TRUCKEE RIVER

FINAL

TOTAL MAXIMUM DAILY LOADS (TMDLs)

AND

WASTE LOAD ALLOCATIONS (WLAs)

Adopted by:

Nevada Division of Environmental Protection
Bureau of Water Quality Planning

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INTRODUCTION

Section 303(d) of the Clean Water Act requires states to identify waters that do not or are not expected to meet applicable water quality standards with technology-based controls alone. Once these waters are identified, states are to develop total maximum daily loads (TMDLs) at a level necessary to achieve the applicable water quality standards. The Truckee River at Lockwood is listed on Nevada's 303(d) List for total nitrogen, total phosphorus and total dissolved solids. NDEP has chosen to use the chemical specific approach for the establishing TMDLs.

Section 303(d) of the Clean Water Act requires states implement water quality-based controls where technology based limits and implemented Best Management Practices (BMPs) are not sufficient to achieve water quality standards. A TMDL is a tool for implementing State water quality standards and is based on the relationship between pollutant sources and in-stream water quality conditions. TMDLs integrate the management of both point and nonpoint sources of pollution to a waterbody. The TMDL establishes the allowable loadings or other quantifiable parameters for a waterbody and thereby provides the basis for establishing water quality-based controls. These controls should provide the pollution reduction necessary for a waterbody to meet water quality standards.

A TMDL quantifies pollutant sources and allocates allowable loads to the contributing point and nonpoint sources so that the water quality standards are attained. The greatest amount of loading that a water can receive without violating water quality standards is the loading capacity. The waste load allocation (WLA) is the portion of a receiving water's loading capacity that is allocated to existing or future point sources of pollution. EPA regulations (40 CFR 130.2(g)) provide that load allocations for nonpoint sources and/or natural background "are best estimates of the loading which may range from reasonably accurate estimates to gross allotments...."

This document first describes the methodology used for determining a TMDL for both conservative and nonconservative parameters. Then water quality attainment programs other than waste load allocations in the Truckee Meadows Water Reclamation Facility (formerly known as the Reno/Sparks Wastewater Treatment Facility) NPDES permit are discussed. Finally, TMDLs/WLAs for TDS, TN and TP are discussed including a discussion of the proposed NPDES permit and attainability.

TMDL/WLA SUMMARY

Total Dissolved Solids

TMDL: 900,528 lbs/day at Lockwood

WLA for Truckee Meadows NPDES Permit:

For effluent flows ? 30 MGD:
90,126 lbs/day

For effluent flow 30 MGD - 40 MGD:
(influent flow) x (360 mg/l) x 8.345

Permit Max. : 120,168 lbs/day

Total Nitrogen

TMDL: 1000 lbs/day at Lockwood

LA: 500 lbs/day

WLA for Truckee Meadows NPDES Permit:

500 lbs/day annual average

500 lbs/day 30-day average (May-October)

Total Phosphorus

TMDL: 214 lbs/day at Lockwood

LA: 80 lbs/day nonpoint source/background

WLA for Truckee Meadows NPDES Permit:

134 lbs/day

The TMDL compliance point is set at Lockwood. Lockwood was selected because the majority of controllable pollutant sources (Steamboat Creek, North Truckee Drain and the Truckee Meadows Water Reclamation Facility) are upstream from Lockwood. This compliance point should be protective of nutrient enhancement in downstream reaches because conditions of biotic uptake downstream have been documented by monitoring data.

METHODOLOGY

The methodology to calculate Total Maximum Daily Loads (TMDLs) varies with the type of pollutant, with one method of calculation for pollutants which are generally classified as conservative and another method for pollutants generally classified as nonconservative (Federal Register, Vol.43, No.250).

Conservative pollutants are those pollutants which persist in the water column of the aquatic environment and remain essentially constant in a given segment over time. The conservative pollutant TMDL (C-TMDL) of a body of water is that pollutant loading which by simple dilution with the receiving body of water results in an ambient concentration equal to the specified numerical concentration limit for that pollutant, i.e., the concentration limit based upon the applicable water quality standard. The C-TMDL varies directly with the volumes of flows of dischargers and the receiving water body.

Nonconservative pollutants (such as organic compounds) decay or are otherwise removed over time. This decrease in concentration may be due to a number of factors including chemical breakdown and biodegradation. Therefore, nonconservative pollutant TMDLs (N-TMDLs) are not as much an intrinsic property of a body of water as they are factors of the receiving body of water, flow from discharger, and the configuration of the discharge locations on the body of water. N-TMDLs are also affected by a number of factors including chemical and biological processes in the aquatic environment. Therefore, N-TMDLs can only be calculated with fairly sophisticated techniques such as mathematical modeling which takes these factors into account.

EPA has acknowledged that the dividing line between conservative and nonconservative pollutants is not sharp and the classification of a given pollutant may vary according to the site specific situation. Furthermore, as TMDL calculations are made on a case-by-case basis, the states are free to use their judgement in classifying a pollutant as either conservative or nonconservative based on the characteristics of the segment in question. For the Truckee River, NDEP assumed that total phosphorus and total dissolved solids are conservative pollutants and total nitrogen is a nonconservative pollutant.

Once a TMDL load has been calculated, the TMDL is allocated to a wasteload allocation and load allocation (WLA/LA) between point and nonpoint sources, respectively. Thus, this process has significance to both point and nonpoint sources of pollution.

Conservative Pollutant Procedure

TMDLs for conservative pollutants were based on simple dilution calculations assuming the system is represented by average conditions over time (Technical Guidance Manual for Performing Waste Load Allocations; Book II; Chapter 3; June, 1984) Conservative pollutant TMDLS were calculated as follows:

1. To calculate the TMDLs in pounds per day using the flow data (in cubic feet per second), and the concentration of pollutant (micrograms per liter), the following constant was calculated:

   (1 mg/l)x(1 g/1000 mg)x(oz/28.35 g)x(lb\16 oz)x(28.316 l/ft) = 6.243 x 10^{-5}

   (6.243x10^{-5} lb? l/mg? ft^3)x(60 sec/min)x(60 min/hr)x(24 hr/day) = 5.394 lb? l? sec/mg? ft^3? day

2. The TMDL was calculated using the following calculation:

   (average flow ft^3/sec)x(average concentration mg/l)x(5.394 lb? l? sec/mg? ft^3? day) = TMDL in lbs/day

3. The average flow was obtained from the U.S. Geological Survey Water-Data Report (Garcia, 1992) Station 10350000 Truckee River at Vista located 0.9 miles southeast of Vista, 1.5 mi downstream from Steamboat Creek, 4 mi southeast of Sparks, and at mile 52.23, upstream of Marble Bluff Dam. This station has 63 years of data (1900-07, 1933-54, 1959-91), but the time period 1973-1992 was selected to calculate the average flow of 795 cfs (see Appendix B). 1973 was selected because this was the year that Stampede Reservoir was placed into service, which was the last significant modification to flow control structures in the Truckee River Basin. Thus, the TMDL for:

   Total Phosphorus:
   (795 cfs) x (.05 mg/l) x (5.394) = 214 lbs/day

   Total Dissolved Solids:
   (795 cfs) x (210 mg/l) x (5.394) = 900,528 lbs/day

MARGIN OF SAFETY

Conservative pollutants are assumed not to decay or settle from the water. Conservative pollutant behavior gives a reasonable upperbound on expected instream concentration (Dilks, 1991), and therefore incorporates a margin of safety. In the case of TDS, there is a large difference between the TMDL and WLA; therefore, a large margin of safety has been provided. In the case of phosphorus, no decay has been assumed. Since the Truckee River is very productive, some decay, if not significant decay, of phosphorus is expected and monitoring data shows that significant decay of phosphorus does occur between Lockwood and Wadsworth. Brock assumed a phosphorus recycle rate of 80% which means that 80% of the phosphorus that is removed is make available for uptake in the next downstream element. This implies a 20% margin of safety is included in assuming phosphorus is a conservative pollutant. Therefore, assuming zero decay of phosphorus allows for a margin of safety. Also, for both TDS and phosphorus, the TMDLs are calculated based on average annual flows and concentrations.

Non-conservative Pollutant Procedure

For total nitrogen, assumed to be a non-conservative pollutant, the Dynamic Stream Simulation and Assessment Model (DSSAM III) was utilized to determine the TMDL. DSSAM was designed to simulate a system where polluting substances are entering the stream from a variety of sources, including point source effluents, surface water runoff, ground water, and leaching and scouring from the bottom sediments. DSSAM provides a dynamic representation of diel (24-hour) variation in constituent concentrations. The model simulates competition between two species of benthic algae and can model growth of nitrogen fixing algae under low nitrogen conditions. For more detailed information on the development of DSSAM refer to Appendix A.

Model scenarios were run varying the loads from different sources. Computer simulation results indicate that nitrogen loads in excess of 1,000 pounds per day at Vista may result in excessive accumulations of aquatic plants, with associated problems of substandard dissolved oxygen concentrations (Brock et.al., 1992). Total loading to the river at Vista from all sources, both point and non-point, should be targeted to not exceed 1,000 pounds during low flow periods.

At the 1,000 pounds per day loading rate, the water quality standard recommended by Brock et.al. (1992) for total nitrogen and the existing standard are listed below.

Control Point	Existing Standard	Brock's Recommendation
Lockwood	0.75 mg/l	0.70 mg/l
Derby Dam	0.75 mg/l	0.65 mg/l
Wadsworth	0.75 mg/l	0.55 mg/l
Pyramid Lake	0.75 mg/l	0.40 mg/l

MARGIN OF SAFETY

Besides the fact that Brock's recommended standard is less than the existing standard, numerous other conservative assumptions were built into the model development. Therefore, a margin of safety has been included in the model and an additional margin of safety is not necessary.

WATER QUALITY ATTAINMENT PROGRAMS

The following sections discuss nonpoint source reduction programs that should result in the reduction of TN, TP and TDS loads to the Truckee River.

Wastewater Reuse

Wastewater reuse not only reduces effluent flow to the river (consequently reducing the load), but also reduces demand for fresh Truckee River water for irrigation. By applying effluent to water-right-decreed lands, the higher quality water normally diverted from the Truckee River for this purpose would remain in the river.

Nutrient loading to the River can also be lessened by reducing the nonpoint source flows associated with agricultural surface runoff. Surface irrigation of agricultural lands with freshwater is generally practiced in the region, resulting in tailwater runoff to the Truckee River or its tributaries. As the water flows across the land, it captures pollutants located on the ground surface and transports them to the River. For those lands irrigated with effluent, sprinkler irrigation methods should be used, eliminating the tailwater runoff and its associated pollutant loadings.

NPDES Stormwater Permit

The City of Reno, City of Sparks, Washoe County and the Nevada Department of Transportation within the area of Truckee River Basin (excluding the Pyramid Lake Indian Reservation) were issued a permit to discharge from storm water outfalls to the Truckee River and it tributaries on July 31, 1990. The permittees have legal authority to:

- -- control pollutants in stormwater discharge;
- -- prohibit illegal discharges and control spills; and,
- -- to require compliance and carry out inspections.

The permit contains a variety of requirements which will result in the control of pollutants including implement and evaluate effectiveness of BMPs, inventory of major potential sources of pollution, monitoring program, measures to detect illegal discharges/illicit disposal practices and improvement plans to control pollutants in stormwater runoff from construction sites.

Steamboat Creek Nonpoint Source Pollution Control Project

Sponsored by the Washoe County Department of Comprehensive Planning and the City of Reno, the Steamboat Creek nonpoint source pollution control project assessed the feasibility of constructing alum addition facilities to control and remove phosphorus and suspended sediment from urban runoff and agricultural return flows in Steamboat Creek (Runke, et.al., 1992). Laboratory and pilot-scale field testing showed that alum treatment of Steamboat Creek waters was effective at reducing levels of total phosphorus and other pollutants.

The project also assessed the preliminary feasibility of constructing and operating a full-scale alum treatment facility to treat the majority of Steamboat Creek flows. A "concept design" was developed based on experience with the pilot-scale field test. In addition, a preliminary cost estimate for a full-scale treatment facility was also determined. Not including the costs for land, other right-of-way, legal and administrative services, planning costs (such as EAW or EIS), construction of electrical service lines and cover, the estimated capitol cost is $4,917,000. A preliminary estimate of annual operation costs for the treatment facility not including cost for alum sludge transportation or heating is $1,368,400/year (Runke et.al., December 2, 1991).

Washoe County Water Quality Education Program

UNR Cooperative Extension was funded to conduct a public education program aimed at reducing nonpoint sources of pollution, directed at all households, plus residential and agricultural land uses.

Xeriscape Ordinance

An ordinance was researched that addresses: efficiency of drip irrigation and xeriscape; potential for nonpoint source pollution reduction from fertilizers, pesticides, sediment loss, and herbicides from all landscaping that might affect surface and groundwater via percolation and urban runoff; conservation of water resources and prevention of nonpoint source pollution.

Herman Ditch Project

Currently, runoff from agricultural lands is a primary source of nonpoint source pollution. Elevated levels of nitrate, ammonia, phosphate, and chloride can all be traced to various ranching and farming activities. The Herman Ditch Project will evaluate the water quality impacts of agricultural activities. This project will also develop pollution prevention Best Management Practices related to agricultural activities. The objectives of the project are:

1) characterize the hydrologic and chemical regimes of the return-flow system;

2) evaluate the relationship, if any, between the aforementioned water quality changes in the Truckee River

and Herman Ditch return-flow waters, with an emphasis on developing mass loading estimates for that portion of the river;

3) based on the results of the first two objectives, design and construct a detention basin for the purpose of removing nutrients and suspended solids from return-flows before they enter the Truckee River;

4) evaluate the effectiveness, with respect to pollution prevention, of currently adopted agricultural BMPs in the Herman Ditch drainage regime.

Water Quality Attainment Program

Washoe County Regional Water Supply and Quality Study (draft Jan., 1993) outlines a Water Quality Attainment Program (WQAP) which identifies a set of facilities and programs designated to improve the water quality condition of the Truckee River system by reducing both agricultural and urban point and nonpoint source pollutant loadings. The major components of the WQAP include flow augmentation, a wetlands treatment system for Steamboat Creek, a Helms Pit discharge treatment facility or uses of the discharge as irrigation supply, stream protection, and pasture improvement. Further study and monitoring of agricultural and urban nonpoint source pollutant loadings is also recommended to help determine additional programs to reduce pollutant loadings and their associated water quality benefits and costs.

Flow augmentation: The impacts of low flows in the lower Truckee River relate directly to depressed dissolved oxygen (DO) concentration levels and barriers to spawning Lahontan cutthroat trout and Cui-ui. Model runs to date appear to show that by purchasing water rights and augmenting the flow of the lower River during critical periods, the water quality condition of the river can be improved.

Wetlands Treatment System for Steamboat Creek: Potential sources of pollution to Steamboat Creek include agricultural irrigation return flows, grazing animals, golf course runoff, and septic tank leach fields. A wetlands treatment system has been identified which is capable of removing large amounts of the nutrients associated with Steamboat Creek.

Helms Pit: Two alternatives have been identified to reduce the nutrient loading from this source. The first alternative is to build a treatment facility to biologically reduce the nutrient concentrations. The second alternative is to irrigate water-right-decreed lands with water from the Helms Pit.

Stream Protection: Animal wastes from grazing animals are a significant source of pollutant loading to Steamboat Creek. By constructing protective measures around the creek, such as fencing and stream crossings, and providing alternative water sources, the pollutant loadings associated with grazing animals can be minimized. It is recommended that this type of protective measure be considered for implementation as part of a comprehensive nonpoint source pollution reduction program.

Pasture Improvement: Pasture improvement involves a variety of activities including land leveling, reseeding, pasture maintenance, and management such as rotational grazing. The water quality benefits associated with such activities relate to minimizing nutrient movements associated with surface runoff from pastureland. It is recommended that this type of protective measure be considered for implementation as part of a comprehensive nonpoint source pollution reduction program.

Flood Control Facilities

Under natural conditions, a sediment load is transported by flood flows. For drainages tributary to the Truckee River, this sediment loading will ultimately be discharged into the Truckee River and Pyramid Lake. Construction of flood control facilities can alter the natural sedimentation/erosional processes, usually causing greater sediment outflow from the basin for initial period after construction and until the system restabilizes. Construction of channel systems may also transport sediment through the system which would normally settle out and remain in the watershed.

The design of future flood control systems will need to consider these sedimentation and erosion processes to prevent excessive amounts of sediment from moving through the system and discharging into the Truckee River. Appropriate erosion and sediment control measures in constructed facilities are also necessary to prevent damage or diminished capacity. Control of sediment could be accomplished through debris basins, detention basins, sediment traps, and erosion control. Flood control projects will assist in improving water quality through sediment and debris control, improved maintenance of storm drainage and flood control systems, and stream restoration.

1993 Projects Approved for Funding:

Steamboat Creek and Truckee River Classification and Channel Stability Rating Project

The purpose of this study is to measure the current morphologic characteristics of Steamboat Creek, and to classify sections of the Creek based on the measurements. Classification systems are used as guidelines to the morphologic balance of a naturally functioning stream. After classification, the Creek sections will be ranked for stability with regard to erosion, deposition tendencies. The advantage of a stream classification system is to determine if there is an erosion, deposition problem within that stream section that will need mitigation work in the form of best management practices.

Because the past human alterations have changed the morphologic characteristics of the Creek, it is highly possible that sections of Steamboat Creek will not fit perfectly into any one of the categories. However, the classification will provide a guide as to what morphological changes to expect to occur on Steamboat Creek over time, and/or what mitigation plans should be in place to prepare for expected impacts. Knowing what type of stream Steamboat Creek should be also provides direction for restoring the stream back to its natural state.

The final product of this project will consist of a categorization of stability of the creek sections. The categorization will provide the user with an understanding of whether Steamboat Creek sections are in their natural state with respect to erosion and deposition rates, and provide an estimation of the expectation of what may occur on Steamboat Creek morphologically. The numeric stability or instability at each transect location will assist mitigation and restoration decisions. General best management practices will also be recommended for the stream sections, and will be used in subsequent years to direct restoration efforts.

Truckee River Restoration at Rainbow Bend

The project site is located in Lockwood, Storey County at Rainbow Bend modular home park. The Washoe-Storey Conservation District is proposing to plant 2-year old native Cottonwoods every 15 feet on the south bank of the Truckee River. The tree planting project will improve the water quality by reducing erosion potential and serve as a canopy over the river to reduce water temperatures.

Truckee Meadows Suburban Agricultural Nonpoint Source Education Program

The aim of this project is to reduce nonpoint source (NPS) pollution in the Truckee River watershed by public education of a particular target audience of citizens who are engaged in potentially polluting activities such as raising livestock or trash-dumping in ditches on small (two to ten acre) "ranchettes". The project objectives are:

1. Increase target audience knowledge about:
   a. Sources of pollution
   b. Methods of correction (Best Management Practices)
   c. Financing/grant opportunities for property owners

2. Reduce/prevent pollution from:
   a. Irrigation return flows
   b. Improper animal waste management
   c. Unmanaged grazing in or near stream

d. Inappropriate fertilization
e. Bank erosion
f. Stormwater runoff
g. Improper ditch maintenance or dumping trash in ditches.

3. Increase implementation of best management practices.

4. Educate audience about ag-related ground water protection strategies (including abandoned well sealing and septic system care).

Evaluating the Efficacy of Low Cost Wetlands Treatment to Improve Lower Truckee River Water Quality

The project is multi-faceted, including the integration of science, management, and public education. Specific objectives are:

1) Design a low cost/low maintenance wetlands to treat effluent from the Numana Hatchery.

2) Monitor the hydrology and water quality characteristics of existing (pre-construction) conditions, giving particular focus to the relationship between surface discharge and shallow groundwater.

3) Technical training (technology transfer) of Pyramid Lake Paiute Tribe members to perform monitoring, water quality analysis (NDEP laboratory certification), and overall wetlands maintenance. Successful execution of this objective will insure the long term "stewardship" of the wetlands facility.

4) Construction of designed wetlands which will become an integral part of a nature center, thereby allowing the public to gain a direct understanding of, and appreciation for, the role of wetlands in improving water quality and serving as an important wildlife habitat.

5) Post-construction monitoring of the hydrology and water quality characteristics of the 'engineered' wetlands, with a focus towards accurately defining the degree of treatment (BMP effectiveness).

Truckee River Fencing, Offsite Livestock Water

The Carson Walker RC&D has proposed to build seventeen miles of fence along the west side of Highway 447 from the south boundary of the Pyramid Lake Paiute Indian Reservation at Wadsworth to Highway 446 west of Nixon. The fence would provide winter range unit for the tribal cattle, keeping them out of the lower Truckee River riparian area and a critical portion of Pyramid Lake shoreline. It is also proposed to use Numana Fish

Hatchery return flow water to install a offsite livestock/wildlife watering system for the winter range created by the fence.

This project will improve riparian condition along the Truckee River within the reservation by controlling livestock use of the river area. Improving the riparian condition will help reduce sediment inflow into the lake. This project would protect the riparian zone in the bulk of the spawning area of the endangered Cui-ui.

TOTAL DISSOLVED SOLID (TDS)

Background

The Truckee River at Lockwood was identified on Nevada's 303(d) list as requiring a TMDL to be established for TDS in the 2-year planning period, however in general, the water quality standards for TDS are being attained. A TMDL/WLA is proposed for TDS to fulfill antidegradation requirements. CFR 130.7(b)(3) (July 24, 1992) states "for the purposes of listing waters under section 130.7(b), the term 'water quality standard applicable to such waters' and 'applicable water quality standards' refer to those water quality standards established under section 303 of the Act, including numeric criteria, narrative criteria, waterbody uses and antidegradation requirements".

EPA's Guidance for Water Quality-Based Decisions: The TMDL Process points out that by identifying threatened good quality waters, States take a more proactive, "pollution prevention" approach to water quality management for the following reasons:

- Consistent with 40 CFR 130.7 (c)(1)(ii) which requires that TMDLs be established for all pollutants that prevent or are expected to prevent water quality standards from being achieved.

- Encourages States to maintain and protect existing water quality.

- Easier and less costly in the long term to prevent impairments than rather retrofit controls to clean up pollution problems.

- Meets EPA objectives to support the State's collection of data on impacted or threatened waters.

TMDL/WLA

TMDL: 900,528 lbs/day at Lockwood

WLA for Truckee Meadows NPDES Permit:

For effluent flows ? 30 MGD:
90,126 lbs/day

For flow 30 MGD - 40 MGD:
(influent flow) x (360 mg/l) x 8.345

Permit Max. : 120,168 lbs/day

Truckee Meadows NPDES Permit

The existing NPDES permit issued for the Truckee Meadows Water Reclamation Facility requires the plant limit its 30-day average TDS discharge to 360 mg/l at all times of the year. The purpose of the permit limit is to protect overall loading of TDS to Pyramid Lake and to fulfill antidegradation requirements. The discharge from the facility has been in violation of this limit. Violations occur during the winter months of the year when a relatively high proportion of the water supply is being obtained from groundwater sources. Recent drought conditions have further aggravated this condition.

EPA's Technical Guidance Manual for Performing Waste Load Allocations, Book VII: Permit Averaging Periods suggests that never to be exceeded criteria are conceptually inconsistent with the stochastic nature of wastewater treatment processes and effluent concentration they produce. Realistically, some exceedance frequency must be acknowledged. Therefore, it is proposed to revise the Truckee Meadows permit from a 30-day average to an annual average limit.

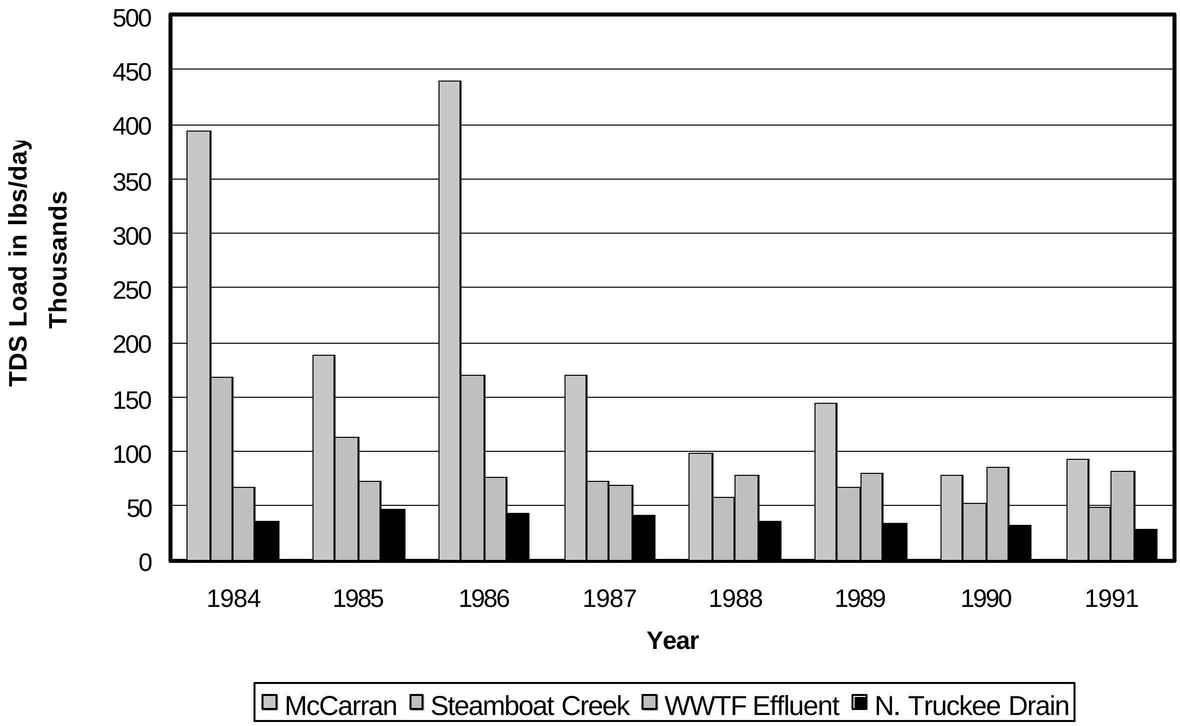
Initiating the waste load allocation at 30 MGD is based on the cities of Reno and Sparks projections that effluent flow will increase 4.2 MGD in the next five years which is the life of the permit. This flow projection was based on building department data and 325 gallons per connection. The annual average effluent flow in 1992 was approximately 25 MGD. 4.2 MGD added to 25 MGD is 29.2 MGD. Allowing for some uncertainty, 30 MGD was selected.

Attainability

Figure 1 presents the annual average TDS loads in lbs/day from McCarran (background), Steamboat Creek and North Truckee Drain (nonpoint sources) and the wastewater treatment facility (point source) for the years 1983-1991. As can be seen in Figure 1, existing conditions have been achieving the total maximum daily load.

The proposed NPDES permit will require the permittee to submit a Management Plan for TDS reduction for the purpose of ensuring that the waste load allocation is attained. This Management Plan will be developed in accordance with the recommendations outlined in the October 1991 NPDES Compliance Study by John Carollo Engineers. This plan shall be submitted for approval by NDEP by April 30, 1994. Once approved, this plan shall become an enforceable part of the permit.

Figure 1 Annual Average TDS Loads



	McCarran	Steamboat Creek	North Truckee Drain	Total NPS/ Background	Wastewater Treatment Facility	Total	TMDL	Reduction Required
1984	394,139	168,804	36,052	598,995	67,316	666,311	900,528	0
1985	187,655	113,405	46,463	347,523	71,927	419,450	900,528	0
1986	439,696	170,090	43,361	653,147	76,949	730,096	900,528	0
1987	169,987	71,683	41,700	283,370	69,638	353,008	900,528	0
1988	97,521	58,321	36,253	192,095	77,538	269,633	900,528	0
1989	144,114	66,117	34,253	244,484	80,455	324,939	900,528	0
1990	78,040	51,385	32,910	162,335	84,942	247,277	900,528	0
1991	92,201	48,723	28,970	169,894	82,174	252,068	900,528	0
Mean	259,881	93,566	37,522	376,403	74,611	451,014	900,528	0

TOTAL NITROGEN

Background

Significant exceedances of the dissolved oxygen water quality standard are occurring in the Truckee River below Vista. The primary source of the problem is the oxygen demand associated with benthic aquatic plants and accumulated detritus that are found in the river downstream from Vista. Through water quality modeling (DSSAM III) and field experimentation, Brock et.al. (1992) have determined that nitrogen is the limiting nutrient in the Truckee River; that is, relative to the concentration of phosphorus, nitrogen is available to the periphyton in the least supply. DSSAM model scenarios have shown that if the existing flow regime continues into the future, further restrictions on nitrogen loads will be needed in order to improve oxygen conditions in the Truckee River.

Brock et.al. (1992) recommends that the total maximum daily load from all sources be set at 1,000 lbs/day of nitrogen at Lockwood during summer low flow conditions to be protective of the single value 5 mg/l dissolved oxygen limit. Computer simulation results indicate that nitrogen loads in excess of 1,000 pounds per day at Vista result in accumulations of aquatic plants with associated problems of substandard dissolved oxygen. It is also recommended that the level of treatment at the wastewater treatment facility needed to meet the 1,000 lb/day TMDL during low flow periods be maintained throughout the year and that loads in excess of 1,000 lbs/day should not be encouraged until potential impacts of these loads to Pyramid Lake are better defined.

Kennedy/Jenks Consultants (1992) reviewed the Brock et.al. (1992) report and DSSAM III model and recommended further model refinement in three primary areas:

1) oxygen reareation at low flows,
2) fundamental ecosystem measurements (benthic photosysthesis and respiration),
3) bioavailability of nutrients, especially organic nitrogen.

Kennedy/Jenks further recommended that the Cities of Reno/Sparks continue to support field testing and refinement of the model. They encourage NDEP to consider alternatives to solving dissolved oxygen problems. These may include, but are not limited to, seasonal loading limits, flow augmentation, effluent reuse, nonpoint source controls, and artificial aeration.

TMDL/WLA

Existing data shows that the average nonpoint source contribution is approximately 500 lbs/day. Therefore, 500 lbs/day was determined as the load allocation and 500 lbs/day as the waste load allocation.

TMDL: 1000 Lbs/day at Lockwood during summer low flows

LA: 500 lbs/day

WLA for Truckee Meadows NPDES Permit:

500 lbs/day annual average

500 lbs/day 30-day average (May-October)

Truckee Meadows NPDES Permit:

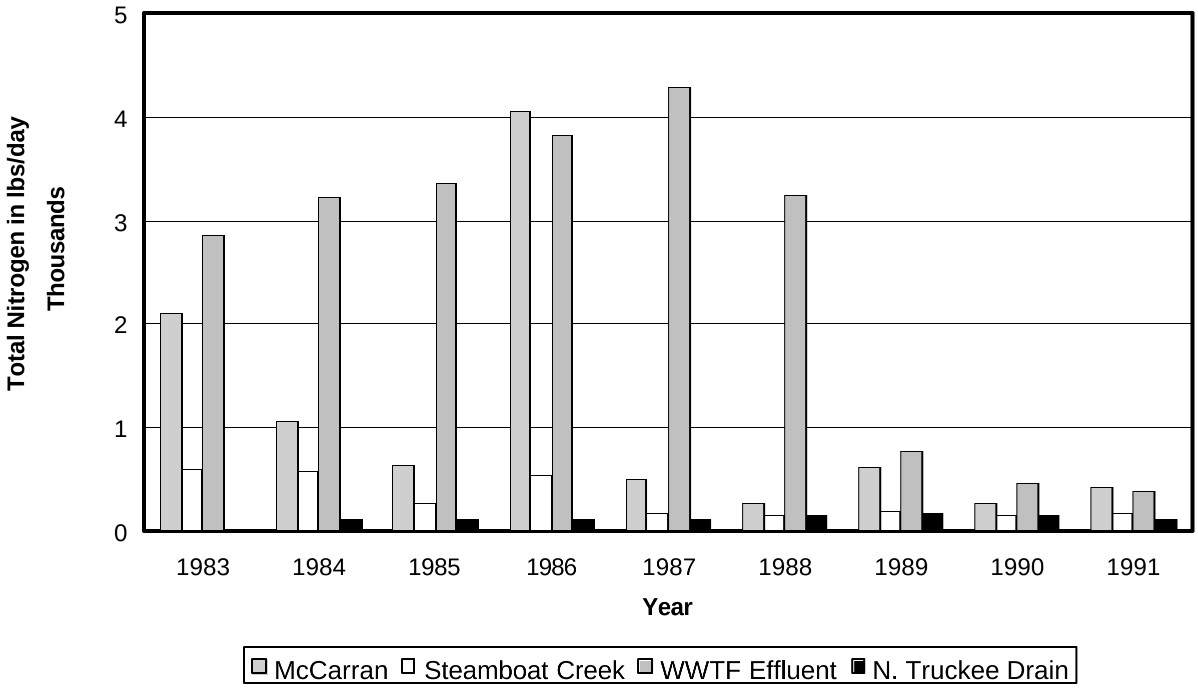
The proposed NPDES permit will limit total nitrogen to 500 lbs/day 30-day average during the growing season (May-October). The proposed permit will also limit total nitrogen to 500 lbs/day annual average. Within 6 months of permit issuance, the permittee will be required to submit a proposal to NDEP outlining anticipated water quality studies to be completed in the following 3 to 5 year period. The purpose of the studies is to further address uncertainties in the water quality modeling which could result in revising the TMDL if necessary. The studies will include but not be limited to modeling which incorporates oxygen reareation at low flows, fundamental ecosystem measurements (benthic photosynthesis and respiration) and bioavailability of nutrients. The proposal will include specific work elements, goals, budget and completion schedule.

Attainability

Figure 2 shows the annual average total nitrogen loads in lbs/day from McCarran (background), Steamboat Creek and North Truckee Drain (nonpoint sources) and the wastewater treatment facility (point source) for the years 1983-1991. The figure suggests that since nitrogen removal became operational at the wastewater treatment facility (1989), the TMDL of 1,000 lbs/day is being attained.

It is likely that the TMDL of 1,000 lbs/day will be exceeded at some times during periods of runoff. Mass balance calculations show that although the TMDL will be exceeded due to high flows, and consequently, a relatively large load, the TN water quality standard will be attained (see Appendix C for more detailed analysis). While loads in excess of 1,000 lbs/day during high flow periods will probably not be assimilated by the river's benthic community, at this time, the TMDL will not be varied seasonally until potential impacts of these loads to Pyramid Lake are better defined (Brock, et. al, 1992).

Figure 2. Annual Average Total Nitrogen Loads



	McCarran	Steamboat Creek	North Truckee Drain	Total NPS/ Background	Wastewater Treatment Facility	Total	TMDL	Reduction Required
1983	2,097	598	ND	2,695	2,853	5,548	1,000	4,548
1984	1,056	579	110	1,745	3,219	4,964	1,000	3,964
1985	629	269	112	1,010	3,358	4,368	1,000	3,368
1986	4,049	530	118	4,697	3,829	8,526	1,000	7,526
1987	489	168	113	770	4,295	5,065	1,000	4,065
1988	273	148	141	562	3,237	3,799	1,000	2,799
1989	611	188	171	970	763	1,733	1,000	733
1990	261	150	145	556	462	1,018	1,000	18
1991	417	173	121	711	384	1,095	1,000	95
Mean	1,098	311	129	1,524	2,489	4,013	1,000	3,013

TOTAL PHOSPHORUS

Background

Investigations of the synergistic relationships of chemical constituents in the lower Truckee River have been conducted utilizing the DSSAM III Water Quality Model (Brock, 1992). The results indicate that nitrogen is the nutrient limiting algae growth in the lower Truckee River. However, it should be noted that the model is inconclusive about the role of phosphorus in stimulating blue-green algae populations.

Studies are being conducted by the University of California at Davis under contract by the Pyramid Lake Paiute Tribe and Pyramid Lake Fisheries on nutrient cycling and limnology in Pyramid Lake. It is a goal of the studies to better define phosphorus cycling in Pyramid Lake so that the impact of changes in phosphorus loading pattern can be predicted. It should be noted that the studies are scheduled to be completed in August of 1993. This four year study will produce scientifically sound data for water quality standards for Pyramid Lake and the lower Truckee River. Studies on phosphorus cycling in the lake have not been completed.

Although the DSSAM III model was primarily used to predict dissolved oxygen values in the Truckee River based on different nitrogen loading and flow rates, DSSAM III runs also varied conditions of flow and phosphorus loads. NDEP evaluated the results of the DSSAM III runs to determine which conditions of flow and phosphorus loads provided phosphorus concentration near the existing standard of 0.05 mg/l. The DSSAM III model scenarios which resulted in a phosphorus concentration near 0.05 mg/l (see Table 1) were similar to the TMDL obtained using the conservative pollutant calculation approach.

TMDL/WLA

TMDL: 214 lbs/day at Lockwood

LA: 80 lbs/day nonpoint source/background

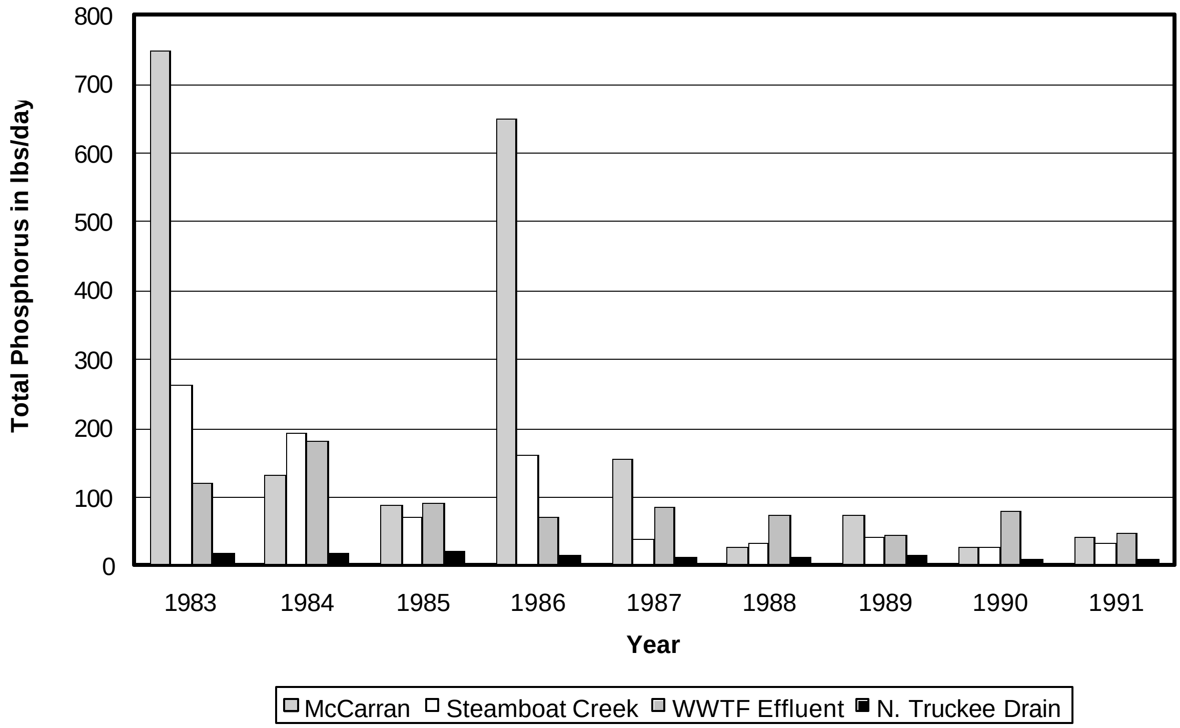
WLA for Truckee Meadows NPDES Permit:

134 lbs/day

Truckee Meadows NPDES Permit:

Until the completion of the studies to determine a scientifically valid phosphorus loading to the river, NDEP proposes to maintain the existing total phosphorus waste load allocation of 134 lbs/day which complies with the anti-degradation requirements of NRS 445.253 and 40 CFR 131.12(a)(1). In addition to the waste

Figure 3. Annual Average Total Phosphorus Loads



	McCarran	Steamboat Creek	North Truckee Drain	Total NPS/ Background	Wastewater Treatment Facility	Total	TMDL	Reduction Required
1983	749	263	17	1,029	120	1,149	214	935
1984	132	193	19	344	181	525	214	311
1985	89	72	21	182	90	272	214	58
1986	650	162	16	828	72	900	214	686
1987	155	40	14	209	86	295	214	81
1988	26	33	12	71	75	146	214	0
1989	73	43	15	131	46	177	214	0
1990	28	27	10	65	79	144	214	0
1991	43	33	10	86	48	134	214	0
Mean	216	96	15	327	89	416	214	202

Table 1. Data from DSSAMIII showing predicted phosphorus (P) concentrations based on specific P Loads and flow rates.

Run No.	Nonpoint Source P Load (lb/da)	RSWTP P Load (lb/da)	Total P Load (lb/da)	RSWTF Flow Rate (cfs)	Model Flow Designation Med=1987 Low=1988 Calib=1989	Annual Average Flow at Vista (cfs)	Total P at Lockwood (mg/l)	Total P at Derby Dam (mg/l)	Total P at Wadsworth (mg/l)	Total P at Pyramid (mg/l)	Total P McCarran to Pyramid[1] (mg/l)
R1	182	44	226	40.23[2]	Calib	478	0.062	0.074	0.063	0.041	0.056
R2	193	134	327	46.42[3]	Med	538	0.099	0.124	0.103	0.069	0.094
R3	87	134	221	46.42	Low	278	0.120	0.154	0.119	0.064	0.108
R4	174	134	308	61.89[4]	Med	538	0.094	0.116	0.096	0.065	0.088
R5	75	134	209	61.89	Low	278	0.110	0.149	0.111	0.057	0.098
R6	157	134	291	77.36[5]	Med	538	0.090	0.109	0.090	0.061	0.083
R7	180	134	314	46.42	Med	538	0.097	0.120	0.100	0.067	0.091
R8	213	0	213	0	Med	538	0.062	0.070	0.061	0.043	0.056
R9	201	0	201	0	Med	538	0.059	0.065	0.057	0.041	0.053
R10	174	87	261	61.89	Med	538	0.082	0.098	0.085	0.060	0.077
R11	193	65	253	46.42	Med	538	0.081	0.096	0.083	0.059	0.076
R12	75	87	162	61.89	Low	278	0.086	0.113	0.089	0.050	0.078
R13	165	44	209	40.23	Calib	478	0.057	0.067	0.057	0.039	0.052
R14	200	44	244	40.23	Calib	478	0.066	0.081	0.069	0.047	0.062
R15	182	44	226	40.23	Calib	478	0.062	0.074	0.063	0.043	0.057
R16	75	134	209	61.89	Low	278	0.110	0.151	0.118	0.067	0.104

Table 1. –continued--

Run No.	Nonpoint Source P Load (lb/da)	RSWTP P Load (lb/da)	Total P Load (lb/da)	RSWTF Flow Rate (cfs)	Model Flow Designation Med=1987 Low=1988 Calib=1989	Annual Average Flow at Vista (cfs)	Total P at Lockwood (mg/l)	Total P at Derby Dam (mg/l)	Total P at Wadsworth (mg/l)	Total P at Pyramid (mg/l)	Total P McCarran to Pyramid[1] (mg/l)
R17	75	134	209	61.89	Low	278	0.110	0.150	0.116	0.065	0.102
R18	75	134	209	61.89	Low	278	0.110	0.149	0.115	0.063	0.101
R19	75	134	209	61.89	Low	278	0.110	0.149	0.113	0.061	0.100
R20	75	134	209	61.89	Low	278	0.110	0.149	0.112	0.059	0.099
R21	75	134	209	61.89	Low	278	0.110	0.152	0.120	0.069	0.106
R22	75	0	75	61.89	Low	278	0.044	0.045	0.037	0.023	0.034
R23	75	134	209	61.89	Low	278	0.110	0.151	0.119	0.067	0.105
R24 ALT 17-B	0	23	---	43.32	Low	278	0.063	0.074	0.058	0.031	0.051
R25 ALT 97-E	0	49	---	23.21	Low	278	0.089	0.116	0.090	0.050	0.080
R26 ALT 17-E	0	33	---	15.47	low	278	0.084	0.107	0.084	0.047	0.074

Table 1. –continued--

Run No.	Nonpoint Source P Load (lb/da)	RSWTP P Load (lb/da)	Total P Load (lb/da)	RSWTF Flow Rate (cfs)	Model Flow Designation Med=1987 Low=1988 Calib=1989	Annual Average Flow at Vista (cfs)	Total P at Lockwood (mg/l)	Total P at Derby Dam (mg/l)	Total P at Wadsworth (mg/l)	Total P at Pyramid (mg/l)	Total P McCarran to Pyramid[1] (mg/l)
R18 10%	75	134	209	61.89	Low	278	0.110	0.149	0.114	0.062	0.101
R27 25%	75	134	209	61.89	Low	278	0.110	0.148	0.128	0.093	0.117
R28 50%	75	134	209	61.89	Low	278	0.110	0.148	0.135	0.111	0.126
R29 75%	75	134	209	61.89	Low	278	0.110	0.148	0.138	0.120	0.130
R30 100%	75	134	209	61.89	Low	278	0.110	0.1478	0.140	0.125	0.133

1) Total integrated over entire reach for specified time frame
2) 40.23 cfs = 26 mgd
3) 46.42 cfs = 30 mgd
4) 61.89 cfs = 40 mgd
5) 77.36 cfs = 50 mgd

load allocation, the permit will limit the total phosphorus concentration to 0.40 mg/l.

The permit will also mandate a monitoring program to determine whether wastewater discharges from the Reno-Sparks Water Reclamation Facility may be causing violations to water quality standards, to maintain and validate water quality models, and to assess trends in water quality.

Attainability

Figure 3 shows the annual average phosphorus loads in lbs/day from McCarran (background), Steamboat Creek and North Truckee Drain (nonpoint sources) and the wastewater treatment facility (point source) for the years 1983-1991. As can be seen significant reductions in nonpoint sources and/or background will be required to achieve the TMDL. NDEP feels that the projects outlined in the Water Quality Attainment Program section above will endeavor to achieve the necessary reductions.

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APPENDIX A - DSSAM

Background

The current version of the DSSAM model is an enhanced hybrid of two previously published stream models (SSAM IV and LPSM). DSSAM II had its origins in SSAM IV (Stream Simulation and Assessment Model, Version IV) and LPSM (Lotic Periphyton Simulation Model). SSAM IV is a steady-state model of water quality in stream environments that deals with both hydraulics and water quality, but it deals with periphyton and aquatic macrophytes in only a rudimentary manner. The LPSM model on the other hand, focuses specifically on the dynamics of the periphyton community. LPSM is dynamic, but does not deal with stream chemistry or hydraulics, except as input data. Therefore, the LPSM periphyton algorithm was installed in a modified version of SSAM IV to create DSSAM. The resulting model is both dynamic and deterministic, capable of simulating diel swings of all the water quality constituents modeled.

DSSAM was developed initially during 1985-1987 to investigate potential biostimulatory effects that various operational scenarios of the Reno-Sparks Wastewater Treatment Facility might have on the Truckee River. That version of DSSAM (sometimes referred to as the "Earth Metrics Truckee River model") was calibrated based on field data collected during 1986; it emphasized variations in pH, dissolved oxygen, and ammonia nitrogen (both total and un-ionized) because of the relevance of these water quality parameters on fish survival. In 1990, additional development of the river model involved the capacity to specify diel variations of constituents at the upstream boundary and one point load, and the incorporation of additional constituents of interest (particulate phosphorus, soluble nonreactive phosphorus, particulate organic nitrogen).

DSSAM may be applied to a river system with distributed surface inflows and/or outflows, and distributed groundwater inflows and/or outflows. The model was developed to operate two distinct submodels in sequence: 1) system layout and flow balance; and 2) simulation of water quality constituents. The first submodel (hydraulic) starts with the headwater flow of the mainstream and proceeds downstream, conducting a flow balance by adding (or subtracting, as appropriate) distributed surface flow, distributed subsurface flow, point load flows, and diversion flows. The model calculates the average velocity, cross-sectional area, and hydraulic radius at specified points in the stream network and stores these data for later use. The second submodel (Water Quality) also starts at the headwater of the stream, utilizes hydraulic data stored by the hydraulic submodel, and proceeds downstream, solving a system of differential equations to predict concentration of the water quality constituents.

The concentration of the water quality constituents at any point in the stream system are the results of two processes:

1. The collection and physical transport of the substance from upstream sources by the flowing water;

2. The biochemical and physical reactions causing changes in concentrations or chemical composition during the time that the substances are being transported.

Both of these processes are simulated by the model. For the first process, the constituents entering the water are mixed with main streamflow and transported downstream at the average cross-sectional velocity of the flow. The second process is simulated by state-of-the-art kinetics (biochemical and physical reactions). Kinetic equations have been included in DSSAM III for the following constituents:

1. Soluble reactive phosphate
2. Soluble non-reactive phosphate
3. Particulate phosphorus
4. Ammonium
5. Nitrate
6. Nitrite
7. Soluble organic nitrogen
8. Particulate organic nitrogen
9. Ultimate biochemical oxygen demand
10. Dissolved oxygen
11. Benthic algae
12. Acidity
13. Alkalinity
14. Carbon dioxide
15. Total dissolved solids
16. Chloride

The model calculated diel constituent concentrations for constant flow conditions over some time period. The time period chosen should not be less than the travel time of the flow through the sub-basin being modeled. The term "pass" represents the length of time (in days) it takes for water entering the first cell to leave the last cell. During a single pass of the model, it is assumed that river flows do not vary significantly relative to total travel time. Steady state models based on a cartesian reference frame (such as DSSAM) are not appropriate for modeling periods characterized by variable flow, such as storms and subsequent runoff.

A model "simulation" consists of a single model pass, or a connected series of model passes. Passes of the river model are connected by using the final values for the first pass as initial conditions for the second pass; the final values for the second pass become initial conditions for the third pass, and so on.

Thus, model simulations could vary in length from a single pass to an entire year. The concept of linking multiple passes during a simulation provides a mechanism for predicting biological responses--such as accumulations of benthic algae--which integrate conditions over an entire growing season.

The time span for a pass of the model is user defined. The program is structured so that time periods can be linked successively, and at the end of a period the program writes a set of final values for all constituents and model elements. This output data file for the period can then represent the initial values for a new time period. Accordingly, DSSAM III could be run for a day or a year of river time, depending on the application at hand. Water temperature, light, and extinction coefficient can be changed each day, every few days, or can remain constant for the entire pass. Options are available to account for diel variability (i.e., ten samples per day) in constituent concentration for upstream boundary conditions and one point load such as a wastewater treatment plant.

Scope of Model Application to the Truckee River

DSSAM modeled the Truckee River beginning at the downstream boundary of Reno (East McCarran Blvd. in Sparks) to Marble Bluff Dam which is considered the inlet of the Truckee River to Pyramid Lake. DSSAM was applied to the Truckee River as a steady-state model whereby river and tributary flows and loads are assumed to be constant during the individual time periods of the model. In the modeled reach of the Truckee River, nutrient loads to the Truckee River, below Reno to Pyramid Lake, consist of tributaries North Truckee Drain (NTD) and Steamboat Creek (SBC), tertiary-treated effluent from the Truckee Meadows Water Reclamation Facility (TMWRF), irrigation return flows and groundwater inflows. There are no perennial tributaries of consequence downstream from Lockwood.

The TMWRF, a 40 MGD design capacity wastewater treatment facility which includes phosphorus and nitrogen removal and tertiary filtration in its treatment processes, discharges to Steamboat Creek just upstream from the its confluence with the Truckee River. Also included in the model are diffuse groundwater flows to the Truckee River in the vicinity of Wadsworth which result in a significant net accrual of water throughout the year.

The DSSAM model has been tailored for lotic (flowing water) ecosystems like the Truckee River where benthic (bottom) biological processes play a significant role in determining key water quality parameters. The water quality constituents modeled by DSSAM focus on the transformations of the various forms of nitrogen and phosphorus, dissolved oxygen, decay of oxygen-demanding substances (sediments, BOD, ammonia), the carbonate equilibrium that determines pH, and two constituents modeled as conservative substances (total dissolved solids and chloride).

Description of Model Simulations

The best available snapshot of nutrient loading to the river consisted of a multi-agency data collection program during September 1989. At the time of the intensive synoptic sampling, river flows were relatively stable and the facility upgrade at the TMWRF that included nitrogen removal was fully functional. The monitoring effort included a detailed flow study conducted by the USGS, which provided the best estimates currently available of groundwater accrual to the river's main stem. This 1989 synoptic data set was used to calibrate the DSSAM model.

The calibrated DSSAM model provided a tool for assessing the potential impacts of various scenarios of future land use and water flow on Truckee River water quality. A series of simulations were run involving differing levels of nutrient loading from agriculture in the Truckee Meadows, as well as various loading scenarios from the TMWRF. Various possibilities were evaluated for future nutrient loads discharged from the TMWRF: from the current permitted load of 1664 lb. nitrogen and 134 lb. phosphorus; zero discharge of N with the permitted 134 lb P; zero discharge of N and P; and a series of scenarios based on TMWRF concentrations assumed to be achievable with present technology. Treatment performance of the facility during 1990 was extrapolated to 30 MGD as well as 40 MGD (the existing facility's design hydraulic capacity). Flow conditions for the simulations were either those of 1987 (median flow year) or 1988 (low flow year).

Based on results of an initial set of model simulations, a second series was conducted to more closely examine the effects of incremental nitrogen loads from the TMWRF at permitted P (134 lb) and 40 MGD. The set of coefficients used in the final version of the model calibrated to 1989 conditions was used for the succeeding 22 runs of the model. An additional three simulations were conducted to evaluate model sensitivity to non-point loads and temperature. Computer simulation results indicate that nitrogen loads in excess of 1,000 pounds per day at Vista result in accumulations of aquatic plants with associated problems of substandard dissolved oxygen.

Appendix B

FLOW AT VISTA - CFS

Year	Max.	Min.	Mean
1973	573	573	573
1974	3250	465	1122
1975	2770	532	902
1976	856	377	570
1977	465	76	263
1978	1710	241	607
1979	1420	227	395
1980	2040	307	735
1981	2200	181	598
1982	4720	339	1477
1983	6290	411	2557
1984	3350	378	1471
1985	1880	266	661
1986	5210	400	1349
1987	1570	268	572
1988	437	68	292
1989	949	131	422
1990	1140	36	268
1991	1330	47	263
Grand Average			795

Appendix C

HIGH FLOW ANALYSIS OF TOTAL NITROGEN TMDL

To evaluate attainment of the total nitrogen (TN) water quality standard when the TMDL of 1,000 lbs/day is exceeded, due to high flows, the following calculations were performed. A TN concentration at Vista was back calculated using existing data and the projected impact of the Truckee Meadows Water Reclamation Facility (WRF) discharging 500 lbs/day total nitrogen. A projected load at Vista **(C)** was calculated using existing data for the background (McCarran) load plus nonpoint source (NPS) load plus 500 lbs/day. The NPS load was assumed to be the sum of the Steamboat Creek (SBC) load upstream from the water reclamation facility and the North Truckee Drain (NTD) load. The projected TN concentration at Vista was calculated by dividing the projected load at Vista **(C)** by the calculated flow at Vista **(A)** times the appropriate conversion factor. The calculated flow at Vista **(A)** was assumed to be the sum of the flows from McCarran, Steamboat Creek, the sewage treatment plant (STP) and North Truckee Drain.

As can be seen in the table below, even though the 1,000 lbs/day at Vista is exceeded, the TN water quality standard of 0.75 mg/l is not exceeded in years of high flow namely 1984 through 1986.

Year	**A** Calculated flow at Vista in cfs (McCarran + SBC + WRF + NTD)	**B** Background + NPS TN load in lbs/day	**C** Background + NPS + 500 TN load TN in lbs/day	**C/(A x 5.394)** Calculated Conc. at Vista mg/l
1984	1233	1738	2238	0.34
1985	664	1010	1510	0.42
1986	1610	4693	5193	0.60
1987	557	770	1270	0.42
1988	298	562	1062	0.66
1989	544	969	1469	0.50
1990	290	556	1056	0.68
1991	244	711	1211	0.91