4.0 ALUMINUM

During the 2001 SWQB intensive water quality survey in the Upper Rio Grande (Part 2) Watershed, exceedences of the New Mexico water quality standard for chronic aluminum were documented at two sampling stations on Little Tesuque Creek (SWQB Stations 10 and 11). Consequently, the Little Tesuque Creek from Rio Tesuque to headwaters was listed on the 2004-2006 Clean Water Act Integrated §303(d)/§305(b) list for aluminum.

4.1 Target Loading Capacity

Target values for this aluminum TMDL 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 dissolved aluminum are based on numeric criteria. This TMDL is also consistent with New Mexico's antidegradation policy.

According to the New Mexico water quality standards (20.6.4.900.M NMAC), the dissolved aluminum chronic criterion is 87 µg/L and the dissolved aluminum acute criterion is 750 µg/L for aquatic life uses.

High chronic levels of dissolved aluminum can be toxic to fish, benthic invertebrates, and some single-celled plants. Aluminum concentrations from 100 to 300 µg/L increase mortality, retard growth, gonadal development and egg production of fish (http://h2osparc.wq.ncsu.edu). To be conservative, these TMDLs were drafted for chronic aluminum and, therefore, should also protect against any acute exceedences.

Data was collected from the Little Tesuque Creek at the first crossing of Hyde Park Road (Hwy 475) (SWQB station 10) and at Hyde Park Road above Hyde Park (SWQB station 11) eight times between May 22 and October 4, 2001 (Table 4.1). Dissolved aluminum concentrations exceeded the chronic criterion for aluminum at both stations during spring sampling. The calculated dissolved aluminum 4-day average during the spring sampling run was 500 µg/L at station 10 and 143 µg/L at station 11. Aluminum was also detected during the summer sampling at both stations, but at concentrations below the chronic aluminum criterion. Aluminum was not detected at these two stations during the fall season in 2001. Concurrently collected total suspended solids (TSS) data reported in Table 4.1 will be discussed in the Linkage(s) section below.

Table 4.1 Dissolved aluminum (Al) and TSS concentrations in the Little Tesuque Creek

Sample Date	SWQB Station 10[(a)]		SWQB Station 11[(b)]	
	Dissolved Al (µg /L)	TSS (mg/L)	Dissolved Al (µg /L)	TSS (mg/L)
5/22/2001	400*	3	110*	7
5/23/2001	500*	6	130*	7
5/24/2001	600*	7	190*	9
8/21/2001	20	4	70	3K
8/22/2001	20	3K	60	3K
10/2/2001	10K	3K	10K	3K
10/3/2001	10K	3K	10K	9
10/4/2001	10K	3K	10K	3K

(a) Little Tesuque Creek at the first crossing of Hyde Park Road (Hwy 475)
(b) Little Tesuque Creek at Hyde Park Road above Hyde Park
K = reported as "below detection limit"
* Exceedence of 87 µg /L dissolved aluminum chronic water quality criterion.

4.2 Flow

TMDLs are calculated for the Little Tesuque Creek at a specific flow. Metal concentrations in a stream vary as a function of flow. As flow increases the concentration of metals can increase. When available, USGS gages are used to estimate flow. Where gages are absent, geomorphologic cross section field data are collected at each site and flows are modeled or actual flow measurements are taken. In this case, flow was measured on the Little Tesuque Creek at SWQB station 10 during the spring sampling run using standard USGS procedures (NMED/SWQB 2001a). The measured flow value was 1.36 cubic feet per second (cfs). Therefore,

Little Tesuque Creek critical flow = 1.36 cfs

The flow value for Little Tesuque Creek was converted from cfs to units of million gallons per day (mgd) as follows:

$$1.36\,\frac{ft^3}{\sec} \times 1{,}728\,\frac{in^3}{ft^3} \times 0.004329\,\frac{gal}{in^3} \times 86{,}400\,\frac{\sec}{day} \times 10^{-6} = 0.88\,mgd$$

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 should be a goal to be attained. Meeting the calculated target load may be a difficult objective.

4.3 Calculations

A target load for aluminum is calculated based on a flow, the current water quality criterion, and a conversion factor (8.34) that is a used to convert milligrams per liter (mg/L) units to pounds per day (lbs/day) (see Appendix A for Conversion Factor Derivation). The target loading capacity is calculated using **Equation 1**. The results are shown in Table 4.2.

Critical Flow (mgd) x Standard (mg/L) x 8.34 = Target Loading Capacity (Eq. 1)

Table 4.2 Calculation of target loads for dissolved aluminum

Location	**Flow+ (mgd)**	**Dissolved Al chronic criterion (mg/L)**	**Conversion Factor**	**Target Load Capacity (lbs/day)**
Little Tesuque Creek	0.88	0.087	8.34	0.64

+ Since USGS gages were unavailable, flow was measured during the 2001 spring sampling run (NMED/SWQB 2001a).

The measured loads for dissolved aluminum were similarly calculated. The arithmetic mean of the data from the downstream sampling site (station 10) collected during the spring run was substituted for the standard in **Equation 1**. The calculated dissolved aluminum 4-day average during the spring sampling run was 500 µg /L (0.50 mg/L) at station 10. The same conversion factor of 8.34 was used. Results are presented in Table 4.3.

Table 4.3 Calculation of measured loads for dissolved aluminum

Pollutant sources	**Flow (mgd)**	**Dissolved Al Arithmetic Mean* (mg/L)**	**Conversion Factor**	**Measured Load Capacity (lbs/day)**
Little Tesuque Creek	0.88	0.5	8.34	3.67

Notes: * Arithmetic mean of dissolved aluminum concentration at station 10 during the spring sampling run (see Table 4.1).

4.4 Waste Load Allocations and Load Allocations

4.4.1 Waste Load Allocation

There are no point source contributions associated with this TMDL. The WLA is zero.

4.4.2 Load Allocation

In order to calculate the LA, the WLA, and MOS were subtracted from the target capacity (TMDL) following **Equation 2**.

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

The MOS is estimated to be 25% of the target load calculated in Table 4.2. Results are presented in Table 4.4. Additional details on the MOS chosen are presented in Section 4.7 below.

Table 4.4 Calculation of TMDL for dissolved aluminum

Location	WLA (lbs/day)	LA (lbs/day)	MOS (25%) (lbs/day)	TMDL (lbs/day)
Little Tesuque Creek	0	0.48	0.16	0.64

The extensive data collection and analyses necessary to determine background dissolved aluminum loads for the Little Tesuque Creek watershed was beyond the resources available for this study. It is therefore assumed that a portion of the load allocation is made up of natural background loads.

The NPS and background load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated target load allocation (Tables 4.4) and the measured load (Table 4.3), and are shown in Table 4.5.

Table 4.5 Calculation of load reduction for dissolved aluminum

Location	LA (lbs/day)	Measured Load (lbs/day)	Load Reduction (lb/day)
Little Tesuque Creek	0.48	3.67	3.19

4.5 Identification and Description of Pollutant Source(s)

Nonpoint pollutant sources that could contribute to the observed load include loss of riparian habitat, natural causes (including geology). There are no point sources in this assessment unit.

4.6 Link Between Water Quality and Pollutant Sources

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.

SWQB fieldwork includes an assessment of the potential sources of impairment (NMED/SWQB 1999). The completed *Pollutant Source(s) Documentation Protocol* forms in **Appendix B** 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 potential sources of impairment in this watershed. Staff completing these forms identify and quantify potential sources of NPS impairments along each reach as determined by field reconnaissance and assessment. 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 this TMDL.

Aluminum is the most common metal in the Earth's crust and the third most common element. Aluminum comprises, on average, about eight percent of the Earth's crust. In general, increased metals in the water column can commonly be linked to sediment transport and accumulation, where the metals are a constituent part of the sediment. This does not appear to be the case in the Little Tesuque Creek as evidenced by the fact that there is not a relationship between dissolved aluminum and TSS concentrations at either Station 10 or 11 according to the 2001 sampling data (Table 4.1, Figure 4.1).

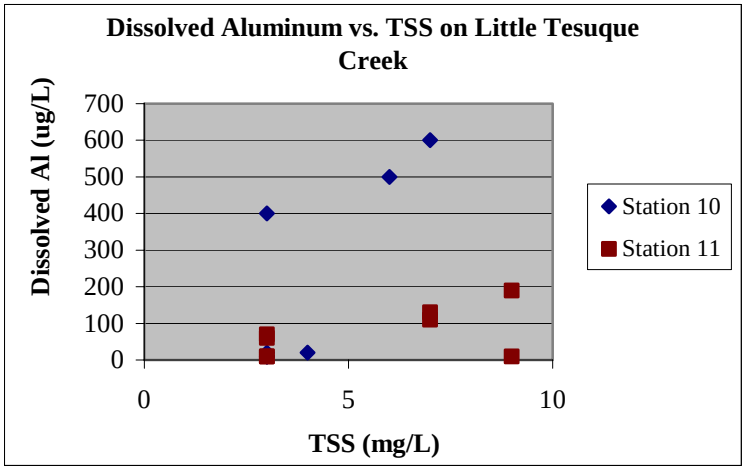

Figure 4.1 Relationship between Dissolved Aluminum and TSS in Little Tesuque Creek

High aluminum is characteristic of the spring snowmelt/runoff period and is not pronounced during baseflow conditions in the Little Tesuque Creek. Normal aqueous chemical processes, enhanced by the slight natural acidity of snow and rain, are capable of rendering some of this abundant, naturally-occurring aluminum available to the stream system. The fact that high

dissolved aluminum concentrations were measured during the spring sampling run as opposed to below detection limit concentrations during fall sampling runs are indicative of a landscape source. Acidic anions as well as carbonic acid carried in snow are released into the soil as the snow melts and bring aluminum species into solution. Thus, aluminum concentrations are often high during spring runoff in many areas in New Mexico despite the expected diluting effects of high flow.

There are no known existing or historic aluminum mines in the watershed. In the absence of identifiable degraded uplands, anthropogenic sources of aluminum, poor streambank condition, or land use impacts to explain high levels of sedimentation that may have led to high aluminum concentrations, the largest probable source for high aluminum concentrations measured during snowmelt runoff appears to be local watershed bedrock and natural surface geology processes.

4.7 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and NPS load estimates, and the modeling analysis. For this TMDL, there will be no MOS for point sources, since there are none. However, for NPSs the MOS is estimated to be an addition of **25%** for aluminum in this case, excluding background. This MOS incorporates several factors:

- Errors in calculating NPS loads

  A level of uncertainty exists in sampling NPSs of pollution. Techniques used for measuring metals concentrations in stream water can lead to inaccuracies in the data. Therefore, a conservative MOS for metals increases the TMDL by **15%.**

- Errors in calculating flow

  Flow estimates were based on one measurement during the spring sampling run. Instrument and operator error can lead to inaccuracy in flow measurements. Accordingly, a conservative MOS increases the TMDL by an additional **10%.**

4.8 Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during the spring, summer, and fall of 2001 in order to ensure coverage of any potential seasonal variation in the system. Critical condition is set to high flow for dissolved aluminum because data exceedences were observed during high spring flows. A flow measurement taken during the spring sampling run was used in the calculations.

4.9 Future Growth

Estimations of future growth are not anticipated to lead to a significant increase for dissolved aluminum that cannot be controlled with BMP implementation in this watershed. Therefore, a growth allocation was not included in the waste load allocation for this TMDL.