5.0 PLANT NUTRIENTS

The potential for excessive nutrients in the Rio Puerco, Bluewater Creek, and Rio Moquino were noted through visual observation during the 2004 SWQB intensive watershed survey. Assessment of various water quality parameters indicated nutrient impairment in Rio Puerco (Arroyo Chijuilla to northern boundary of Cuba), Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir), Bluewater Creek (Bluewater Reservoir to headwaters), and Rio Moquino (Laguna Pueblo to Seboyetita Creek).

5.1 Target Loading Capacity

The target values for nutrient loads are determined based on 1) the presence of numeric and narrative criteria, 2) the degree of experience in applying the indicator, and 3) the ability to easily monitor and produce quantifiable and reproducible results. For this TMDL document the target value for plant nutrients is based on both narrative and numeric translators. This TMDL is consistent with the New Mexico State antidegradation policy.

The New Mexico WQCC has adopted a narrative water quality criterion for plant nutrients to sustain and protect existing or attainable uses of the surface waters of the state. This general criterion applies to surface waters of the state at all times unless a specific criterion is provided elsewhere. The general water quality criteria require that a stream have water quality, streambed characteristics, and other attributes of habitat sufficient to protect and maintain coldwater aquatic life. The narrative plant nutrient criterion leading to an assessment of use impairment is as follows (Subsection E of 20.6.4.13 NMAC):

> ***Plant Nutrients:*** *Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in the dominance of nuisance species in surface waters of the state.*

There are two potential contributors to nutrient enrichment in a given stream: excessive nitrogen and/or phosphorus. The reason for controlling plant growth is to preserve aesthetic and ecologic characteristics along the waterway. The intent of numeric criteria for phosphorus and nitrogen is to control the excessive growth of attached algae and higher aquatic plants that can result from the introduction of these plant nutrients into streams. Numeric criteria also are necessary to establish targets for total maximum daily loads (TMDLs), to develop water quality-based permit limits and source control plans, and to support designated uses within the watershed.

Nutrient criteria development in the State of New Mexico has taken place in three steps, thus far. First, the EPA compiled nutrient data from the national nutrient dataset, divided it by waterbody type, grouped it into nutrient ecoregions, and calculated the 25th percentiles for each aggregate and Level III ecoregion. EPA published these recommended water quality criteria to help states and tribes reduce problems associated with excess nutrients in waterbodies in specific areas of the country (USEPA 2000). Next a U.S. Geological Survey (USGS) employee, Evan Hornig, who assisted EPA Region 6 with nutrient criteria development, refined the recommended

ecoregional nutrient criteria. Hornig used regional nutrient data from EPA's Storage and Retrieval System (STORET), the USGS, and the SWQB to create a regional dataset for New Mexico. Threshold values were calculated based on EPA procedures and the median for each Level III ecoregion.

The third round of analysis was conducted by SWQB to produce nutrient threshold values for streams based on ecoregion and designated aquatic life use. For this analysis, total phosphorus (TP), total Kjeldahl nitrogen (TKN), and nitrate plus nitrite (N+N) data from the National Nutrient Dataset (1990-1997) was combined with Archival STORET data from 1998, and 1999-2006 data from the SWQB in-house database. The data were then divided by waterbody type, removing all rivers, reservoirs, lakes, wastewater treatment effluent, and playas. For all of the stream data, Level III and IV Omernik ecoregions (Omernik 2006) as well as the designated aquatic life use were assigned to all stream data using GIS coverages and the station's latitude and longitude. Medians were calculated for each ecoregion/aquatic life use group using Excel. For comparison purposes, values below the detection limit were estimated in two ways; using the substitution method (one half the detection limit) in Excel and using the nonparametric Kaplan-Meier method in Minitab. Interestingly, the results from the different analysis produced very similar results. However, the threshold values that will be incorporated into the SWQB Stream Nutrient Assessment Protocol were calculated using the Kaplan-Meier method and are shown in Table 5.1.

Table 5.1. SWQB's Recommended Nutrient Targets for streams (in mg/L)

	ECOREGION									
Parameter	21-Southern Rockies		23-AZ/NM Mountains		22-AZ/NM Plateau		24-Chihuahuan Desert	26-SW Tablelands		
TP	0.02		0.02		0.05		0.04	0.03		
TN	0.25		0.25		0.35		0.53	0.38		
ALU	CW	T/WW (volcanic)	CW	T/WW	CW	T/WW	T/WW	CW	T	WW
TP	0.02	0.02 (0.05)	0.02	0.05	0.04	0.09	0.04	0.02	0.03	0.03
TN	0.25	0.25	0.25	0.29	0.28	0.48	0.53	0.25	0.38	0.45

NOTES:
TP = Total Phosphorus
TN = Total Nitrogen
ALU = Designated Aquatic Life Use
CW = Coldwater (those water quality segments having only coldwater uses)
T = Transitional (those water quality segments with marginal coldwater or both cold and warmwater uses)
WW = Warmwater (those water quality segments having only warmwater uses)

The Rio Puerco (Arroyo Chijuilla to northern boundary of Cuba) is located in Ecoregion 22 (Arizona/New Mexico Plateau). In addition, this assessment unit is covered by the water quality standards in 20.6.4.99 NMAC, which has an aquatic life use designation. According to Table 5.1, the Rio Puerco (Arroyo Chijuilla to northern boundary of Cuba) should have numeric nutrient targets of 0.09 mg/L for total phosphorus and 0.48 mg/L for total nitrogen.

Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir) is located in Ecoregion 22 (Arizona/New Mexico Plateau). In addition, this assessment unit is classified under 20.6.4.109 NMAC and has a designated aquatic life use of coldwater aquatic life. According to Table 5.1, Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir) should have numeric nutrient targets of 0.04 mg/L for total phosphorus and 0.28 mg/L for total nitrogen.

Bluewater Creek (Bluewater Reservoir to headwaters) is located in Ecoregion 23 (Arizona/New Mexico Mountains). In addition, this assessment unit is classified under 20.6.4.109 NMAC and has a designated aquatic life use of coldwater aquatic life. According to Table 5.1, Bluewater Creek (Bluewater Reservoir to headwaters) should have numeric nutrient targets of 0.02 mg/L for total phosphorus and 0.25 mg/L for total nitrogen.

Rio Moquino (Laguna Pueblo to Seboyetita Creek) is located in Ecoregion 23 (Arizona/New Mexico Mountains). In addition, this assessment unit is classified under 20.6.4.109 NMAC and has a designated use of coldwater aquatic life (20.6.4.109 NMAC). According to Table 5.1, Rio Moquino (Laguna Pueblo to Seboyetita Creek) should have numeric nutrient targets of 0.02 mg/L for total phosphorus and 0.25 mg/L for total nitrogen.

Total Nitrogen is defined as the sum of Nitrate+Nitrite (N+N), and Total Kjeldahl Nitrogen (TKN). At the present time, there is no USEPA-approved method to test for Total Nitrogen, however a combination of USEPA method 351.2 (TKN) and USEPA method 353.2 (Nitrate + Nitrite) may be appropriate for monitoring Total Nitrogen.

Table 5.2. Nutrient TMDL Target Concentrations

Assessment Unit	Total Phosphorus	Total Nitrogen
Rio Puerco (Arroyo Chijuilla to northern boundary of Cuba)	0.09 mg/L	0.48 mg/L
Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir)	0.04 mg/L	0.28 mg/L
Bluewater Creek (Bluewater Reservoir to headwaters)	0.02 mg/L	0.25 mg/L
Rio Moquino (Laguna Pueblo to Seboyetita Creek)	0.02 mg/L	0.25 mg/L

5.2 Flow

The presence of plant nutrients in a stream can vary as a function of flow. As flow decreases, the stream cannot effectively dilute its constituents, which causes the concentration of plant nutrients to increase. Thus, a TMDL is calculated for each assessment unit at a specific flow.

The *critical condition* can be thought of as the "worst case" scenario of environmental conditions in the waterbody in which the loading expressed in the TMDL for the pollutant of concern will

continue to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence. The critical flow is used in calculation of point source (National Pollutant Discharge Elimination System [NPDES]) permit WLA and in the development of TMDLs.

The critical flow condition for these TMDLs occurs when the ratio of effluent to stream flow is the greatest and was obtained using a 4Q3 regression model. The 4Q3 is the minimum average four consecutive day flow that occurs with a frequency of at least once every 3 years. Low flow was chosen as the critical flow because of the negative effect decreasing, or low, flows have on nutrient concentrations and algal growth.

The 4Q3s for Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir) and Bluewater Creek (Bluewater Reservoir to headwaters) are based on USGS Gage data. USGS Gage 08341500: Bluewater Creek at Bluewater Dam, NM was used to calculate the 4Q3 for Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir). USGS Gage 083413000: Bluewater Creek above Bluewater Dam, NM was used to calculate the 4Q3 for Bluewater Creek (Bluewater Reservoir to headwaters). The 4Q3s were estimated using the USGS A193 calculation for Log Pearson Type III distribution through DFLOW software, Version 3.1 (USEPA 2006). DFLOW 3.1 is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis. The calculated 4Q3 is as follows:

- Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir) = 0.16 cfs
- Bluewater Creek (Bluewater Reservoir to headwaters) = 0.01 cfs

It is often necessary to calculate a critical flow for a portion of a watershed where there is no active flow gage. The 4Q3 derivations for the Rio Puerco and Rio Moquino were based on analysis methods described by Waltemeyer (2002). In this analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following statewide regression equation is based on data from 50 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 = 1.2856 \times 10^{-4} \; DA^{0.42} \; P_w^{\;3.16} \qquad \text{(Eq. 3)}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)

The average standard error of estimate (SEE) and coefficient of determination are 126 and 48 percent, respectively, for this regression equation (Waltemeyer 2002). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35} \qquad \text{(Eq. 4)}$$

where,

S = Average basin slope (percent).

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3 for the Rio Puerco was estimated using the statewide regression equation because the mean elevation for this assessment unit was below 7,500 feet in elevation. On the other hand, the 4Q3 for the Rio Moquino was estimated using the regression equation for mountainous regions because the mean elevation for this assessment unit was above 7,500 feet in elevation (Table 5.3).

Table 5.3 Calculation of 4Q3 Low-Flow Frequencies

Assessment Unit	Average Elevation (ft.)	Drainage Area (mi^2)	mean winter precipitation (in.)	Average basin slope (percent)	4Q3 (cfs)
Rio Puerco (Arroyo Chijuilla to northern boundary of Cuba)	7398	137.98	8.75	14.7	0.965
Rio Moquino (Laguna Pueblo to Seboyetita Creek)	8189	74.27	5.7	11	0.039

The 4Q3 values were converted from cubic feet per second (cfs) to units of million gallons per day (MGD) as follows:

$$_____\ \frac{\text{ft}^3}{\text{sec}} \times 1{,}728 \frac{\text{in}^3}{\text{ft}^3} \times 0.004329 \frac{\text{gal}}{\text{in}^3} \times 86{,}400\ \frac{\text{sec}}{\text{day}} \times 10^{-6} = _____\ \text{MGD} \qquad \text{(Eq. 4)}$$

It is important to remember that the TMDL is a planning tool to be used to achieve water quality standards. Since flows vary throughout the year in these systems the target load will vary based on the changing flow. Management of the load to improve stream water quality and meet water quality criteria should be a goal to be attained.

5.3 Calculations

This section describes the relationship between the numeric target and the allowable pollutant-level by determining the waterbody's total assimilative capacity, or loading capacity, for the pollutant. The loading capacity is the maximum amount of pollutant loading that a waterbody can receive while meeting its water quality objectives.

As a river flows downstream it has a specific carrying capacity for nutrients. This carrying capacity, or TMDL, is defined as the mass of pollutant that can be carried under critical low-flow conditions without violating the target concentration for that constituent. These TMDLs were developed based on simple dilution calculations using 4Q3 flow, the numeric target, and a conversion factor. The specific carrying capacity of a receiving water for a given pollutant, may be estimated using **Equation 1**.

4Q3 (in MGD) x Numeric Target (in mg/L) x 8.34 = TMDL (pounds per day [lbs/day]) (Eq. 1)

The annual target loads for TP and TN are summarized in Table 5.4.

Table 5.4. Estimates of Annual Target Loads for TP & TN

Assessment Unit	Parameter	4Q3 Flow (MGD)	Numeric Target (mg/L)	Conversion Factor	Target Load (lbs/day)
Rio Puerco (Arroyo Chijuilla to northern bnd of Cuba)	Total Phosphorus	0.768+	0.09	8.34	0.577
	Total Nitrogen	0.768+	0.48	8.34	3.074
Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir)	Total Phosphorus	0.103	0.04	8.34	0.034
	Total Nitrogen	0.103	0.28	8.34	0.241
Bluewater Creek (Bluewater Reservoir to headwaters)	Total Phosphorus	0.007	0.02	8.34	0.001
	Total Nitrogen	0.007	0.25	8.34	0.015
Rio Moquino (Laguna Pueblo to Seboyetita Creek)	Total Phosphorus	0.025	0.02	8.34	0.004
	Total Nitrogen	0.025	0.25	8.34	0.052

Notes:
+ *Combined Flow = 4Q3 low-flow (0.624 MGD) + WWTP design capacity (0.144 MGD)*

The measured loads for TP and TN were similarly calculated. In order to achieve comparability between the target and measured loads, the same flow value was used for both calculations. The geometric mean of the collected data that exceeded the numeric targets (Table 5.5) was substituted for the numeric target in **Equation 1**. The same conversion factor of 8.34 was used. The results are presented in Table 5.6.

Table 5.5 SWQB nutrient data

Sample site	Collection date/time	TP (mg/L)	TN (mg/L)
Bluewater Creek above Bluewater Lake @ USGS gage 8341300	4/5/2004 16:35	0.0344	0.459
Bluewater Creek above Bluewater Lake @ USGS gage 8341300	5/3/2004 11:35	<0.03	0.513
Bluewater Creek above Bluewater Lake @ USGS gage 8341300	6/8/2004 17:20	0.03035	0.434
Bluewater Creek above Bluewater Lake @ USGS gage 8341300	7/13/2004 15:00	<0.03	0.33
Bluewater Creek above Bluewater Lake @ USGS gage 8341300	8/10/2004 18:10	0.0334	0.42
Bluewater Creek above Bluewater Lake @ USGS gage 8341300	11/2/2004 15:45	0.02	0.31
Bluewater Creek above Bluewater Lake @ USGS gage 8341300	11/15/2004 15:06	0.022	0.27
GEOMETRIC MEAN of Exceedences		**0.033**	**0.382**
BLUEWATER CREEK AT MOUTH OF BLUEWATER CANYON	4/5/2004 15:20	<0.03	0.352
BLUEWATER CREEK AT MOUTH OF BLUEWATER CANYON	5/3/2004 10:05	<0.03	0.325
BLUEWATER CREEK AT MOUTH OF BLUEWATER CANYON	6/8/2004 15:00	<0.03	0.489
BLUEWATER CREEK AT MOUTH OF BLUEWATER CANYON	7/13/2004 13:30	<0.03	0.451
BLUEWATER CREEK AT MOUTH OF BLUEWATER CANYON	8/10/2004 17:00	0.0311	0.534
BLUEWATER CREEK AT MOUTH OF BLUEWATER CANYON	9/13/2004 13:00	<0.03	0.381
BLUEWATER CREEK AT MOUTH OF BLUEWATER CANYON	11/2/2004 14:20	0.011	0.33
BLUEWATER CREEK AT MOUTH OF BLUEWATER CANYON	11/15/2004 16:30	0.007	0.32
GEOMETRIC MEAN of Exceedences		**n/a**	**0.436**
Rio Puerco @ Hwy 550 Bridge	3/31/2004 7:30	0.111	0.61
Rio Puerco @ Hwy 550 Bridge	4/14/2004 17:10	0.178	0.652
Rio Puerco @ Hwy 550 Bridge	6/29/2004 11:15	<0.03	0.34
Rio Puerco @ Hwy 550 Bridge	7/27/2004 13:40	<0.03	0.28
Rio Puerco @ Hwy 550 Bridge	9/1/2004 13:10	<0.03	0.401
Rio Puerco @ Hwy 550 Bridge	11/17/2004 12:00	0.004	0.3
Rio Puerco @ Hwy 550 Bridge	3/7/2006 16:35	0.078	0.53
Rio Puerco abv WWTP	3/30/2004 14:10	0.102	0.6
Rio Puerco abv WWTP	4/14/2004 12:41	0.21	0.764
Rio Puerco abv WWTP	6/29/2004 14:30	0.0341	0.644
Rio Puerco abv WWTP	7/27/2004 14:28	3.06	12.1
Rio Puerco abv WWTP	9/1/2004 16:33	1.60	8.7
Rio Puerco abv WWTP	9/30/2004 12:40	3.27	18.9
Rio Puerco abv WWTP	11/18/2004 14:20	1.53	8.09
Rio Puerco blw WWTP @ Sanchez Property	3/30/2004 15:15	0.172	1
Rio Puerco blw WWTP @ Sanchez Property	4/14/2004 16:34	0.185	0.837
Rio Puerco blw WWTP @ Sanchez Property	6/29/2004 16:15	1.76	11.01
Rio Puerco blw WWTP @ Sanchez Property	7/27/2004 15:10	1.40	6.27
Rio Puerco blw WWTP @ Sanchez Property	9/1/2004 17:25	1.17	13.27
Rio Puerco blw WWTP @ Sanchez Property	9/30/2004 13:26	1.40	8.75
Rio Puerco blw WWTP @ Sanchez Property	10/14/2004 14:25	4.05	4.27
Rio Puerco blw WWTP @ Sanchez Property	11/18/2004 15:22	1.00	6.59
Rio Puerco blw WWTP @ Sanchez Property	3/7/2006 11:55	1.67	9.2
GEOMETRIC MEAN of Exceedences		**0.758**	**3.064**

Sample site	Collection date/time	TP (mg/L)	TN (mg/L)
Cuba WWTP Outfall Channel	3/30/2004 14:00	2.88	23.8
Cuba WWTP Outfall Channel	4/14/2004 12:40	3.72	231.83
Cuba WWTP Outfall Channel	6/29/2004 14:40	6.72	40.2
Cuba WWTP Outfall Channel	7/27/2004 14:25	3.74	37
Cuba WWTP Outfall Channel	9/1/2004 16:30	2.55	15.8
Cuba WWTP Outfall Channel	9/30/2004 12:36	1.64	9.43
Cuba WWTP Outfall Channel	11/18/2004 14:16	4.25	20.7
	AVERAGE	**3.64**	**24.5**
Rio Moquino blw confluence with Seboyetita Crk and Seboyeta Crk	6/8/2004 11:05	<0.03	0.329
Rio Moquino blw confluence with Seboyetita Crk and Seboyeta Crk	7/13/2004 9:35	<0.03	0.466
Rio Moquino blw confluence with Seboyetita Crk and Seboyeta Crk	8/10/2004 11:30	<0.03	0.403
Rio Moquino blw confluence with Seboyetita Crk and Seboyeta Crk	9/13/2004 9:45	0.0413	0.373
Rio Moquino blw confluence with Seboyetita Crk and Seboyeta Crk	11/2/2004 11:45	0.017	0.32
Rio Moquino blw confluence with Seboyetita Crk and Seboyeta Crk	11/16/2004 11:00	0.007	0.28
	GEOMETRIC MEAN of Exceedences	**n/a**	**0.357**

Notes:
TP = Total Phosphorus
TN = Total Nitrogen
mg/L = Milligrams per liter
n/a = not applicable because less than two exceedences in the Assessment Unit
Exceedences of the nutrient targets are highlighted in **YELLOW**.

Table 5.6. Estimates of Annual Measured Loads for TP and TN

Assessment Unit	Parameter	Flow (MGD)	Geometric Mean Conc. * (mg/L)	Conversion Factor	Measured Load (lbs/day)
Rio Puerco (Arroyo Chijuilla to northern bnd of Cuba)	Total Phosphorus	0.768+	0.758	8.34	4.855
	Total Nitrogen	0.768+	3.064	8.34	19.63
Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir)	Total Phosphorus	0.103	n/a	8.34	< Target Load
	Total Nitrogen	0.103	0.436	8.34	0.375
Bluewater Creek (Bluewater Reservoir to headwaters)	Total Phosphorus	0.007	0.033	8.34	0.002
	Total Nitrogen	0.007	0.382	8.34	0.022
Rio Moquino (Laguna Pueblo to Seboyetita Creek)	Total Phosphorus	0.025	n/a	8.34	< Target Load
	Total Nitrogen	0.025	0.357	8.34	0.074

Notes:
+ Combined Flow = 4Q3 low-flow (0.624 MGD) + WWTP design capacity (0.144 MGD)
* Geometric mean of TP and TN exceedences (See Table 5.5 for data).
n/a Not Applicable because less than two exceedences

5.4 Waste Load Allocations and Load Allocations

5.4.1 Waste Load Allocation

The only existing point source along these assessment units is the NPDES-permitted WWTP owned and operated by the Village of Cuba (NM0024848). There are no individually permitted Municipal Separate Storm Sewer System (MS4) storm water permits in these assessment units.

Excess nutrient levels may be a component of some (primarily construction) storm water discharges so these discharges should be addressed. In contrast to discharges from other industrial storm water and individual process wastewater permitted facilities, storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the NPDES construction general storm water permit (CGP) requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. In addition, the current CGP also includes state specific requirements to implement BMPs that are designed to prevent to the maximum extent practicable, an increase in sediment, or a parameter that addresses sediment (e.g., total suspended solids, turbidity, siltation, stream bottom deposits, etc.) and flow velocity during and after construction compared to preconstruction conditions. In this case, compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Other industrial storm water facilities are generally covered under the current NPDES Multi-Sector General Storm Water Permit (MSGP). This permit also requires preparation of an SWPPP that includes identification and control of all pollutants associated with the industrial activities to minimize impacts to water quality. In addition, the current MSGP also includes state specific requirements to further limit (or eliminate) pollutant loading to water quality impaired/water quality limited waters from facilities where there is a reasonable potential to contain pollutants for which the receiving water is impaired. In this case, compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

Therefore, this TMDL does not include a specific WLA for storm water discharges for these assessment units. However, because the Village of Cuba owns and operates an NPDES-permitted wastewater treatment plant a WLA for the WWTP is included in this TMDL.

A simple mixing model was used to calculate the WLA for NM0024848. Effluent limitations for TP and TN were calculated using the following equation:

$$C_e = \frac{C_s(Q_a + Q_e) - C_a Q_a}{Q_e}$$

where C_e = allowable WWTP effluent concentration (mg/L)

C_s = target concentration (mg/L)
C_a = average concentration of non-exceedence values at Hwy 550 Bridge (mg/L)
Q_e = design capacity of WWTP (million gallons per day)
Q_a = critical 4Q3 low-flow of stream (million gallons per day)

The equation is based on a simple steady-state mass balance model. The target threshold value and ambient upstream concentrations used to calculate the annual effluent limitation are 0.09 and 0.025 mg/L, respectively for TP and 0.48 and 0.33 mg/L, respectively for TN. The data that were used to calculate the ambient upstream concentration (C_a) are found in Table 5.5. The results of this mixing calculation for the Rio Puerco are presented in Table 5.7.

Table 5.7 Effluent concentrations and WLAs to meet WQS in the Rio Puerco

Parameter	Q_a (MGD)	Q_e (MGD)	C_s (mg/L)	C_a (mg/L)	C_e (mg/L)	WLA (lbs/day)
Total Phosphorus	0.624	0.144	0.09	0.025	0.372	0.447
Total Nitrogen	0.624	0.144	0.48	0.33	1.13	1.36

NOTES: Q_a = critical 4Q3 low-flow of stream (MGD)
Q_e = design capacity of Cuba WWTP (MGD)
C_s = target concentration (mg/L)
C_a = average concentration of non-exceedence values at Hwy 550 Bridge (mg/L)
C_e = allowable WWTP effluent concentration (mg/L)
WLA = Waste Load Allocation (lbs/day) = C_e x Q_e x 8.34

Current loading from the WWTP was estimated from seven grab samples collected by SWQB staff during 2004. The TP and TN concentrations measured at the WWTP outfall pipe averaged 3.64 and 24.5 mg/L, respectively. Assuming that discharge was at current design capacity (0.144 MGD), the current phosphorus loading from the plant into the Rio Puerco is 4.37 lbs/day and the current nitrogen loading from the plant into the Rio Puerco is 29.4 lbs/day. The current phosphorus loading from the WWTP is approximately 9 times the level that it should be to maintain the chemical and biological integrity of the stream. Similarly, the nitrogen loading is approximately 22 times the appropriate level.

Implementation suggestions for the WLA are included in Section 8.1

5.4.2 Load Allocation

In order to calculate the LAs for phosphorus and nitrogen, the WLAs and MOSs were subtracted from the target capacity (TMDL) using the following equation:

$$WLA + LA + MOS = TMDL \qquad \textbf{(Eq.2)}$$

The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors in flow calculations. Results using an explicit MOS of 15% (see Section 5.7 for details) are presented in Table 5.8.

Table 5.8. Calculation of Annual TMDL for TP and TN

Assessment Unit	Parameter	WLA (lbs/day)	LA (lbs/day)	MOS (15%) (lbs/day)	TMDL (lbs/day)
Rio Puerco (Arroyo Chijuilla to northern bnd of Cuba)	TP	0.447	0.043	0.087	0.577
	TN	1.357	1.256	0.461	3.074
Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir)	TP	0	0.029	0.005	0.034
	TN	0	0.205	0.036	0.241
Bluewater Creek (Bluewater Reservoir to headwaters)	TP	0	0.0008	0.0002	0.001
	TN	0	0.013	0.002	0.015
Rio Moquino (Laguna Pueblo to Seboyetita Creek)	TP	0	0.0034	0.0006	0.004
	TN	0	0.044	0.008	0.052

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated target load allocation (Table 5.4) and the measured load (Table 5.6), and are shown in Table 5.9.

Table 5.9. Calculation of Load Reduction for TP and TN

Assessment Unit	Parameter	Target Load[(a)] (lbs/day)	Measured Load (lbs/day)	Load Reduction (lbs/day)	Percent Reduction [(b)]
Rio Puerco (Arroyo Chijuilla to northern bnd of Cuba)	TP	0.490	4.855	4.365	90%
	TN	2.613	19.63	17.02	87%
Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir)	TP	0.029	< Target Load	0	0%
	TN	0.205	0.375	0.170	45%
Bluewater Creek (Bluewater Reservoir to headwaters)	TP	0.0008	0.002	0.0012	60%
	TN	0.013	0.022	0.009	41%
Rio Moquino (Laguna Pueblo to Seboyetita Creek)	TP	0.0034	< Target Load	0	0%
	TN	0.044	0.074	0.030	41%

Note: The MOS is not included in the load reduction calculations because it is a set aside value which accounts for any uncertainty or variability in TMDL calculations and therefore should not be subtracted from the measured load.
(a) Target Load = TMDL - MOS
(b) Percent reduction is the percent the existing measured load must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

5.5 Identification and Description of Pollutant Sources

Probable sources of impairment for TP that could contribute to these assessment units are listed in Table 5.10. Probable sources of impairment for TN are listed in Table 5.11.

Table 5.10 Pollutant Source Summary for Total Phosphorus

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Rio Puerco (Arroyo Chijuilla to northern bnd of Cuba)	Point: NM0024848	4.37[a]	60% Municipal Point Source Discharge
	Nonpoint:	2.94[b]	40% Channelization; Drought-related Impacts; Highway/Road/Bridge Runoff (non-construction related); Loss of Riparian Habitat; Natural Sources; Rangeland Grazing; Streambank Modifications/destabilization; Wildlife other than Waterfowl
Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir)	Point:	0	0%
	Nonpoint:	0.029	100% Loss of Riparian Habitat; Rangeland Grazing; Streambank Modifications/destabilization
Bluewater Creek (Bluewater Reservoir to headwaters)	Point:	0	0%
	Nonpoint:	0.002	100% Forest Roads (Road Construction and Use); Loss of Riparian Habitat; Rangeland Grazing; Silviculture Harvesting; Streambank Modifications/destabilization
Rio Moquino (Laguna Pueblo to Seboyetita Creek)	Point:	0	0%
	Nonpoint:	0.0034	100% Loss of Riparian Habitat; Rangeland Grazing; Surface Mining

Notes:

[a] The magnitude for point sources was calculated by multiplying the average TP concentration from the WWTP outfall pipe (3.64 mg/L) by the WWTP design capacity (0.144 MGD) and the 8.34 conversion factor to get a result in lbs/day.

[b] The magnitude for nonpoint sources was calculated by multiplying the geometric mean of TP exceedences above the WWTP (0.565 mg/L) by the 4Q3 low-flow (0.624 MGD) and the 8.34 conversion factor to get a result in lbs/day.

* From the 2006-2008 Integrated CWA §303(d)/§305(b) List. This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed or quantified at this time.

Table 5.11 Pollutant Source Summary for Total Nitrogen

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Rio Puerco (Arroyo Chijuilla to northern bnd of Cuba)	Point: NM0024848	29.4[a]	74% Municipal Point Source Discharge
	Nonpoint:	10.4[b]	26% Channelization; Drought-related Impacts; Highway/Road/Bridge Runoff (non-construction related); Loss of Riparian Habitat; Natural Sources; Rangeland Grazing; Streambank Modifications/destabilization; Wildlife other than Waterfowl
Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir)	Point:	0	0%
	Nonpoint:	0.375	100% Loss of Riparian Habitat; Rangeland Grazing; Streambank Modifications/destabilization
Bluewater Creek (Bluewater Reservoir to headwaters)	Point:	0	0%
	Nonpoint:	0.022	100% Forest Roads (Road Construction and Use); Loss of Riparian Habitat; Rangeland Grazing; Silviculture Harvesting; Streambank Modifications/destabilization
Rio Moquino (Laguna Pueblo to Seboyetita Creek)	Point:	0	0%
	Nonpoint:	0.074	100% Loss of Riparian Habitat; Rangeland Grazing; Surface Mining

Notes:

[a] The magnitude for point sources was calculated by multiplying the average TN concentration from the WWTP outfall pipe (24.5 mg/L) by the WWTP design capacity (0.144 MGD) and the 8.34 conversion factor to get a result in lbs/day.

[b] The magnitude for nonpoint sources was calculated by multiplying the geometric mean of TN exceedences above the WWTP (1.996 mg/L) by the 4Q3 low-flow (0.624 MGD) and the 8.34 conversion factor to get a result in lbs/day.

* From the 2006-2008 Integrated CWA §303(d)/§305(b) List. This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed or quantified at this time.

5.6 Linkage Between Water Quality and Pollutant Sources

The source assessment phase of TMDL development identifies sources of nutrients that may contribute to both elevated nutrient concentrations and the stimulation of algal growth in a waterbody. Where data gaps exist or the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

Phosphorus and nitrogen generally drive the productivity of algae and macrophytes in aquatic ecosystems, therefore they are regarded as the primary limiting nutrients in freshwaters. The main reservoirs of natural phosphorus are rocks and natural phosphate deposits. Weathering, leaching, and erosion are all processes that breakdown rock and mineral deposits allowing phosphorus to be transported to aquatic systems via water or wind. The breakdown of mineral

phosphorus produces inorganic phosphate ions ($H_2PO_4^-$, HPO_4^{2-}, and PO_4^{3-}) that can be absorbed by plants from soil or water (USEPA 1999). Phosphorus primarily moves through the food web as organic phosphorus (after it has been incorporated into plant or algal tissue) where it may be released as phosphate in urine or other waste by heterotrophic consumers and reabsorbed by plants or algae to start another cycle (Nebel and Wright 2000).

The largest reservoir of nitrogen is the atmosphere. About 80 percent of the atmosphere by volume consists of nitrogen gas (N_2). Although nitrogen is plentiful in the environment, it is not readily available for biological uptake. Nitrogen gas must be converted to other forms, such as ammonia (NH_3 and NH_4^+), nitrate (NO_3^-), or nitrite (NO_2^-) before plants and animals can use it. Conversion of gaseous nitrogen into usable mineral forms occurs through three biologically mediated processes of the nitrogen cycle: nitrogen fixation, nitrification, and ammonification (USEPA 1999). Mineral forms of nitrogen can be taken up by plants and algae and incorporated into plant or algal tissue. Nitrogen follows the same pattern of food web incorporation as phosphorus and is released in waste primarily as ammonium compounds. The ammonium compounds are usually converted to nitrates by nitrifying bacteria, making it available again for uptake, starting the cycle anew (Nebel and Wright 2000).

Rain, overland runoff, groundwater, drainage networks, and industrial and residential waste effluents transport nutrients to receiving waterbodies. Once nutrients have been transported into a waterbody they can be taken up by algae, macrophytes, and microorganisms either in the water column or in the benthos; they can sorb to organic or inorganic particles in the water column and/or sediment; they can accumulate or be recycled in the sediment; or they can be transformed and released as a gas from the waterbody (Figure 5.1).

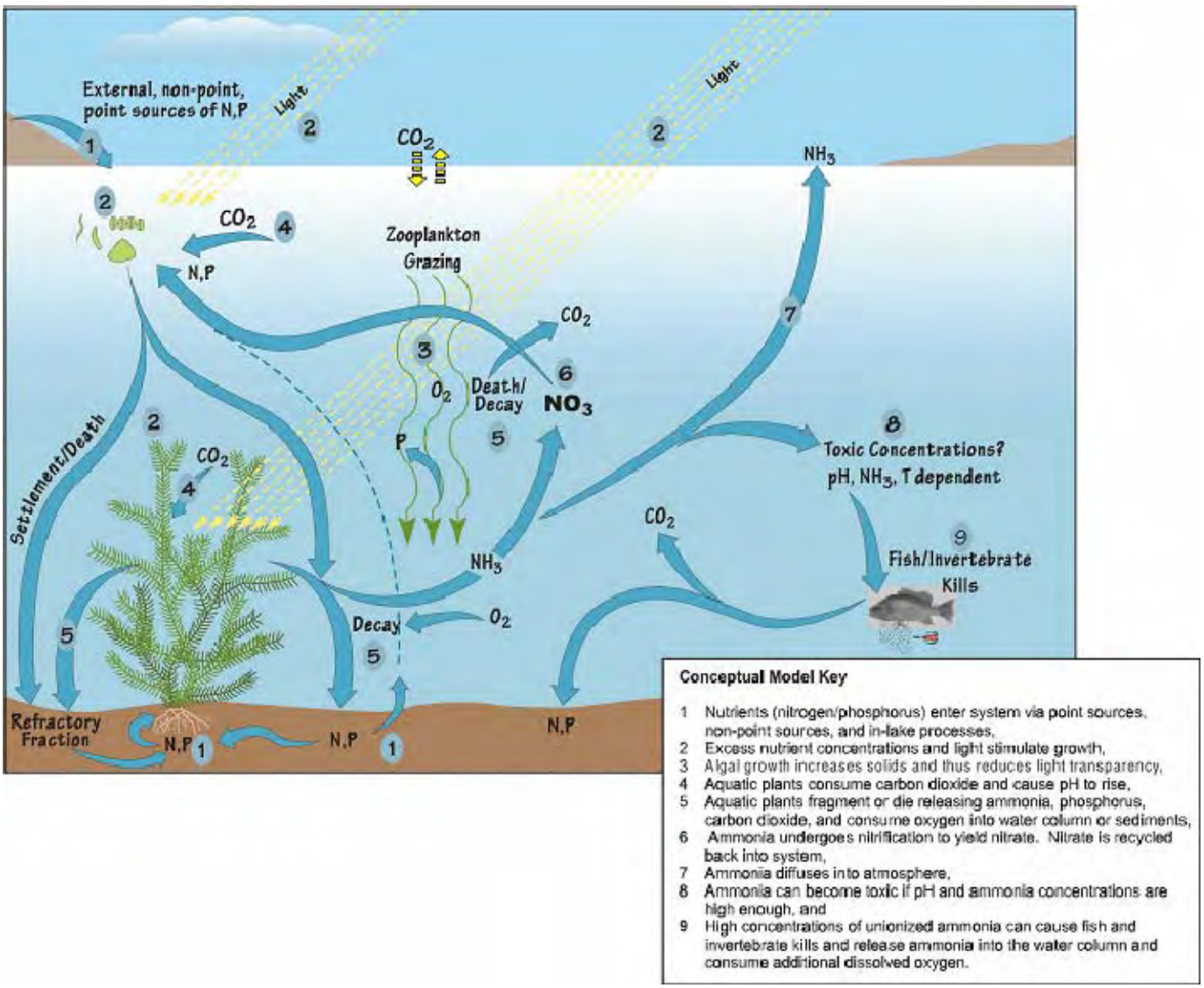

Figure 5.1. Nutrient Conceptual Model (USEPA 1999)

As noted above, phosphorus and nitrogen are essential for proper functioning of ecosystems. However, excess nutrients cause conditions unfavorable for the proper functioning of aquatic ecosystems. Nuisance levels of algae and other aquatic vegetation (macrophytes) can develop rapidly in response to nutrient enrichment when other factors (e.g., light, temperature, substrate, etc.) are not limiting (Figure 5.1). The relationship between nuisance algal growth and nutrient enrichment in stream systems has been well documented in the literature (Welch 1992; Van Nieuwenhuyse and Jones 1996; Dodds et al. 1997; Chetelat et al. 1999). Unfortunately, the magnitude of nutrient concentration that constitutes an "excess" is difficult to determine and varies by ecoregion.

As described in Section 5.2, the presence of plant nutrients in a stream can vary as a function of flow. As flow decreases through water diversions and/or drought-related stressors, the stream cannot effectively dilute its constituents, which causes the concentration of plant nutrients to

increase. Nutrients generally reach the a waterbody from land uses that are in close proximity to the stream because the hydrological pathways are shorter and have fewer obstacles than land uses located away from the riparian corridor. However, during the growing season (i.e. in agricultural return flow) and in storm water runoff, distant land uses can become hydrologically connected to the stream, thus transporting nutrients from the hillslopes to the stream during these time periods.

In addition to agriculture, there are several other human-related activities that influence nutrient concentrations in rivers and streams. Residential areas contribute nutrients from septic tank disposal systems, landscape maintenance, as well as backyard livestock (e.g. cattle, horses) and pet wastes. Urban development contributes nutrients by disturbing the land and consequently increasing soil erosion, by increasing the impervious area within the watershed, and by directly applying nutrients to the landscape. Recreational activities such as hiking and biking can also contribute nutrients to the stream by reducing plant cover and increasing soil erosion (e.g. trail network, streambank destabilization), direct application of human waste, campfires and/or wildfires, and dumping trash near the riparian corridor.

Undeveloped, or natural, landscapes also can deliver nutrients to a waterbody through decaying plant material, soil erosion, air deposition, and wild animal waste. Another geographically occurring nutrient source is atmospheric deposition, which adds nutrients directly to the waterbody through dryfall and rainfall. Atmospheric phosphorus and nitrogen can be found in both organic and inorganic particles, such as pollen and dust. The contributions from these natural sources are generally considered to represent background levels.

Water pollution caused by on-site septic systems is a widespread problem in New Mexico (McQuillan 2004). Septic system effluents have contaminated more water supply wells, and more acre-feet of ground water, than all other sources in the state combined. Groundwater contaminated by septic system effluent can discharge into streams gaining from groundwater inflow. Nutrients such as phosphorous and nitrogen released into gaining streams from aquifers contaminated by septic systems can contribute to eutrophic conditions.

SWQB fieldwork includes an assessment of the probable sources of impairment (NMED/SWQB 1999). The completed Pollutant Source(s) Documentation Protocol forms in Appendix A provide documentation of a visual analysis of probable sources along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in this watershed. Data collected during the 2004 survey showed exceedences both above and below the wastewater treatment plant indicating the nutrient problem in the Rio Puerco is attributable to both point and nonpoint sources.

It is important to consider not only the land directly adjacent to the stream, which is predominantly privately held, but also to consider upland and upstream areas in a more holistic watershed approach to implementing TMDLs. These nutrient TMDLs were calculated using the best available methods that were known at the time of calculation and may be revised in the future.

5.7 Margin of Safety (MOS)

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. The MOS can be expressed either implicitly or explicitly. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

For these nutrient TMDLs, the margin of safety was developed using a combination of conservative assumptions and explicit recognition of potential errors. Therefore, this margin of safety is the sum of the following two elements:

- *Conservative Assumptions*

  Treating phosphorus and nitrogen as conservative pollutants, that is a pollutant that does not readily degrade in the environment, was used as a conservative assumption in developing these loading limits.

  Using the 4Q3 critical low flow to calculate the allowable load.

  Using the treatment plant design capacity for calculating the point source loading when, under most conditions, the treatment plant is not operating at full capacity.

- *Explicit recognition of potential errors*

  A level of uncertainty exists in sampling nonpoint sources of pollution. Accordingly, a conservative MOS decreases the TMDL by **10 percent**.

  Flow estimates were based on the estimation of the 4Q3 for gaged and ungaged streams and compared to actual flows and cross-sectional information taken in the field. Techniques used for measuring flow in water have a ±5 percent precision. Accordingly, a conservative MOS decreases the TMDL by **5 percent**.

5.8 Consideration of Seasonal Variability

Section 303(d)(1) of the CWA requires TMDLs to be "established at a level necessary to implement the applicable WQS with seasonal variation." Data used in the calculation of these TMDLs were collected during spring, summer, and fall in order to ensure coverage of any potential seasonal variation in the system. Exceedences were observed from March through November, during all seasons, which captured flow alterations related to snowmelt, agricultural diversions, and summer monsoonal rains. Data that exceeded the target concentration for TP and TN were used in the calculation of the measured loads (Table 5.6) and can be found in Table 5.5.

The critical condition used for calculating the TMDL was low-flow. Calculations made at the critical low-flow (4Q3), in addition to using other conservative assumptions as described in the previous section on MOS, should be protective of the water quality standards designed to preserve aquatic life in the stream. It was assumed that if critical conditions were met during this time, coverage of any potential seasonal variation would also be met.

5.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2030. Growth estimates for Cibola and Sandoval Counties project a 16% and 77% growth rate, respectively, through 2030. Since future projections indicate that nonpoint sources of nutrients will more than likely increase as the region continues to grow and develop, it is imperative that BMPs continue to be utilized and improved upon in this watershed while continuing to improve road conditions and grazing allotments and adhering to SWPPP requirements related to construction and industrial activities covered under the general permit.