# 5.0 STREAM BOTTOM DEPOSITS

During the 2000 SWQB intensive water quality survey in the Upper Rio Grande Watershed (Part 1), impairment of the aquatic community due to excessive SBD was documented at Rio Pueblo de Taos (Arroyo del Alamo to Rio Grande del Rancho) (SWQB Stations 15 and 16). Consequently, this assessment unit was listed on the 2002-2004 CWA §303(d) list for SBD. Cordova Creek (Costilla Creek to headwaters) was listed for SBD on the 2002-2004 CWA §303(d) list. The SBD TMDL for this assessment unit was previously completed (NMED/SWQB 1999a).

## 5.1 Target Loading Capacity

Target values for this SBD 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. This TMDL is also consistent with New Mexico's antidegradation policy.

According to the NM WQS (20.6.4 NMAC), the general narrative standard for SBD reads:

> 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.

The impact of fine sediment deposits is well documented in the literature. An increased sediment load is often the most important adverse effect of activities on streams, according to a monitoring guidelines report (EPA 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).

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 SBD, SWQB/NMED 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 2004), which is online at http://www.nmenv.state.nm.us/swqb/links.html. The purpose of the protocol is to provide a reproducible quantification of the narrative criteria for SBD. A final set of monitoring procedures was implemented at a wide variety of sites during the 2000 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 NM, a strong relationship ($r^2$=0.75) was established between embeddedness and the biological scores using data collected in 1998 (SWQB/NMED 2004). A strong 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 70, the target embeddedness for fully supporting a designated use would be 45% and the target fines would be 20% (SWQB/NMED 2004). Since this relationship is based on NM streams, 20% was chosen for the target value for percent fines.

The Red River below the fish hatchery was chosen as the benthic macroinvertebrate reference station for the Rio Pueblo de Taos 20 meters below the Taos WWTF effluent channel (SWQB Station 15). They are both in ecoregion 22 and have similar geomorphic characteristics as displayed in Table 5.1 (see **Appendix C** for field data). Benthic macroinvertebrate samples and pebble counts were collected at both stations (Barbour et al. 1999, Wohlman 1954).

**Table 5.1 Geomorphic Characteristics of Benthic Macroinvertebrate Sampling Sites**

| Dimensions | Reference Site[(a)] | Study Site[(b)] |
|---|---|---|
| Cross-section Area (feet) | 61.0 | 69.0 |
| Width (feet) | 33.5 | 41.0 |
| Maximum Depth (feet) | 2.75 | 2.30 |
| Mean Depth (feet) | 1.81 | 1.70 |
| Width:Depth Ratio | 18.5 | 24.4 |
| Entrenchment Ratio | 3.88 | 2.24 |

Notes:
[(a)] Reference Site = Red River below Fish Hatchery
[(b)] Study Site = Rio Pueblo de Taos 20 meters below the Taos WWTF effluent channel

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 5.2). Select results of the pebble count and benthic macroinvertebrate surveys are shown in Table 5.2 and Figure 5.1. **Appendix C** of this document contains field data.

**Table 5.2 Pebble Count and Benthic Macroinvertebrate Results**

| Results | Reference Site[a] | Study Site[b] | Percent of Reference |
|---|---|---|---|
| ***Pebble count*** | | | |
| Percent Fines (< 2 mm) | 17% | 85% | 500% |
| D50 | 56 mm | <0.062 mm | — |
| D84 | 180 mm | 0.50 mm | — |
| ***Benthic metrics*** | | | |
| Standing Crop (number/square meter) | 2,609 | 11,790 | — |
| Ephemeroptera/ Plecoptera/ Tricoptera Taxa | 13 | 8 | — |
| Taxa Richness | 28 | 27 | — |
| Hilsenhoff's Biotic Index | 4.4 | 6.18 | — |
| **Total Biologic Score** | 54 | 38 | 70% |
| **Total Habitat Score (out of a possible 200)** | 180 | 107 | 59% |

Notes:
[a] Reference Site = Red River below Fish Hatchery
[b] Study Site = Rio Pueblo de Taos 20 meters below the Taos WWTF effluent channel
mm = Millimeters
— = Not applicable

**Figure 5.1 Comparison of Pebble Count Data at Reference and Study Sites (USDA 1998).**

## Contingency Tables

The following is a summary of the data you entered in the Data Input Worksheet. Summary data are presented as (1) total number of pebbles counted that were less than and greater than the designated particle size criterion and (2) percentage of pebbles counted that were less than the designated particle size criterion. Also presented is a p-value for each particle size criterion. A small p-value indicates the proportion of particles less than the criterion is statistically different between your reference and study reaches. For example, p-values <0.10 indicate a significant difference at the 10% level of significance (90% confidence level); p-values <0.05 indicate a significant difference at the 5% level of significance (95% confidence level); and p-values <0.01 indicate a significant difference at the 1% level of significance (99% confidence level).

**User-selected size criterion: <ctrl-u>**

**2mm**

| | < | > or = | Total |
|---|---|---|---|
| Reference | 17 | 83 | 100 |
| Study | 85 | 15 | 100 |
| Total | 102 | 98 | 200 |

| Reference < | Study < | Average < | Average >= |
|---|---|---|---|
| 17.0% | 85.0% | 51.0% | 49.0% |

| p-value | <.0001 |
|---|---|

**4 mm**

| | < | > or = | Total |
|---|---|---|---|
| Reference | 18 | 82 | 100 |
| Study | 85 | 15 | 100 |
| Total | 103 | 97 | 200 |

| Reference < | Study < | Average < | Average >= |
|---|---|---|---|
| 18.0% | 85.0% | 51.5% | 48.5% |

| p-value | <.0001 |
|---|---|

**8 mm**

| | < | > or = | Total |
|---|---|---|---|
| Reference | 19 | 81 | 100 |
| Study | 85 | 15 | 100 |
| Total | 104 | 96 | 200 |

| Reference < | Study < | Average < | Average >= |
|---|---|---|---|
| 19.0% | 85.0% | 52.0% | 48.0% |

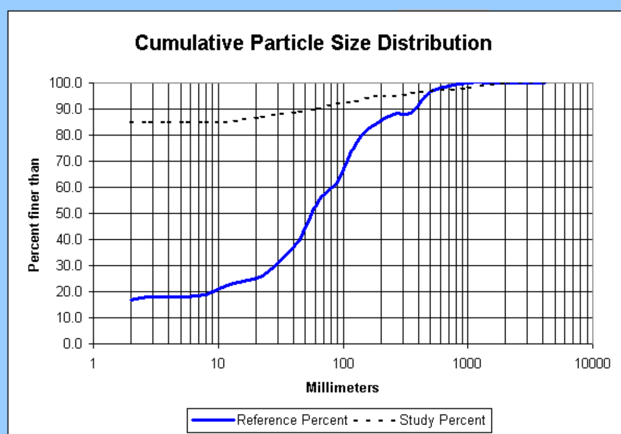
| p-value | <.0001 |
|---|---|

## Graphs

The following is a graphical output of the data you entered in the Data Input Worksheet. Presented are a cumulative distribution table and graph, and a histogram table and graph.

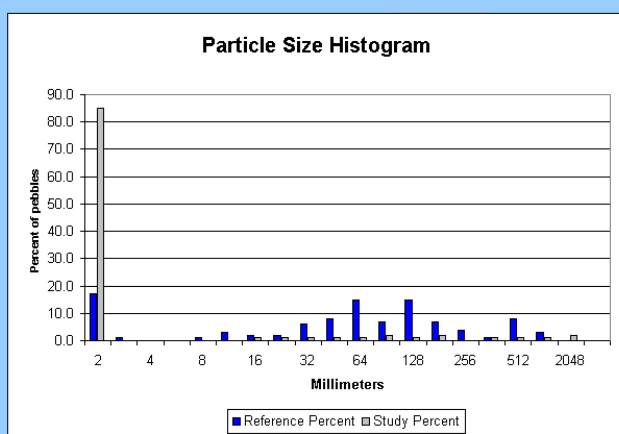
**Cumulative Distribution**

| Size finer than (mm) | Reference Percent | Study Percent |
|---|---|---|
| 2 | 17.0 | 85.0 |
| 2.8 | 18.0 | 85.0 |
| 4 | 18.0 | 85.0 |
| 5.6 | 18.0 | 85.0 |
| 8 | 19.0 | 85.0 |
| 11.3 | 22.0 | 85.0 |
| 16 | 24.0 | 86.0 |
| 22.6 | 26.0 | 87.0 |
| 32 | 32.0 | 88.0 |
| 45.3 | 40.0 | 89.0 |
| 64 | 55.0 | 90.0 |
| 90.5 | 62.0 | 92.0 |
| 128 | 77.0 | 93.0 |
| 181 | 84.0 | 95.0 |
| 256 | 88.0 | 95.0 |
| 362 | 89.0 | 96.0 |
| 512 | 97.0 | 97.0 |
| 1024 | 100.0 | 98.0 |
| 2048 | 100.0 | 100.0 |
| 4096 | 100.0 | 100.0 |




**Histogram**

| Size finer than (mm) | Reference Percent | Study Percent |
|---|---|---|
| 2 | 17.0 | 85.0 |
| 2.8 | 1.0 | 0.0 |
| 4 | 0.0 | 0.0 |
| 5.6 | 0.0 | 0.0 |
| 8 | 1.0 | 0.0 |
| 11.3 | 3.0 | 0.0 |
| 16 | 2.0 | 1.0 |
| 22.6 | 2.0 | 1.0 |
| 32 | 6.0 | 1.0 |
| 45.3 | 8.0 | 1.0 |
| 64 | 15.0 | 1.0 |
| 90.5 | 7.0 | 2.0 |
| 128 | 15.0 | 1.0 |
| 181 | 7.0 | 2.0 |
| 256 | 4.0 | 0.0 |
| 362 | 1.0 | 1.0 |
| 512 | 8.0 | 1.0 |
| 1024 | 3.0 | 1.0 |
| 2048 | 0.0 | 2.0 |
| 4096 | 0.0 | 0.0 |



## 5.2 Flow

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

## 5.3 Calculations

No calculations were necessary because all loads are specified in percent fines. The target loads for SBD are shown in Table 5.3.

**Table 5.3 Calculation of Target Loads for SBD**

| Location | SBD Standards[(a)] (% fines) | SBD Target Load Capacity (% fines) |
|---|---|---|
| Rio Pueblo de Taos (Arroyo del Alamo to Rio Grande del Rancho) | 20 | 20 |

Notes:
[(a)] This value is based on a narrative standard. The background values for SBD were taken from the SBD Assessment Protocol (SWQB/NMED 2004).

Measured load was determined by a pebble count as described in the SBD Assessment Protocol (SWQB/NMED 2004). Fines are defined as particles less than 2 millimeters (mm) in diameter. Results are displayed in Table 5.4 and Figure 5.1. **Appendix C** of this document contains field data.

**Table 5.4 Calculation of Measured Loads for SBD**

| Location | SBD (% fines) | SBD Measured Load (% fines) |
|---|---|---|
| Rio Pueblo de Taos (Arroyo del Alamo to Rio Grande del Rancho) | 85 | 85 |

Notes:
SBD = Stream bottom deposits

## 5.4 Waste Load Allocations and Load Allocations

### 5.4.1 Waste Load Allocation

The Taos WWTF is located within this assessment unit and discharges into the Rio Pueblo de Taos. The NPDES permit (Permit No. NM0024066) has total suspended solids (TSS) limits of 30 mg/L (30-day average) and 45 mg/L (7-day average) that are based on the Secondary Treatment Rule 40 CFR 133. There is some debate regarding whether or not TSS from WWTPs has an impact on SBD. TSS sampling in ambient streams typically measures suspended sediment from erosional processes. Since TSS sampling in WWTP effluent typically measures biosolids, which are less inclined to settle on the stream bottom, EPA contends that TSS from WWTPs have no impact on SBD. Therefore, the WLA is zero.

### 5.4.2 Load Allocation

In order to calculate the LA, the WLA and MOS were subtracted from the target capacity TMDL following **Equation 5**:

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

The MOS is estimated to be 25 percent of the target load calculated in Table 5.3. Results are presented in Table 5.5. Additional details on the MOS chosen are presented in Section 5.7.

**Table 5.5 TMDL for Stream Bottom Deposits**

| Location | WLA (% fines) | LA (% fines) | MOS (25%) (% fines) | TMDL (% fines) |
|---|---|---|---|---|
| Rio Pueblo de Taos (Arroyo del Alamo to Rio Grande del Rancho) | 0 | 15 | 5 | 20 |

Notes:
WLA = Waste load allocation
LA = Load allocation
MOS = Margin of safety
TMDL = Total maximum daily load

The extensive data collection and analyses necessary to determine background SBD loads for the Rio Pueblo de Taos watershed was beyond the resources available for this study. Therefore, it is assumed that a portion of the LA is made up of natural background loads. The load reduction necessary to meet the target load was estimated as the difference between the target LA (Table 5.3) and the measured load (Table 5.4), shown in Table 5.6.

**Table 5.6 Calculation of Load Reduction for Stream Bottom Deposits**

| Location | LA (% fines) | Measured Load (% fines) | Load Reduction (% fines) |
|---|---|---|---|
| Rio Pueblo de Taos (Arroyo del Alamo to Rio Grande del Rancho) | 15 | 85 | 70 |

## 5.5 Identification and Description of Pollutant Source(s)

Nonpoint pollutant sources that could contribute to the observed load include range grazing (riparian and/or upland); municipal point sources; land disposal; highway/road/bridge construction; highway maintenance and runoff; crop-related sources; construction. The point source contributions associated with this TMDL were not considered to be applicable.

## 5.6 Linkage of 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 (SWQB/NMED 1999b). 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 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 this TMDL.

A substantial and healthy benthic macroinvertebrate community exists at Red River below the fish hatchery. An increase in percent fines and consequent reduction in biological score at Rio Pueblo de Taos below the Taos WWTF results from a number of potential factors. There is a change in soil type and geology from the upper station to the lower station in the valley. The main sources of impairment along this lower reach appear to be from livestock grazing and removal of riparian vegetation in the floodplain upstream of the lower sampling stations. Agricultural practices such as grazing appear to have contributed to the removal of riparian vegetation and streambank destabilization.

There are irrigation ditches coming off of the Rio Pueblo de Taos that at times divert the majority of the flow from the stream. Reductions in flow due to irrigation demands can greatly reduce a stream's ability to efficiently transport sediment. At present, the state of NM does not have an "instream flow" mechanism in place whereby water would be left in a stream bed to be used to protect habitat and water quality for fish, wildlife, recreational, and/or aesthetic uses. It is possible that the increased sediment is due to population growth and road construction, in addition to flow reduction, irrigation, and climatic change. However, the sediment that was present in 2000 (85 percent) appears to have been substantially reduced based on visual observations in 2003. Measurments of percent fines from 1998 were 46 percent. It is possible that the increase in 2000 was due to an episodic event, either from a side arroyo or main channel.

## 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. For this TMDL, there will be no MOS for point sources since none that were accounted for. However, the MOS is estimated to be an addition of 25% for SBD caused by nonpoint sources, excluding background. This MOS is based on the uncertainty in the relationship between embeddedness, fines, and biological score. In this case, the percent fines are based on a narrative standard and there are also potential errors in measurement of nonpoint source loads due to equipment accuracy, time of sampling, and other factors. Accordingly, a conservative MOS for SBD increases the TMDL by 25%. Because flow estimates were not needed for the SBD TMDL, an additional MOS is not warranted.

## 5.8 Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during the fall which is biological index period SWQB/NMED has determined is the best time to collect benthic macroinvertebrates in NM (SWQB/NMED 2004b). Fall is a critical time in the life cycle stages of benthic macroinvertebrates in NM. Fall is also generally the low-flow period of the mean annual hydrograph in NM 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.

## 5.9 Future Growth

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