4.0 SPECIFIC CONDUCTANCE

During the 2000 SWQB intensive water quality survey, exceedences of the NM water quality criteria for SC were documented in the following assessment units (20.6.4.123 NMAC):

- Rio Grande del Rancho (Rio Pueblo de Taos to Highway 518)
- Rio Fernando de Taos (Rio Pueblo de Taos to headwaters)

According to the NM WQS (20.6.4.123 NMAC), the standard for SC reads:

> *In any single sample: conductivity shall not exceed 400 µmhos (500 µmhos for the Rio Fernando de Taos). . .*

The following subsections present the SC TMDLs for these two assessment units.

4.1 Target Loading Capacity

Target values for these SC TMDLs will be determined based on 1) the presence of numeric 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, target values for SC are based on the reduction in total dissolved solids (TDS) necessary to achieve numeric SC criteria. This TMDL is also consistent with New Mexico's antidegradation policy.

The NM Water Quality Control Commission (WQCC) has adopted a numeric water quality criterion for SC to protect the designated use of High Quality Coldwater Fishery (HQCWF). The water quality criterion has been set at a level to protect coldwater aquatic life. The HQCWF use designation requires that a stream have water quality, streambed characteristics, and other attributes of habitat sufficient to protect and maintain a HQCWF. The primary standard leading to an assessment of use impairment is the numeric criteria for SC of 400 µmhos (500 µmhos for the Rio Fernando de Taos).

4.2 Flow

SC in a stream can vary as a function of flow. As flow decreases, the concentration of total dissolved solids (TDS) can increase, thereby increasing the SC. Similarly, as flows decline, temperatures have a tendency to increase, thus affecting SC values. These TMDLs are calculated for each reach at a specific flow.

The flow values used to calculate the TMDL for SC on these assessment units were obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the annual lowest 4 consecutive day period discharge that will not fall below that discharge at least every 3 years (Waltemeyer 2002). Low flow was chosen as the critical flow because the exceedances of the SC standard occurred from May to October 2000.

The 4Q3 for Rio Grande del Rancho (Rio Pueblo de Taos to Highway 518) is based on USGS gage data. USGS gage at Rio Grande del Rancho near Talpa, NM (08275500) was used to estimate the 4Q3. The 4Q3 was estimated using a log Pearson Type III distribution through "*Input and Output for Watershed Data Management*" (IOWDM) software, Version 4.1 (USGS 2002a) and "*Surface-Water Statistics*" (SWSTAT) software, Version 4.1 (USGS 2002b). The 4Q3 is as follows:

- Rio Grande del Rancho (Rio Pueblo de Taos to Highway 518): 4Q3 = 3.051 cfs

The 4Q3 value for Rio Grande del Rancho was converted from cfs to units of million gallons per day (MGD) as follows:

$$3.051\,\frac{ft^3}{\sec} \times 1{,}728\,\frac{in^3}{ft^3} \times 0.004329\,\frac{gal}{in^3} \times 86{,}400\,\frac{\sec}{day} \times 10^{-6} = 1.97\,MGD$$

It is often necessary to calculate a critical flow for a portion of a watershed where there is no active flow gage as in Rio Fernando de Taos. 4Q3 derivations for ungaged streams 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):

$$4Q3 \quad = \quad 1.2856 \times 10^{-4}\ DA^{0.42}\ P_w^{\ 3.16} \qquad \text{(Eq. 1)}$$

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):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35} \qquad \text{(Eq. 2)}$$

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 Rio Fernando de Taos was estimated using

the regression equation for mountainous regions (above 7,500 feet in elevation) because the mean elevation for the assessment unit is 7,640 feet in elevation (based on measurements from three stations).

Equation 2 above was used to estimate the 4Q3. Based on an average basin winter mean precipitation of 9.3 inches, drainage area of 67.914 mi^2, and slope of 0.268, the 4Q3 is:

$$4Q3 \quad = \quad 7.3287 \times 10^{-5} \times 67.914^{0.42} \times 9.3^{3.58} \times 0.268^{1.35} = 0.214\,cfs$$

The 4Q3 value for Rio Fernando de Taos was converted from cfs to units of MGD as follows:

$$0.214\,\frac{ft^3}{\sec} \times 1{,}728\,\frac{in^3}{ft^3} \times 0.004329\,\frac{gal}{in^3} \times 86{,}400\,\frac{\sec}{day} \times 10^{-6} = 0.0425\,MGD$$

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality should be a goal to be attained. Meeting the calculated TMDL may be a difficult objective.

4.3 Calculations

SC (SC) may be used to estimate the total ion concentration of a surface water sample, and is often used as an alternative measure of dissolved solids. In order to calculate a load in pounds per day (lb/day), TDS is used as a surrogate for SC. The TDS to SC ratio ranges from 0.5 to 0.9 milligrams per liter (mg/L)/microhos per centimeter (µmhos/cm) (American Public Health Association [APHA] 1998). Specific correlation should be derived by site, if TDS values are available.

TDS values were obtained for these assessment units during the 2000 SWQB/NMED sampling season. These values as well as the SC values are located on Table 4.6 at the end of this section. The TDS to SC ratio values were calculated, and averaged, resulting in TDS:SC ratios of

- Rio Grande del Rancho (Rio Pueblo de Taos to Highway 518): TDS:SC = 0.69
- Rio Fernando de Taos (Rio Pueblo de Taos to headwaters): TDS:SC = 0.74

State WQS to protect the designated HQCWF use states that SC shall not exceed 400µmhos/cm (500 µmhos for the Rio Fernando de Taos). Using the above mentioned reference ratios to estimate the TDS required to achieve State WQS,

$$\text{TDS (mg/L)} \cong \text{SC (µmhos/cm)} \times \text{(ratio)} \qquad \text{(Eq. 3)}$$

The SC to achieve state standards is 400 µmhos/cm (500 µmhos for the Rio Fernando de Taos). Using **Equation 3**, the TDS concentration required to achieve State standards is:

- Rio Grande del Rancho (Rio Pueblo de Taos to Highway 518):

$$400\ \mu\text{mhos/cm} \times (0.67) \cong 268\ \text{mg/L of TDS}$$

- Rio Fernando de Taos (Rio Pueblo de Taos to headwaters):

$$500\ \mu\text{mhos/cm} \times (0.74) \cong 370\ \text{mg/L of TDS}$$

For the purpose of TMDL development, these TDS criteria were used. The TMDLs were developed based on simple dilution calculations using 4Q3 flow and the TDS criteria above (from **Equation 3**). The TMDL calculation includes WLAs, LAs, and a MOS.

Target loads for TDS are calculated based on the 4Q3 flow, the current WQS, and a conversion factor of 8.34, that is used to convert mg/L units to lb/day (see **Appendix A** for conversion factor derivation).

Critical Flow (MGD) x Standard (mg/L) x 8.34 = Target Loading Capacity (Eq. 4)

The target loads (TMDLs) predicted to attain standards were calculated using **Equation 4** and are shown in Table 4.1.

Table 4.1 Calculation of Target Loads

Location	**Flow[(a)] (MGD)**	**Standard[(b)] TDS (mg/L)**	**Conversion Factor[(c)]**	**Target Load Capacity (lb/day)**
Rio Grande del Rancho	1.97	268	8.34	4,403
Rio Fernando de Taos	0.0425	370	8.34	131

Notes:
[(a)] Flow is the 4Q3 value calculated on the previous pages converted from cfs to million gallons per day.
[(b)] TDS is used as a surrogate measure for SC in order to calculate a load in lb/day.
[(c)] Conversion factor used to convert mg/L to lb/day (See **Appendix A**).
MGD = Million gallons per day
mg/L = Milligrams per liter
lb/day = Pounds per day

Background loads were not possible to calculate in this watershed. A reference reach, having similar stream channel morphology and flow, was not found. It is assumed that all or a portion of the LA is made up of natural background loads. In future water quality surveys, finding a suitable reference reach will be a priority.

The measured loads were also calculated using **Equation 4**. In order to achieve comparability between the target and measured loads, the flow rate used was the same for both calculations. The same conversion factor of 8.34 was used. Results are presented in Table 4.2.

Table 4.2 Calculation of Measured Loads

Location	Flow[(a)] (MGD)	Field TDS (mg/L) [(b)]	Conversion Factor[(c)]	Measured Load (lb/day)
Rio Grande del Rancho	1.97	428	8.34	7,032
Rio Fernando de Taos	0.0425	493	8.34	175

Notes:
[(a)] Flow is the 4Q3 value calculated on the previous pages converted from cfs to million gallons per day.
[(b)] The field measurement is the arithmetic mean of the SC exceedances, converted to TDS (see Table 4.6).
[(c)] Conversion factor used to convert mg/L to lb/day (See **Appendix A**).
MGD = Million gallons per day
mg/L = Milligrams per liter
lb/day = Pounds per day

4.4 Waste Load Allocations and Load Allocations

4.4.1 Waste Load Allocation

There are no individually permitted point source facilities or MS4 storm water permits in these assessment units. TDS 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 best management practices 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 pre-construction 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.

Individual waste load allocations for the General Permits were not possible to calculate at this time in this watershed using available tools. Loads that are in compliance with the General Permits from facilities covered are therefore currently calculated as part of the watershed load allocation.

4.4.2 Load Allocation

In order to calculate the LA, the WLA and MOS were subtracted from the target capacity (TMDL), as shown below in **Equation 5**.

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 5)}$$

Results using a MOS of 15% (as explained in Section 4.7), are presented in Table 4.3.

Table 4.3 Calculation of TMDL for TDS (SC Surrogate)

Location	WLA (lb/day)	LA (lb/day)	MOS (15%) (lb/day)	TMDL (Target Load Capacity) (lb/day)
Rio Grande del Rancho	0	3,743	660	4,403
Rio Fernando de Taos	0	111	20	131

Notes:
WLA = Waste load allocation
LA = Load allocation
MOS = Margin of safety
TMDL = Total maximum daily load
lb/day = Pounds per day

The load reduction that would be necessary to meet the target load was calculated to be the difference between the LA (Table 4.3) and the measured load (Table 4.2), and is shown in Table 4.4.

Table 4.4 Calculation of Load Reduction for TDS (SC Surrogate)

Location	LA (lb/day)	Measured Load (lb/day)	Load Reduction (lb/day)
Rio Grande del Rancho	3,743	7,032	3,289
Rio Fernando de Taos	111	175	64

Notes:
lb/day = Pounds per day

4.5 Identification and Description of Pollutant Source(s)

Pollutant sources that could contribute to these waterbodies are listed in Table 4.5.

Table 4.5 Pollutant Source Summary

Pollutant	Magnitude[(a)] (lb/day)	Location	Potential Sources (% from each)
Point Source			
None	0	---	0
Nonpoint Source			
TDS	4,403	Rio Grande del Rancho	100% Unknown and Natural
TDS	131	Rio Fernando de Taos	100% Unknown and Natural

Notes:
TDS = Total dissolved solids
lb/day = Pounds per day
[(a)] WLA + LA + MOS = TMDL

4.6 Link Between Water Quality and Pollutant Sources

Where available data are incomplete or where the level of uncertainty in the characterization of sources is large, the recommended approach to TMDLs requires the development of allocations based on estimates utilizing the best available information.

SWQB fieldwork includes an assessment of the potential sources of impairment (SWQB/NMED 1999b). The Pollutant Source(s) Documentation Protocol, shown as **Appendix B**, provides an approach for a visual analysis of a pollutant source along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of potential sources of impairment in this watershed. Table 4.5 identifies and quantifies potential sources of nonpoint source impairments along each reach as determined by field reconnaissance and assessment. The sources of impairment to these waterbodies are considered to be natural.

4.7 Margin of Safety

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. For this TMDL, there is no MOS for point sources, since there are none. However, for the nonpoint sources the MOS for SC is estimated to be an addition of 15 percent of the TMDL. This MOS incorporates several factors:

- Errors in calculating nonpoint source loads

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

- Errors in calculating flow

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 increases the TMDL by 5 percent.

4.8 Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during high and low flow seasons in order to ensure coverage of any potential seasonal variation in the system. As shown in Table 4.6, exceedences were observed from May through October, which are months that capture the spring runoff and summer monsoonal rains. The critical condition used for calculating the TMDL was low flow. Data that exceeded the standard for SC were used in the calculation of the measured loads and can be found in Table 4.6 at the end of this section.

4.9 Future Growth

Estimates of future growth are not anticipated to lead to a significant increase in SC that cannot be controlled with BMP implementation in this watershed.

Table 4.6 Specific Conductance Results from 2000 Sampling Effort

Location	Activity Start Date	SC (µmhos/cm)	TDS (mg/L)	Site-Specific TDS to SC Ratio
Rio Fernando de Taos at Hwy 64 bridge	05-16-2000	206	154	0.75
	05-17-2000	212	208	0.98
	07-31-2000	***558****	282	0.51
	08-01-2000	373	312	0.84
	08-02-2000	***532****	348	0.65
	10-17-2000	430	286	0.66
	10-18-2000	426	274	0.64
	10-19-2000	429	270	0.63
Rio Fernando de Taos at USGS gage	05-16-2000	409	276	0.67
	05-17-2000	415	286	0.69
	07-31-2000	***707****	344	0.49
	08-01-2000	466	388	0.83
	08-02-2000	***548****	400	0.73
	10-17-2000	***605****	420	0.69
	10-18-2000	***592****	398	0.67
	10-19-2000	***584****	416	0.71
Rio Fernando de Taos near Lower Ranchito	05-16-2000	***721****	476	0.66
	05-17-2000	***703****	484	0.69
	07-31-2000	***605****	414	0.68
	08-01-2000	218	420	1.93
	08-02-2000	***695****	454	0.65
	10-17-2000	***786****	504	0.64
	10-18-2000	***842****	580	0.69
	10-19-2000	***856****	566	0.66
			Average	**0.74**
Arithmetic Mean of Exceedances Converted to TDS = 667 x 0.74 = 493 mg/L				
Rio Grande del Rancho at USGS gage	05-16-2000	248	166	0.67
	07-31-2000	344	216	0.63
	10-17-2000	377	268	0.71
Rio Grande del Rancho below Rio Chiquito	05-16-2000	***577 ****	392	0.68
	07-31-2000	***644 ****	400	0.62
	10-17-2000	***700 ****	488	0.70
			Average	**0.67**
Arithmetic Mean of Exceedances Converted to TDS = 640 x 0.67 = 428 mg/L				

Notes:
* = Exceeds water quality criterion for SC.
µmhos/cm = microhos per centimeter
mg/L = Milligrams per liter
TDS = Total dissolved solids
SC = Specific conductance