic resources as opposed to authorized land uses, such as livestock grazing. As a result, many of the restrictions and requirements placed on ranching are not equally applied to wild horse and burro herds, even though the environmental impacts are essentially the same.

Wild horses and burros have virtually no natural predators and their herd sizes can double about every four years. In 1978, the Wild Free-Roaming Horses and Burros Act was amended requiring BLM to set Appropriate Management Levels (AML) and remove excess wild horses. As a result, the BLM removes thousands of animals from the range each year as part of its efforts to control herd sizes. AMLs for each Herd Management Area are established through FLPMA's land use planning process; i.e. RMPs. As of 2015, the currently established total maximum AML for both horses and burros on public lands in the western United States is 26,715, as shown in Table 3-6. Advocates for protection of free-ranging horses have argued that the AML was too low compared when compared to the forage allocated for cattle. Congress has not suggested that AML be raised but instead has directed the BLM to look into more effective forms of population control.

Table. 3-6. 2015 BLM counts/estimates of wild horses and burros by state, and established AML.

State	Horses	Burros	Total	Max. AML
Arizona	303	4,860	5,163	1,676
California	4,395	2,946	7,341	2,200
Colorado	1,415	0	1,415	812
Idaho	633	0	633	617
Montana	172	0	172	120
Nevada	27,599	2,611	30,210	12,811
New Mexico	175	0	175	83
Oregon	4,327	49	4,376	2,715
Utah	4,550	355	4,905	1,956
Wyoming	3,760	0	3,760	3,725
Total	47,329	10,821	58,150	26,715

Source: BLM Horse and Burro Quick Facts website, accessed 12-9-2015
http://www.blm.gov/wo/st/en/prog/whbprogram/history_and_facts/quick_facts.html

Between 1971 and 2001, BLM removed 193,000 horses and burros from federal rangelands, but was unable to maintain the populations at AML. Adoptions did not keep pace with removals, and in numerous instances, excess healthy animals were destroyed. In response to public outcry, Congress passed several measures to prevent BLM from destroying healthy animals. As a result of this direction, BLM now has a program to provide sanctuary to the excess animals. Unfortunately, the removal, adoption, and sanctuary programs have been unsuccessful in effectively reducing the number of animals on public lands. Today, over 58,000 animals remain on public lands, more than 31,000 animals over the established AML of 26,715. By BLM's count, nearly 30,210 animals of this western state total - 27,599 horses and 2,611 burros – are located in Nevada, many of them in Nye County. The stability of land, natural resources, and local Nye County economy depend on keeping herds at a minimum.

Effective Management Practices include:

- Conveying water from streams to watering sites away from riparian areas;
- Moving salt blocks away from riparian areas;
- Fencing selected riparian areas in National Forests;
- Monitoring impacts of grazing on riparian areas;
- Installing walkways to prevent trapping and drowning;
- Promoting cooperation between the ranching industry and federal land management agencies for the long-term management of range lands; and
- Encouraging BLM to manage wild horse and burro numbers.

The goal of many environmental groups and coalitions to remove cattle from all riparian areas in the western states remains a threat to the livestock industry of Nye County. In response to these concerns, many recent federal plans have severely restricted and even removed grazing from public lands. BLM's 2014 Draft RMPs/EISs for the Las Vegas and Pahrump Field Offices and Carson City Field Office propose extensive management agency (BLM) goals and objectives reiterate the management practices noted above, and also make several additional recommendations including:

- Permanent closure of previously restricted grazing allotments;
- Making existing allotments unavailable in the future; and
- Closing all allotments.

Nye County continues to promote cooperation between the diverse groups interested in the riparian areas within the County by coordinating resource management efforts with federal and state agencies to ensure that important Nye County economic sections that are reliant on access to public can be sustained.

Key surface water management issues in Nye County include:

- **Promoting riparian area management and protection;**
- **Implementing conservation measures in areas, where appropriate;**
- **Improving understanding of the relationships between surface and ground water uses;**
- **Maintaining instream flows for recreation, wildlife, and agricultural uses; and**
- **Reducing flood hazards and nonpoint source pollution.**

These issues are addressed in later Chapters of this plan.

3.5. GROUNDWATER RESOURCES

In addition to its surface water resources, Nye County has considerable groundwater resources. Groundwater occurs at various depths under the entire county and has been developed for municipal, agricultural, and mining supplies as well as for other purposes. In recent decades, the demand on the groundwater resources has grown significantly, in part reflecting the growth of the various economic sectors of the County, and in part reflecting the interest in exporting water from Nye County through large-scale interbasin transfers of water. Because most of the surface water resources of Nye County are already appropriated, the groundwater resources represent the only

remaining source of water available to support Nye County's future well-being through economic diversification and expansion.

In this section, an overview of the groundwater resources of Nye County is presented. This overview includes a description of the hydrologic conditions and sources of water, the quantity of water that is present, the quality of that water, the committed groundwater resources, and the issues associated with their development and use.

General Geologic Conditions

The geologic units of Nye County may be grouped into seven categories based on their significance to groundwater: 1) valley-fill deposits, comprising mixtures of gravel, sand, silt and clay that include the alluvial and playa deposits; 2) younger volcanic rocks, comprising ash-flow tuff and basalt; 3) older volcanic rocks, comprising dacite, latite, andesite, and tuffs; 4) Triassic sediments, comprising freshwater limestone, conglomerate, sandstone, siltstone, and tuff; 5) intrusive rocks, comprising granitic plutons; 6) upper Paleozoic carbonate rocks, comprising predominantly limestone and dolomite, but with inter-bedded shale and siltstone aquitards; and 7) lower Paleozoic and older rocks, comprising predominantly clastic rocks including shale and quartzite, but with some inter-bedded carbonate units. For more detailed descriptions of the geologic units present, the reader is referred to Nevada Bureau of Mines and Geology Bulletin 77, Geology and Mineral Deposits of Southern Nye County, Nevada, 1972, by Henry R. Cornwall, and Bulletin 99A, Geology of Northern Nye County, Nevada, 1985, by Frank J. Kleinhampl and Joseph I. Ziony.

In general, the geologic units of Nye County can be divided into three major aquifer systems, the valley-fill aquifers, the volcanic aquifers, and the regional carbonate aquifer. The regional carbonate aquifer is divided into six systems: an upper carbonate system, an upper clastic aquitard, a lower carbonate system, a Cambrian aquitard, a middle Cambrian carbonate aquifer, and a lower clastic aquitard.

The ability of the aquifer systems of Nye County to store and transmit groundwater, and to yield water to wells, depends upon the type of aquifer and its characteristics. Typically, the alluvial deposits are more productive where they comprise coarse-grained gravels and sand deposits, but exhibit low well yields in the playa areas where clay predominates. The production from the consolidated volcanic and carbonate aquifers depends largely on the degree of faulting and fracturing. The fractured limestone and dolomite units are quite productive aquifers, with yields as high as 3,000 gallons per minute reported for some wells drilled into similar units in Clark County. Some geologic units have little or no productivity because of their fine-grained nature. These units include shale, quartzite, and granite. When fractured, these units may be capable of producing low to moderate well yields (a few tens of gallons per minute), but generally act as aquitards (units that tend to retard the movement of water horizontally and vertically between aquifers).

The distribution of geologic units and the relationships between aquifers and aquitards is variable because of the past geologic history of Nye County. The carbonate and other sedimentary rock units that were originally deposited as flat lying sediments on the ocean floor have since been faulted, folded, fractured, and in some instances, intruded by granitic rocks. Low-angle faults have resulted in older rocks being thrust over younger rocks while high-angle basin and range faults have resulted in significant offsets in geologic units. The intrusion of plutons, dikes, sills, and volcanic

conduits has further disturbed the rocks and aquifers. The net result of this deformation is that the aquifers in Nye County are not continuous. Rather, they are broken into discrete compartments that are usually bounded either by fault zones or contacts between rocks with contrasting hydraulic properties. This compartmentalization is an important, but poorly understood, aspect of the regional hydrologic conditions. The regional carbonate aquifer, for example, is commonly perceived as a continuous aquifer while in reality, it has been broken up both horizontally and vertically into dozens, and perhaps hundreds, of individual compartments. A better understanding of how these compartments interact can only be achieved through further testing and study.

Groundwater Occurrence and Flow

Figure 3-11 shows the conceptual hydrogeologic conditions in Nye County. Recharge derived from precipitation over the upland areas replenishes the groundwater reservoir each year. Groundwater flows from the upland areas toward the valley floors. In undrained basins, all of the groundwater stays within the basin where the recharge fell and is discharged to the surface or consumed by plants (a process referred to as evapotranspiration).

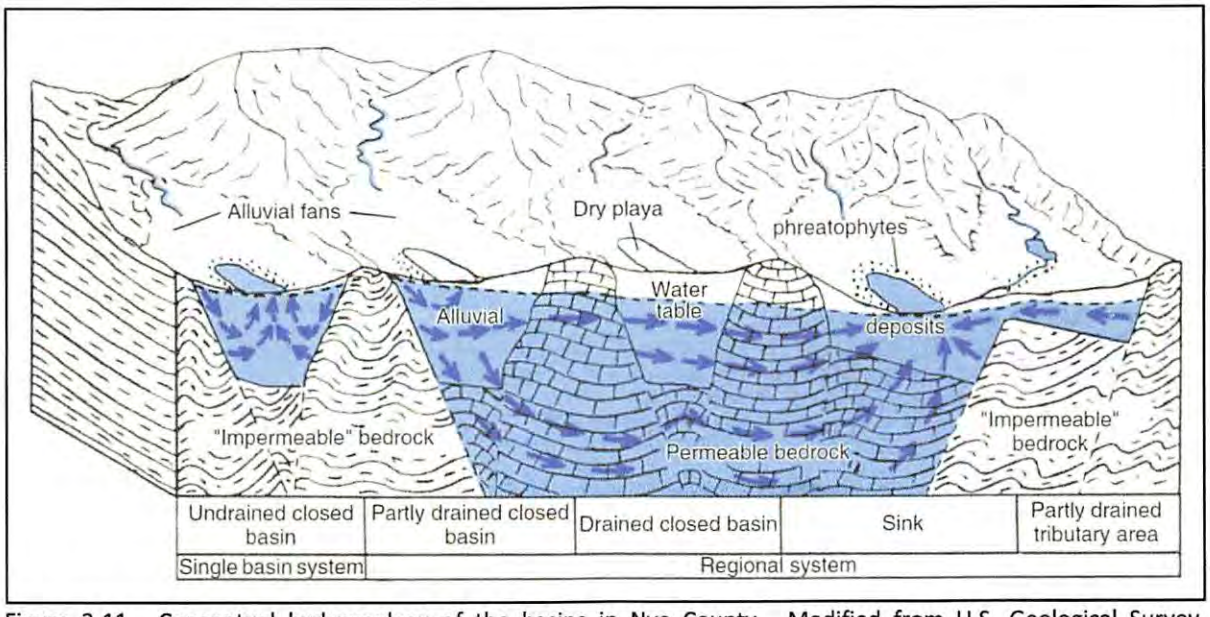


Figure 3-11. Conceptual hydrogeology of the basins in Nye County. Modified from U.S. Geological Survey Professional Paper 813-G.

Nye County is located within the Great Basin, a 200,000 square mile area that drains internally. All precipitation in the region evaporates, sinks underground or flows into lakes (mostly saline). Creeks, streams, or rivers find no outlet to either the Gulf of Mexico or the Pacific Ocean. The region is bounded by the Wasatch Mountains to the east, the Sierra Nevada to the west, and the Snake River Plain to the north. The south rim is less distinct. The Great Basin includes most of Nevada, half of Utah, and sections of Idaho, Wyoming, Oregon, and California. Located in the Basin and Range sub-region the area is characterized by many north-south trending mountain ranges. These mountain ranges are separated by flat valleys or basins (Hunt, 1974).

Hydrologically, the Great Basin is separated into eastern and western areas on the basis of the occurrence of depositional facies of continental-shelf and continental-slope and -rise deposits. The western area includes the approximate western one-third of the Great Basin and is characterized by marine sedimentary rocks (chert, shale, siltstone, sandstone, and limestone) and marine volcanic rocks of Paleozoic and early Mesozoic age. The eastern two-thirds of the Great Basin is characterized by alternating sedimentary sequences that are dominated either by clastic rocks (mostly sandstone, shale, and conglomerate) with minor amounts of carbonate rocks (limestone or dolomite) or by carbonate rocks (limestone and dolomite) with minor amounts of clastic rocks (Harrill and Prudic, 1998). Nye County includes areas characterized by each of these two distinct facies.

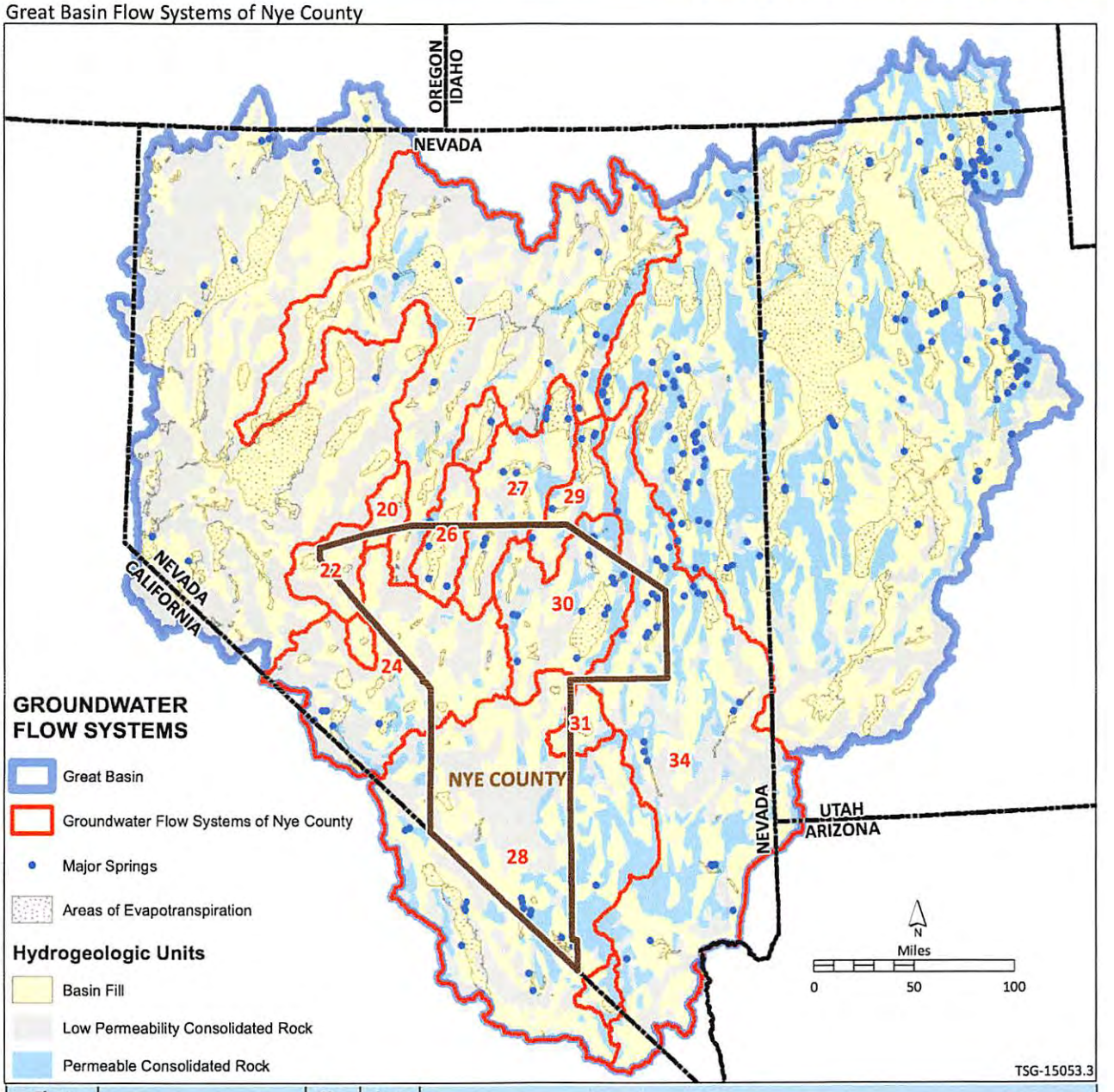
In general in the eastern Great Basin, the overall thickness of carbonate rocks exceeds that of clastic rocks, especially in the Middle Cambrian to Lower Triassic parts of the stratigraphic section. Combined thickness of carbonate and clastic rocks ranges from about 5,000 ft to nearly 30,000 ft. The area of eastern and transitional depositional facies correspond to the general area of the carbonate rock province as used by Harrill and Prudic (1998).

The Great Basin regional aquifer system includes most of Nevada and parts of Utah, California, Oregon, Idaho, and Arizona that contain numerous basins that collectively constitute a significant regional ground-water resource. Most of the basins share common geologic and hydrologic characteristics. In addition to basins that function as independent hydrologic systems, this group includes contiguous basins that have varying degrees of hydraulic continuity through permeable consolidated rocks, or that are linked by river systems (Harrill and Prudic, 1998).

In parts of western Utah and eastern Nevada, structural basins are underlain and bounded by thick sequences of permeable carbonate rocks; this creates complex flow systems that contain both basin-fill and carbonate-rock aquifers. Most of the basins throughout the area contain basin-fill aquifers, which are physically separated by intervening mountain ranges composed of consolidated rock and have varying degrees of hydraulic connectivity. The carbonate-rock aquifers are within the carbonate-rock province, a 100,000-mi^2 area that is mostly in eastern Nevada and western Utah. This area is characterized by some degree of hydraulic continuity between basins through the carbonate-rock aquifers. Several large multi-basin ground-water flow systems have been identified in the carbonate-rock province (Harrill and Prudic, 1998).

As previously noted, where two or more basins are hydraulically connected, they form a flow system. Figure 3-12 shows the groundwater flow systems that underlie Nye County. The Railroad Valley system and the Death Valley system are the two major flow systems in the County, but recharge over Nye County provides appreciable water to the Northern Big Smoky Valley system, the Diamond Valley system, the White River system, and the South Central Marshes system. The hydraulic connection between individual basins in each of these systems is usually the carbonate rocks that underlie the valley-fill deposits and crop out in the mountains. These rocks are commonly referred to as the regional carbonate aquifer.

Great Basin Flow Systems of Nye County



Flow System No.	Flow System	No. Basins	Area (sq mi)	Nye County Portion
34	Colorado	34	16,300	Coal Valley, Garden Valley, White River Valley
28	Death Valley	30	15,800	Amargosa Desert, Buckboard Mesa, Cactus Flat, Crater Flat, Death Valley, Groom Lake Valley, Papoose Valley, Frenchman Flat, Gold Flat, Indian Springs Valley, Jackass Flats, Kawich Valley, Lida Valley, Mercury Valley, Oasis Valley, Pahrump Valley, Rock Valley, Sarcobatus Flat, Stonewall Flat, Yucca Flat
27	Diamond Valley	6	3,120	Antelope Valley, Monitor Valley North & South
22	Gabbs Valley	1	1,280	Gabbs Valley
7	Humboldt	34	16,800	Upper Reese Valley
29	Newark Valley	3	1,450	Little Smoky Valley North & Central
26	Northern Big Smoky Valley	1	1,320	Big Smoky Valley North
31	Penoyer Valley	1	700	Penoyer Valley
30	Railroad Valley	4	4,130	Hot Creek Valley, Little Fish Lake Valley, Little Smoky Valley South, Railroad Valley North
20	Smith Creek Valley	1	582	Smith Creek Valley
24	South Central Marshes	12	6,790	Alkali Spring Flat, Big Smoky Valley, Ione Valley, Ralston Valley, Stone Cabin Valley

Figure 3-12. Groundwater flow systems, hydrogeologic units, and areas of evapotranspiration of the Great Basin. After Harrill et al (1988) and Schruben et al (1994).

The sources of groundwater in these flow systems include recharge from precipitation, mountain runoff, and regional inflow from carbonate rock aquifers. The regional carbonate aquifer stores hundreds of millions of acre-feet of water. However, the U.S. Geological Survey has estimated that if the water stored in the upper 100 feet were extracted, the central carbonate aquifer could yield about six million acre-feet of stored water. It is important to note, however, that the extraction of such huge volumes of water, and the subsequent lowering of water levels, could have significant adverse impacts on the groundwater regime of the basins where extraction occurs. The issues associated with this type of groundwater development are discussed in a later chapter.

Nye County includes portions of eleven groundwater flow systems but does not have any single flow system entirely within its boundaries. Collectively, these flow systems total more than 68,000 square miles. The most important flow systems in Nye County are the Death Valley system, the South Central Marshes systems, the Railroad Valley system, and the Colorado system because recharge over the mountainous areas of these regions sustain much of the flow through the Death Valley and Railroad Valley systems with much smaller contributions to the other flow systems. The groundwater in these systems ultimately discharges to regional sinks including the saltpan at Death Valley in Inyo County, the Muddy Springs area in Clark County, discharge areas in Esmeralda County, and the extensive springs and evapotranspiration areas in central Railroad Valley, Big Smoky Valley, and Little Fish Lake Valley.

From a water planning perspective, the recognition of flow system sources and discharge areas is important. For example, the Death Valley flow system includes 20 hydrographic basins that are located wholly, or partially, in Nye County. Within this flow system, recharge derived from areas in Clark County and northern Nye County provide the source of most of the groundwater in southern Nye County. The groundwater in Pahrump Valley and eastern Amargosa Desert is derived primarily from precipitation that falls over the Spring Mountains. The groundwater in central Amargosa Desert is derived primarily from recharge from the Sheep Range, in north-central Clark County (Buqo, 2004).

Much of the groundwater in the eastern and central Death Valley system discharges at the springs and evapotranspiration areas in the Nevada portions of Amargosa Desert and Pahrump Valley. Some discharges in California at the springs at Tecopa and the playa area south of Death Valley Junction. Some portion of the groundwater discharge at the springs and saltpan at Death Valley may also be derived from the underflow of groundwater from Nye County that originated as recharge over Clark County or even portions of Lincoln County. Thus, much of southern Nye County's groundwater resources originates from recharge in Clark County and some areas in California rely upon the portion of recharge that crosses the state line from Nye County into Inyo County. These hydrologic conditions indicate the need for cooperative water planning across county and state lines to ensure that developments in one part of a flow system do not result in unacceptable impacts in other parts of the flow system.

General Basin Hydrology

Nye County's eleven flow systems include all or portions of 43 individual hydrographic basins. Figure 3-13 shows the locations of these basins, and Table 3-7 provides summary information on the water budget parameters for each of these basins. The water budget in its simplest form is an accounting of the flows to and flows from a basin and is assumed to be balanced under natural or