APPENDIX H

WATER QUALITY / WATER RESOURCES

- Driscoll Analysis
- Location Hydraulic Study

Technical Report

Project: EA for US 550
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Task: Use of Driscoll Method to estimate water quality impacts on the Animas River from US 550 improvements

INTRODUCTION AND DRISCOLL METHOD

CDOT and FHWA are developing an Environmental Assessment (EA) for the potential environmental, social, and economic impacts of reconstructing US 550 as a four-lane highway. As part of this study, the FHWA is requiring the use of the Driscoll Method. The project is located in La Plata County, Colorado. The 15.5 mile project corridor extends from the New Mexico state line to approximately one-half mile south of the junction of County Road (CR) 220. The project study area generally extends 300 feet east and west of the existing highway centerline.

The Driscoll Method is a procedure for estimating the impacts of highway runoff on the water quality of receiving waters such as streams, rivers, and lakes. For details of this procedure refer to the four volumes of Pollutant Loadings and Impacts from Highway Stormwater Runoff by Driscoll et al. (FHWA-RD-88-006 - 009). The volumes are as follows:

1. Design Procedure, 1990
2. Users Guide for Interactive Computer Implementation of Design Procedure, 1990
3. Analytical Investigation and Research Report, 1990
4. Research Report Data Appendix, 1989

For stream and river analyses, the program uses a Probabalistic Dilution Model (PDM) developed under EPA's National Urban Runoff Program (NURP program) to compute the probability distributions of in-stream concentrations of pollutants during highway runoff events. From rainfall statistics, statistics for runoff water quality concentrations and streamflow data, probabilities of stream concentrations are determined. From these probabilities, stream concentrations that are exceeded once every three years are determined. These can be compared to EPA's 3-year recurrence toxic criteria values for aquatic life (EPA acute criteria) or similar state criteria.

For the US 550 analysis, URS used spreadsheets based on the worksheets in the Design Procedure to estimate 3-year concentrations.

Snowfall and snowpack are not considered in the model – all precipitation is considered rainfall. This adds some loss of accuracy, but the procedure does not allow for adjustments due to snow.

INPUTS TO DRISCOLL MODEL

Roadway Areas

For the runoff calculations, two parameters are input to the Driscoll model:

1. The total area of right-of-way that drains to the river (AROW), and
2. The paved (i.e., impervious) portion of this area (AHWY).

These areas were calculated for both existing and future conditions using AutoCAD and GIS (Geographical Information Systems) applications.

Rainfall

The model requires statistical analysis of rainfall data at or near the site of interest. The parameters include mean and coefficient of variation for four characteristics of storms:

1. Volume of rain during the event (inches)
2. Intensity of the event (in/hr)
3. Duration of the event (hours)
4. Time interval between storms (hours).

Driscoll, Volume I (Figure 2) includes statistics for regions across the United States. These statistics resulted from data collection and analysis by the US Weather Service and were input into the analysis for US 550. The project area lies within Zone 6 according to Figure 2 (Driscoll, 1990). The respective statistics for Zone 6 are included in Table 1.

Table 1. Rainfall Input Data for Initial Estimates (Zone 6)

Volume (inches)		**Intensity (in/hr)**		**Duration (hours)**		**Interval (hours)**	
Mean	**Coefficient of variation**	**Mean**	**Coefficient of variation**	**Mean**	**Coefficient of variation**	**Mean**	**Coefficient of variation**
MVP	CVVP	MIP	CVIP	MDP	CVDP	MTP	CVTP
0.17	1.51	0.045	1.04	3.6	1.02	277	1.48

Average Flow

To determine the concentrations of constituents in the river, a characterization of flows are required. Input parameters include:
1. The total drainage area of the basin above US 550 (ATOT)
2. Average stream flow in the river (MQS)
3. Coefficient of variation of stream flows (CVQS).

The contributing watershed area to the crossing is approximately 874.5 sq. miles.

Limited stream flow and water quality data are available from USGS gaging stations within the US 550 project area on the Animas River. For USGS Station 09363500 near Cedar Hill, New Mexico, the daily mean flow from 69 years of record is 380 cfs. For USGS Station 09361500, on the Animas River at Durango, Colorado, the daily mean flow for 90 years of record is 317 cfs. The average of these two values (348.5-cfs) was used for this analysis. Appendix A provides information for these stations.

For the coefficient of variation of stream flows, the Design Procedure (Driscoll, Volume I) recommends a value of 2.0 for relatively arid areas such as Southwestern Colorado.

The average flow per square mile was calculated from the watershed drainage area and the average stream flow data, yielding a value of 0.40 cfs/sq mile.

Runoff Water Quality

Highway runoff data was collected by the FHWA for 993 storms at 31 sites in 11 states (data from several FHWA studies are included in Driscoll et al., Volume IV: Research Report Data Appendix). From this data, site median concentrations (TCRs) were calculated for 10 pollutants (given in Table 3 of Driscoll, Volume I) for both urban (greater than 30,000 vehicles per day (ADT)) and rural settings (less than 30,000 vehicles per day (ADT)). Also in this table are values for different percentile levels based on statistical distributions of the data. For example, a 50^{th} percentile value indicates that one-half of the data for a given pollutant is below this value and one-half is above this value.

Traffic data for the existing and proposed conditions indicate that the study area is a rural highway. For the US 550 project analysis, the values for site median concentrations at the 80^{th} percentile were used. The values from Table 3 in Volume I (Design Procedure) that represent the existing and proposed conditions, for rural highways are:

- 0.022 mg/L for Copper
- 0.080 mg/L for Lead

- 0.080 mg/L for Zinc.

These three metals were analyzed because the Design Procedure presents criteria values for only these three contaminants. Also, EPA criteria for TSS are not acute values. Furthermore, metals are a common concern in highway runoff.

Table 3 summarizes the Colorado Department of Public Health and Environment (CDPHE) standards (CDPHE WQCC Regulation No. 31) and EPA threshold effect levels (Design Procedures, page 17) used in the analysis for the metals in dissolved form. Both sets of values are based on a total hardness (as $CaCO_3$) value of 200 mg/l, obtained from USGS data for Station 09363500. In comparing the EPA and the CDPHE acute standards, it is found that CDPHE utilizes more conservative values. The CDPHE acute standards (CDPHE, 2002) are based on short-term continuous-exposure contact with significant safety factors. However, minor or infrequent exceedances of these values may not result in adverse impacts. Therefore, the less conservative thresholds from the NURP, which do not have safety factors applied and for which short-duration intermittent exposures do have adverse impacts, were also used in the analysis.

Table 3. Water Quality Standards and Effect Levels

Constituents (dissolved)	CDPHE Acute Standards (mg/L)	EPA Threshold Effect Level (mg/L)
Copper	0.026	0.080
Lead	0.136	0.850
Zinc	0.211	1.200

A coefficient of variation for a given pollutant is also an input to the model. Driscoll (page 13 in Volume I) indicates that 0.75 is a good estimate for all pollutants at all sites, and that 0.71 is even better for urban highways (> 30,000 ADT) and 0.84 is better for rural highways (< 30,000 ADT). Therefore, for the US 550 Driscoll analysis, 0.84 was used as the coefficient of variation.

Estimating the soluble fraction (FSOL) of a pollutant in highway runoff is important, and Driscoll provides the following for the three metals (page 15 of Volume I):

- 40% for Copper
- 10% for Lead
- 40% for Zinc.

A summary of input parameters for the three metals is presented in Table 4.

TABLE 4. Input Values for Driscoll Method Analysis

	Areas			Runoff Quality Characteristics				WQ Criteria (from Design Procedure)	
	Watershed Drainage Area to (sq miles)	Total right of way (acres)	Paved surface (acres)	Urban or Rural	Site Median Concentration (mg/l)	Coefficient of Variation	Soluble Fraction (%)	CDPHE Acute Criterion[1] (mg/l)	EPA Suggested Threshold Effect Level (mg/l)
Existing Condition									
Copper	874.5	28.9	4.2	rural	0.038	0.84	40	0.026	0.080
Lead	874.5	28.9	4.2	rural	0.179	0.84	10	0.136	0.850
Zinc	874.5	28.9	4.2	rural	0.139	0.84	40	0.211	1.200
Future Condition- 2a									
Copper	874.5	38.7	20.4	rural	0.038	0.84	40	0.026	0.080
Lead	874.5	38.7	20.4	rural	0.179	0.84	10	0.136	0.850
Zinc	874.5	38.7	20.4	rural	0.139	0.84	40	0.211	1.200
Future Condition- 2b									
Copper	874.5	50.0	20.4	rural	0.038	0.84	40	0.026	0.080
Lead	874.5	50.0	20.4	rural	0.179	0.84	10	0.136	0.850
Zinc	874.5	50.0	20.4	rural	0.139	0.84	40	0.211	1.200
Future Condition- 2d									
Copper	874.5	42.6	20.4	rural	0.038	0.84	40	0.026	0.080
Lead	874.5	42.6	20.4	rural	0.179	0.84	10	0.136	0.850
Zinc	874.5	42.6	20.4	rural	0.139	0.84	40	0.211	1.200

[1] Table Value Standards found in Regulation No. 31.

RESULTS

Spreadsheets based on the workbooks in the Design Procedures were used to calculate runoff and water quality before and after the US 550 improvements. For existing and future conditions and for each of the three metals, the following were calculated:

- The 3-year stream concentration,
- Ratio of 3-year stream concentration to CDPHE acute criteria, and
- Ratio of 3-year stream concentration to the EPA threshold effect level.

The acute criteria are based on bioassay results and are the highest concentration that produces no adverse effect on the most sensitive species during short duration exposures. The less conservative threshold effect levels are NURP estimates of approximate concentrations that would cause adverse impacts for short-duration, intermittent exposures produced by stormwater runoff.

Based on the Design Procedure (including Table 6, page 24), results of the calculations can be analyzed with the following guidelines:

- If the ratio of estimated concentrations to acute criteria is less than 0.75, a toxicity problem is unlikely.
- If the ratio of estimated concentrations to acute criteria is more than 5.0, a toxicity problem is likely and reduction measures (e.g., detention ponds) are recommended.
- If the ratio of estimated concentrations to acute criteria is between 0.75 and 5.0, a toxicity problem is possible.
- If the ratio of estimated concentrations to threshold effects levels is greater than 1.0, negative impacts to the receiving water are possible.

The results for existing and future conditions are summarized in Table 6. Results show that for the existing and future conditions toxicity is not a risk, due to the relatively small amount of roadway area draining to the river versus the total river drainage area to the point of the crossing.

Additional information regarding inputs into the Driscoll Model is included in Appendix B.

Table 6. Results from Driscoll Method Analysis

	Copper			Lead			Zinc		
	Once in 3-year stream concentration from Driscoll Method (µg/l)	Ratio of 3-year concentration to acute criteria	Ratio of 3-year concentration to threshold effect level	Once in 3-year stream concentration from Driscoll Method (µg/l)	Ratio of 3-year concentration to acute criteria	Ratio of 3-year concentration to threshold effect level	Once in 3-year stream concentration from Driscoll Method (µg/l)	Ratio of 3-year concentration to acute criteria	Ratio of 3-year concentration to threshold effect level
Existing Condition	0.560	0.022	0.00699	0.659	0.005	0.00078	2.05	0.010	0.00171
Future Condition- 2a	1.300	0.050	0.01621	1.527	0.011	0.00180	4.74	0.023	0.00395
Future Condition- 2b	1.335	0.051	0.01668	1.572	0.012	0.00185	4.88	0.023	0.00407
Future Condition- 2d	1.310	0.050	0.01638	1.543	0.011	0.00182	4.79	0.023	0.00399

REFERENCES

Colorado Department of Public Health and Environment, Water Quality Control Commission. 2002. Regulation No. 31 The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31).

Driscoll et al., Pollutant Loadings and Impacts from Highway Stormwater Runoff, Volume I: Design Procedure, FHWA-RD-88-006, 1990.

Driscoll et al., Pollutant Loadings and Impacts from Highway Stormwater Runoff, Volume II: Users Guide for Interactive Computer Implementation of Design Procedure, FHWA-RD-88-007, 1990.

Driscoll et al., Pollutant Loadings and Impacts from Highway Stormwater Runoff, Volume III: Analytical Investigation and Research Report, FHWA-RD-88-008, 1990.

Driscoll et al., Pollutant Loadings and Impacts from Highway Stormwater Runoff, Volume IV: Research Report Data Appendix, FHWA-RD-88-009, 1989.