4.0 SEDIMENTATION/SILTATION (STREAM BOTTOM DEPOSITS)

Based on additional sampling performed in the Fall of 2001, impairment due to excessive Sedimentation/Siltation (previously listed as impairment due to Stream Bottom Deposits, [SBD]) was documented for Bitter Creek (Red River to the headwaters) (NMED/SWQB 2004c). Consequently, this assessment unit was listed on the 2004-2006 Integrated CWA §303(d)/§305(b) list for Sedimentation/Siltation (NMED/SWQB 2004a).

4.1 Target Loading Capacity

Target values for this Sedimentation/Siltation TMDL will be determined based on 1) the presence of numeric criteria or appropriate numeric translator to a narrative standard, 2) the degree of experience in applying the indicator, and 3) the ability to easily monitor and produce quantifiable and reproducible results. This TMDL is also consistent with New Mexico's antidegradation policy.

The state of New Mexico has developed and adopted a narrative "bottom deposit" standard. The current general narrative standard for the deposition of material on the bottom of a stream channel is specifically found in Section 20.6.4.12(A) of the State of New Mexico Standards for Interstate and Intrastate Surface Waters (NMAC 2002):

> ***Bottom Deposits**: Surface waters of the State shall be free of water contaminants from other than natural causes that will settle and damage or impair the normal growth, function, or reproduction of aquatic life or significantly alter the physical or chemical properties of the bottom.*

Clean stream bottom substrates are essential for optimum habitat for many fish and aquatic insect communities. The impact of fine sediment deposits is well documented in the literature. Impairment occurs when critical habitat components, such as spawning gravels and cobble surfaces, are physically covered by fines thereby decreasing intergravel oxygen and reducing or eliminating the quality and quantity of habitat for fish, macroinvertebrates, and algae (Chapman and McLeod 1987, Lisle 1989, Waters 1995). An increased sediment load is often the most important adverse effect of activities on streams, according to a monitoring guidelines report (USEPA 1991). This impact is largely a mechanical action that severely reduces the available habitat for macroinvertebrates and fish species that utilize the streambed in various life stages. Minshall (1984) cited the importance of substratum size to aquatic insects and found that substratum is a primary factor influencing the abundance and distribution of insects. Aquatic detritivores also can be affected when their food supply either is buried under sediments or diluted by increased inorganic sediment load and by increasing search time for food (Relyea et al. 2000). In addition, sediment loads that exceed a river's sediment transport capacity often trigger changes in stream morphology (Leopold and Wolman 1964). Streams that become overwhelmed with sediment often go through a period of accelerated channel widening and streambank erosion before returning to a stable form (Schumm 1977, Knighton 1984). These morphological changes tend to accelerate erosion, thereby reducing habitat diversity and placing additional stress on designated aquatic life uses.

The SWQB Sediment Workgroup evaluated a number of methods described in the literature that would provide information allowing a direct assessment of the impacts to the stream bottom substrate. In order to address the narrative criteria for bottom deposits, SWQB compiled techniques to measure the level of sedimentation of a stream bottom. These procedures are presented in Appendix D of the *State of New Mexico Procedures for Assessing Standards Attainment for the Integrated §303(d)/§305(b) Water Quality Monitoring and Assessment Report* (NMED/SWQB 2004c). The purpose of the protocol is to provide a reproducible quantification of the narrative criteria for bottom deposits in small wadeable streams. A final set of monitoring procedures was implemented at a wide variety of sites during the 2001 monitoring season. These procedures included conducting pebble counts (to determine percent fines), stream bottom cobble embeddedness, geomorphologic measurements, and the collection and enumeration of benthic macroinvertebrates.

The target levels involved the examination of developed relationships between percent fines and biological score as compared to a reference site. Using existing data from New Mexico, a relationship (r^2=0.75) was established between embeddedness and the biological scores using data collected in 1998 (NMED/SWQB 2004c). A correlation (r^2= 0.719) was also found when relating embeddedness to percent fines. Although these correlations were based on a limited data set, TMDL studies on other reaches, including those in the Cimarron Basin, the Jemez Basin, and the Rio Guadalupe, have shown this relationship to be consistent. These relationships show that at the desired biological score of at least 79, the target embeddedness for fully supporting a designated use would be 45% and the target percent fines would be 20% (NMED/SWQB 2004c). Since this relationship is based on New Mexico streams, 20% was utilized for the target value for percent fines in previous TMDLs for small wadeable streams in New Mexico.

The Columbine Creek at Columbine Camp Ground was chosen as the benthic macroinvertebrate reference station for Bitter Creek about 100 meters above Red River (SWQB Station 10). They are both in ecoregion 21 and have similar geomorphic characteristics. Benthic macroinvertebrate samples and pebble counts were collected at both stations (Barbour et al. 1999, Wohlman 1954).

Collection of benthic macroinvertebrates involved the compositing of three individual kick net samples taken from a riffle at each sampling location. Each kick involved the disturbance of approximately one-third of a square meter of substrate for one minute into a 500-micron mesh net. The rapid bioassessment protocol (RBP) metrics were applied to a 300-organism subsample of the composite sample at each site (Barbour et al. 1999). Selection of those metrics that are particularly suited to the delineation of sediment impacts highlights the degree of impairment. Ephemeroptera/Plecoptera/Tricoptera (EPT) taxa, the number of sediment adapted organisms, taxa richness, and Hilsenhoff's Biotic Index (HBI) all indicate some degree of impairment attributable to sedimentation (Table 4.1). Select results of the pebble count and benthic macroinvertebrate surveys are shown in Table 4.1.

Table 4.1 Pebble Count and Benthic Macroinvertebrate Results

Results	Reference Site[a]	Study Site[b]	Percent of Reference
Pebble count			
% Fines (< 2 mm)	4%	81%	2,025%
D50	66 mm	—	—
D84	155 mm	5 mm	—
Benthic metrics			
Standing Crop (number/square meter)	2,035	2,395	—
Ephemeroptera/ Plecoptera/ Tricoptera Taxa	21	3	—
Taxa Richness	35	10	—
Hilsenhoff's Biotic Index	2.96	5.70	—
Total Biologic Score	66	30	45%

Notes:
[a] Reference Site = Columbine Creek at Columbine Camp Ground
[b] Study Site = Bitter Creek about 100 meters above Red River
mm = Millimeters
— = Not applicable

4.2 Flow

No streamflow data are necessary because all loads are specified in percent fines.

4.3 Calculations

No calculations were necessary because all loads are specified in percent fines. The target loads for sedimentation are shown in Table 4.2.

Table 4.2 Calculation of Target Loads for Sedimentation/Siltation

Location	Sedimentation Standard[a] (% fines)	Sedimentation Target Load Capacity (% fines)
Bitter Creek (Red River to Headwaters)	20	20

Notes:
(a) This value is based on a narrative standard. The background values for bottom deposits were taken from the Stream Bottom Deposit Assessment Protocol (NMED/SWQB 2004d).

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 WQSs. 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.

Measured load was determined by a pebble count as described in the Stream Bottom Deposit Assessment Protocol (NMED/SWQB 2004d). Fines are defined as particles less than 2 millimeters (mm) in diameter. Results are displayed in Table 4.3 .

Table 4.3 Calculation of Measured Loads for Sedimentation/Siltation

Location	Sedimentation/ Siltation Measured Load (% fines)
Bitter Creek (Red River to Headwaters)	81

4.4 Waste Load Allocations and Load Allocations

4.4.1 Waste Load Allocation

There are no Municipal Separate Storm Sewer System (MS4) storm water permits in this AU. Sediment may be a component of some industrial and construction storm water discharges covered under General Permits, 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) for construction sites greater than one acre 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 (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 [TSS], turbidity, siltation, SBDs, 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 wasteload 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 following **Equation 1**:

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 1)}$$

The MOS is estimated to be 20 percent 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.

Table 4.4 TMDL for Sedimentation/Siltation

Location	WLA (% fines)	LA (% fines)	MOS (20%) (% fines)	TMDL (% fines)
Bitter Creek (Red River to Headwaters)	0	16	4.0	20

The extensive data collection and analyses necessary to determine background sedimentation loads for these AUs was beyond the resources available for this study. Therefore, it is assumed that a portion of the load allocation is made up of natural background loads. The nonpoint source and background load reductions necessary to meet the target load was calculated to be the difference between the target load (Table 4.4) and the measured load (Table 4.3). This load reduction table (Table 4.5) is presented for informational purposes only.

Table 4.5 Calculation of Load Reduction for Sedimentation/Siltation

Location	Target Load[(a)] (% fines)	Measured Load (% fines)	Load Reduction (% fines)	Percent Reduction[(b)]
Bitter Creek (Red River to Headwaters)	16	81	65	80%

Notes: 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 = LA + WLA
(b) Percent reduction is the percent the existing measured load must be reduced to achieve the TMDL, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

4.5 Identification and Description of Pollutant Source(s)

Probable nonpoint sources that may be contributing to the observed load are displayed in Table 4.6:

Table 4.6 Pollutant source summary for Sedimentation/Siltation

Pollutant Sources	Magnitude[(a)]	Location	Potential Sources[(b)]
Point:			
None	0%	--------	0%
Nonpoint:			
Sedimentation	81.0%	Bitter Creek (Red River to Headwaters)	100% Acid Mine Drainage Highway/Road/Bridge Runoff (non-construction related) Natural Sources Other Recreational Pollution Sources Surface Mining

Notes:
(a) Measured Load expressed as % fines.
(b) From the 2004-2006 Integrated CWA 303(d)/305(b) list (NMED/SWQB 2004a). 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.

4.6 Linkage of Water Quality and Pollutant Sources

SWQB fieldwork includes an assessment of the potential sources of impairment (NMED/SWQB 1999b). The *Pollutant Source(s) Documentation Protocol* form and summary 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 potential sources of impairment in this watershed. Staff completing these forms identify and quantify potential sources of nonpoint source 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 these TMDLs.

New Mexico's existing bottom deposits narrative WQS includes the phrase " *…from other than natural causes…*" Therefore, the degree to which sediment delivery and transport from the alteration scars is a natural phenomenon, has been exacerbated by human activities, or is the result of a combination of both should be considered. Even though the alteration scars are the primary source of excessive fine sediment loads and storm events during the summer and fall are the primary source of sediment transport, the anthropogenic influence of the forest road, land development, and the sand and gravel operation are contributing to impairment in Bitter Creek. Therefore, it cannot be stated that sediment impairment in Bitter Creek is completely due to natural causes. The geology in the watershed contributes to the amount of sediment available for transport. The Bitter Creek sediment load originates from the highly erodible alteration scars. This large, active sediment load in the lower canyon plays an important role in the formation and maintenance of instream habitat. Spring snowmelt and intense summer and fall precipitation events contribute to the amount of sediment transported into Bitter Creek and ultimately into Red River.

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 will be no MOS for point sources since none were accounted for in the TMDL calculation. However, the MOS is estimated to be 20% for sedimentation. This MOS is based on the uncertainty in the relationship between embeddedness and percent fines. In this case, the percent fines numeric target was determined to interpret the narrative standard. There are also potential errors in measurement of nonpoint source and background loads due to sampling technique, time of sampling, and other factors. Accordingly, a conservative MOS for sedimentation accounts for **20%** of the TMDL.

4.8 Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during the fall, which is a biological index period; meaning fall is a critical time in the life cycle stages of aquatic biota. Fall is also generally the low-flow period of the mean annual hydrograph in New Mexico when bottom deposits are most likely to settle and cause impairment, after the summer monsoon season but before annual spring runoff. It is assumed that if critical conditions are met during this time, coverage of any potential seasonal variation will also be met.

4.9 Future Growth

Estimations of future growth are not anticipated to lead to a significant increase for sedimentation that cannot be controlled with BMP implementation in the watershed, continued improvement of road conditions, and proper operation of the sand and gravel operations.