4.0 Evaluation of Nonpoint Source Concerns

This section is intended to provide an up-to-date evaluation of nonpoint source concerns either currently or potentially impacting water quality on the Pyramid Lake Indian Reservation. This updated evaluation first addresses concerns previously identified in the 1994 Plan, and then provides descriptions of several more recently identified concerns that were not included as part of the 1994 assessment. BMPs and abatement measure recommendations specific for each topic are listed within each section, with the broader category recommendations then discussed in further detail in section 5.0.

4.1 Current Status of Previously Assessed NPS Concerns

This section includes brief descriptions of each NPS problems identified and ranked in the 1994 Plan. The summaries are copied here directly from the 1994 Plan (shown in italics). Chapter references cited within summaries can be located in the full version of the 1994 Plan, included with this document as Appendix A. Following the 1994 description of each concern, we now include updated information and current status as is relevant to each topic, as well as a listing of water quality parameters affected by the source, and descriptions of any mitigation/abatement activities that have been completed or are in progress. A table listing significant mitigation and abatement activities that are completed, planned, or in progress is provided in Table 2 in the following section.

ATMOSPHERIC LOADING- 1994 SUMMARY:

The atmosphere as a source of NPS pollution to waterbodies has received considerable attention over the past decade. For Pyramid Lake and the Reservation as a whole, atmospheric loading is primarily a source of nutrients, particularly nitrogen. In chapter two, we quantified the potential input of nutrients to Pyramid Lake through precipitation to the surface of the lake, dry fallout of dust, and wind-blown tumbleweeds. The quantification of atmospheric nutrient loadings to Pyramid Lake indicates that they are probably a small source of nitrogen, particularly precipitation. Combining the different pathways, atmospheric loadings of nutrients to Pyramid Lake contribute up to 35 Mg (77,000 lbs) of nitrogen and 7 Mg (15,400 lbs) of phosphorus in an extremely wet year. For an average year, the input of nitrogen decreases to approximately 25 Mg (55,000 lbs) while phosphorus loading remains at approximately 7 Mg due to very low phosphate concentrations in precipitation. This input of nitrogen to the lake from atmospheric sources (primarily precipitation) should contribute to the algal production of Pyramid Lake (Lebo et al. 1994b). Because the lake is managed by the Tribe as a sport fishery, an increase in nitrogen concentration and hence algal production from its present low nutrient state is desired. The loading of atmospheric nitrogen to the lake is beneficial at this time and enhances the desired water qualities for the system (e.g. food for fish).

Current status and mitigation/abatement activities:

As described above and in the 1994 Plan, atmospheric NPS nutrient deposition to Pyramid Lake consists primarily of nitrogen. This small source of nitrogen loading is considered to perhaps actually be beneficial to the lake ecology and the fishery by stimulating productivity. Nutrient stimulation from river inputs produce pronounced blooms of *Nodularia spumigena*, a native cyanobacterium which fixes atmospheric nitrogen into lake waters, which produce hepatoxins in mass decay.

More recent research is beginning to show that currently in many areas, the primary consideration for atmospheric NPS deposition is for the constituent mercury. Studies conducted indicate a variety of sources exist in Northern Nevada that can contribute to atmospheric mercury, including undisturbed and mining-disturbed enriched substrates, extensive geothermal activity, coal-fired power plants, and gold ore processing facilities (Lyman, et al., 2007). While it is possible that the majority of mercury deposition in Pyramid Lake is the result of incoming Truckee River flows, atmospheric deposition of Mercury to Pyramid Lake may exacerbate the risk of bioaccumulation in fish tissues and the potential risks to human health. Studies conducted on fish tissue from Pyramid Lake Lahontan Cutthroat Trout from 2001-2003 have shown that (depending on sample year) 17% to 56% of the trout contained muscle mercury levels above the EPA criterion level of 0.30 ppm (Slotton, 2003). These study results emphasize the risk that mercury deposition in water bodies can pose to human health. Atmospheric mercury can be deposited in three primary forms, with gaseous oxidized mercury being of the most concern due to high deposition rates, reactivity, and solubility in water. Standardized methods for measuring atmospheric deposition of gaseous oxidized mercury are currently being researched. (Lyman, et al., 2009)

Water Quality Parameters Affected:

- Bioaccumulation (mercury)
- nitrogen

Recommendations:

- Review ongoing research in atmospheric mercury deposition, particularly for studies involving the Truckee River watershed, to determine the order of magnitude for this concern.
- As technology and funding opportunities develop, plan and implement an atmospheric mercury deposition measuring station in the Pyramid Lake basin.
- Participation in regional working groups to address problems associated with atmospheric mercury deposition. Through workgroup participation the tribe will

develop the opportunity to comment on and influence air quality decisions on regional and state levels.

- Continue to study bioaccumulation of mercury in fish tissue of Pyramid Lake Lahontan Cutthroat Trout.
- Continue to work on reducing nutrient loading which increases cyanobacteria.

EPHEMERAL STREAMS- 1994 SUMMARY:

Overland and ephemeral (i.e. occasional) stream flows are a common feature in desert regions following storm events. Stream inflows to Pyramid Lake from storm events and snowmelt from adjacent mountains are potentially important sources of nutrients, total dissolved solids (TDS), and sediments to the lake that were discussed in chapter two. To evaluate loadings of these constituents to Pyramid Lake by stream inflows, comprehensive surveys of streams flowing into the lake were conducted during February and March of 1993. Dissolved nutrient concentrations in streams discharging to Pyramid Lake during the February and March 1993 surveys were variable but often quite high in both nitrogen and phosphorus. Despite the high nutrient concentrations in the streams, the total daily loading of nutrients to the lake from stream inflows was relatively small due to low total inflow. The input of nitrogen, phosphorus, and sediment to Pyramid Lake for the two samplings ranged 40-62, 31-62, and 52,800-120,000 lbs/day, respectively.

Total nutrient loadings to Pyramid Lake for the February storm event and for snowmelt were used to estimate annual nutrient loads. Because stream flow around Pyramid Lake should depend on overall precipitation, we calculated annual values for the minimum, average, and maximum scenarios used above for precipitation. These are 1.55, 7.56, and 13.7 in/yr, with values corresponding to minimum, average, and maximum annual precipitation at Reno, Nevada, during 1888-1992. Total annual nutrient loading to the lake from streams was small for all scenarios, with maximum inputs of nitrogen and phosphorus of only 3300 and 2640 lbs/yr, respectively. However, our estimates for stream inflow to Pyramid Lake are lower than the value reported by Van Denburgh et al. (1973) in a previous hydrologic survey of the region. Combining our estimate for stream inflow in an average precipitation year with the one from Van Denburgh et al. yields an input of 3620 acre-ft/yr. This revised value represents a best estimate of stream inflow to Pyramid Lake in an average precipitation year. Under this revised scenario, streams contribute small amounts of nutrients, TDS, and sediment to Pyramid Lake. The input of TDS and sediment to the lake from ephemeral streams may adversely affect water quality while nutrients will be beneficial at this time (see atmospheric loading).

Current status and mitigation/abatement activities:

The 1994 evaluation of NPS contribution from ephemeral streams indicates that the overall input is small, however some contribution of nutrients, TDS, and sediment to Pyramid Lake are noted. Land-use within sub-watersheds containing ephemeral

streams on the reservation has not changed appreciably since the 1994 study, primarily consisting of rangeland with minimal or no development. Therefore, it is determined for this report that we can continue to estimate the contribution of NPS pollution directly to Pyramid Lake from this source to be small, from drainages contained within the reservation and adjoining open lands.

One area of concern, however, is the potential sediment transport and degraded water quality which from flash flows in an ephemeral stream draining an agricultural and urban area. Such problems are best studied by examining larger interval events, such as a 5 or 10 year storm. The largest ephemeral stream on the reservation is Mullen Creek, which enters Pyramid Lake at a large alluvial fan associated with Washout Beach. The water in this drainage, when it is present, is from the Warm Springs and Palomino Valleys – developing areas located north of Reno. Land use issues in these valleys are currently being noted and commented upon by the Tribe, as changes occur. A county land use plan indicates the future may bring more settlement in the valley and a wastewater treatment plant not far from the canyon where Mullen Creek passes through the Virginia Range. Some of the larger NPS issues in the valley include urban development, cattle and horse holdings (including the BLM Wild Horse Adoption Center) and the Washoe County Regional Shooting Complex as a source of lead. More information about flows on Mullen Creek may be needed, as it is likely a stream with high flash flows and significant erosion potential. Anecdotal evidence indicates the groundwater flowing beneath Mullen Creek provides drinking water to Sutcliffe, and thereby, pollution affecting recharge areas in the Warm Springs valley are of interest to the Tribe. Because this falls out of the jurisdictional area, coordination with Washoe County and interested stakeholders will be important. This is an opportunity for the tribes watershed-based plan to be developed in upcoming years.

The Nevada Department of Transportation was scheduled to conducted repairs in 2011 in the reservation near milepost 2.86 on Route 446 (Sutcliffe-Nixon Highway). The project intends to construct energy dissipation structures, as well as rebuilt and stabilized the embankment at an outlet of a culvert. (NDOT, 2010) The project was necessitated by an ephemeral stream where flows are cutting into the road and shoreline embankment, very near the waters of Pyramid Lake. The project is on hold, as BIA is directing a Draft Environmental Impact Assessment for the project. This will provide an opportunity to look in greater detail at the issue of ephemeral flows and enhanced roadway stabilization BMPs for water quality. (J. Mosley, pers. comm.)

The 1994 evaluation of ephemeral streams and the current status discussion above address NPS pollution from streams that flow directly toward or into Pyramid Lake. However, the 1994 plan does not address intermittent or ephemeral streams or washes

that drain toward or directly into the Lower Truckee River on the reservation. There are a number of intermittent or ephemeral streams draining to the Lower Truckee that are incised and actively eroding, and are potential, or in some cases known, sources of sediment NPS pollution to the River. The following description is captured from the Pyramid Lake Tribe Comprehensive Resource Management Plan (CRMP) developed in 2005: "Dead Ox Wash is a steeply incised, intermittent stream that drains into the Truckee River. There is active erosion along the steep banks, which contributes a significant sediment load to the river" (NRCS, 2005).

There are a number of ephemeral streams in the Pyramid Lake Reservation which do not flow into the Truckee River / Pyramid Lake watershed at all. This includes streams that flow into the dry Winnemucca Lake, but the surface waters are very unlikely to ever reach Pyramid Lake. These waters and the springs that feed them are still a concern for non-point source pollution, as they support beneficial uses to the tribe. Sometimes these drainages are in critical areas where little other water is to be found. These uses include rangeland cattle water and some of the tribe's best riparian wildlife habitat. Though not included in the 1994 study, they are included in review for this plan.

In cases where isolated ephemeral streams are degraded, they experience many of the same problems with sedimentation, nutrient overloading, and bacterial contamination. Degraded streambanks erode, cut down the water table in a mountain meadow, and create drier conditions locally while depositing sediments in previously rich areas. Impacts to some drainages have been severe, such as at the San Emidio Creek. Feral horse populations combined with recent wildfire activity have degraded one of the more enriched wildlife habitats in the region. At recent restoration projects in a number of springs, perennial and ephemeral drainages, fence enclosures combined with watering facilities have promoted riparian vegetation, which naturally stabilizes the drainages.

Water Quality Parameters Affected:

- nitrogen
- phosphorus
- TDS
- sediment
- pathogens (*E. coli*)
- Bioaccumulation (lead)

Recommendations:

- Implementation of additional fencing exclosures and livestock water developments on prioritized lake tributaries.
- Continued monitoring of stream conditions and water quality within exclosures.
- Continued inspection of fencing exclosures.
- Assessment and mapping of ephemeral streambank erosion areas on Truckee River tributaries.
- Ephemeral stream bank restorations using bioengineering techniques in areas of active erosion.
- Update to the Pyramid Lake Livestock & Grazing Ordinance to increase voluntary compliance and effective enforcement.
- Coordinate with upstream users, outside of the reservation boundary, through the watershed-based plan to be developed.
- Monitor for potential toxic contributors to water quality at Mullen Creek, Olinghouse Creek, and any location where a contributing activity may occur.

GROUNDWATER TO LAKE- 1994 SUMMARY:

Groundwater inputs to Pyramid Lake are poorly characterized but have generally been considered to be relatively small (see chapter 2). Nutrient and TDS loadings to Pyramid Lake through groundwater inflow were calculated from a revised estimate of inflow and representative groundwater nutrient and TDS concentrations. Dissolved inorganic nitrogen (DIN) and phosphate (DRP) concentrations used in the calculation were for the public well in Sutcliffe which were 0.32 and 0.065 mg/L, respectively. Annual loading rates of nutrients and TDS through groundwater inflow were calculated by multiplying total inflow by its nutrient and TDS concentrations. Groundwater loading rates for DIN, DRP, and TDS were 10.1, 2.1, and 10,200 tons per year, respectively, indicating that groundwater may contribute to lower water quality by contributing to increasing TDS concentration in Pyramid Lake

Current status and mitigation/abatement activities:

Changes in land-use that could potentially impact groundwater quality and flow have not occurred within the reservation in areas that might influence groundwater input to Pyramid Lake. Therefore it is determined for this report that NPS inputs from this source to Pyramid Lake continue to be minimal. While the groundwater inflow may increase TDS concentration and lower water quality, it is considered a natural background source and concentration, and mitigation or abatement activities for treatment do not exist. However, land-use activities that could either lower groundwater levels or further pollute groundwater could potentially increase the contribution of NPS pollution from this source.

Water Quality Parameters Affected:

- nitrogen
- phosphorus
- TDS

Recommendations:

- Through ordinance language and/or project permitting conditions, minimize potential groundwater level reductions or pollution inputs to groundwater surrounding Pyramid Lake.

GUANOMI MINE- 1994 SUMMARY:

We assessed the potential contamination to Pyramid Lake waters from Guanomi Mine by collecting soil and water samples at the site in May 1993 (see chapter 3). Surface water at the site on the sampling date was limited to the mouth of a mine shaft and a seepage stream. In the water samples collected from those two locations, major earth elements of iron, aluminum, and calcium comprised the bulk of ions measured. The sample from the mine shaft also contained manganese (8.7 mg/L), copper (5.8 mg/L), and zinc (4.2 mg/L). It is noteworthy that the composition of the water collected from the mouth of the mine shaft probably reflects particle-bound metals, as indicated by high iron and aluminum concentrations. Metal concentrations in the seepage stream, with the exception of manganese (1.9 mg/L), were all <1 mg/L. The stream did contain small concentrations of copper (0.04 mg/L) and zinc (0.68 mg/L), which are 2-5 times higher than guidance values provided by the U.S. Environmental Protection Agency. However, the stream disappeared into the soil at the site after only 30 feet and did not reach the lake shoreline.

For the soil samples collected, several of the elements were at or near the detection limit in all samples. This includes both cadmium and mercury, which are of potential regional and national concern. For the metals which were detected, it is interesting that the soil content in the lake shoreline sample was actually higher than any of the four piles containing soil excavated from the mine shaft (mine tailings). This includes arsenic, barium, chromium, manganese, strontium, vanadium, and zinc. The only metal that was higher in the piles than in the soil collected from the lake shoreline was lead, which was threefold higher in the tailing piles. This suggests that erosion of soil from the mine tailing piles could be a source of lead to the lake. Soil samples collected along a transect between the mine site and the present day lake shoreline revealed that there was a trend of increasing content toward the lake for many metals. This includes aluminum, cobalt, nickel, copper, zinc, chromium, vanadium, arsenic, barium, strontium, and manganese.

Our assessment of the Guanomi Mine site indicates that the mining activity that has taken place has probably had a minimal effect on the transport of metals to the lake. Indeed, many of the elements for which soils were analyzed were highest along the current lake shoreline. The exception to that pattern is lead which was much higher in the tailing piles than near the lake.

However, the highest soil content of lead was actually found in the soil profile collected near the seepage stream. This suggests that the relatively high lead content of soils at the mine site is probably associated with the mineral outcropping rather than localized to the tailing piles. It is likely that the contamination potential from the site is not different from mineral outcroppings located throughout the Pyramid Lake basin. This suggests that potential nonpoint source lead input to the lake is not localized to the Guanomi Mine site but regional in nature. However, it is possible that the construction of mine shafts into the hillside has facilitated aqueous phase metal transport during winter storms. M. Martin (Director, Tribal Environmental Department pers. comm.) indicated that runoff from the site following a recent storm event was acidic (pH < 1). The Tribe should continue monitoring the site during this coming winter to better assess the potential threat of runoff from the site (see chapter 10).

Current status and mitigation/abatement activities:

Assessment of the Guanomi Mine site in 1994 indicates that the site posed a significant potential threat to water quality in Pyramid Lake during storm event overland runoff. The PLPT implemented a mine reclamation project beginning in 2003. A description of the project is provided below in text from the 2007 Final Report to NRCS, written by PLPT project manager and Metallurgical Engineer Donna Marie Noel:

> The Guanomi Mine site is a historical mining property found on the banks of Pyramid Lake, located on the Pyramid Lake Reservation. Due to the acidic drainage from the property, it was identified in the EPA Non-point Source Report, BLM Abandoned Mines Survey, and BIA Minerals Assessment Report as a non-point source of metal loading into Pyramid Lake. The upland vegetation and riparian areas are severely stressed from poor soil conditions, leaching tailings, acidic water, and disrupted flow channels causing invasive species and limited diversity in the plant species. The wetland/riparian areas on the site were traditionally used by the Paiute People for making baskets and tanning hides, the practice continues today by some tribal members. The riparian areas have been deteriorating thru the years thus restricting viable traditional use areas.
>
> Mining at the site began before the reservation was set aside by congress. Railroad workers discovered the mineralization at the site thru a cut in the rail bed. Mining at the site created approximately 150 feet of underground workings without producing any substantial quantities of precious metals. Foster continued to mine the site until the 1970's then left without completing any reclamation. Upon researching the claim history, there were no legal claims or holdings at the mine site. The area was included in the Pyramid Lake Reservation with no previous ownership and thus no parties legally responsible for cleaning up the site. The tribe began assessing the site for reclamation as early as 2000 by characterizing the contamination sources and conditions, followed by developing a reclamation plan for cleanup. The plan was composed of distinct tasks that could be completed independently as funding became available.


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During the second season cows came on the site and ate the wetland plants but it did not prevent vegetation the following spring. The NRCS grant provided funding to erect a fence on the perimeter and an entrance gate to the reclaimed mine site. This kept the cattle out of the area and provided some security from visitors passing by. NRCS funding was used to purchase a native upland seed mixture and native wetland mixture determined by the state BLM Office. Seeding the upland area was accomplished by Girl Scout volunteers, BLM and Pyramid Lake Natural Resources staff. Seed was dispersed with hand spreaders and a truck equipped with a tire drag was used to cover the seed. This prevented the local bird population from feasting on the seed. A secondary wetland planting was done to diversify the riparian community by transplanting cattails and other riparian species form Numana Wetlands, along the Truckee River. The wetland seed mixture was purchased and dispersed to supplement the plant community. All the transplants and seeding for the site was completed in November 2006. In the spring 2007 many new plants had emerged.

A Guanomi Mine Site Reclamation monitoring plan will be developed to assess vegetation success, water treatment, containment, and other environmental parameters, such as water quality and macroinvertebrate sampling performed as part of the Pyramid Lake Water Quality Program. Vegetation survey, wildlife inventory and observations will be recorded by Natural Resources Personnel for determining reclamation success. Tribal members using the site for hides and baskets will be asked to help assess the wetland recovery for traditional cultural use.

Water Quality Parameters Affected:

- pH
- Various toxic metals

Recommendations:

- Runoff from the mine area should be sampled and analyzed for pH and metal concentrations during high precipitation events.
- Evaluate site for implementing additional revegetation efforts.

SUTCLIFFE FISH OPERATIONS- 1994 SUMMARY:

The Tribe operates several fish hatcheries and a rearing facility near Sutcliffe to support the cui-ui and trout population of Pyramid Lake. The two freshwater facilities are located to the southwest of Sutcliffe approximately one half mile from the shoreline of the lake. Because the facilities discharge wastewater to a lagoon system, the impact on Pyramid Lake from the small amount of water used at the facilities (35 gal/min) for several months each year is probably negligible. The shoreline fish rearing facility has a greater potential impact of the lake due to its location on the shoreline of Pyramid Lake and its direct discharge to the lake. It is important to

note that the discharge from the shoreline to the lake is used to attract adult fish into the constructed channels of the facility during the breeding season. A sampling of the nutrient content of water from the discharge channel to the lake in February 1993 revealed concentrations of dissolved inorganic nitrogen (nitrate and ammonium) and phosphate similar to lake waters. This suggests that water discharged from the facility should not stimulate algal growth near its outfall. However, the facility may be an important source of organic nitrogen to the lake.

Current status and mitigation/abatement activities:

PLPT fish hatchery facilities have been upgraded to include drum filtering systems. Drum filter systems are utilized to remove organic solids from effluent water before discharge, and are an effective means of reducing nutrient contributions to receiving waters from discharged hatchery water. Removal of organic solids reduces the organic nitrogen inputs to lake and river water, at least partially mitigating this concern as addressed in the 1994 Plan. Sampling of discharge water from the shoreline facility at Sutcliffe in 1994 determined the discharge water to be similar in inorganic nitrogen and phosphate concentrations to that of the receiving lake water. The addition of drum filtering systems should further reduce nutrient inputs to the lake, effectively mitigating NPS concerns for the Sutcliffe facilities.

Water Quality Parameters Affected:

- Organic nitrogen
- Phosphates

Recommendations:

- Periodic testing of facility discharge water to monitor nitrogen and phosphorus concentrations.

LAKE SHORELINE GRAZING- 1994 SUMMARY:

The grazing of cattle along the shoreline of Pyramid Lake is another potential small source of nutrients to the lake. When cattle are moved to their summer ranges around the lake, animal wastes associated with foraging along the lake's shoreline potentially contributes to total nutrient loading to Pyramid Lake. It is estimated that cattle contribute 5750 lbs of nitrogen and 1920 lbs of phosphorus to the lake annually. The potential loading of nutrients to the lake from livestock manure will probably be reduced in the future due to movement of cattle to new grazing ranges as water sources are developed. Livestock manure is also a potential source of bacterial contamination to the lake. It is important to note that summer range includes the river delta (see Riparian Grazing along River).

Current status and mitigation/abatement activities:

While the amount of nutrient loading to Pyramid Lake and the Lower Truckee from cattle grazing is determined as minimal, there does exist the potential for bacterial contamination in amounts that could potentially pose threats to human health. The PLPT Water Quality Standards (WQS) provide primary contact recreation (swimming, ceremonial use) as a designated beneficial use for Pyramid Lake beach areas and the Lower Truckee River. PLPT conducted bacterial monitoring during summer 2010. Four sites were chosen (two river and two lake) at easily accessible and popular swimming and recreation areas. Testing results from July-September 2010 for E coli show that during the sampling period there were no levels exceeding the WQS E coli criteria that support the primary contact designated use. Perhaps of larger concern for bacterial contamination is human waste associated with lake recreation, discussed under that section summary to follow.

Water Quality Parameters Affected:

- Nitrogen
- Phosphorus
- Pathogen indicators (E coli)

Recommendations:

- Continued development of alternative upland water sources.
- Continued monitoring for pathogen indicators at popular beach areas during recreation season.

SUTCLIFFE DOMESTIC WASTEWATER - 1994 SUMMARY:

The potential contribution of nutrients to groundwater and eventually Pyramid Lake through domestic wastewater produced in Sutcliffe was estimated to be a small source of nitrogen. Based on the present population of Sutcliffe (240 individuals) and typical characteristics of wastewater production, the total nutrient content of domestic wastewater was calculated to be 2220 and 380 lbs/yr of nitrogen and phosphorus, respectively. The potential for transport of the nutrient content of the wastes produced to Pyramid Lake through groundwater is reduced considerably by treatment of the wastewater in a lagoon system. Through treatment in the static lagoon system used by the community of Sutcliffe, potential nutrient loading to Pyramid Lake is reduced to 444 lbs/yr of nitrogen and only 19 lbs/yr of phosphorus. Domestic wastes in Sutcliffe are also a potential source of bacterial contamination to the lake. However, effective treatment of the waste in the lagoon systems should reduce potential bacterial contamination to a negligible level.

Current status and mitigation/abatement activities:

The Sutcliffe wastewater lagoon is a vinyl-lined basin which treats the effluent with aerobic and anaerobic bacteria, with a percolating overflow basin that may be used under circumstances where extremely high wastewater discharges are realized. If the percolation basin is used, it is feasible for a limited amount of nitrate and phosphorous to be discharged to the ground. Such a discharge could travel in subsurface flow to Pyramid Lake. Since its installation, the system has required the use of the overflow basin in only limited circumstances, so there have been minimal to insignificant nutrient discharges. (E. Ingraham, pers. comm.)

While the system is effective, it does not currently service all the homes in Sutcliffe, including fee lands. Sutcliffe is a location proposed for more housing, and the system may need additional capacity to service such housing. It may need to be mandated that homes and businesses be connected to the wastewater treatment system, in order to protect groundwater and resulting discharges to the lake.

Water Quality Parameters Affected:

- nitrogen
- phosphorus

Recommendations:

- Monitor operations of treatment plant
- Research ongoing and potential nutrient loadings to help determine if system improvement and/or expansion is necessary
- Promote, and perhaps require through a Tribal Ordinance, that all wastewater systems in Sutcliffe be serviced by the Tribal treatment facility.

SUTCLIFFE URBAN RUNOFF - 1994 SUMMARY:

The volume of urban runoff from the community of Sutcliffe to Pyramid Lake was estimated using the Rational Method (see section 4.4). Based on 11 land-use categories and an average rainfall of 0.65 ft/yr, total urban discharge to the lake was calculated to be 6.6 acre-ft per year. Pollutant loads to Pyramid Lake from Sutcliffe urban runoff were predicted from total discharge and water quality information for runoff from various land-uses (TRPA 1977; CSWRCB 1980). Annual loads were determined for sediment (5880 lbs), total nitrogen (20 lbs), nitrate (4.2 lbs), phosphate (9 lbs), and chloride (161 lbs). These loads are extremely small indicating that urban runoff from Sutcliffe is an insignificant source of sediments, nutrients, and dissolved salts. Runoff of toxic compounds is also probably negligible.

Current status and mitigation/abatement activities:

The Sutcliffe community has not grown appreciably in population since the 1994 assessment. Based on calculations for runoff pollution in the 1994 Plan, it is determined for this report that NPS inputs from this source to Pyramid Lake continue to be negligible. Changes have occurred to the town landscape, including a new laboratory for the Pyramid Lake Fisheries, and a small subdivision. Improvements are scheduled to be made to the drinking water system, which may help promote future residential expansion.

The town is located on a rather sloped site, draining directly into Pyramid Lake with little attenuation in streambeds or intervening wetlands. High flows from unusual storm events could wash excessive sediments and urban pollution into the lake. Progressive urban land planning and design, called "Low Impact Development"(LID), takes into consideration drainage from paved surface, attenuating flow velocities and pollutants in on-site created wetlands or detention basins. Applying these philosophies to future developments at Sutcliffe, especially for larger projects, will help maintain water quality. Such approaches should be examined and illustrated further, if a long-range town improvement plan is developed for the Sutcliffe area.

As flows from upstream sources pass through Sutcliffe, channelized creeks may increase scour through the town or at a downstream outlet. It is known that points of entry to the Hardscrabble Creek, through the Lowery property, is obscured and localized flooding has been observed. (E. Ingraham, Pers. Comm.) To better understand the flows in the drainage, observations of storm events and possibly hydrological modeling may be useful. At that point, a determination could be made in how to manage flows to moderate scour, sediment movement and nutrient transport. Improvement of this ephemeral stream to proper functioning condition in its upstream areas, may improve conditions in the urban reach of the drainage.

Water Quality Parameters Affected:

- Sediment
- Nutrients

Recommendations:

- Develop protocols and/or ordinances that encourage LID and other forms of onsite stormwater management in the design of future projects.
- Monitor and document storm events through the existing drainage system
- Prepare hydrological models, if needed, to design stable drainage systems

SOLID WASTE - 1994 SUMMARY:

For the Reservation, the potential impact of pollutants leaching from landfills on surface waters is small due to the arid climate of the region and the recent closure of all landfill sites to solid waste burial. In the past, there were as many as 50 different sites throughout the Reservation in which solid wastes were buried (D. John, Tribal Manager pers. comm.). These sites have now all been closed and sealed with a layer of soil. Presently, the Tribe exports solid wastes generated on the Reservation to a site near Reno. Our assessment of the potential for release from the old sites is low due to arid conditions on the Reservation which limit degradation and transport of pollutants.

Current status and mitigation/abatement activities:

Regulating dumping, offering waste collection and education programs have been helpful in managing solid waste on the surfaces of the reservation. While there have been reductions in illegal dumping, the activities continue. Satellite dump sites are identified by GPS and tracked, with the help of a grant from the USEPA. Maps are created to determine where there is an ongoing high level of illegal dumping. The documented sites are cleaned and returned to natural condition as much as possible. Some grading activities may follow pick-up. Follow-up visits are made to determine if dumping behavior continues. If violators are caught, information is transferred to the Environmental Department and then forwarded to the Tribal Court for processing.

Voluntary compliance is a key to the solid waste program's success. Recycling activities include metal materials, mixed paper cardboard, liquid petroleum products and radiator fluid, electronic waste and other household hazardous wastes. These materials are collected at the paved recycling center in Wadsworth by the PLPT Solid Waste Department. They are transferred to an off-site recycling facility. If spills occur during transfer, procedures are in place to contain and dispose of the spilled material. (T. Tsonetokoy, pers. comm.) Posters and brochures have been distributed to try to increase the consideration and cooperation of individuals, by re-establishing pride in the Reservation's natural, unspoiled beauty.

Poorly maintained, stored non-operational and abandoned vehicles are another form of waste which can effect NPS and water quality. Hydrocarbons may gradually seep into the ground and be transported in surface flows and groundwater to the Tribal water bodies. It is unknown at this time exactly how widespread this problem is currently, so research may need to be undertaken to survey the problem and develop parameters to control spills from older, stored, and abandoned vehicles. In a worst case scenario, the Environmental Department may take action through the Solid Waste Ordinance to address a site at which the resident or company is clearly in violation.

Water Quality Parameters Affected:

- Bioaccumulation (lead, mercury)
- Chemical Constituents
- Floating Materials
- Oil and Grease
- Pesticides
- Radioactivity (Microwave ovens, smoke alarms)
- Toxicity

Recommendations:

- Continued monitoring, clean-up and prosecution of illegal dumping as necessary.
- Monitor transfer and collection sites to determine if run-off is a concern.
- Increase public pride about protecting the Tribal watershed, and about what disposal and recycling resources are currently available.
- Increase public knowledge about the household hazardous waste program.

LAKE RECREATION- 1994 SUMMARY:

The uses of Pyramid Lake and its shoreline for recreational purposes are some of the primary sources of income to the Tribe. The lake is a prime area for camping, boating, swimming, and fishing for Tribal members and visitors from the surrounding communities. On a typical summer weekend, the lake receives 6000-10,000 visitors, and the total number of individuals using the lake can exceed 20,000 during peak periods (M. Hartog, Tribal Ranger pers. comm.). The estimated number of total visitors to the lake on an annual basis is 100,000, with approximately equal numbers in the summer and fall-spring fishing seasons. Recreational activities around Pyramid Lake have several potential impacts on the lake including nutrient loading and sediment transport to the lake. However, nutrient and sediment loadings should be minimal due to the distribution of portable toilet facilities at areas around the lake receiving heavy use and low rainfall. Perhaps, the most important potential sources of NPS pollution to the lake are through boating and jetski activities at the Marina and throughout the lake. Potential inputs to the lake from boating activities include petroleum products such as gas and oil and the leaching of metals from structures at the Marina, but data to directly assess the impacts of these recreational activities on Pyramid Lake are lacking.

Current status and mitigation/abatement activities:

As described in the 1994 Plan, Pyramid Lake continues to be a prime attraction for recreational season tourism and activity. Toilet facilities at heavily used areas have

recently been improved to include permanent buildings with pit toilets, an important upgrade from the previous portable toilet system. Toilet facilities are regularly serviced to remove waste offsite. Nutrient and sediment loadings attributable to bathroom needs and uses were determined to be minimal in the 1994 Plan, and are further mitigated with the new bathroom facility upgrades. An increase in public events that occur at the lake may cause situations where the current facilities could be overloaded, and cumulative impacts from recreational boating would be observable.

Vehicles and power boats can be sources of direct pollutants to the lake. Boating and jet ski activity continue to have potential impacts, however as was true in 1994, data to assess the impacts is lacking. Vehicles and boats that experience mechanical failure near the lake shore, or in the water, may be a source of petroleum and other toxic chemicals. Spills in the beach sands may very likely go undetected but can negatively affect water quality.

Introduced invasive aquatic species can put the ecosystems out-of-balance. The Pyramid Lake Fisheries has an active plan to promote clean boat use, along with monitoring for infestations. The Drain-clean-dry program is intended to prevent the spread of quagga mussel (*Dreissena rostriformis bugensis*), which in the Summer of 2011 were found to infest nearby Lahontan Reservoir. This species has been known to consume plankton and other food sources for smaller fish, producing excrement that may promote blue-green algae and acidobacteria. (Puterski, 2011)

Perhaps a more immediate concern related to potential recreation NPS impacts is illegal dumping of grey water tanks from recreational vehicles (RVs). Travel trailers and motor homes are the most popular camping means on Pyramid Lake beaches. A busy holiday weekend can feature thousands of RVs along the shoreline, and even a small percentage of those illegally dumping waste tanks could pose significant NPS pollution impacts to Pyramid Lake. The degradation of beneficial use, particularly the risk to public health, is a significant concern.

Figure 7. Educational Flyer

Monitoring the lake may needed to be better combined with public safety notices, regarding bacteria or hepatoxins. The EPA has recently initiated the BEACH program (Beaches Environmental Assessment and Coastal Health) which may be applicable to PLPT environmental department actions, with programmatic funding from CWA 303(c). This would enhance public safety with targeted monitoring, reporting, and notifications.

Currently there are two RV waste dump stations on the reservation in Sutcliffe and Wadsworth, though they are not necessarily convenient to the traveler, nor always available. A portable grey water disposal service is available for a $10 fee. Illegal dumping of RV tanks near lakeshore areas is known to occur, and citations have been issued. Public information materials aimed at education and discouraging illegal dumping are produced and provided to visitors (Figure 7). Flyers also provide information for grey water disposal service. Tribal regulations prohibit improper disposal of RV waste water.

As recreational use of the lake is a significant source of pride and revenue for the tribe, it should continue and be expanded in sustainable ways, as indicated in the Pyramid Lake Economic Development Plan (PLEDP). The plan includes many elements which support lake recreation, and supports water quality management goals along with beneficial uses of the water. (Carey, 2011) Before too many changes occur, it may benefit the Tribe to plan growth, safety, management, and long term improvements in a "Lake Recreation Master Plan" that would reflect the community's interest and be approved by the Tribal Council.

Water Quality Parameters Affected:

- Nutrients
- Pathogen indicators (*E. coli*)
- Invasive Species
- Toxic Chemicals (petroleum and vehicle fluids)

Recommendations:

- Research opportunities and feasibility of installing convenient public RV dump stations, perhaps in combination with fishing reporting stations.
- Continue to monitor heavy-use beach areas for pathogen indicators during recreation season, and improve the protocol system for .
- Continue to develop education and outreach materials and programs to discourage illegal dumping of RV waste tanks.
- Expand funding for Tribal Rangers to help with enforcement of wastewater dumping.

- Develop a Lake Recreational Master Plan, which may consider camping areas away from the shoreline to prevent potential oil, fuel, and wastewater spills.
- Limit motorized vehicle access to shorelines, with an ordinance and enforcement.
- Research potential impacts of jet skis and other motorized boating on the lake, and consider regulation if necessary.
- Review the EPA BEACH program and as available, apply for grants to execute the program, if applicable to lake management and water quality goals.
- Make it clear to tribal officials and special event operators, that special events must comply with water quality standards and file a PLPT 401 Certification, if applicable.

UPSTREAM SOURCES- 1994 SUMMARY:

There are a multitude of potential NPS inputs to the Truckee River upstream of the Reservation, and it is beyond the scope of this assessment for the Reservation to attempt to quantify them. Here, we simply try to give a general characterization of upstream activities within the Truckee River basin for comparison with priority pollutant scans conducted during August 1993. Further, our characterization of the region only extends to changes in regional population and generalizations about commercial activities, which have intensified over the past four decades. Since 1950, the population of the region (Washoe County) has expanded from 50,205 to over 250,000 (Andriot 1983; Nevada State Demographer's Office 1991). Concurrent with the population increase has been a corresponding increase in the production of domestic wastewater and NPS inputs through urban runoff. These are both part of Nevada's water quality programs. Commercially, the region depends heavily on service industries for employment, with only small (<1% in 1975) contributions from agriculture and mining operations (USEPA 1976). Manufacturing (6%) and construction (7%) jobs also contribute substantially to commercial activities.

A survey of the concentrations of potentially toxic organic compounds and metals in the Truckee River on the Reservation was conducted during August 1993 to assess impacts of urban activities on the water quality of the river. The concentrations of potentially toxic compounds in Truckee River waters were low for all samples. Volatile organic compounds and pesticides were not detected in any of the samples collected. In addition to no pesticides and volatile compounds in the samples, only three metals of potential concern were detected. These are arsenic (As), zinc (Zn), and copper (Cu). For arsenic and zinc, the measured concentrations appear to be affected by inputs both upstream and within the Reservation boundaries. Organic compounds detected in the samples were limited to hexanedioic acid, phthalate compounds, and unknown hydrocarbons. Generally, the concentrations of the detected compounds were low indicating minimal inputs. The general lack of metal and organic compounds in the Truckee River as it enters the Reservation indicates that upstream urban development has not caused a widespread toxic contamination of river waters.

Current status and mitigation/abatement activities:

Urban and agricultural land uses and discharges continue to affect the water quality of the lower Truckee River. As mentioned earlier in this report, regional growth of Reno at sites like the Truckee Meadows has led to increased point source pollution (such as the Truckee Meadows Water Reclamation Facility) and increased non-point sources such as construction sites and surface run-off from streets and landscapes. These discharges will likely get more complicated, with endocrine disrupting compounds, volatile organic compounds, and other chemicals with toxic side effects increasingly being used in the built environment.

Out of the 22 sources of NPS pollution that were assessed in the 1994 Plan, the "Upstream Sources" category ranked as having the greatest NPS impacts to the Lower Truckee River and Pyramid Lake. The Truckee Meadows urban area continues to impact downstream areas with NPS pollution. Although the Tribe does not regulate this source of NPS pollution, they continue to work with upstream entities and stakeholders to move toward longer-term and more sustainable solutions to the management of wastewater and stormwater pollution generated upstream of the reservation. Working to improve flow volume in the Truckee River through TROA, the tribal waters will have reduced concentrations of NPS pollutants from upstream sources.

A possible objective for the tribe could be to promote more stringent regulation on water quality entering the reservation. The process for tighter water quality control could be realized by determining if waters of the Tribe (and U.S.) are impaired under section 303(d) of the CWA. Following this step, total maximum daily load (TMDL) pollution standards are established to set the reduction goal to improve pollution-impaired waters. The "load," or quantity, is the amount of a certain pollutant that is permitted for that water body (with a factor of safety included). TMDLs involve both point and nonpoint sources of pollutants. (EPA, 1991) It is not clear at the time of this writing if developing TMDL standards for the tribe's surface water is the best action, but interest is increasing in exploring this option. It is common that upstream TMDLs (i.e. Reno) follow a more stringent standard if it were established for water located downstream. (Hecox, 2011) These more specific water quality standards would be valuable to the beneficial uses at Pyramid Lake, as well as the downstream users on the Truckee-Carson canal, including the Fallon Paiute-Shoshone Tribe.

Water Quality Parameters Affected:

- Nutrients
- Pesticides
- Suspended sediment

- Total Dissolved Solids
- Temperature
- Turbidity
- Dissolved Oxygen
- CECs
- Toxicity

Recommendations:

- Continued involvement with TROA, workgroups, committees, and advisory teams addressing upstream water quality management and flow volumes.
- Continue to work with Nevada Department of Environmental Protection to develop appropriate WQS for Truckee River reaches upstream of Wadsworth.
- Continue to monitor and analyze water quality data for compliance with WQS criteria and beneficial uses
- Development of TMDLs for tribal waters as needed.

HERMAN IRRIGATION DITCH - 1994 SUMMARY:

The irrigation of croplands along the floodplain of the Truckee River potentially affects water quality along many stretches of the river. Herman Ditch is of particular importance to this study due to its discharge back to the river just upstream of the town of Wadsworth. Data are available for Herman Ditch as part of a study currently being conducted by the Desert Research Institute of the University of Nevada in Reno (D. Cockrum pers. comm.). The description of the project and some initial results presented below are taken from quarterly progress reports obtained from Nevada Division of Environmental Protection and DRI. An examination of the impact of Herman Ditch on the water quality in the Truckee River was prompted by unexplained increases in total phosphorus (and phosphate) and nitrate along the Wadsworth stretch of the river.

For the 1993 season, approximately 380 acres of cropland were flood irrigated from Herman Ditch to grow alfalfa and grasses. Water usage along the ditch involved alternating periods of 1-3 weeks of use followed by 1-2 weeks in which the diversion was dry. Overall, 2671 acre-ft of water was diverted from the Truckee River of which 14% (370 acre-ft) was returned through the discharge to the river. Flow in the ditch was highly variable and could range from 0 to 7 cfs over a 24 hour period, with discharge back to the river equally variable over time. Nutrient concentrations in the return flow to the river are typically high in total nitrogen (TN) and phosphorus (TP); the average flow weighted concentrations for TN and TP for 1993 were 1.5 and 0.3 mg/L, respectively. D. Cockrum estimated that the total nitrogen and phosphorus loadings to the Truckee River from Herman Ditch were 1531 and 277 pounds, respectively. Low concentrations of dissolved inorganic nitrogen (nitrate and ammonium) in Herman Ditch discharge during the 1993 study suggest that the majority of the nitrogen load may be as

organic nitrogen. The DRI study also showed that the Herman Ditch return flow to the river was also very low in dissolved oxygen.

Current status and mitigation/abatement activities:

As described above, Herman Ditch was calculated to impose significant water quality impacts in the 1994 assessment. It was ultimately ranked as one of the top five NPS concerns at the time. Agricultural patterns in the Wadsworth area have changed since the early 2000s. The Herman Ditch is not known to have significant measurable discharges in recent years. If it becomes an issue again, it is possible to create a treatment wetland similar to the experimental wetland at the Numana Fish Hatchery. Laser leveling fields and converting crops to lower water demand crops are other options to consider.

Along with Herman, there are numerous other agricultural irrigation ditches currently functioning on the reservation, and we will expand this section to discuss these ditches. The role that irrigated agricultural land and irrigation ditches play in accumulation and transport of pollutants has been studied extensively, and must be considered substantial in terms of impacts to water quality.

The only ditch with an observed field return flow currently in use is the Pierson Ditch. This ditch has a significant discharge at a point called the "tile drain outlet" where water flows almost year-round. This water quality has exceeded the Truckee River water quality value of 1.2 mg/l for total nitrogen well over half the observed time of monitoring, once exceeding the value by five times the standard. The PLPT Environmental Department is considering this site as a prime location to create a nutrient treatment wetland in the near term. The wetland will improve water quality while providing useful environmental benefits to local wildlife, including the endangered northern leopard frog (*Rana pipiens*) and tule (*Scirpus californicus*), which is of ethnobotanical significance to the Northern Paiute tribes.

Irrigation delivery in general is an activity which is affected by, and can contribute to, NPS issues. Because most irrigation ditches on the reservation flow through earthen canals, water traveling through the ditches absorb and transport TDS which is located in the soils. It would be a worthy research project to accurately gauge how much contribution to NPS parameters occurs in a farm field with return flows, sampling of water quality before the entry of water to a farm field. Some ditches, such as the Fellnagle Ditch and the Indian Ditch, flow past farm fields and return ditch water to the Truckee River, without being used in any farm field. However it is perceived that these waters are often higher in TDS after the ditch than before. Accurately measuring this

gain in TDS could provide a basis for lining the ditches with concrete, preventing the gain.

Another issue with irrigation system management is the ongoing maintenance due to the relatively high levels of sediment flowing in the river. The sediments tend to collect in ditches, or at the base of dams such as at Numana Dam, and at times need to be cleared in order to provide functional delivery of water to farms. Within these sediments may be other undesirable materials such as heavy metals, toxic pollutants, and invasive species such as Eurasian water milfoil. Management of sediments will be an ongoing activity requiring coordination and creative solutions, in order to minimize significant disturbance and smothering of vital streambed habitat. Some examples of this coordination could include harvesting organic-rich sediments for use in residential applications, and selling mineral rights to sediment located at the channel bottom near dams.

The primary crop grown on the reservation is alfalfa, which requires large amounts of irrigation water. Crop conversions or rotations to less water demanding crops could help to mitigate NPS pollution contributions from return flows. Modified irrigation practices and laser leveling of farm fields could be ways to improve efficiency of water delivery and limiting nutrient run-off.

Water Quality Parameters Affected:

- Nitrogen
- Phosphorus
- Suspended Solids
- Dissolved Solids
- Dissolved Oxygen
- Invasive Weeds

Recommendations:

- Crop conversion/diversification
- Created wetlands at points of concentrated agricultural field return flows, including the Tile Drain Outlet and Herman Ditch (as applicable)
- Coordination with the PLPT Water Resources Department for irrigation ditch management to reduce unnecessary disruption of sediments, harvesting when possible.
- Improve with concrete lining Fellnagle, Indian, and other ditches which are soil-lined and have bypass flows that return to the Truckee River.

- Conduct extensive research on nutrient gains in irrigation water, before and after flowing through fields through the seasons with various irrigation, land management and fertilization practices.

FERNLEY GROUNDWATER- 1994 SUMMARY:

The largest source of groundwater to the river occurs downstream of Wadsworth through the Fernley flow system. As of the early 1980's, there were 4000 acres of cropland in the Fernley farm district under cultivation by flood irrigation. Bratberg et al. (1982) reviewed the water balance for the Fernley area and concluded that the area receives approximately 13,000 AF/yr of groundwater recharge through snowmelt, irrigation, and canal leakage. The largest source of groundwater recharge in that region was through irrigation, which was clearly indicated by a mound in the water table of up to 15 feet under the farming district during the irrigation season. The authors estimated the flow of groundwater from the Fernley area to Wadsworth based on the hydrologic characteristics of the system . The Fernley flow system was predicted to contribute 5250 AF/yr to Truckee River flow through groundwater accrual downstream of Wadsworth. In an earlier study, Van Denburgh et al. (1973) predicted a somewhat lower contribution of groundwater (4000 AF/yr) to the Truckee River from the Fernley system. The difference between the two estimates is entirely due to one of the coefficients used in the calculation, with the latter estimate by Bratberg et al. based on updated information on the transmissivity of soils between Fernley and Wadsworth.

Surveys of Truckee River water quality conducted during May-July 1994 indicated large increases in total dissolved solids (TDS) and nitrate concentrations downstream of Wadsworth where groundwater from Fernley enters the river. The observed spatial distributions for TDS concentration for our 1994 study are consistent with previous studies of the river indicating a large TDS input by Fernley groundwater. The contribution of TDS loading to the river via groundwater from Fernley was estimated by multiplying average inflow (i.e. 7.2 ft3/sec) by the TDS concentration of average groundwater inflow to the river in that region (726 mg/L, Bratberg et al. 1982). TDS loading through the Fernley flow system was calculated to be 28,320 lbs/day, which is an important component of total TDS loading to the river.

Current status and mitigation/abatement activities:

Studies of groundwater conditions in the Fernley/Wadsworth area were conducted by the Desert Research Institute in the years following the creation of the 1994 Plan. Within the issue of the area's shared underlying water table are the subset issues of water transmission and loss from the Truckee Canal, groundwater recharge via flows from montane, riparian, canal and agricultural areas, water supply via wells, water quality in wells, water discharge to the Truckee River, and water quality of discharges to the Truckee River. To examine these issues, several idealized statistical models were created by research professor Greg Pohll and a number of associates that simulated the geographic, geologic, hydrologic and chemical characteristic of the environment. The landmark study of this series, published in November 2001, was used to project what TDS loadings would be experienced at the Truckee River in the vicinity of

Wadsworth, as a result of various land management scenarios in the Fernley/Wadsworth area (Pohll, et. al. 2001.)

The model indicated that the water table is benched in the area of the community of Fernley, similar to the surface of the watershed that exists above it. Water flows downslope from Fernley in two directions – East and northward to the Fernley Sink, and West and northward to Wadsworth, beneath Dodge Flat, ending at the Truckee River. The Truckee is incised as it drops elevation toward Pyramid Lake, and as a result, it intersects this groundwater flow at several points, including Wadsworth, the S-S Ranch area, and the Dead Ox Meadows springs. The flow of TDS in groundwater is illustrated in Figure 8.

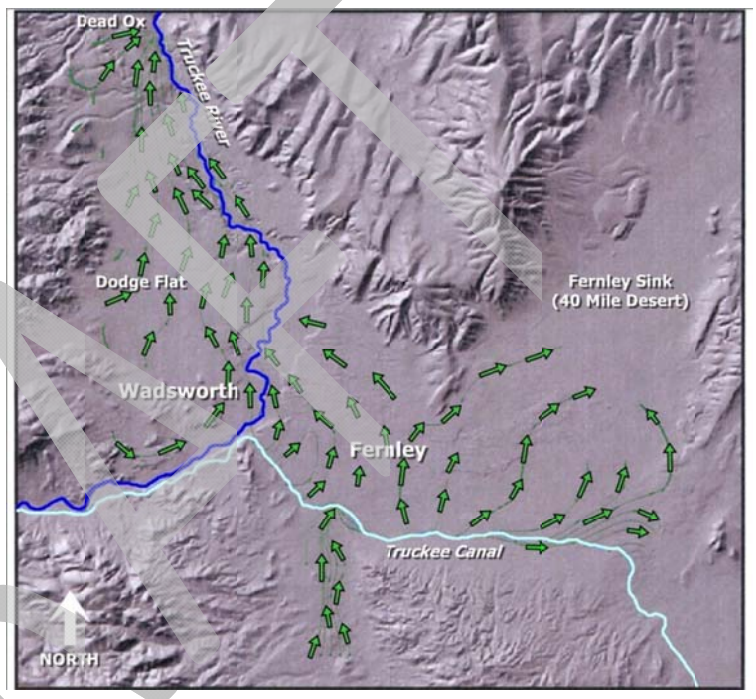

Figure 8. Flow pattern of groundwater TDS in the Fernley area. (Static model resulting flows are shown in green arrows) Sources: Pohll, et. al., 2001; Epstein, et. al. 2007

This groundwater flows through the sediments of ancient Lahontan Lake, which are particularly high in sodium-sulfate salts in the vadose zone above the water table. This transport is a significant source of TDS at Wadsworth, mobilized by water flowing through the ground to the Truckee River. The greatest concentration of TDS in local groundwater is actually north of Fernley in a leg of the "40 Mile Desert" groundwater. As shown in the model results (Figure 9), this particularly high concentration of salts is shown. The groundwater model predicts that the TDS migrates toward the Truckee River by 2051.

The results of the model provide more insight into transmission of TDS to the Truckee River. In the reach near Wadsworth, not including Dead Ox, TDS contributions were calculated to be an average of 47,620 lbs/day for the period 1990-2000. The rate calculated as of 2001 was 33,333 lbs/day. The rate forecasted for 2051, under current conditions, is 34,206 lbs/day. Under alternative management scenarios for the year 2051, several management options caused no significant effect on the quantity of TDS flowing to the Truckee River. Little change results from either eliminating recharge from irrigated agricultural fields in the west Fernley area, from doubling Fernley's municipal

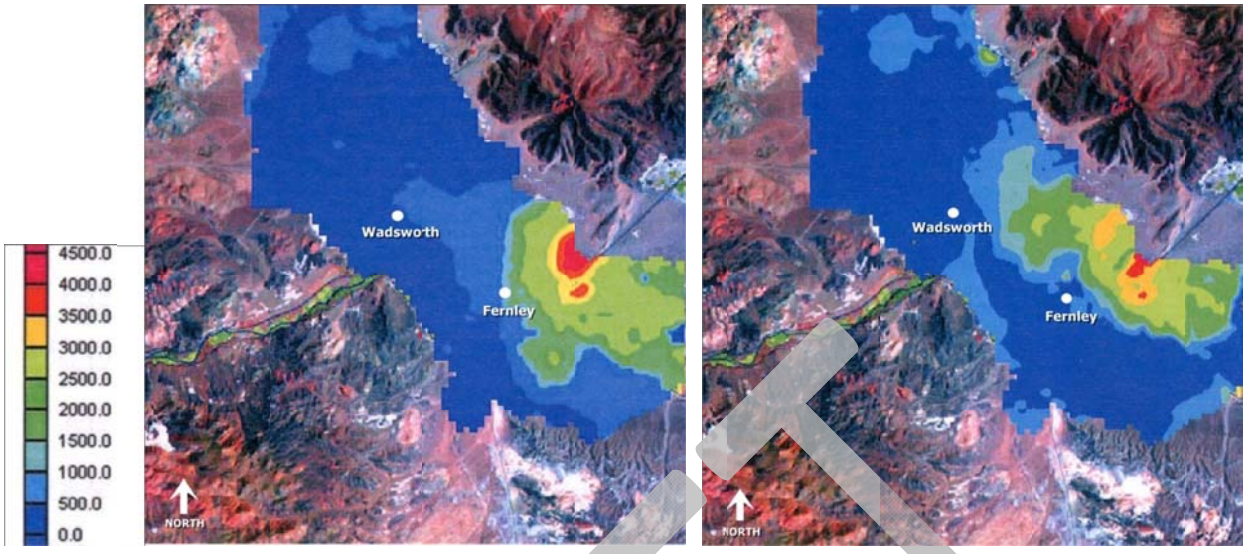

Figure 9. Modeled distribution of Total Dissolved Solids (TDS) concentrations in the Fernley Area, Predicted results for the years 2001 (left) and 2051 (right). Source: Pohll, et. al., 2001

well pumping rates, or from implementing a "forced hydraulic remediation" well in the vicinity the 40 Mile Desert groundwater. The greatest reduction of TDS in 2051 (a reduction of 86%) could occur from a modeled scenario where no water would recharge the Fernley area from either agricultural fields or from seepage from the Truckee Canal (Pohll, 2001). While such a hypothetical situation is not very likely, it should be noted there has been significant change in the Fernley agricultural area in recent years.

During the decade of 2000-2010 fantastic growth occurred to Fernley's residential and commercial areas. An optimistic master plan from that period forecast population growing nearly 400% from 2000 levels by 2035. (Epstein, et. al., 2007) Given current economic conditions, that may not actually happen, but the 2010 census indicates it did grow by 226% in one decade (U.S. Census Bureau, 2011). As a result, water is not diverted as often or as much (or sometimes at all) in the diversion ditches located in the community. Many agricultural areas will no longer be farmed as they now support office parks and subdivisions. Some existing farm fields are fallow and appear to be held by real estate speculators but not farmed. In addition, after a catastrophic breach of the Truckee Canal embankment on January 8, 2008, the flows in the repaired canal are currently limited to 350 cfs – less than half its full capacity. (USBR, 2008)

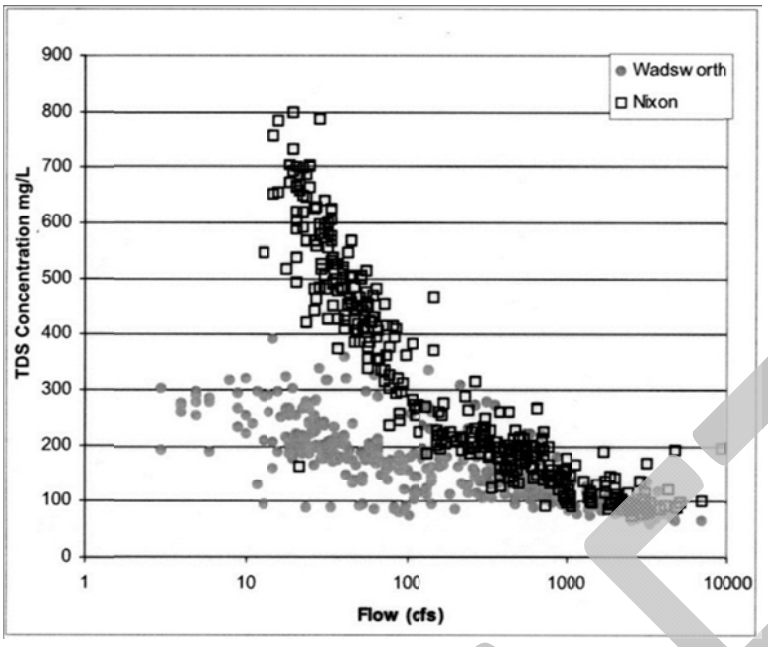

Figure 10. Total Dissolved Solids (TDS) and Flow in cfs at Two Truckee River Monitoring Stations. (Source: Pohll, et. al., 2001)

Perhaps one of the more telling observations about TDS from the 2001 study is the comparison of water quality at monitoring stations in Wadsworth and downstream at Nixon. This paired comparison is seen in Figure 10. When external factors were eliminated, there was an interesting correlation of flow rates to water quality. When flows in the Truckee River were above 600cfs, the TDS levels were not distinctly different between the monitoring stations. (Pohll, et. al. 2001) Perhaps this information might be useful in guiding water management decisions in diversions from the Truckee River. If flows can be maintained near to 600 cfs, the TDS introduced from groundwater sources (both Fernley and Dead Ox locations) should not significantly alter Truckee River water quality. Note that this management change does not affect actual loading of TDS to the Truckee River, but dilutes it such that concentrations are not as significant. Very high flows (e.g. floods) will temporarily stop the flow of TDS because of the river recharging the groundwater, but the movement of salts return as the floodwaters recede (G. Pohll, pers. comm.)

Water Quality Parameters Affected:

- Total Dissolved Solids

Recommendations:

- Continue research, modeling and tracking of TDS input from the Fernley basin, 40 Mile Desert and Dodge Flat groundwater sources.
- Coordinate and manage minimum Truckee River flow volumes to be as near to 600 cfs as is feasible while meeting other goals in agreements such as OCAP and TROA.

WADSWORTH IRRIGATION- 1994 SUMMARY:

River water quality data collected during 1994 were used to estimate total inflow to the river downstream of Wadsworth. For eight sampling dates, changes in the composition of Truckee River waters along the Wadsworth stretch of the river indicated the input of 14±3.7 ft^3/sec (cfs, mean std. dev.). A comparison of estimated inflow during the 1994 irrigation season with estimated inflow from Fernley (7.2 cfs) reveals that a large fraction of total inflow may be contributed by return flows from irrigation of croplands within the floodplain of the river. Further, the installation of drainage pipes under several fields north of Wadsworth should facilitate the movement of excess irrigation water back to the river with its accompanying TDS and nitrate concentrations.

Current status and mitigation/abatement activities:

Roughly 1000 acres of reservation land adjacent to the river is dedicated for the use of irrigated crop land. Of the 1000 acres of irrigated alfalfa fields, 300+ acres have been laser leveled in recent years. Laser leveling irrigated fields increases water use efficiency, and also slows or entirely mitigates water and sediment runoff from fields to the river. Several irrigated fields in the Wadsworth area have been retrofitted with tile drains, designed to improve drainage from the irrigated fields. Results of PLPT water quality monitoring of the tile drain outlets show a significant decrease in water quality for many parameters. Discharge of this degraded water into the Truckee River results in significant contribution of NPS pollution for the following parameters:

Water Quality Parameters Affected:

- Nitrogen
- Phosphorus
- Total Dissolved Solids

Recommendations:

- Crop conversion/diversification.
- Research and implement options for removal of tile drain structures and alternative drainage regimes from irrigated fields.

WADSWORTH DOMESTIC WASTEWATER - 1994 SUMMARY:

The potential input of nutrients to the Truckee River from domestic wastes produced in Wadsworth is limited by the sparse population (545) of that community. Overall, the total production of domestic wastes in Wadsworth can be estimated by multiplying the number of residents in the community by typical per capita water usage and nutrient concentrations in domestic wastewater. The production of domestic wastes in Wadsworth probably contributes a

negligible amount of NPS nutrient loading to the Truckee River. The total nitrogen and phosphorus content of domestic wastes in Wadsworth were calculated to be approximately 5000 and 870 lbs/yr, respectively. However, only a small proportion of the total nutrient content of the waste produced should be released to groundwater and, subsequently, reach the Truckee River through groundwater transport. The town of Wadsworth has recently constructed a lagoon system for the treatment of domestic wastes, which should effectively remove nutrients from wastewaters produced. Using removal efficiencies of 80 and 95% for nitrogen and phosphorus (see section 4.4), respectively, in a lagoon system, the potential contributions of NPS nutrient loading to groundwater and eventually the Truckee River from domestic wastes in Wadsworth are 1000 (nitrogen) and 44 (phosphorus) pounds per year.

Current status and mitigation/abatement activities:

The lagoon system at Wadsworth features three clay-lined basins, to which domestic waste water is treated with aerobic and anaerobic bacteria. The system is self-contained, such that processed water is evaporated. A percolating overflow basin is present, which may be used in cases where water input exceeds loss due to evaporation. At this basin, it is possible for a limited amount of nitrate and phosphorous to be discharged to the ground, which could travel in subsurface flow to the Truckee River. In all the years of operation (to 2011) the system has not required the use of this overflow basin, and thus there has been no nutrient discharge to surrounding waters. (E. Ingraham, pers. comm.) However, this system may be nearing capacity, and it does not serve all the residents of Wadsworth, including a trailer park and many fee lands in the area. The Tribal properties at Big Bend are also served by a septic system and are located close to the river.

To have all properties off septic systems at Wadsworth, the lagoon system would need to be expanded. Safe crossing of a wastewater line under the Truckee River may not be economically feasible, and a small separate lagoon system on the east bank of the river may be considered. Expansion of sewer service would require coordination and hopefully financial participation from the counties of Washoe and Storey, as well as grant funding as it may become available. Economically, the current dynamic of Wadsworth does not support expansion of the wastewater system by the Tribe's efforts alone.

Water Quality Parameters Affected:

- nitrogen
- phosphorus

Recommendations:

- Monitor operations of the Wadsworth treatment plant

- If percolation basin is utilized, research potential nutrient loadings to help determine if future system improvements are necessary
- Coordinate with Washoe and Storey counties to examine the possibilities of system expansion
- Seek grant funding to upgrade and expand the Wadsworth treatment facilities to serve all residents in the community.
- Consider expansion of infrastructure as suggested in the PLEDP

WADSWORTH URBAN RUNOFF- 1994 SUMMARY:

The volume of urban runoff from the community of Wadsworth to the Truckee River was estimated using the Rational Method (see sections 4.4 and 7.4). Based on 23 land-use categories and an average rainfall of 0.55 ft/yr, total urban discharge to the river was calculated to be 16.5 acre-ft per year. Pollutant loads to Truckee River from Wadsworth urban runoff were predicted from total discharge and water quality information for runoff from various land-uses (TRPA 1977; CSWRCB 1980).. Annual loads were determined for sediment (24,000 lbs), total nitrogen (40 lbs), nitrate (8.4 lbs), phosphate (20 lbs), and chloride (400 lbs). These loads are extremely small indicating that urban runoff from Wadsworth is an insignificant source of sediments, nutrients, and dissolved salts. Runoff of toxic compounds is also probably negligible.

Current status and mitigation/abatement activities:

The Wadsworth community has not grown appreciably in population since the 1994 assessment. Based on calculations for runoff pollution in the 1994 Plan, it is determined for this report that NPS inputs from this source to the Truckee River continue to be negligible. This may change in the future, as the Pyramid Lake Economic Development Plan becomes implemented. Tribal enterprises may expand, industrial development may occur, and commercial enterprises may create unique, economically viable shopping districts.

Water Quality Parameters Affected:

- Sediment
- Nutrients
- Oil and Grease
- Floating materials

Recommendations:

- Encourage low impact Green Infrastructure development for any future projects
- Promote BMPs such as retention basins for directed urban stormwater flows
- Regulate construction activity through the PLPT 401 Certification Regulations

NUMANA HATCHERY- 1994 SUMMARY:

The Tribe operates a freshwater hatchery facility (Numana Hatchery) along the Dead Ox Meadows stretch of the river to support the development of a thriving Lahontan cutthroat trout population in Pyramid Lake. The facility utilizes groundwater as a water supply and employs water recycling technology to reduce the total amount of water needed to rear the trout. Even with efficient water recycling, Numana Hatchery discharges approximately 250 gal/min of wastewater (P. Wagner, Director, Pyramid Lake Fisheries pers. comm.), with suspected nitrogen and phosphorus concentrations of 2.8 and 0.4 mg/L, respectively. Based on these suspected concentrations, the hatchery potentially contributes 10 lbs of nitrogen and 1.4 lbs of phosphorus to the river per day. Because the effluent is discharged to land adjacent to the river, the actual loading of nitrogen and phosphorus to the river will be lowered through soil retention and biological utilization. The potential impact of the nitrogen content of the hatchery effluent will probably be further reduced in the future due to the construction of a wetland to treat the discharge. The project is currently being implemented at Numana Hatchery to evaluate the effectiveness of an engineered wetland environment to remove nitrogen from the hatchery's effluent (see chapter 9).

Current status and mitigation/abatement activities:

The PLPT Numana Fish Hatchery began operations in 1981, and over the years has been a major supplier of Lahontan Cutthroat Trout to Pyramid Lake. An artificial constructed wetland was completed below the Numana Hatchery in September of 1994 (Figure 9). The constructed wetland was designed by Huffman and Associates of Reno, Nevada, with funding support from the USEPA Clean Lakes Program. The wetland area was constructed to provide nutrient removal from hatchery water before discharging into the Truckee River. In 1995, Professor John J. Warwick of University Nevada Reno and graduate student Daniel Spinogatti Jr. conducted a study of the artificial wetlands to determine the efficacy of this type of system in removing excess nutrients, targeting nitrogen and phosphorus (Warwick, 1995). The study results indicate that the constructed wetland is effective in reducing nutrient levels of hatchery effluent, demonstrating a 41% reduction in total nitrogen and a 19% reduction in total phosphorus. Subsequent water quality monitoring by the PLPT Environmental Department demonstrates that the Numana constructed wetland continues to be effective in lowering nutrient levels of hatchery effluent. Further

Figure 11. Numana Constructed Wetland Area

enhancements to the Numana wetlands area are being evaluated and considered for potential effectiveness in reducing NPS pollution and providing additional wetland habitat.

PLPT fish hatchery facilities have been upgraded to include drum filtering systems. Drum filter systems are utilized to remove organic solids from effluent water before discharge, and are an effective means of reducing nutrient contributions to receiving waters. Removal of organic solids reduces the organic nitrogen inputs to lake and river water, at least partially mitigating this concern as addressed in the 1994 Plan.

Water Quality Parameters Affected:

- Organic nitrogen
- Phosphates

Recommendations:

- Periodic testing of facility discharge water to monitor nitrogen and phosphorus concentrations.

DEAD OX GROUNDWATER- 1994 SUMMARY:

Previous water quality studies of the Truckee River have identified Dead Ox Meadows as a region of important groundwater inflow (e.g. Bratberg et al. 1982). The source of water entering the river along Dead Ox Meadows has been attributed to snowmelt from the Pah Rah Mountains to the west of the river along Dodge Flat. The mountains in that region receive approximately 43,000 acre-ft (AF) of precipitation annually which Bratberg et al. calculated should produce a groundwater inflow to the river of 1250 AF/yr (Maxey-Eakin method). An additional 100 AF/yr was estimated to enter the river from the eastern side. Converting total annual input (1350 AF/yr) to a flow rate , yields a value of 1.9 ft3/sec (cfs). We estimated total groundwater inflow along the Dead Ox Meadows stretch of the river for eight sampling dates during May-July 1994 from changes in the composition of river waters. For the sampling dates, mean inflow to Dead Ox Meadows was calculated to be 3.1±2.2 cfs (mean std.dev.). Because the groundwater inflow to that region is high in total dissolved solids (TDS), it is a large source of TDS to the river.

Current status and mitigation/abatement activities:

Although the Dead Ox area has been calculated to be a large source contributor of total dissolved solids (TDS) to the river, the inflow is associated with mountain precipitation and is a natural phenomenon. These flows likely originate in the Truckee Range and salts (chlorides are more significant than sulfur in water) at Dead Ox Spring have been

measured between 2,500 and 5,500 mg/L. (Pohll, et. al. 2001) Dead Ox Meadows flows (slightly upstream from Dead Ox Spring), are more attributed to groundwater from irrigated agriculture causing a leaching effect in the upslope soils. The naturally high inputs of TDS to the river from groundwater inflows emphasizes the importance of controlling and reducing development associated inputs from upstream sources, such as the Truckee Meadows Water Reclamation Facility (TMWRF) and urban stormwater runoff from the Truckee Meadows area.

Practicable mitigation measures for natural groundwater inflow are not currently available. The only mitigation option is an act of prevention - to not increase the rate of dissolution of unsaturated zone salts. Currently there is no indication that irrigated agriculture is an option, or is desired, in the northern Dodge Flat area or in the drainages associated with Dead Ox Meadows.

Water Quality Parameters Affected:

- Total dissolved solids

Recommendations:

- Maintain current dry-land range use in lands above and associated with Dead Ox Meadows.

NIXON IRRIGATION- 1994 SUMMARY:

Downstream of Nixon, the water quality data from May-July 1994 indicate that irrigation of croplands affects both nutrient and TDS concentrations of river waters. For data from May 18, there were steady increases in conductivity, nitrate, and phosphate concentrations between river miles 110 and 116, which occurred despite high river flow (1050 cfs) recorded for that date (U.S. Geological Survey, Carson City, Nevada). When the water usage records are examined for May 1994, croplands along regions 7-10 were irrigated during May 11-19, particularly in regions 9 and 10. Thus, there is a circumstantial correspondence between the irrigation of croplands downstream of Nixon and changes in river water quality. It is noteworthy that spikes in nitrate data along the river in the vicinity of Nixon may also be explained by subsurface return flow from irrigated croplands (see Fig. 5.11); the nitrate spike following transect #6 at station 5 in Nixon corresponded to a date in which croplands were irrigated along region 8 the preceding week.

The water quality data collected during 1994 indicate that changes in the composition of Truckee River waters downstream of Nixon occur throughout the irrigation season. Plots of the change in conductivity and phosphate concentrations in regions downstream of Nixon indicate increases in both constituents throughout the May-July study period, with larger increases at low flow (<100 cfs, transects 5-8). The only exception to this pattern is a decrease in conductivity on

June 28 (#6) following a period in which extensive irrigation of croplands occurred. It is possible that conductivity at station 5 on that date may have been elevated due to return flow of high conductivity water from two fields close to the sampling location which were flooded during June 26-28. With the exception of conductivity on that date, both conductivity and phosphate increased downstream of Nixon for all eight sampling dates. This suggests that the input of subsurface irrigation return flow to the river downstream of Nixon may occur slowly over time rather than immediately following the flooding of adjacent fields (with some exceptions). Thus, groundwater inflow to the river due to irrigation of croplands downstream of Nixon may be somewhat continuous throughout the irrigation season, contributing to the TDS and phosphorus load of the river.

Current status and mitigation/abatement activities:

The return flows from agriculture at Nixon are largely through seepage, and not as much from captured return flows, via either ditches or drain tiles. To change the transport of nutrients from field to river, we may consider several ways to improve efficiency of nutrient uptake. Two options are presented here, but they are not necessarily the only available.

First, creating agricultural systems where more efficient use of water occurs, so that a greater percentage of nutrients are taken into plants versus flowing into the groundwater that drains to the river. This could be accomplished through irrigation systems which use in-line drip tubing to serve the plants. The nutrients, if needed, can be fed in liquid form in small amounts directly through the drip systems. This type of crop served by such a system would very likely be different from one such as alfalfa.

Second, farmers can consider changing crops to plant or a combination of plants which create a more efficient, sustainable ecosystem. Farmers might think of growing specialty crops such as producing native grass seed. Seed is utilized for erosion control and ecological restoration projects. Sometimes local seed sources are difficult to locate, and are a relatively expensive product to purchase. Established pure stands of native grasses take skill in preparing, but might require less water and nutrients once developed. Grass fields may still be irrigated by a flood system. Another specialty crop to consider are organic fruits and vegetables, which would be well-served with a drip system, and perhaps grown in combination with other plants in an intensive planting.

Water Quality Parameters Affected:

- Nitrogen
- Phosphorus
- Total Dissolved Solids

Recommendations:

- Research and test crop conversion/diversification into specialty crops
- Experiment with alternative irrigation systems
- If either or both approaches are successful, apply them, hopefully with grant funding to assist farmers in the transition
- Seek input and participation from farmers to create ways to more efficiently use nutrients in the Nixon farm area, and across the reservation

NIXON DOMESTIC WASTEWATER - 1994 SUMMARY:

The production of domestic wastes in Nixon may have a small impact on groundwater in that region and the Truckee River. It is potentially the largest source of domestic wastes to surface waters and groundwater on the Reservation due to its larger population (818, D. John, Tribal Manager pers. comm.) and a lower level of treatment relative to Sutcliffe and Wadsworth. For the community of Nixon, nitrogen and phosphorus produced as domestic wastes were estimated to be approximately 7530 and 1310 lbs/yr, respectively. The treatment of domestic wastes produced in Nixon is through septic tanks at individual homes. For infiltration systems of wastewater disposal, USEPA (1992b) reported a removal efficiency of 10-80% for nitrogen and 29-99% for phosphorus. Accounting for nutrient retention in the septic tanks (using values close to the middle of the reported ranges, 50% for nitrogen and 65% for phosphorus), potential nitrogen and phosphorus loadings to groundwater from domestic wastes in Nixon were calculated to be 3765 and 460 lbs/yr, respectively. Because there is a somewhat constant inflow of groundwater to the river downstream of Nixon (see chapter 6), much of this loading may eventually reach the Truckee River. The impact of domestic nutrient loading to the river through groundwater inflow cannot be assessed at this time given the lack of data on groundwater inflow and composition near Nixon.

Current status and mitigation/abatement activities:

The Tribe has instituted a septic tank service operation to increase convenience to customers in the area. All of Nixon residents continue to remain on septic systems, as well as a handful of Wadsworth and Sutcliffe properties. This includes two large systems at Sutcliffe for Crosby Lodge and the Tribe, and at Wadsworth numerous small systems as well as a sizable system for the campground at Big Bend Ranch and a private system for a Wadsworth mobile home park. Public knowledge about the septic pumping service has helped to return over-filled tanks to functional condition. Septic systems are most effective without significant untreated overflow to the leach system. Increasing the service frequency with a scheduled service program will reduce the risk of NPS pollution of groundwater. (E. Ingraham and R. Quintero, pers. comm.)

Recent testing indicates that groundwater is not significantly affected at two monitoring wells in Nixon. The samples, testing for Nitrate+Nitrite as Nitrogen with the EPA 300.0

method, resulted in measurements less than 0.5 mg/L, which is below the reporting level. (NSHL, 2011) If septic systems are not functioning properly, it is feasible that pathogens may also be transported to the groundwater. Lifespan of organisms in the groundwater is a factor of physical characteristics and chemical composition of the soil, as well as competing organisms located in the living portion of the soil. (Fallon and Perry, 1996) At this time, there is no indication of pathogens in groundwater at the Tribe's monitoring stations (E. Ingraham, pers. comm.).

Water Quality Parameters Affected:

- Nutrients (Nitrogen and Phosphorus)
- Pathogen indicators (*E. coli*)

Recommendations:

- Continue the Tribal septic suction services.
- Continue monitoring groundwater
- Invest in additional monitoring wells at strategic locations.
- Expand septic service with a scheduled servicing program by zones, in order that treatment is best maintained to prevent polluted discharges to groundwater.
- Examine the urgency and feasibility of constructing a lagoon and force main sewerage system for Nixon, and adding sewer lines in Sutcliffe and Wadsworth.

NIXON URBAN RUNOFF- 1994 SUMMARY:

The volume of urban runoff from the community of Nixon to the Truckee River was estimated using the Rational Method (see sections 4.4 and 7.4). Based on 18 land-use categories and an average rainfall of 0.63 ft/yr, total urban discharge to the river was calculated to be 11.4 acre-ft per year. Pollutant loads to the Truckee River from Nixon urban runoff were predicted from total discharge and water quality information for runoff from various land-uses (TRPA 1977; CSWRCB 1980). Annual loads were determined for sediment (10,500 lbs), total nitrogen (28.3 lbs), nitrate (6.6 lbs), phosphate (12 lbs), and chloride (218 lbs). These loads are extremely small indicating that urban runoff from Nixon is an insignificant source of sediments, nutrients, and dissolved salts. Runoff of toxic compounds is also probably negligible.

Current status and mitigation/abatement activities:

The Nixon community has not grown appreciably in population since the 1994 assessment. Based on calculations for runoff pollution in the 1994 Plan, it is determined for this report that NPS inputs from this source to the Truckee River continue to be negligible. Housing is expanding gradually, with a plan for 15 units currently expected to go to construction in 2012. As with Wadsworth and Sutcliffe, change is anticipated

through implementation of the Pyramid Lake Economic Development Plan. Increased commercial enterprises will bring about change to the landscape, which would likely require improvements to infrastructure. (Carey, 2011)

Currently, the commercial district of Nixon experiences an annual flush of activity when the Burning Man Festival occurs around Labor Day. Since the 1994 Report was written this festival has taken seasonal residence in the Black Rock Desert and creates a flush of activity all along Highway 447 on the PLIR. Some of this activity is less desirable and potentially a source of NPS. Vintage vehicles breaking down on the roadside and strewn garbage is known to occur. Playa dust from the desert is transported with returning visitors, and may be a minor source to the Truckee River when they swim near the Nixon bridge. Currently, the effect of the Burning Man community is not considered unreasonable, but it should be monitored in case the event grows to such proportion where the impact is measurably problematic to water quality.

Water Quality Parameters Affected:
None currently

Recommendations:

- Encourage low impact Green Infrastructure development for any future projects.
- Enforce PLPT 401 Certification Regulations for construction projects and other events that effect water quality
- Promote BMPs in designs for community infrastructure as implemented

RIPARIAN GRAZING ALONG RIVER- 1994 SUMMARY:

Livestock grazing along the lower Truckee River on the Reservation is potentially an important source of NPS pollution during winter months. Currently, cattle are moved from summer ranges around the Reservation to farms along the floodplain of the river during fall of each year. The cattle spend the winter months on the fields along the river and then are moved back to summer ranges the following spring. Through the partial implementation of a range management plan, the Tribe has already begun to address potential impacts from the cattle on the Truckee River (see chapter 9). The stretch of the river downstream from Wadsworth has been fenced to restrict livestock access to riparian zones, and the Tribe is working on providing alternative winter rangeland for the cattle. When the range management plan has been fully implemented, the impacts of livestock on the river should be minimal due to a limited presence of cattle within the floodplain. Currently, potential nutrient loadings to the Truckee River from winter foraging of cattle on fields along the river were estimated to be 7500-15,000 lbs of nitrogen and 2600-5100 lbs of phosphorus. These loadings will be greatly reduced when alternative winter pasture is available for the cattle.

One area of the river where cattle exclusion is probably less important is the delta region. The delta is currently a rich rangeland for cattle which is flat (low erosion potential) and vegetated with native grasses. Although restriction of cattle from the delta would probably reduce nutrient loading to the lake by a small amount, those nutrients are beneficial to the fish population of the lake by stimulating adequate algal growth. Movement of cattle from the delta should receive low priority compared with other regions of the river.

Current status and mitigation/abatement activities:

Riparian areas on the Truckee River within the reservation are not included as part of open range grazing units, and are technically "off limits" to cattle. The Lower Truckee within reservation boundaries has been fenced on both sides for its entire length in an effort to keep cattle from grazing riparian areas. Current grazing activity within Truckee River riparian areas is the result of "trespass" cattle, as they find their way in through fencing areas in need of repair.

Water Quality Parameters Affected:

- Nitrogen
- Phosphorus
- Pathogen indicators (E coli)

Recommendations:

- Continued development of alternative water sources upslope and away from riparian areas.
- Monitoring of fencing integrity and repairs as needed.
- Develop ordinance language and consequences to further discourage ranchers allowing cattle into riparian areas.