US EPA-APPROVED

TOTAL MAXIMUM DAILY LOAD (TMDL)

FOR THE

CIMARRON RIVER WATERSHED

[CANADIAN RIVER TO HEADWATERS]

SEPTEMBER 3, 2010

SPECIAL NOTE: In previous DRAFT versions of the Cimarron River Watershed TMDL, the NPDES permit number for the Angel Fire Wastewater Treatment Plant was listed as NM0028011 in Table 4.7 and in textual references on pp. 43 and 59. These citations were incorrect. Any reference to NM0028011 in this TMDL should actually refer to NPDES Permit Number NM0030503. NMED-SWQB regrets this editing error.

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COVER PHOTO*: Upstream view of the Cimarron River at Cimarron Canyon State Park's Tolby Campground, June 13, 2006.*

LIST OF ABBREVIATIONS

4Q3	4-Day, 3-year low-flow frequency
BMP	Best management practices
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CGP	Construction general storm water permit
CWA	Clean Water Act
^oC	Degrees Celcius
^oF	Degrees Farenheit
HUC	Hydrologic unit code
$j/m^2/s$	Joules per square meter per second
km^2	Square kilometers
LA	Load allocation
lbs/day	Pounds per day
mgd	Million gallons per day
mg/L	Milligrams per Liter
mi^2	Square miles
mL	Milliliters
MOS	Margin of safety
MOU	Memorandum of Understanding
MS4	Municipal separate storm sewer system
MSGP	Multi-sector general storm water permit
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
QAPP	Quality Assurance Project Plan
RFP	Request for proposal
SEE	Standard Error of the Estimate
SSTEMP	Stream Segment Temperature Model
SWPPP	Storm water pollution prevention plan
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WLA	Waste load allocation
WQCC	Water Quality Control Commission
WQS	Water quality standards (NMAC 20.6.4 as amended through August 31, 2007)
WBP	Watershed-based plan
WWTP	Wastewater treatment plant

EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to develop Total Maximum Daily Load (TMDL) management plans for water bodies determined to be water quality limited. A TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined in 40 Code of Federal Regulations Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint source and background conditions. TMDLs also include a Margin of Safety (MOS).

The Surface Water Quality Bureau (SWQB) conducted a water quality survey of the Cimarron Basin of northeastern New Mexico in 2006. Water quality monitoring stations were located within the Cimarron Watershed to evaluate the impact of tributary streams and ambient water quality conditions. As a result of assessing data generated during this monitoring effort, impairment determinations of New Mexico water quality standards include the following:

- DISSOLVED ARSENIC in Cimarron River (Cimarron Village to Turkey Creek), Cimarron River (Turkey Creek to Eagle Nest Lake), and Ute Creek (Cimarron River to headwaters);
- BACTERIA (*E. coli*) in Cieneguilla Creek (Eagle Nest Lake to headwaters), North Ponil Creek (South Ponil Creek to Seally Canyon), Ponil Creek (US 64 to confluence of North and South Ponil), Ponil Creek (Cimarron River to US 64), Rayado Creek (Miami Lake diversion to headwaters), Sixmile Creek (Eagle Nest Lake to headwaters), and Ute Creek (Cimarron River to headwaters);
- PLANT NUTRIENTS in Cieneguilla Creek (Eagle Nest Lake to headwaters), Cimarron River (Canadian River to Cimarron Village), Cimarron River (Turkey Creek to Eagle Nest Lake), Moreno Creek (Eagle Nest Lake to headwaters), Ponil Creek (US 64 to confluence of North and South Ponil Creeks), Rayado Creek (Cimarron River to Miami Lake diversion), and Sixmile Creek (Eagle Nest Lake to headwaters); and
- TEMPERATURE in Cieneguilla Creek (Eagle Nest Lake to headwaters), Cimarron River (Cimarron Village to Turkey Creek), Moreno Creek (Eagle Nest Lake to headwaters), Rayado Creek (Miami Lake diversion to headwaters), Sixmile Creek (Eagle Nest Lake to headwaters), South Ponil Creek (Ponil Creek to Middle Ponil), and Ute Creek (Cimarron River to headwaters).

SWQB data collections documented continued impairments of the New Mexico WQS. These are "old" impairment listings that already resulted in a TMDL but continue to be impaired based on the 2006 data and assessments include:

- TURBIDITY on Cieneguilla Creek (Eagle Nest Lake to headwaters), North Ponil Creek (South Ponil Creek to Seally Canyon), Ponil Creek (US 64 to confluence of North and South Ponil Creeks), and Sixmile Creek (Eagle Nest Lake to headwaters);
- TEMPERATURE on Middle Ponil Creek (South Ponil Creek to Greenwood Creek), North Ponil Creek (South Ponil Creek to Seally Canyon), and Ponil Creek (US 64 to confluence of North and South Ponil Creeks); and
- SEDIMENTATION/SILTATION on Cieneguilla Creek (Eagle Nest Lake to headwaters) and Rayado Creek (Cimarron River to Miami Lake diversion).

As a result of assessing data generated during this monitoring effort, SWQB staff also documented improvements in water quality which resulted in several impairments being removed from the 2010-2012 CWA §303(d) List of Assessed Waterbodies. These "delisted" waters include:

- ALUMINUM on Cieneguilla Creek (Eagle Nest Lake to headwaters), Cimarron River (Canadian River to Cimarron Village), Cimarron River (Cimarron Village to Turkey Creek), Ponil Creek (Cimarron River to US 64), and Ponil Creek (US 64 to confluence of North and South Ponil Creeks);
- BACTERIA (Fecal Coliform) on Cieneguilla Creek (Eagle Nest Lake to headwaters) and Moreno Creek (Eagle Nest Lake to headwaters);
- SEDIMENTATION/SILTATION on Middle Ponil Creek (South Ponil Creek to Greenwood Creek), North Ponil Creek (South Ponil Creek to Seally Canyon), Ponil Creek (Cimarron River to US 64), and Ponil Creek (US 64 to confluence of North and South Ponil Creeks);
- TEMPERATURE on Ponil Creek (Cimarron River to US 64); and
- TURBIDITY on Middle Ponil Creek (South Ponil Creek to Greenwood Creek), Moreno Creek (Eagle Nest Lake to headwaters), and Ponil Creek (Cimarron River to US 64).

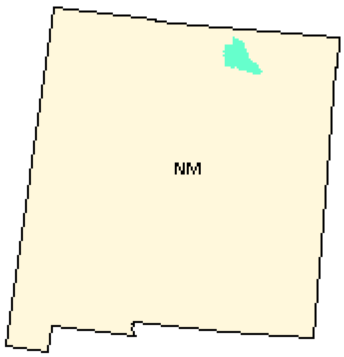
Waters removed from the 303(d) list do not require development of a TMDL.

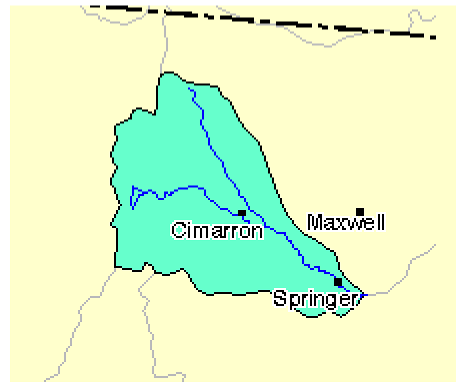
This TMDL document addresses the above noted impairments as summarized in the tables below. The data used to develop this TMDL were collected during the 2006 Cimarron Watershed survey with follow-up collections in 2007, 2008, and 2009. The 2006 study identified other potential water quality impairments which are not addressed in this document. Additional data needs for verification of those impairments are being identified and data collection will follow. If these impairments are verified, subsequent TMDLs will be prepared in a separate TMDL document.

The SWQB's Monitoring and Assessment Section will collect water quality data during the next rotational cycle. The next scheduled monitoring date for the Cimarron Watershed is 2016 at which time TMDL targets will be re-examined and potentially revised as this document is considered to be an evolving management plan. In the event that new data indicate that the targets used in this analysis are not appropriate and/or if new standards are adopted, the load capacity will be adjusted accordingly. When water quality standards have been achieved, the reach will be moved to the appropriate category in the Integrated Report.

The SWQB's Watershed Protection Section will continue to work with watershed groups to develop Watershed-Based Plans to implement strategies that attempt to correct the water quality impairments detailed in this document. Implementation of items detailed in the Watershed-Based Plans will be done with participation of all interested and affected parties.

TOTAL MAXIMUM DAILY LOAD FOR
CIENEGUILLA CREEK (EAGLE NEST LAKE TO HEADWATERS)

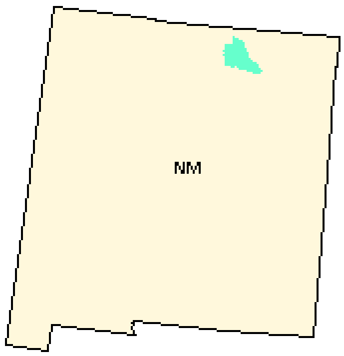


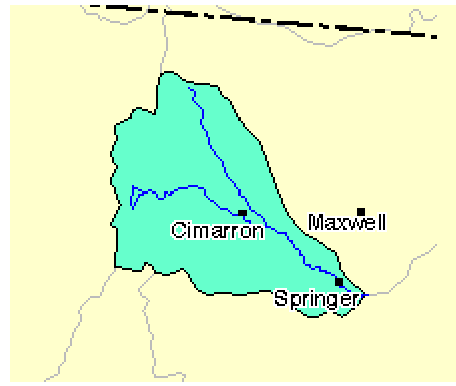


New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_065 formerly known as NM-CR2-50000
Segment Length	12.63 miles
Parameters of Concern	*E. coli*, Temperature, Plant Nutrients
Uses Affected	Secondary Contact; High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	56 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Loss of riparian habitat; municipal point source dischargers, other recreational pollution sources, rangeland grazing, streambank modification/destabilization
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5A
TMDL for:	**WLA + LA + MOS = TMDL**
E. coli	**2.39×10^9 + 6.21×10^8 + 3.34×10^8 = 3.34×10^9 cfu/day**
Temperature	**0* + 131.79 + 14.64 = 146.43 $j/m^2/s/day$**
Plant Nutrients:	
Total Phosphorus	**0.25 + 0.065 + 0.035 = 0.35 lbs/day**
Total Nitrogen	**2.3 + 0.67 + 0.33 = 3.3 lbs/day**

* See discussion in Section 6.4.1.

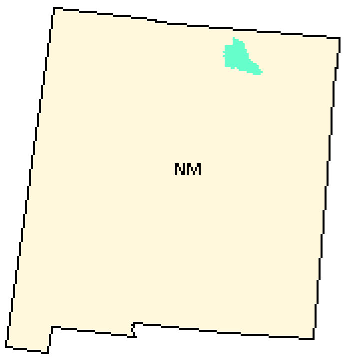
TOTAL MAXIMUM DAILY LOAD FOR
CIMARRON RIVER (CANADIAN RIVER TO CIMARRON VILLAGE)

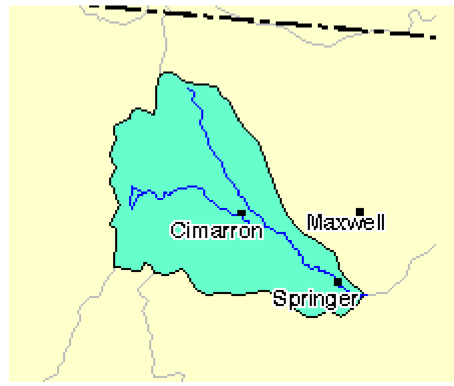




New Mexico Standards Segment	20.6.4.306
Waterbody Identifier	NM-2305.1.A_10 formerly known as NM-CR2-10000
Segment Length	37.79 miles
Parameters of Concern	Plant Nutrients
Uses Affected	Warmwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	1,032 square miles
Land Type	Southwest Tablelands (Ecoregion 26)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Flow alterations from water diversions, impervious surface/ parking lot runoff, on-site treatment systems (septic systems and similar decentralized systems), rangeland grazing
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5A
TMDL for:	
Plant Nutrients:	**WLA + LA + MOS = TMDL**
Total Phosphorus	**0.075 + 0.051 + 0.014 = 0.14 lbs/day**
Total Nitrogen	**1.1 + 0.79 + 0.21 = 2.1 lbs/day**

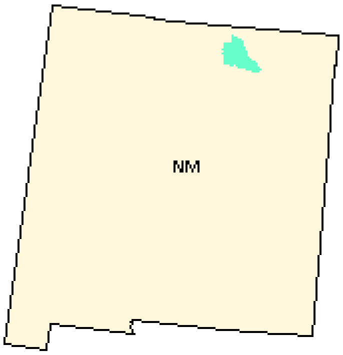
TOTAL MAXIMUM DAILY LOAD FOR
CIMARRON RIVER (CIMARRON VILLAGE TO TURKEY CREEK)

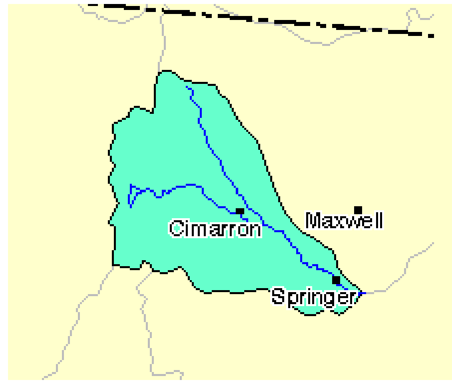




New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_040 formerly known as NM-CR2-10000
Segment Length	4.25 miles
Parameters of Concern	Arsenic, Temperature
Uses Affected	Domestic Water Supply, High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	294 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Baseflow depletion from groundwater withdrawls, loss of riparian habitat, rangeland grazing, source unknown
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5
TMDL for:	**WLA + LA + MOS = TMDL**
Arsenic	**0 + 0.236 + 0.059 = 0.295 lbs/day**
Temperature	**0 + 104.70 + 11.63 = 116.33 j/m^2/s/day**

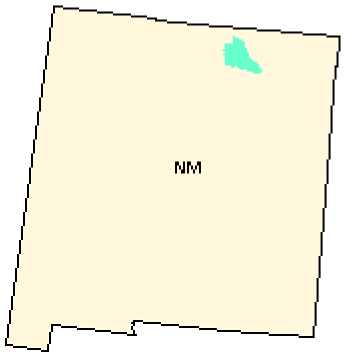
TOTAL MAXIMUM DAILY LOAD FOR
CIMARRON RIVER (TURKEY CREEK TO EAGLE NEST LAKE)

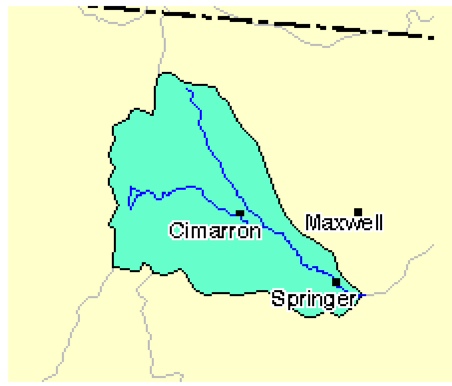




New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_130 formerly known as NM-CR2-20000
Segment Length	18.19 miles
Parameters of Concern	Arsenic, Plant Nutrients
Uses Affected	Domestic Water Supply, High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	265 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Dam or impoundment, on-site treatment systems (septic systems and similar decentralized systems), other recreational pollution sources, source unknown, wildlife other than waterfowl
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5A
TMDL for:	**WLA + LA + MOS = TMDL**
Arsenic	**0 + 0.150 + 0.040 = 0.190 lbs/day**
Plant Nutrients:	
Total Phosphorus	**0 + 0.324 + 0.036 = 0.36 lbs/day**
Total Nitrogen	**0 + 3.96 + 0.44 = 4.4 lbs/day**

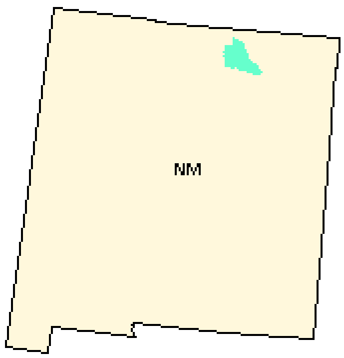
TOTAL MAXIMUM DAILY LOAD FOR
MORENO CREEK (EAGLE NEST LAKE TO HEADWATERS)

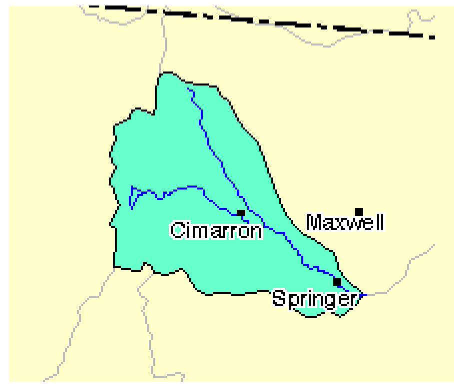




New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_060 formerly known as NM-CR2-30000
Segment Length	9 miles
Parameters of Concern	Temperature, Plant Nutrients
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	73.8 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	On-site treatment systems (septic systems and similar decentralized systems), rangeland grazing, wastes from pets
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5A
TMDL for:	**WLA + LA + MOS = TMDL**
Temperature	**0 + 97.35 + 10.82 = 108.16 j/m²/s/day**
Plant Nutrients:	
Total Phosphorus	**0 + 0.018 + 0.002 = 0.02 lbs/day**
Total Nitrogen	**0 + 0.225 + 0.025 = 0.25 lbs/day**

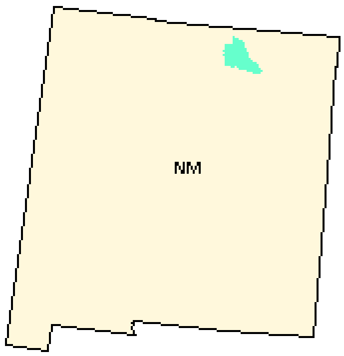
TOTAL MAXIMUM DAILY LOAD FOR
NORTH PONIL CREEK (SOUTH PONIL CREEK TO SEALLY CANYON)

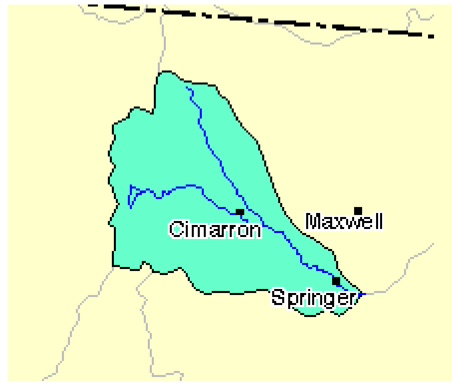




New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_110 formerly known as NM-CR2-10400
Segment Length	14.78 miles
Parameters of Concern	*E. coli*
Uses Affected	Secondary Contact
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	85 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Forest roads (road construction and use), habitat modification – other than hydromodification, loss of riparian habitat, low water crossing, rangeland grazing, silviculture harvesting
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5A
TMDL for: *E. coli*	**WLA + LA + MOS = TMDL** **0 + 6.45×10^8 + 7.16×10^7 = 7.16×10^8 cfu/day**

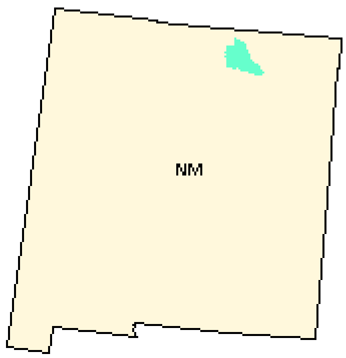
TOTAL MAXIMUM DAILY LOAD FOR
PONIL CREEK (CIMARRON RIVER TO US 64)

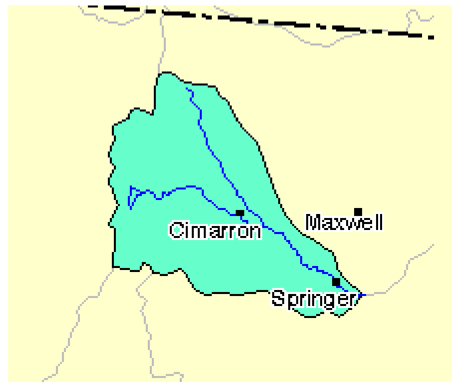




New Mexico Standards Segment	20.6.4.306
Waterbody Identifier	NM-2306.A_100 formerly known as NM-CR2-10300
Segment Length	9.9 miles
Parameters of Concern	*E. coli*
Uses Affected	Secondary Contact
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	331 square miles
Land Type	Southwestern Tablelands (Ecoregion 26)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Avian sources (waterfowl and/or other), on-site treatment systems (septic systems and similar decentralized systems), source unknown, wastes from pets
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5A
TMDL for: *E. coli*	**WLA + LA + MOS = TMDL** **3.96×10^7 + 1.93×10^9 + 2.19×10^8 = 2.19×10^9 cfu/day**

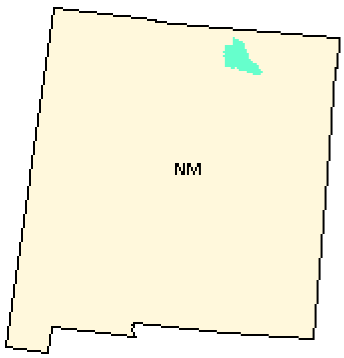
TOTAL MAXIMUM DAILY LOAD FOR
PONIL CREEK (US 64 TO CONFL OF NORTH & SOUTH PONIL)

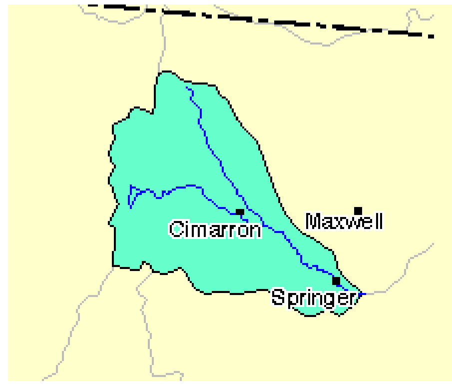




New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_101 formerly known as NM-CR2-10300
Segment Length	7 miles
Parameters of Concern	*E. coli*, Plant Nutrients
Uses Affected	Secondary Contact; High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	233 square miles
Land Type	Southern Rockies (Ecoregion 21); Southwestern Tablelands (Ecoregion 26)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Livestock (grazing or feeding operations), loss of riparian habitat, on-site treatment systems (septic systems and similar decentralized systems), rangeland grazing, wastes from pets, streambank modification/destabilization
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5A
TMDL for:	**WLA + LA + MOS = TMDL**
E. coli	**0 + 9.03x10^{8} + 1.00x10^{8} = 1.00x10^{9} cfu/day**
Plant Nutrients:	
Total Phosphorus	**0 + 0.036 + 0.004 = 0.04 lbs/day**
Total Nitrogen	**0 + 0.396 + 0.044 = 0.44 lbs/day**

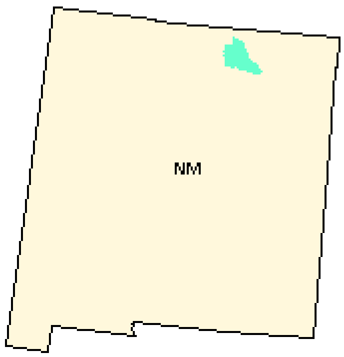
TOTAL MAXIMUM DAILY LOAD FOR
RAYADO CREEK (CIMARRON RIVER TO MIAMI LAKE DIVERSION)

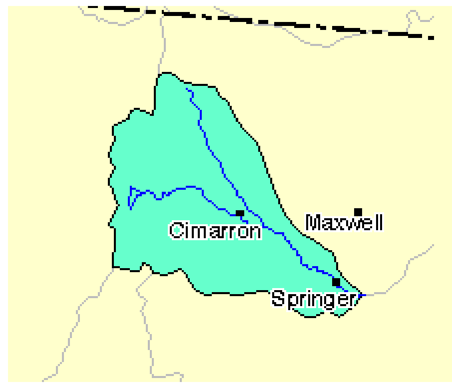




New Mexico Standards Segment	20.6.4.307
Waterbody Identifier	NM-2305.3.A_80 formerly known as NM-CR2-10100
Segment Length	14.24 miles
Parameters of Concern	Plant Nutrients
Uses Affected	Marginal Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	202 square miles
Land Type	Southwestern Tablelands (Ecoregion 26)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Dam or impoundment, habitat modification – other than hydromodification, highway/road/bridge runoff (non-construction related), loss of riparian habitat, rangeland grazing
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5
TMDL for:	
Plant Nutrients:	**WLA + LA + MOS = TMDL**
Total Phosphorus	**0 + 0.063 + 0.007 = 0.07 lbs/day**
Total Nitrogen	**0 + 0.918 + 0.102 = 1.02 lbs/day**

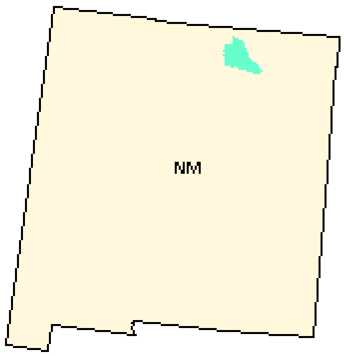
TOTAL MAXIMUM DAILY LOAD FOR
RAYADO CREEK (MIAMI LAKE DIVERSION TO HEADWATERS)

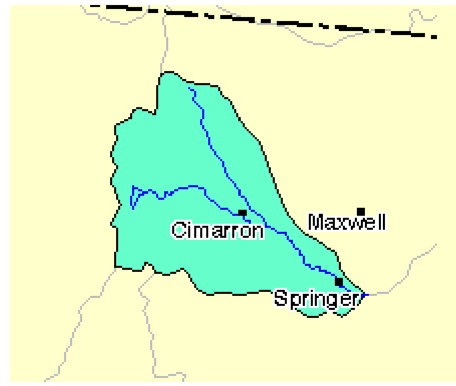




New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_051 formerly known as NM-CR2-10200
Segment Length	24.26 miles
Parameters of Concern	*E. coli*, Temperature
Uses Affected	Secondary Contact, High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	59 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Baseflow depletions from groundwater withdrawls, on-site treatment systems (septic systems and similar decentralized systems), rangeland grazing, wildlife other than waterfowl
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5A
TMDL for:	**WLA + LA + MOS = TMDL**
E. coli	**0 + $5.24x10^9$ + $5.83x10^8$ = $5.83x10^9$ cfu/day**
Temperature	**0 + 143.96 + 16.00 = 159.96 $j/m^2/s/day$**

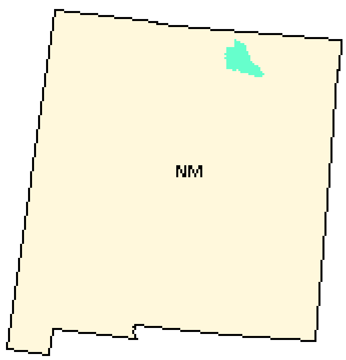
TOTAL MAXIMUM DAILY LOAD FOR SIXMILE CREEK (EAGLE NEST LAKE TO HEADWATERS)

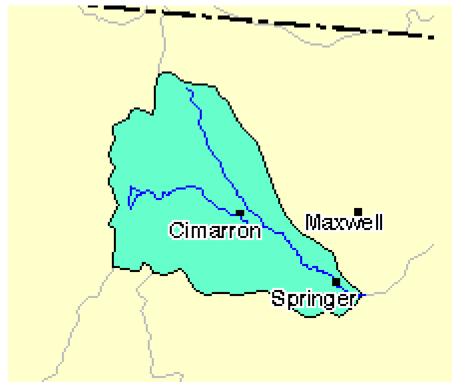




New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_064 (no previous waterbody identifier)
Segment Length	4.6 miles
Parameters of Concern	*E. coli*, Temperature, Plant Nutrients
Uses Affected	Secondary Contact, High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	10.5 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Animal feeding operations (NPS), habitat modification – other than hydromodification, livestock (grazing or feeding operations), natural sources, on-site treatment systems (septic systems and other similar decentralized systems), rangeland grazing, wildlife other than waterfowl
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5
TMDL for:	**WLA + LA + MOS = TMDL**
E. coli	**0 + 4.73×10^8 + 5.25×10^7 = 5.25×10^8 cfu/day**
Temperature	**0 + 171.46 + 19.05 = 190.51 j/m²/s/day**
Plant Nutrients:	
Total Phosphorus	**0 + 0.018 + 0.002 = 0.02 lbs/day**
Total Nitrogen	**0 + 0.207 + 0.023 = 0.23 lbs/day**

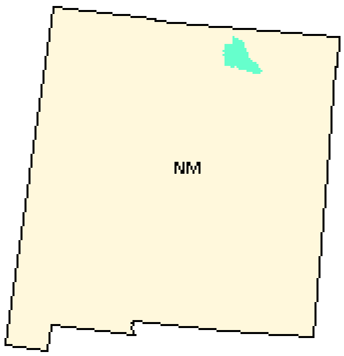
**TOTAL MAXIMUM DAILY LOAD FOR
SOUTH PONIL CREEK (PONIL CREEK TO MIDDLE PONIL)**

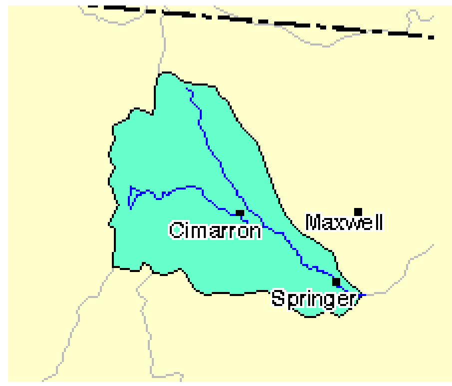




New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_120 formerly known as NM-CR2-10600
Segment Length	5.23 miles
Parameters of Concern	Temperature
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	94.8 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Rangeland grazing
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5A
TMDL for: Temperature	**WLA + LA + MOS = TMDL** **0 + 143.09 + 15.90 = 158.99 j/m^2/s/day**

TOTAL MAXIMUM DAILY LOAD FOR
UTE CREEK (CIMARRON RIVER TO HEADWATERS)





New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_068 formerly known as NM-CR2-Ute
Segment Length	8.04 miles
Parameters of Concern	Arsenic, *E. coli*, Temperature
Uses Affected	Domestic Water Supply, Secondary Contact, High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	15.8 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	51% Forest; 47% Rangeland; 2% Agriculture; <1% Urban
Probable Sources	Loss of riparian habitat, on-site treatment systems (septic systems and similar decentralized systems), rangeland grazing, source unknown
Land Management	84% Private; 9% Forest Service; 7% State; <1% Native Lands
IR Category	5
TMDL for:	**WLA + LA + MOS = TMDL**
Arsenic	**0 + 0.004 + 0.001 = 0.005 lbs/day**
E. coli	**0 + 2.02×10^9 + 2.24×10^8 = 2.24×10^9 cfu/day**
Temperature	**0 + 177.99 + 19.78 = 197.77 $j/m^2/s/day$**

1.0 INTRODUCTION

Under Section 303 of the federal Clean Water Act (CWA), states establish water quality standards, which are submitted and subject to the approval of the U.S. Environmental Protection Agency (USEPA). Under Section 303(d)(1) of the CWA, states are required to develop a list of waters within a state that are impaired and establish a total maximum daily load (TMDL) for each pollutant. A TMDL is defined as "*a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standard including consideration of existing pollutant loads and reasonably foreseeable increases in pollutant loads*" (USEPA 1999). A TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined in 40 Code of Federal Regulations (CFR) Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint sources and natural background conditions." TMDLs also include a margin of safety (MOS). This document provides TMDLs for assessment units within the Cimarron watershed that have been determined to be impaired based on a comparison of measured concentrations and conditions with numeric water quality criteria or with numeric translators for narrative standards.

This document is divided into several sections. Section 2.0 provides background information on the location and history of the Cimarron Watershed, provides applicable water quality standards for the assessment units addressed in this document, and briefly discusses the intensive water quality survey that was conducted in the Cimarron Watershed in 2006. Section 3.0 presents the TMDLs developed for dissolved arsenic in the Cimarron Watershed. Section 4.0 provides *E. coli* TMDLs, Section 5.0 contains nutrient TMDLs, and Section 6.0 details temperature TMDLs. Pursuant to CWA Section 106(e)(1), Section 7.0 provides a monitoring plan in which methods, systems, and procedures for data collection and analysis are discussed. Section 8.0 discusses implementation of TMDLs (phase two) and the relationship between TMDLs and Watershed-Based Plans (WBPs). Section 9.0 discusses assurance, Section 10.0 public participation in the TMDL process, and Section 11.0 provides references.

2.0 CIMARRON WATERSHED CHARACTERISTICS

The Cimarron Basin was sampled by the Surface Water Quality Bureau (SWQB) from March to November 2006. Surface water quality monitoring stations were selected to characterize water quality of perennial stream reaches of the Cimarron River and its tributaries. Water quality impairments identified during this survey are addressed in this document.

2.1 Location Description

The Cimarron River Watershed (US Geological Survey [USGS] Hydrologic Unit Codes [HUC] 11080002) is located in northeastern New Mexico (NM) and is bounded by the Sangre de Cristo Mountains to the west and the Canadian River and Great Plains to the east. The Cimarron River watershed where it enters the Canadian River southeast of Springer, NM to its headwaters drains approximately 2673 square kilometers (1032 square miles). Elevation ranges from 3792 meters (12,441 feet) atop Baldy Mountain to 1759 meters (5770 ft.) at the USGS Gage 07211000 in Springer, NM.

The Cimarron River watershed is located in Omernik Level III Ecoregion 21 (Southern Rockies) in the headwaters and Level III Ecoregion 26 (Southwestern Tablelands) in the lowlands. Therefore, the vegetation of the Cimarron Watershed includes both the Rocky Mountain and Great Plains floras (Omernik 2006). As presented in **Figure 2.1**, land use is 51% forest, 31% grassland, 16% shrubland, 2% agricultural, and <1% urban.

Historic and current land uses in the watershed include farming, ranching, mining, recreation, and municipal related activities. Much of the land ownership adjacent to the river is private with the exceptions of Forest Service land at higher elevations and a small portion of the Valle Vidal in the headwaters of the Ponils (**Figure 2.2**). The elevation range for the various sampling sites in the survey was 5781 feet (ft.) to 8445 ft. above sea level. Annual precipitation ranges from 30 inches in the mixed conifer forests at higher elevations to 15 inches in the semiarid grasslands at lower elevations (NRCS 2007).

Local wildlife includes deer, elk, bear, antelope, turkey, chipmunk, squirrel, beaver, coyote, red fox, porcupine, raccoon, bobcat, mountain lion, and a few bighorn sheep. Golden eagles, long billed curlew, and other birds may be seen in the area. Several species within this watershed are listed as either threatened or endangered by both State and federal agencies. Endangered species include the Southern redbelly dace (*Phoxinus erythrogaster*), Southwestern willow flycatcher (*Empidonax traillii extimus*), Least tern (*Sterna antillarum*), Black-footed ferret (*Mustela nigripes*), and Holy Ghost ipomopsis (*Ipomopsis sancti-spiritus*). Threatened species include the Arkansas River shiner (*Notropis girardi*), Suckermouth minnow (*Phenacobius mirabilis*), Arkansas River speckled chub (*Macrhybopsis tetranema*), Bald eagle (*Haliaeetus leucocephalus*), Mexican spotted owl (*Strix occidentalis lucida*), and Piping plover (*Charadrius melodus*).

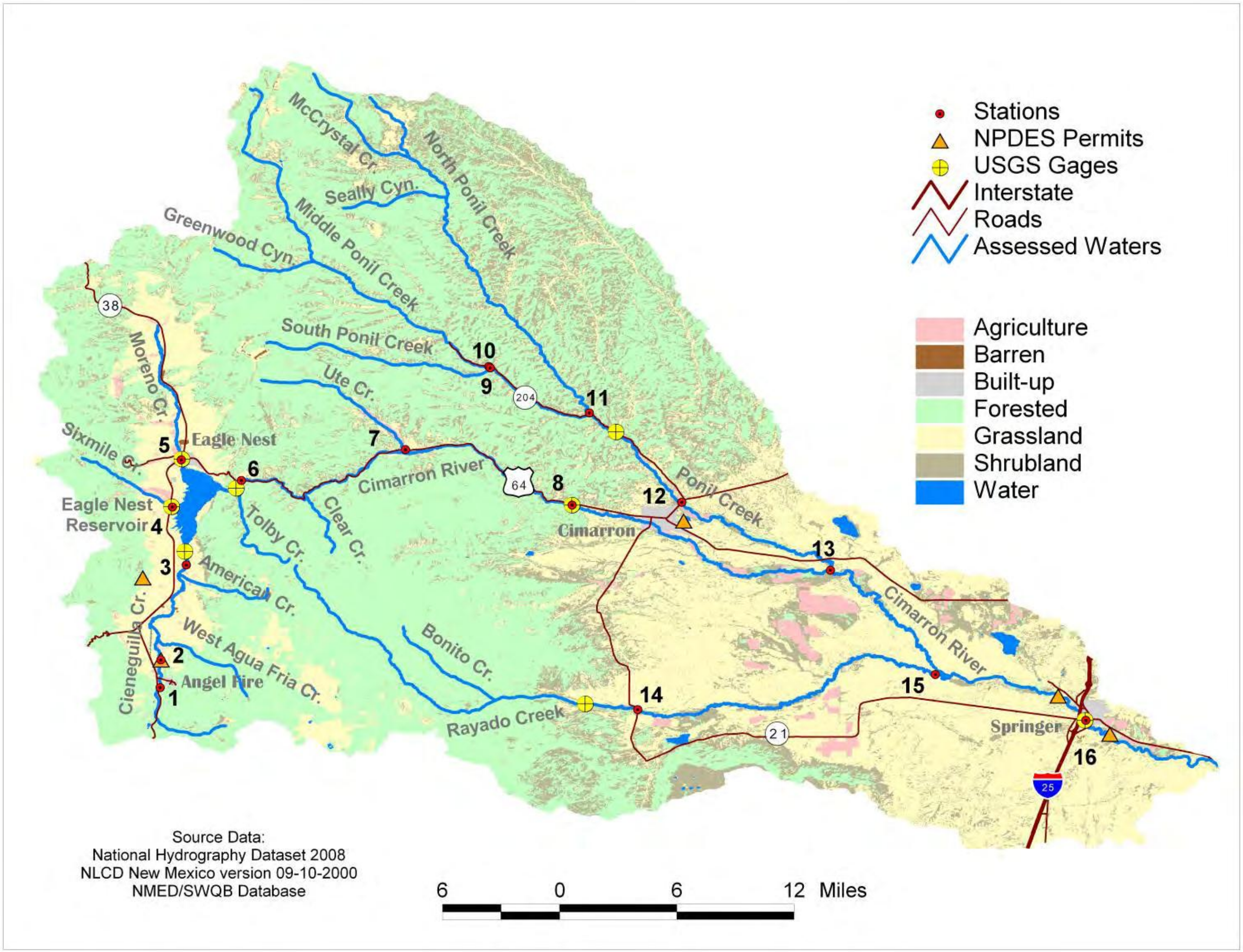


Figure 2.1 Land Use and 2006 Sampling Stations in the Cimarron Watershed. See Table 2.1 for station information.

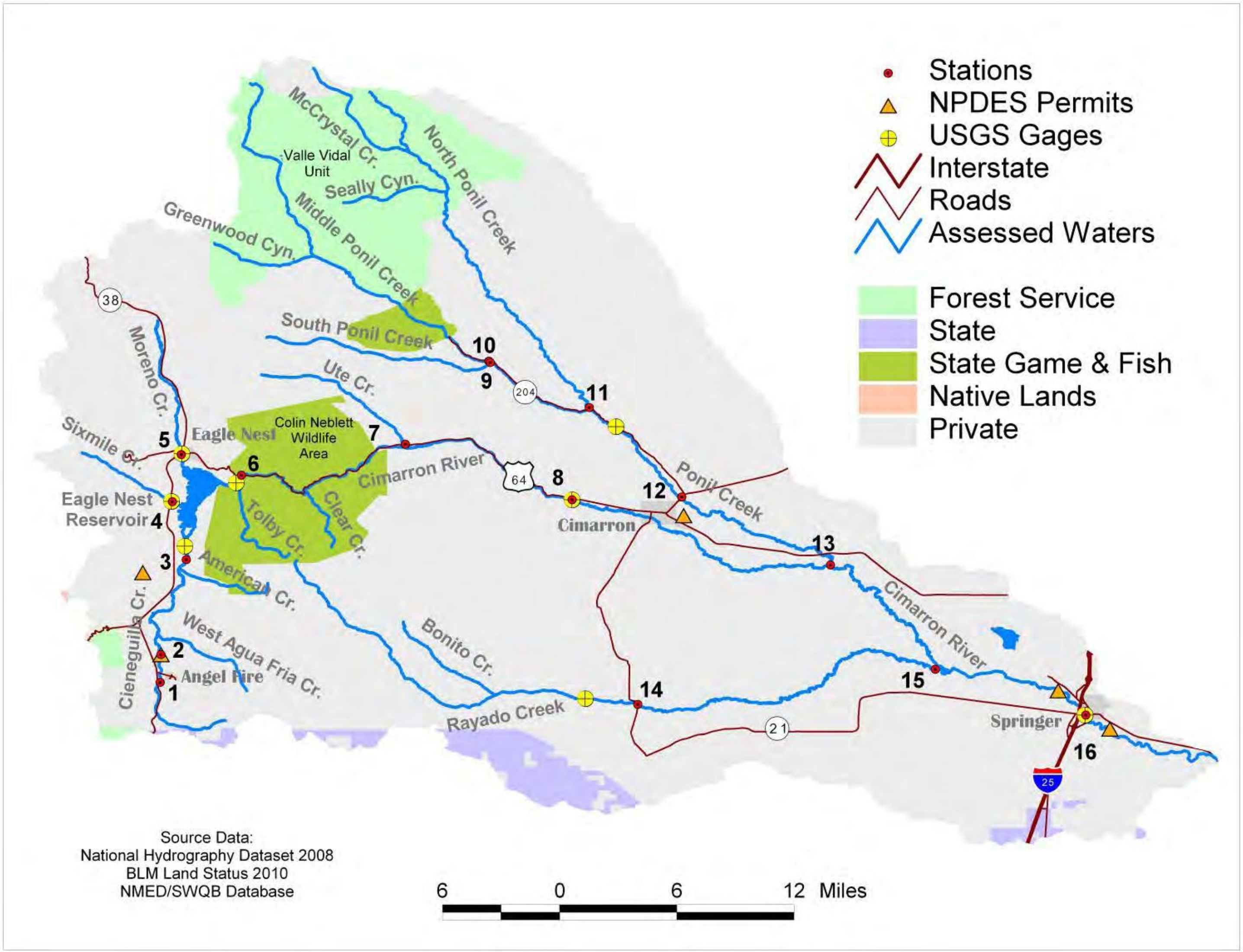


Figure 2.2 Land Management and 2006 Sampling Stations in the Cimarron Watershed

2.2 Geology and Land Use

Both the bedrock geology and the hydrology of the Cimarron watershed are complex. The Cimarron River and its tributaries originate in the Sangre de Cristo Mountains. Cieneguilla, Sixmile, and Moreno Creeks form the headwaters of the Cimarron River. After their convergence into Eagle Nest Lake, the Cimarron River flows east-southeast through Cimarron Canyon State Park and the villages of Ute Park, Cimarron, and Springer. The river empties into the Canadian River several miles southeast of Springer, NM.

The geology of the Cimarron Watershed is characterized by sandstone, shale, mudstone, and claystone that are flanked by limestone or calcareous rocks in the western headwaters, mafic volcanic rocks and metamorphic rocks in the southern headwaters, and intrusive or plutonic rocks in the central watershed (**Figure 2.3**). Taking a closer look, Cimarron Canyon has two distinct terrains that are separated by the Fowler Pass fault near Clear Creek. The rocks on the northeast side of the fault have been intruded by gabbro and granite, both coarse-grained plutonic rocks. The rocks on the southwest side of the fault were once sedimentary or igneous rocks that were heated and squeezed under tremendous pressure deep within the earth's crust turning them into metamorphic rocks and forming the lineation and banding characteristic of many of them. They consist predominantly of quartz, feldspar, and hornblende.

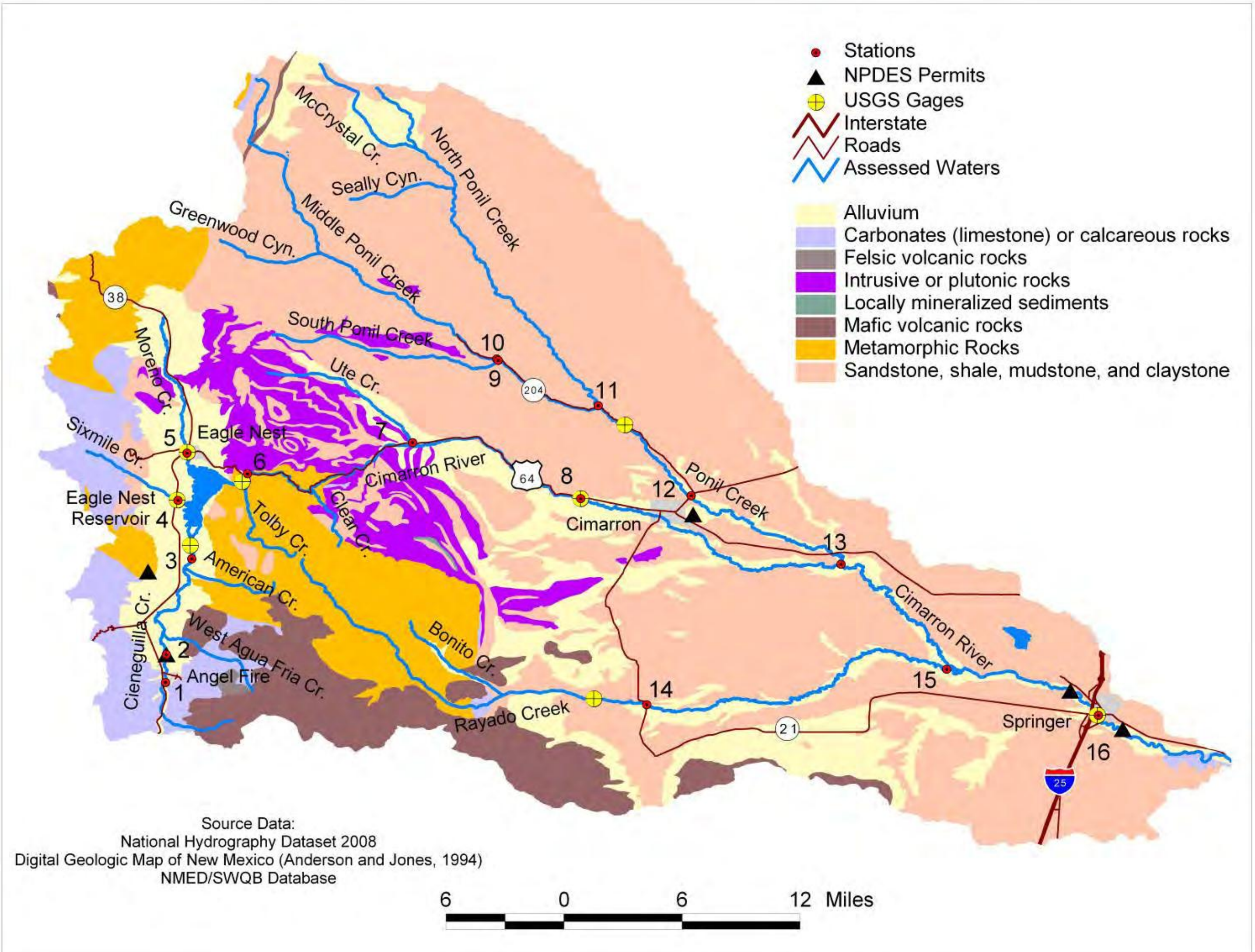


Figure 2.3 Geologic Map of the Cimarron Watershed and 2006 Sampling Stations

2.3 Water Quality Standards and Designated Uses

Water quality standards (WQS) for all assessment units in this document are set forth in sections, 20.6.4.306, 20.6.4.307, and 20.6.4.309 of the *Standards for Interstate and Intrastate Surface Water s,* 20.6.4 New Mexico Administrative Code, as amended through August 1, 2007 (NMAC 2007). These standards have been approved by EPA for Clean Water Act purposes.

20.6.4.306 CANADIAN RIVER BASIN - The Cimarron river downstream from state highway 21 in Cimarron to the Canadian river and all perennial reaches of tributaries to the Cimarron river downstream from state highway 21 in Cimarron.

A. Designated Uses: irrigation, warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

20.6.4.307 CANADIAN RIVER BASIN - Perennial reaches of the Mora river from the USGS gaging station near Shoemaker upstream to the state highway 434 bridge in Mora, all perennial reaches of tributaries to the Mora river downstream from the USGS gaging station at La Cueva in San Miguel and Mora counties, perennial reaches of Ocate creek and its tributaries downstream of Ocate, and perennial reaches of Rayado creek downstream of Miami lake diversion in Colfax county.

A. Designated Uses: marginal coldwater aquatic life, warmwater aquatic life, secondary contact, irrigation, livestock watering and wildlife habitat.

20.6.4.309 CANADIAN RIVER BASIN - The Mora river and perennial reaches of its tributaries upstream from the state highway 434 bridge in Mora, all perennial reaches of tributaries to the Mora river upstream from the USGS gaging station at La Cueva, perennial reaches of Coyote creek and its tributaries, the Cimarron river and its perennial tributaries above state highway 21 in Cimarron, all perennial reaches of tributaries to the Cimarron river north and northwest of highway 64, perennial reaches of Rayado creek and its tributaries above Miami lake diversion, Ocate creek and perennial reaches of its tributaries upstream of Ocate, perennial reaches of the Vermejo river upstream from Rail canyon and all other perennial reaches of tributaries to the Canadian river northwest and north of U.S. highway 64 in Colfax county unless included in other segments.

A. Designated Uses: domestic water supply, irrigation, high quality coldwater aquatic life, livestock watering, wildlife habitat, municipal and industrial water supply and secondary contact.

The numeric criteria identified in these sections are used for assessing waters for use attainability. The referenced Section 20.6.4.900 NMAC provides a list of water chemistry analytes for which SWQB tests and identifies numeric criteria for specific designated uses. In addition, waters are assessed against the narrative criteria identified in Section 20.6.4.13 NMAC, including bottom sediments and suspended or settleable solids, plant nutrients, and turbidity. The individual water quality criteria or narrative standards are detailed for each parameter in the chapters that follow.

Current impairment listings for the Cimarron River Watershed are included in the 2010-2012 State of New Mexico Clean Water Act §303(d)/ §305(b) Integrated List (NMED/SWQB 2010a). The Integrated List is a catalog of assessment units (AUs) throughout the state with a summary of their current status as assessed/not assessed or impaired/not impaired. Once a stream AU is identified as impaired, a TMDL guidance document is developed for that segment with guidelines for stream restoration. Target values for TMDLs are determined based on 1) applicable numeric criteria or appropriate numeric translator to a narrative standard, 2) the degree of experience in applying various management practices to reduce a specific pollutant's loading, and 3) the ability to easily monitor and produce quantifiable and reproducible results. AU names and WQS have changed over the years and the history of these individual changes is tracked in the Record of Decision document associated with the 2010-2012 Integrated List available on the SWQB website.

New Mexico's antidegradation policy is articulated in Subsection A of 20.6.4.8 NMAC. It mandates that "the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state." TMDLs are consistent with this policy because implementation of a TMDL restores water quality so that existing uses are protected and water quality criteria achieved.

2.4 Water Quality Sampling

The Cimarron River Watershed was sampled by the SWQB in 2006. A brief summary of the survey and the hydrologic conditions during the sample period is provided in the following subsections. A more detailed description can be found in Canadian River Water Quality Survey Summary (NMED/SWQB 2010b).

2.4.1 Survey Design

The Monitoring and Assessment Section (MAS) of the SWQB conducted a water quality survey of the Cimarron River Watershed between March and November, 2006. This water quality survey included 16 sampling sites (**Figure 2.1 and Table 2.1**). Most sites were sampled 8 times, while some secondary sites were sampled one to four times. Monitoring these sites enabled an assessment of the cumulative influence of the physical habitat, water sources, and land management activities upstream from the sites. Data results from grab sampling are housed in the SWQB provisional water quality database and were uploaded to USEPA's Storage and Retrieval (STORET) database.

All temperature and chemical/physical sampling and assessment techniques are detailed in the *Quality Assurance Project Plan* (NMED/SWQB 2006) and the SWQB assessment protocols (NMED/SWQB 2008). As a result of the 2006 monitoring effort and subsequent assessment of results, several surface water impairments were determined. Accordingly, these impairments were added to New Mexico's Integrated CWA §303(d)/305(b) List in 2008 (NMED/SWQB 2010a).

Table 2.1 SWQB 2006 Cimarron River Basin Sampling Stations

Station	STATION LOCATION	STORET ID
1	Cieneguilla Creek at Angel Fire Road	05Cieneg019.3
2	Angel Fire WWTP	NM0030503
3	Cieneguilla Creek above Eagle Nest Lake at gage	05Cieneg006.3
4	Sixmile Creek above US 64 near gage	05Sixmil001.4
5	Moreno Creek on NM 64 at gage	05Moreno003.7
6	Cimarron R below Eagle Nest Dam at Tolby CG	05Cimarr077.2
7	Ute Creek above US 64 at Ute Park	05UteCre000.6
8	Cimarron River above Cimarron Village at gage	05Cimarr050.8
9	South Ponil above Middle Ponil	05SPonil008.5
10	Middle Ponil Creek above South Ponil Creek	05MPonil000.1
11	North Ponil Creek above South Ponil	05NPonil000.1
12	Ponil Creek above NM 64	05PonilC014.9
13	Ponil Creek above Cimarron River	05PonilC000.1
14	Rayado Creek on NM 21	05Rayado033.8
15	Rayado Creek above Cimarron River	05Rayado001.8
16	Cimarron River at gage in Springer	05Cimarr013.4

2.4.2 Hydrologic Conditions

There are two active USGS gaging stations in the Cimarron River: the Cimarron River below Eagle Nest Dam and Cimarron River near Cimarron, NM with periods of record from 1950 to present day. The annual daily mean streamflow for the Cimarron River is 16.3 cubic feet per second (cfs) below Eagle Nest Dam and 23.6 cfs near Cimarron, NM (**Figures 2.4 and 2.5**).

During the 2006 watershed survey, daily flows in the Cimarron River below Eagle Nest Dam were below average from July through September with an annual daily mean streamflow of 14.0 cfs, approximately 14% below "normal". Likewise, daily flows in the Cimarron River near Cimarron, NM were below average from January through September with an annual daily mean streamflow of 14.9 cfs, approximately 37% below "normal" (**Figure 2.6**).

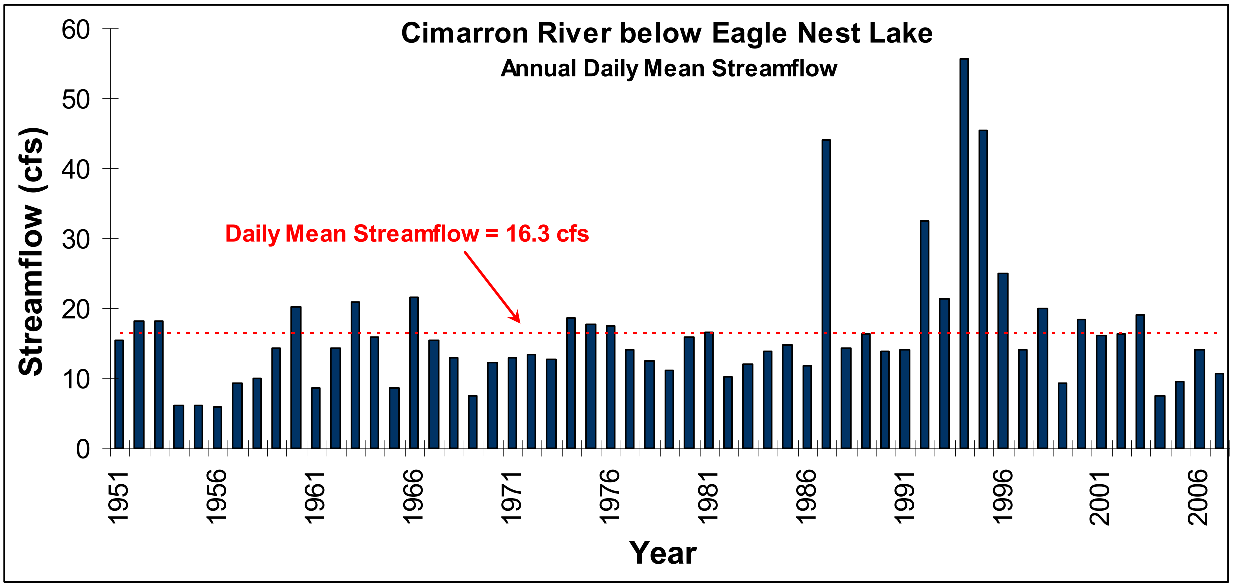


Figure 2.4 Cimarron River below Eagle Nest Dam (1951 – 2007)

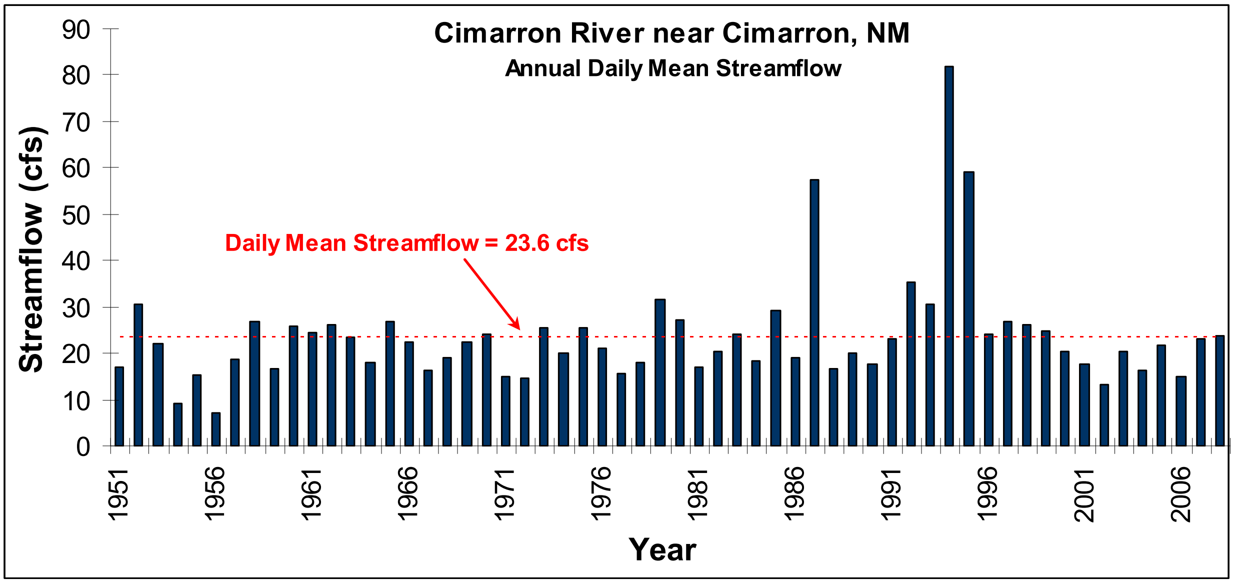
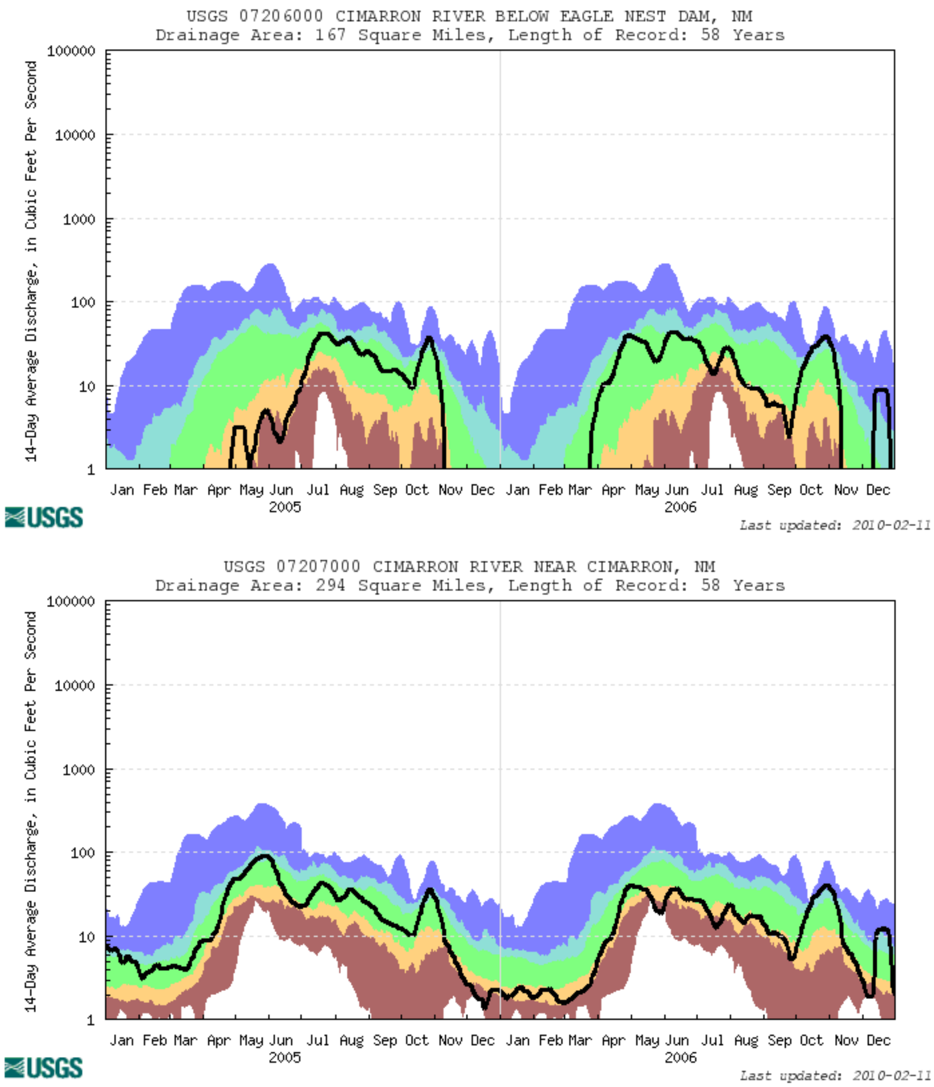


Figure 2.5 Cimarron River near Cimarron, NM (1951 – 2008)



Explanation – Percentile classes					
Lowest - 10th percentile	**10 - 24**	**25 – 75**	**76 - 90**	90th percentile - highest	**Flow**
Much below normal	Below normal	NORMAL	Above normal	Much above normal	

Figure 2.6 USGS streamflow duration hydrographs for the Cimarron River

As stated in the Assessment Protocol (NMED/SWQB 2009), data collected during all flow conditions, including low flow conditions (i.e., flows below 4-day, 3-year flows [4Q3]), will be used to determine designated use attainment status during the assessment process. For the purpose of assessing designated use attainment in ambient surface waters, WQS apply at all times under all flow conditions.

3.0 ARSENIC

Assessment of data from the 2006 SWQB water quality survey in the Cimarron River watershed identified exceedences of the New Mexico water quality standards for arsenic in:

- Cimarron River (Cimarron Village to Turkey Creek)
- Cimarron River (Turkey Creek to Eagle Nest Lake)
- Ute Creek (Cimarron River to headwaters)

Consequently, these waterbodies were listed on the Integrated CWA §303(d)/§305(b) list for arsenic (NMED/SWQB 2010a).

3.1 Target Loading Capacity

The target values for these arsenic TMDLs are based on the dissolved arsenic criteria in 20.6.4.900 NMAC: 2.3 µg/L for domestic water supply, 9.0 µg/L for human health, and 100 µg/L for irrigation. Exceedences for each assessment unit are presented in Table 3.1.

Arsenic is a naturally occurring element widely distributed in the earth's crust. Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching. Fish and shellfish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful.

Table 3.1 Dissolved arsenic exceedences

Assessment Unit	Designated Use Affected	Associated Criterion (µg/L)	Exceedence Ratio (# exceedences / total # samples)
Cimarron River (Cimarron Village to Turkey Creek)	DWS	2.3	3/4
Cimarron River (Turkey Creek to Eeagle Nest Lake)	DWS	2.3	3/4
Ute Creek (Cimarron River to headwaters)	DWS	2.3	3/4

Notes: DWS = Domestic Water Supply
µg/L = micrograms per liter

3.2 Flow

Arsenic concentrations can vary as a function of flow, therefore TMDLs are calculated at a specific flow. Streamflow was measured by SWQB during the 2006 sampling season using standard procedures (NMED/SWQB 2007). Flows measured in Ute Creek above US 64 at Ute Park, NM ranged from 0.06 cfs to 3.24 cfs. Water quality standard exceedences *only* occurred during low flows. Therefore, the critical flow value used to calculate the TMDL for Ute Creek was based on a low-flow condition using a 4Q3 regression model. The 4Q3 is the minimum average 4 consecutive day flow that occurs with a frequency of once in 3 years.

It is necessary to estimate a critical flow for a portion of a watershed where there is no active flow gage as in Ute Creek. This can be accomplished by applying one of several different formulas developed by the U.S. Geological Survey (USGS).

It is possible to extrapolate a known discharge duration and/or return interval at a gaged site to an ungaged site by using a drainage-area ratio adjustment. However, this extrapolation is applicable only when the drainage-area ratio between the gaged and ungaged watersheds is between 0.5 and 1.5. In cases where the recommended areal ratio is outside of this range, as is the case between the Cimarron River (gaged site) and Ute Creek (ungaged site), analysis methods described by Waltemeyer (2002) are used to estimate flow. In this analysis, two regression equations for estimating the 4Q3 flow were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). 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):

$$4Q3 = 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{3.58}\ S^{1.35} \qquad \text{(Eq. 3-1)}$$

where,

4Q3 = minimum average four-day, three-year flow (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (percent).

The average standard error of the estimate (SEE) and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3 for Ute Creek was estimated using the regression equation for mountainous regions (Eq. 3-1) because the average elevation for this assessment unit is greater than 7,500 feet in elevation (Table 3.2).

Table 3.2 Calculation of 4Q3 Flow

Assessment Unit	Average elevation (ft.)	Drainage area (mi^2)	Mean winter precipitation (in.)	Average basin slope (percent)	4Q3 (cfs)
Ute Creek (Cimarron River to headwaters)	9183	15.754	10.01	0.299	0.378

The 4Q3 value for Ute Creek was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows:

$$0.378\ \frac{ft^3}{\sec} \times 1{,}728 \frac{in^3}{ft^3} \times 0.004329 \frac{gal}{in^3} \times 86{,}400\ \frac{\sec}{day} \times 10^{-6} = 0.244 mgd$$

Streamflow in the Cimarron River was measured by the USGS during the 2006 sampling season using active gages below Eagle Nest Dam (USGS 07206000) and near Cimarron, NM (USGS 07207000). Average daily streamflow in the Cimarron River below Eagle Nest Dam ranged from 0.50 cfs to 44 cfs during the SWQB sampling events. Average daily streamflow near Cimarron, NM ranged from 2.3 cfs to 39 cfs during the SWQB sampling events. Water quality standard exceedences *only* occurred during higher flows. Therefore, the critical streamflow value for this TMDL is not the 4Q3 but the lowest streamflow at which the arsenic standard is exceeded, or the expected flow at which arsenic is equal to 2.3 µg/L. Figure 3.1 depicts the relationship between arsenic and streamflow for the Cimarron River below Eagle Nest Lake (R^2 = 0.57) and Figure 3.2 depicts the relationship between arsenic and streamflow for the Cimarron River near Cimarron, NM (R^2 = 0.90).

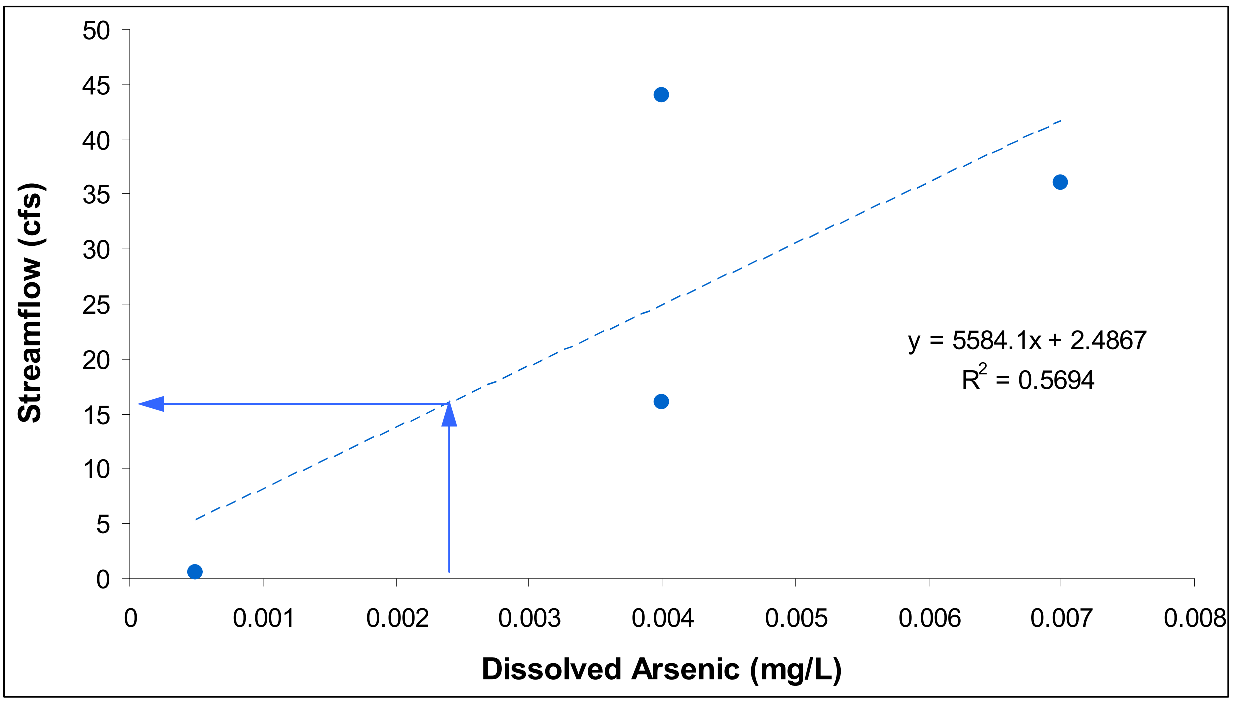


Figure 3.1 Cimarron River below Eagle Nest Lake: Arsenic vs. Streamflow Relationship

The critical flows are based on SWQB data and were calculated using the relationship between arsenic and streamflow presented in Figures 3.1 and 3.2. Using the arsenic-flow relationship and an arsenic standard of 2.3 µg/L (0.0023 mg/L) for the x-variable, the estimated critical flows are:

- Cimarron River (Turkey Creek to Eagle Nest Lake) =
  (5584.1 x 0.0023 mg/L) + 2.4867 ≅ 15.3 cfs
- Cimarron River (Cimarron Village to Turkey Creek) =
  (10802 x 0.0023 mg/L) – 1.0299 ≅ 23.8 cfs

The critical streamflow value for the Cimarron River (Turkey Creek to Eagle Nest Lake) was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows:

$$15.3\,\frac{ft^3}{\sec}\times 1{,}728\,\frac{in^3}{ft^3}\times 0.004329\,\frac{gal}{in^3}\times 86{,}400\,\frac{\sec}{day}\times 10^{-6} = 9.91\,mgd$$

Critical flow for the Cimarron River (Cimarron Village to Turkey Creek) was converted to million gallons per day using the same formula. The resulting critical flows are listed in Table 3.3.

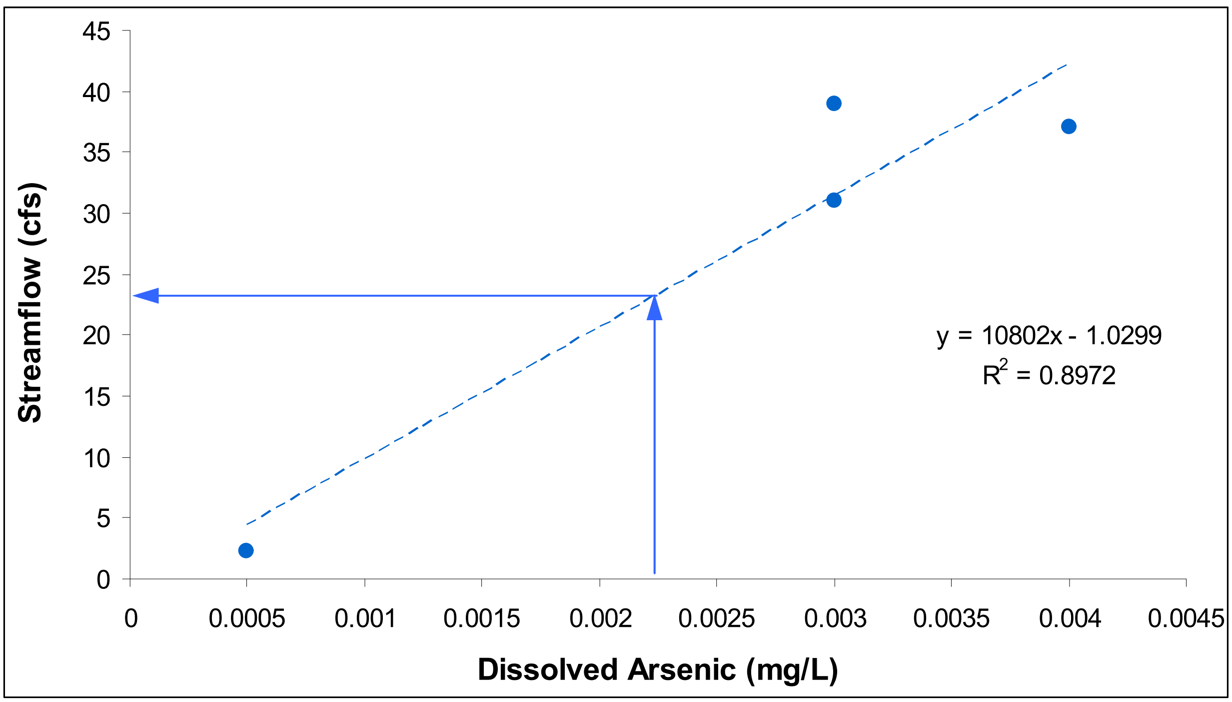


Figure 3.2 Cimarron River near Cimarron, NM: Arsenic vs. Streamflow Relationship

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of a 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.

3.3 Calculations

A target load for arsenic is calculated based on the critical flow, the current water quality criterion, and a conversion factor (0.00834) that is used to convert µg/L units to lbs/day (see Appendix A for conversion factor derivation). The target loading capacity is calculated using Equation 3-2. The results are shown in Table 3.3.

Critical flow (mgd) x Criterion (µg/L) x 0.00834 = Target Loading Capacity (Eq. 3-2)

Table 3.3 Calculation of target loads for dissolved arsenic

Assessment Unit	Critical Flow (mgd)	Dissolved Arsenic[1] (µg/L)	Conversion Factor	Target Load Capacity[2] (lbs/day)
Cimarron River (Cimarron Village to Turkey Creek)	15.4	2.3	0.00834	0.295
Cimarron River (Turkey Creek to Eagle Nest Lake)	9.91	2.3	0.00834	0.190
Ute Creek (Cimarron River to headwaters)	0.244	2.3	0.00834	0.005

Notes: [1] target values are based on the most conservative criterion applicable to each assessment unit.
[2] values rounded to three significant figures

The measured loads for arsenic were similarly calculated. The arithmetic mean of the data used to determine the impairment was substituted for the criterion in Equation 2. The same conversion factor of 0.00834 was used. Results are presented in Table 3.4.

Table 3.4 Calculation of measured loads for dissolved arsenic

Assessment Unit	Critical Flow (mgd)	Dissolved Arsenic Arithmetic Mean[1] (µg/L)	Conversion Factor	Measured Load[2] (lbs/day)
Cimarron River (Cimarron Village to Turkey Creek)	15.4	3.3	0.00834	0.424
Cimarron River (Turkey Creek to Eagle Nest Lake)	9.91	5.0	0.00834	0.413
Ute Creek (Cimarron River to headwaters)	0.244	3.7	0.00834	0.008

Notes: [1] dissolved arsenic concentration is the arithmetic mean of observed exceedences
[2] values rounded to three significant figures

3.4 Waste Load Allocations and Load Allocations

3.4.1 Waste Load Allocation

There are no active point source dischargers on these AUs. Neither are there any Municipal Separate Storm Sewer System (MS4) storm water permits. However, excess metal levels may be a component of some storm water discharges covered under general NPDES permits, so the load from these dischargers should be addressed.

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 National Pollutant Discharge Elimination System (NPDES) Construction General 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. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of an SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation (LA).

3.4.2 Load Allocation

In order to calculate the LA, the WLA and margin of safety (MOS) were subtracted from the target capacity TMDL following Equation 3-3:

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 3-3)}$$

The MOS is estimated to be 20 percent of the target load calculated in Table 3.3. Results are presented in Table 3.5. Additional details on the MOS are presented in Section 3.7.

Table 3.5 TMDL for dissolved arsenic

Assessment Unit	WLA (lbs/day)	LA (lbs/day)	MOS (20%) (lbs/day)	TMDL* (lbs/day)
Cimarron River (Cimarron Village to Turkey Creek)	0	0.236	0.059	0.295
Cimarron River (Turkey Creek to Eagle Nest Lake)	0	0.150	0.040	0.190
Ute Creek (Cimarron River to headwaters)	0	0.004	0.001	0.005

Notes: *values rounded to three significant figures

The extensive data collection and analyses necessary to determine background arsenic loads for the Cimarron River watershed were beyond the resources available for this study. It is therefore assumed that a portion of the LA is made up of natural background loads.

The load reductions necessary to meet the target loads were calculated to be the difference between the calculated TMDL (Table 3.3) and the measured loads (Table 3.4), and are shown in Table 3.6. These load reduction tables are presented for informational purposes only. It is important to note that WLAs and LAs are estimates based on a specific flow condition (see Section 3.2). Under differing hydrologic conditions, the loads will change. For this reason the load allocations given here are less meaningful than are the relative percent reductions. Successful implementation of this TMDL will be determined based on achieving the current water quality standards.

Table 3.6 Calculation of load reduction for dissolved arsenic

Assessment Unit	Target Load (lbs/day) *(a)*	Measured Load (lbs/day)	Load Reduction (lbs/day)	Percent Reduction *(b)*
Cimarron River (Cimarron Village to Turkey Creek)	0.236	0.424	0.188	44%
Cimarron River (Turkey Creek to Eagle Nest Lake)	0.150	0.413	0.263	64%
Ute Creek (Cimarron River to headwaters)	0.004	0.008	0.004	50%

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 = TMDL - MOS
(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

3.5 Identification and Description of Pollutant Source(s)

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list is reviewed and modified, as necessary, with watershed group/stakeholder input during the TMDL public meeting and comment period.

The Probable Source Identification Sheets in Appendix B provide 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 probable sources of impairment in this watershed. The list of "Probable Sources" is not intended to single out any particular land owner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each known impairment. Table 3.7 displays probable sources along the reach as determined by field reconnaissance and assessment. Probable sources of arsenic will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP) process.

Table 3.7 Pollutant source summary for Arsenic

Assessment Unit	Pollutant Sources	Magnitude[(a)] (lbs/day)	Probable Sources[(b)] (% from each)
Cimarron River (Cimarron Village to Turkey Creek)	Point: Nonpoint:	n/a 0.424	0% 100% Baseflow depletion from groundwater withdrawls, rangeland grazing, source unknown
Cimarron River (Turkey Creek to Eagle Nest Lake)	Point: Nonpoint:	n/a 0.413	0% 100% Dam or impoundment, other recreational pollution sources, source unknown
Ute Creek (Cimarron River to headwaters)	Point: Nonpoint:	n/a 0.008	0% 100% Rangeland grazing, source unknown

Notes: *(a)* Measured Loads in pounds per day.
(b) From the Integrated CWA 303(d)/305(b) list (NMED/SWQB 2010a). This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed nor quantified at this time.

3.6 Linkage of Water Quality and Pollutant Sources

Arsenic is a naturally occurring element found in many of the rocks and minerals that make up the earth's crust. The minerals with the highest arsenic content are realgar and orpiment, both arsenic sulfides, which contain 70% and 60% arsenic by weight, respectively. These minerals are rare. More common arsenic containing minerals include arsenopyrite and pyrite ("fool's gold"). These two minerals can contain as much as 48% and 5% arsenic by weight, respectively. One of the geologic settings in which these minerals occur is areas where precious metals have been deposited, and both minerals are common in New Mexico. Although the arsenic in these minerals is chemically bound into their structure, it can be introduced into surface water or groundwater through the dissolution of minerals and ores (NMBGMR 2002).

Baldy Mountain, the highest mountain in the *Cimarron Mountains* subrange of the Sangre de Cristo Mountains, is located in the Moreno Valley near Eagle Nest, NM. Baldy Mountain, as well as others mountains in this range, has seen extensive mining over the years. Gold was discovered around 1867 and mining operations began soon after. Miners strip mined areas of the mountain that they thought had gold. One negative result of the extensive mining in the area is that arsenic can be very concentrated in mine tailings, especially in those associated with gold mining operations.

SWQB performed a water quality survey of Eagle Nest Lake in 2005. There were 4 of 6 exceedences of the domestic water supply criterion (2.3 ug/L). Therefore, Eagle Nest Lake is listed as impaired due to arsenic. Since Eagle Nest Lake sits in the Moreno Valley below many of these abandoned mines, it is reasonable to expect that some of the waste products connected with the "gold rush" have found their way into the surface waters of the Moreno Valley and washed into Eagle Nest Lake. In addition, since Eagle Nest Lake supplies the majority of water to the Cimarron River, it is not surprising that the Cimarron River below Eagle Nest Dam is also listed as impaired due to arsenic.

3.7 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. The MOS can be expressed either implicitly or explicitly. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

For these arsenic TMDLs, the margin of safety was developed using a combination of conservative assumptions and explicit recognition of potential errors. Therefore, this margin of safety takes into account the following assumptions:

- *Conservative Assumptions*

  Using the critical flow, or "worst case scenario," to calculate the allowable loads.

- *Explicit recognition of potential errors*

  A level of uncertainty exists in water quality sampling. Techniques used for measuring arsenic concentrations in stream water can lead to inaccuracies in the data. A conservative MOS for this element is **10 percent.**

There is also inherent error in all flow calculations. A conservative MOS for this element is **10 percent.**

Therefore, based on the potentia l errors described ab ove, a cons ervative, explicit MOS of 20% was assigned to the arsenic TMDLs.

3.8 Consideration of Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs take into consideration seasonal variation in watershed conditions and pollutant loading. During the 2006 water quality survey, arsenic exceedences occurred mainly during higher streamflows, which coincides with seasonal water releases from Eagle Nest dam. Higher flows caused by stormwater runoff may also flush more nonpoint source runoff containing sediment and metals. It is possible the criterion may be exceeded under a low flow condition when there is insufficient dilution. Evaluation of seasonal variability for potential nonpoint sources is difficult due to limited available data. Data used in the calculation of this TMDL were collected during the spring, summer, and fall of 2006 in order to ensure coverage of any potential seasonal variation in the system.

3.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2035. Growth estimates for Colfax County project a 14% growth rate through 2035. However, as of 2008, the largest incorporated town in the county, Raton, had an estimated population of 6,465 people. This showed a decrease of 11.22 percent from the 2000 census population and Raton's population is not expected to have much growth in the future.

According to the data, arsenic loading is mainly from Eagle Nest Lake sourcewater and other diffuse nonpoint sources (i.e. abandoned mines and tailings). Estimates of future growth are not anticipated to lead to a significant increase in metals concentrations that cannot be controlled with best management practice (BMP) implementation in this watershed. However, it is imperative that BMPs continue to be utilized and improved upon in this watershed while adhering to SWPPP requirements related to construction and industrial activities covered under the general permit.

4.0 BACTERIA

Assessment of the data from the 2006 SWQB water quality survey in the Cimarron River watershed identified exceedences of the New Mexico water quality standards for *E. coli* bacteria in:

- Cieneguilla Creek (Eagle Nest Lake to headwaters)
- North Ponil Creek (South Ponil Creek to Seally Canyon)
- Ponil Creek (US 64 to confluence of North and South Ponil)
- Ponil Creek (Cimarron River to US 64)
- Rayado Creek (Miami Lake diversion to headwaters)
- Sixmile Creek (Eagle Nest Lake to headwaters)
- Ute Creek (Cimarron River to headwaters)

As a result, these assessment units were listed on the Integrated CWA §303(d)/§305(b) List with *E. coli* as a pollutant of concern (NMED/SWQB 2010a). When water quality standards have been achieved, the reach will be moved to the appropriate category on the Clean Water Act Integrated §303(d)/§305(b) List of assessed waters.

4.1 Target Loading Capacity

For this TMDL document, target values for bacteria are based on the reduction in bacteria necessary to achieve numeric criteria:

20.6.4.306 NMAC: The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less.

20.6.4.309 NMAC: The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less.

The presence of *E. coli* bacteria is an indicator of the possible presence of other pathogens that may limit beneficial uses and present human health concerns. Exceedences for each assessment unit are presented in Table 4.1.

Table 4.1 *E. coli* exceedences

Assessment Unit	Designated Use Affected	Associated Criterion* (cfu/100mL)	Exceedence Ratio (# exceedences / total # samples)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	SC	235	4/6
North Ponil Creek (South Ponil Creek to Seally Canyon)	SC	235	2/6
Ponil Creek (US 64 to confl of North and South Ponil)	SC	235	3/6
Ponil Creek (Cimarron River to US 64)	SC	410	2/6

Assessment Unit	Designated Use Affected	Associated Criterion* (cfu/100mL)	Exceedence Ratio (# exceedences / total # samples)
Rayado Creek (Miami Lake Diversion to headwaters)	SC	235	2/7
Sixmile Creek (Eagle Nest Lake to headwaters)	SC	235	2/6
Ute Creek (Cimarron River to headwaters)	SC	235	2/6

Notes: * = single sample criterion
SC = Secondary Contact
cfu = colony forming units
mL = milliliters

4.2 Flow

TMDLs are calculated at a specific flow and bacteria concentrations can vary as a function of flow. SWQB determined streamflow during the 2006 sampling season either by using the active USGS gage network or by taking direct in-stream flow measurements utilizing standard procedures. Water quality standard exceedences for all impaired reaches except Ute Creek occurred *only* during lower flows. Therefore, for these reaches, the critical flow value used to calculate the TMDLs was obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the annual lowest 4 consecutive day flow that occurs with a frequency of at least once every 3 years.

When available, USGS gages are used to estimate the critical flow. There are nine gages that were active in the Cimarron Watershed around the time of the water quality survey and data collection efforts (Table 4.2). The 4Q3 flows for Cieneguilla Creek, upper Ponil Creek, Rayado Creek, and Sixmile Creek were estimated using the appropriate gage data and DFLOW software, Version 3.1b (USEPA 2006). DFLOW 3.1b is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis by utilizing algorithms based on Log Pearson Type III distribution.

A climatic year starting April 1 of the prior year and ending March 31 is often used when examining critical low flow conditions in the United States. This choice reduces the likelihood of splitting low flow periods - typically found in the summer or fall - across different years and thereby affecting the results of Log Pearson Type III analysis of series of annual low flows. A different climatic year or shorter season may be used if low flow periods occur at other times of the year or overlap the boundaries of the climatic year.

DFLOW 3.1 allows the user to specify a season that lasts less than a year by indicating the start date and end date of the season. A seasonal component was added to the higher elevation reaches (e.g. Cieneguilla Creek and Sixmile Creek) because cold temperatures and freezing conditions combine to create zero dischage during the winter months. The 4Q3 flows for Cieneguilla Creek and Sixmile Creek were calculated using gage data from the typical growing season for the ecoregion and elevation (July 1 – September 30). The growing seasons were established for three general regions by using the median annual dates of the last and first frost from the National Weather Service (Table 4.3). If a full year's worth of data were included in the critical flow calculations for these high elevation streams then the 4Q3 values would be zero.

Table 4.2 USGS gages in the Cimarron Watershed (HUC 11080002)

Agency	Site Number	Site Name	Period of Record
USGS	7204000	Moreno Creek at Eagle Nest, NM	1928 - 2008
USGS	7204500	Cieneguilla Creek near eagle Nest. NM	1928 - 2008
USGS	7205000	Sixmile Creek near Eagle Nest, NM	1958 - 2008
USGS	7205500	Eagle Nest Lake near Eagle Nest, NM	1987 - present
USGS	7206000	Cimarron River below Eagle Nest Dam, NM	1950 - present
USGS	7207000	Cimarron River near Cimarron, NM	1950 - present
USGS	7207500	Ponil Creek near Cimarron, NM	1916 - present
USGS	7208500	Rayado Creek near Cimarron, NM	1911 - present
USGS	7211000	Cimarron River at Springer, NM	1907 - 2004

Table 4.3 Growing season definitions for ecoregion and elevation classes

Regions	Ecoregion Names	Ecoregion	Begin	End	Length
Mountain >7500 ft	S. Rockies & AZ/NM Mountains	22 & 23	1-July	1-Oct	3 months
Mountains <7500 ft & Plateau	S. Rockies, AZ/NM Mountains & AZ/NM Plateau	20, 21, 22 & 23	15-Jun	1-Nov	4 ½ months
S. Deserts and Plains	SW Tablelands & Chihuahuan Desert	24, 25, 26, & 79	15-May	15-Nov	6 months

In addition, more than 80 percent of the water used in Colfax County goes into agricultural activities and surface water is the primary source of water for irrigated agriculture in the county (DBS&A 2003). Water is diverted from Ponil Creek to Chase Ranch Ditch near Cimarron, NM. Assuming a 1.5 acre-foot/acre allotment, the estimated maximum amount of water diverted from Ponil Creek could be 462 acre-feet (ac-ft) per year, or roughly 1.28 cfs during the growing season; however the ranch has never received its full 1.5 ac-ft allotment. The most it has ever received is 9.5 inches per acre, and in a typical year they receive about 4 inches per acre (DBS&A 2003) translating to approximately 0.67 cfs (highest diversion) and 0.28 cfs (average diversion) during the growing season. The 4Q3 flow for this portion of Ponil Creek was calculated using gage data from the typical growing season for the ecoregion and elevation (May 15 – November 15). The typical amount of water diverted from Ponil Creek during the growing season (0.28 cfs) was added to the calculated 4Q3 value (0.04 cfs) to obtain an estimate of the actual critical flow.

The calculated 4Q3s using DFLOW software and assumptions noted above are:

- Cieneguilla Creek (Eagle Nest Lake to headwaters) = 0.31 cfs
- Ponil Creek (US 64 to confl of North & South Ponil) = 0.32 cfs
- Rayado Creek (Miami Lake diversion to headwaters) = 1.88 cfs
- Sixmile Creek (Eagle Nest Lake to headwaters) = 0.17 cfs

It is often necessary to estimate a critical flow for a portion of a watershed where there is no active USGS flow gage. 4Q3 derivations for ungaged streams in the Cimmaron Watershed were based on analysis methods described by Waltemeyer (2002). In Waltemeyer's 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 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):

$$4Q3 \;=\; 7.3287 \times 10^{-5}\, DA^{0.70}\, P_w^{3.58}\, S^{1.35} \qquad \text{(Eq. 4-1)}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (percent).

The average standard error of the estimate (SEE) and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3s for the North Ponil Creek and lower Ponil Creek were estimated using the regression equation for mountainous regions (Eq. 4-1) because the mean elevations for these assessment units were above 7,500 feet in elevation (Table 4.4).

Table 4.4 Calculation of 4Q3 Low-Flow Frequencies

Assessment Unit	Average Elevation (ft.)	Drainage Area (mi^2)	Mean Winter Precipitation (in.)	Average Basin Slope (percent)	4Q3 (cfs)
North Ponil Creek (South Ponil Creek to Seally Canyon)	8127	85.4	7.34	0.199	0.234
Ponil Creek (Cimarron River to US 64)	7995	325	6.78	0.277	0.702

For Ute Creek (Cimarron River to headwaters), water quality standard exceedences *only* occurred during higher flows. Therefore, the critical streamflow value for Ute Creek is the lowest streamflow at which the *E. coli* standard is exceeded, or the expected flow at which *E.*

coli is equal to 235 cfu/100 mL. Figure 4.1 depicts the relationship between *E. coli* and streamflow for Ute Creek (R^2 = 0.66).

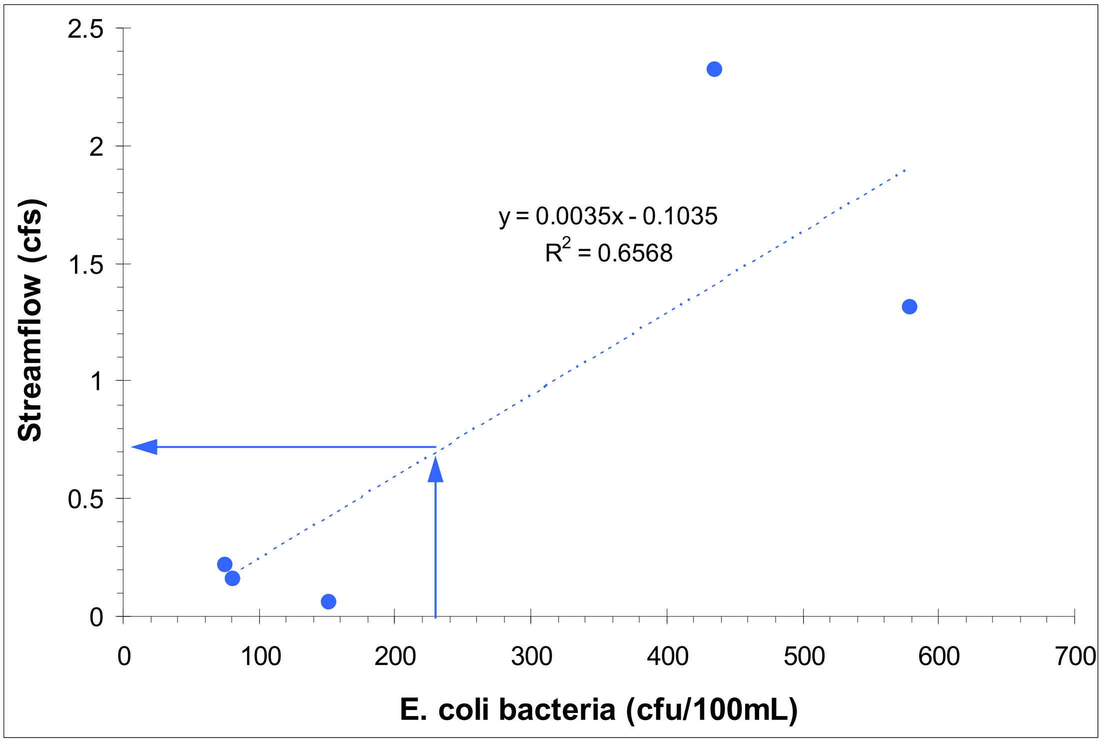


Figure 4.1 Ute Creek above US 64: *E. coli* vs. Streamflow Relationship

The critical flow for Ute Creek is based on SWQB data and was calculated using the relationship between bacteria and streamflow presented in Figure 4.1. Using the bacteria – flow relationship and a standard of 235 cfu/100mL for the x-variable, the estimated critical flow is:

- Ute Creek (Cimarron River to headwaters) =
  (0.0035 x 235 cfu/100mL) – 0.1035 ≅ 0.72 cfs

The critical streamflow value for Ute Creek was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows:

$$0.72\,\frac{ft^3}{\sec}\times 1{,}728\,\frac{in^3}{ft^3}\times 0.004329\,\frac{gal}{in^3}\times 86{,}400\,\frac{\sec}{day}\times 10^{-6} = 0.47\,mgd$$

Critical flows for the other reaches were converted to million gallons per day using the same formula.

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

Bacteria standards are expressed as colony forming units (cfu) per unit volume. The *E. coli* criteria used to calculate the allowable stream loads for the impaired assessment units are listed in Table 4.5. Target loads for bacteria are calculated based on flow values, water quality standards, and a conversion factor (Equation 4-2). The more conservative monthly geometric mean criteria are utilized in TMDL calculations to provide an implicit MOS. Furthermore, if the single sample criteria were used as targets, the geometric mean criteria may not be achieved.

*C as cfu/100 mL * 1,000 mL/1 L * 1 L/ 0.264 gallons * Q in 1,000,000 gallons/day = cfu/day* (Eq. 4-2)

Where C = the water quality criterion for bacteria,
Q = the critical stream flow in million gallons per day (mgd)

Table 4.5 Calculation of target loads for *E.coli*

Assessment Unit	Critical Flow (mgd)	*E.coli* geometric mean criteria (cfu/100mL)	Conversion Factor$^{(a)}$	Target Load Capacity (cfu/day)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	0.70^{+}	126	3.79×10^7	3.34×10^9
North Ponil Creek (South Ponil Creek to Seally Canyon)	0.15	126	3.79×10^7	7.16×10^8
Ponil Creek (US 64 to confl of North and South Ponil)	0.21	126	3.79×10^7	1.00×10^9
Ponil Creek (Cimarron River to US 64)	$0.4583^{\wedge}$	126	3.79×10^7	2.19×10^9
Rayado Creek (Miami Lake Diversion to headwaters)	1.22	126	3.79×10^7	5.83×10^9
Sixmile Creek (Eagle Nest Lake to headwaters)	0.11	126	3.79×10^7	5.25×10^8
Ute Creek (Cimarron River to headwaters)	0.47	126	3.79×10^7	2.24×10^9

Notes: + Combined flow based on design capacity of Angel Fire WWTP (0.50 mgd) and 4Q3 of stream (0.20 mgd)
^ Combined flow based on maximum discharge from Cimarron WWTP (0.0083 mgd) and 4Q3 of stream (0.45 mgd)
(a) Based on equation 2.

The measured loads for *E.coli* were similarly calculated. The arithmetic mean of the data used to determine the impairment was substituted for the criterion in Equation 4-2. The same conversion factor was used. Results are presented in Table 4.6.

Table 4.6 Calculation of measured loads for *E.coli*

Assessment Unit	Critical Flow (mgd)	*E.coli* Arithmetic Mean[(a)] (cfu/100mL)	Conversion Factor[(b)]	Measured Load (cfu/day)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	0.70[+]	912	3.79×10^7	2.42×10^{10}
North Ponil Creek (South Ponil Creek to Seally Canyon)	0.15	212	3.79×10^7	1.21×10^9
Ponil Creek (US 64 to confl of North and South Ponil)	0.21	240	3.79×10^7	1.91×10^9
Ponil Creek (Cimarron River to US 64)	0.4583[^]	446	3.79×10^7	7.75×10^9
Rayado Creek (Miami Lake Diversion to headwaters)	1.22	178	3.79×10^7	8.23×10^9
Sixmile Creek (Eagle Nest Lake to headwaters)	0.11	277	3.79×10^7	1.15×10^9
Ute Creek (Cimarron River to headwaters)	0.47	221	3.79×10^7	3.94×10^9

Notes: + Combined flow based on design capacity of Angel Fire WWTP (0.50 mgd) and 4Q3 of stream (0.20 mgd)
^ Combined flow based on maximum discharge from Cimarron WWTP (0.0083 mgd) and 4Q3 of stream (0.45 mgd)
(a) Arithmetic mean of the measured values used to make the impairment determination.
(b) Based on equation 2.

4.4 Waste Load Allocations and Load Allocations

4.4.1 Waste Load Allocation

There are no active point source dischargers on North Ponil Creek, upper Ponil Creek, Rayado Creek, Sixmile Creek, or Ute Creek AUs. However, there are existing point sources with individual NPDES permits in the Cieneguilla Creek and lower Ponil Creek assessment units. The Village of Angel Fire wastewater treatment plant (WWTP) (NM0030503) discharges directly into Cieneguilla Creek, whereas the Village of Cimarron WWTP (NM0031038) discharges to French Lake which is hydrologically linked to Ponil Creek. Each NPDES-permitted facility that discharges into an impaired reach has a wasteload allocation (WLA) included in this TMDL (Table 4.7).

There are no Municipal Separate Storm Sewer System (MS4) storm water permits in these AUs. However, excess bacteria concentrations may be a component of some storm water discharges covered under general NPDES permits, so the load for these dischargers should addressed.

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 National Pollutant Discharge Elimination System (NPDES) Construction General 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. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of an SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation (LA).

Table 4.7 Waste Load Allocations for *E. coli*

Assessment Unit	**Facility**	**Design Capacity Flow (mgd)**	***E. coli* Effluent Limit[(a)] (cfu/100mL)**	**Conversion Factor[(b)]**	**Waste Load Allocation (cfu/day)**
Cieneguilla Creek (Eagle Nest Lake to headwaters)	**NM0030503** Village of Angel Fire WWTP (October 31, 2012 expiration)	0.50	126	3.79×10^{7}	2.39×10^{9}
Ponil Creek (Cimarron River to US 64)	**NM0031038** Village of Cimarron WWTP (September 30, 2014 expiration)	0.0083	126	3.79×10^{7}	3.96×10^{7}

Notes: *(a)* Based on current in-stream New Mexico WQS for segments 20.6.4.306 and 20.6.4.309 NMAC.
(b) Based on equation 2.

4.4.2 Load Allocation

In order to calculate the LA, the WLA and margin of safety (MOS) were subtracted from the target capacity TMDL following Equation 4-3:

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 4-3)}$$

The MOS is estimated to be 10 percent of the target load calculated in Table 4.5. Results are presented in Table 4.8. Additional details on the MOS chosen are presented in Section 4.7.

The extensive data collection and analyses necessary to determine background *E.coli* loads for the Cimarron River Watershed were beyond the resources available for this study. It is therefore assumed that a portion of the LA is made up of natural background loads.

The load reductions necessary to meet the target loads were calculated to be the difference between the calculated target loads (Table 4.5) and the measured loads (Table 4.6), and are shown in Table 4.9. These load reduction tables are presented for informational purposes only. It is important to note that WLAs and LAs are estimates based on a specific flow condition. Under differing hydrologic conditions, the loads will change. For this reason the load allocations given here are less meaningful than are the relative percent reductions. Successful implementation of this TMDL will be determined based on achieving the *E. coli* standards.

Table 4.8 TMDL for *E.coli*

Assessment Unit	WLA (cfu/day)	LA (cfu/day)	MOS (10%) (cfu/day)	TMDL (cfu/day)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	2.39×10^9	6.21×10^8	3.34×10^8	3.34×10^9
North Ponil Creek (South Ponil Creek to Seally Canyon)	0	6.45×10^8	7.16×10^7	7.16×10^8
Ponil Creek (US 64 to confl of North and South Ponil)	0	9.03×10^8	1.00×10^8	1.00×10^9
Ponil Creek (Cimarron River to US 64)	3.96×10^7	1.93×10^9	2.19×10^8	2.19×10^9
Rayado Creek (Miami Lake Diversion to headwaters)	0	5.24×10^9	5.83×10^8	5.83×10^9
Sixmile Creek (Eagle Nest Lake to headwaters)	0	4.73×10^8	5.25×10^7	5.25×10^8
Ute Creek (Cimarron River to headwaters)	0	2.02×10^9	2.24×10^8	2.24×10^9

Table 4.9 Calculation of load reduction for *E.coli*

Assessment Unit	Target Load(a) (cfu/day)	Measured Load (cfu/day)	Load Reduction (cfu/day)	Percent Reduction(b)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	3.01×10^{9}	2.42×10^{10}	2.12×10^{10}	88%
North Ponil Creek (South Ponil Creek to Seally Canyon)	6.45×10^{8}	1.21×10^{9}	5.61×10^{8}	47%
Ponil Creek (US 64 to confl of North and South Ponil)	9.03×10^{8}	1.91×10^{9}	1.01×10^{9}	53%
Ponil Creek (Cimarron River to US 64)	1.97×10^{9}	7.75×10^{9}	5.78×10^{9}	75%
Rayado Creek (Miami Lake Diversion to headwaters)	5.24×10^{9}	8.23×10^{9}	2.99×10^{9}	36%
Sixmile Creek (Eagle Nest Lake to headwaters)	4.73×10^{8}	1.15×10^{9}	6.82×10^{8}	59%
Ute Creek (Cimarron River to headwaters)	2.02×10^{9}	3.94×10^{9}	1.92×10^{9}	49%

Note: 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 = TMDL - MOS
(b) Percent reduction is the percent the existing measured load must be reduced to achieve the Target Load and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100

4.5 Identification and Description of Pollutant Source(s)

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/ stakeholder input during the TMDL public meeting and comment period.

Probable sources that may be contributing to the observed load are displayed in Table 4.10:

Table 4.10 Pollutant source summary for *E.coli*

Assessment Unit	Pollutant Sources	Magnitude[(a)] (lbs/day)	Probable Sources[(b)] (% from each)
Cieneguilla Creek (Eagle Nest Lake to hw)	Point: NM0028011	2.39×10^{9}	11% Municipal point source discharge
	Nonpoint:	2.18×10^{10}	89% Rangeland grazing, other recreational pollution sources
North Ponil Creek (S Ponil Crk to Seally Cyn)	Point:	n/a	0%
	Nonpoint:	1.21×10^{9}	100% Low water crossing, rangeland grazing, forest roads (road construction and use)
Ponil Creek (US 64 to confl of N & S Ponil)	Point:	n/a	0%
	Nonpoint:	1.91×10^{9}	100% Livestock (grazing or feeding operations), rangeland grazing, wastes from pets
Ponil Creek (Cimarron River to US 64)	Point: NM0031038	3.96×10^{7}	1% Municipal point source discharge
	Nonpoint:	7.71×10^{9}	99% Avian sources (waterfowl and/or other), source unknown, wastes from pets
Rayado Creek (Miami Lake div to hw)	Point:	n/a	0%
	Nonpoint:	8.23×10^{9}	100% rangeland grazing, wildlife other than waterfowl
Sixmile Creek (Eagle Nest Lake to hw)	Point:	n/a	0%
	Nonpoint:	1.15×10^{9}	100% Animal feeding operations (NPS), livestock (grazing or feeding operations), natural sources, rangeland grazing, wildlife other than waterfowl
Ute Creek (Cimarron River to hw)	Point:	n/a	0%
	Nonpoint:	3.94×10^{9}	100% rangeland grazing, source unknown

Notes:
(a) Measured Load (Table 4.6). *Point source* magnitude is based on the WLA calculation from NPDES permit (Table 4.7).
(b) From the Integrated CWA 303(d)/305(b) List (NMED/SWQB 2010a). This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed nor quantified at this time.

The Probable Source Identification Sheets in Appendix B provide 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 probable sources of impairment in a watershed. The list of "Probable Sources" is not intended to single out any particular land owner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each known impairment. Table 4.10 displays probable sources of impairment along the reach as determined by field reconnaissance and assessment. Probable sources of *E.coli* will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

4.6 Linkage of Water Quality and Pollutant Sources

Among the probable sources of bacteria are municipal point source discharges such as wastewater treatment facilities, poorly maintained or improperly installed (or missing) septic tanks, livestock grazing of valley pastures and riparian areas, upland livestock grazing, in addition to wastes from pets, waterfowl, and other wildlife. Howell et. al. (1996) found that bacteria concentrations in underlying sediment increase when cattle (*Bos taurus*) have direct access to streams, such as the waters in the Cimarron River Watershed. Natural sources of bacteria are also present in the form of other wildlife such as elk, deer, and any other warm-blooded mammals. In addition to direct input from grazing operations and wildlife, *E. coli* concentrations may be subject to elevated levels as a result of resuspension of bacteria laden sediment during storm events. Temperature can also play a role in bacteria concentrations. Howell et. al. (1996) observed that bacteria growth increases as water temperature increases, which has the potential to occur in this watershed as well.

The bacteria loading in the Cimarron River Watershed probably originates from a combination of drought-related impacts, municipal point source discharges, and livestock and wildlife wastes. Habitat modifications such as loss of riparian habitat, road maintenance and runoff, and land development or redevelopment as well as other recreational pollution sources may also be important contributors of bacteria.

In order to determine exact sources and relative contributions, further study is needed. One method of characterizing sources of bacteria is a Bacterial, or Microbial, Source Tracking (BST) study. The extensive data collection and analyses necessary to determine bacterial sources were beyond the resources available for this study. However, sufficient data exist to support development of *E.coli* TMDLs to address the stream standards violations.

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 these bacteria TMDLs, the MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors in flow calculations. Therefore, this MOS is the sum of the following assumptions:

- *Conservative Assumptions*
  E.coli bacteria does not readily degrade in the environment.

  Using the monthly geometric mean criterion rather than the single sample criterion, which allows for higher concentrations in individual grab samples, to calculate target loading values.

- *Explicit recognition of potential errors*
  There is inherent error in all flow measurements. A conservative MOS for this element is **10 percent**.

4.8 Consideration of Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs take into consideration seasonal variation in watershed conditions and pollutant loading. Data used in the calculation of these TMDLs were collected during the spring, summer, and fall of 2006 in order to ensure coverage of any potential seasonal variation in the system. Bacteria exceedences occurred during both high and low flow events. Higher flows may flush more nonpoint source runoff containing bacteria. It is possible the criterion may be exceeded under a low flow condition when there is insufficient dilution. Evaluation of seasonal variability for potential nonpoint sources is difficult due to limited available data.

4.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2035. Growth estimates for Colfax County project a 14% growth rate through 2035. However, as of 2008, the largest incorporated town in the county, Raton, had an estimated population of 6,465 people. This showed a decrease of 11.22 percent from the 2000 census population and Raton's population is not expected to have much growth in the future.

According to the data, bacteria loading is primarily due to diffuse nonpoint sources. Estimates of future growth are not anticipated to lead to a significant increase in bacteria concentrations that cannot be controlled with best management practices (BMPs) in this watershed. However, it is imperative that BMPs continue to be utilized in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.

5.0 PLANT NUTRIENTS

The potential for excessive nutrients in Cieneguilla Creek, Cimarron River, Moreno Creek, Ponil Creek, Rayado Creek, and Sixmile Creek was noted through visual observation during the 2006 SWQB watershed survey. Assessment of various water quality parameters indicated nutrient impairment in Cieneguilla Creek (Eagle Nest Lake to headwaters), Cimarron River (Canadian River to Cimarron Village), Cimarron River (Turkey Creek to Eagle Nest Lake), Moreno Creek (Eagle Nest Lake to headwaters), Ponil Creek (US 64 to confluence of North and South Ponil Creeks), Rayado Creek (Cimarron River to Miami Lake diversion), and Sixmile Creek (Eagle Nest Lake to headwaters).

5.1 Target Loading Capacity

For this TMDL document the target value for plant nutrients is based on numeric translators for the narrative criterion set forth in Subsection E of 20.6.4.13 NMAC:

> ***Plant Nutrients:*** *Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in the dominance of nuisance species in surface waters of the state.*

There are two potential contributors to nutrient enrichment in a given stream: excessive nitrogen and/or phosphorus. The reason for controlling plant growth is to preserve aesthetic and ecologic characteristics along the waterway. The intent of criteria for phosphorus and nitrogen is to control the excessive growth of attached algae and higher aquatic plants that can result from the introduction of these plant nutrients into streams. Numeric criteria or translators are necessary to establish targets for TMDLs, to develop water quality-based permit limits and source control plans, and to support designated uses within the watershed.

Phosphorous is found in water primarily as ortho-phosphate. In contrast nitrogen may be found as several dissolved species all of which must be considered in loading. Total Nitrogen is defined as the sum of Nitrate+Nitrite (N+N), and Total Kjeldahl Nitrogen (TKN). At the present time, there is no EPA-approved method to test for Total Nitrogen, however a combination of EPA method 351.2 (TKN) and EPA method 353.2 (Nitrate + Nitrite) is appropriate for estimating Total Nitrogen.

Development of numeric translators for the plant nutrients criterion is the result of a three-step analysis. First, the EPA compiled nutrient data from the national nutrient dataset, divided it by waterbody type, grouped it into nutrient ecoregions, and calculated the 25^{th} percentiles for each Level III ecoregion. EPA published these recommended water quality criteria to help states and tribes reduce problems associated with excess nutrients in waterbodies in specific areas of the country (USEPA 2000). Next a U.S. Geological Survey (USGS) employee, Evan Hornig, who assisted EPA Region 6 with nutrient criteria development, refined the recommended ecoregional nutrient criteria. Hornig used regional nutrient data from EPA's Storage and Retrieval System (STORET), the USGS, and the SWQB to create a regional dataset for New Mexico. Threshold values were calculated based on EPA procedures and the median for each Level III ecoregion.

The third round of analysis was conducted by SWQB to produce nutrient threshold values for streams based on ecoregion and designated aquatic life use. For this analysis, total phosphorus (TP), total Kjeldahl nitrogen (TKN), and nitrate plus nitrite (N+N) data from the National Nutrient Dataset (1990-1997) were combined with Archival STORET data from 1998, and 1999-2006 data from the SWQB in-house database. The data were then divided by waterbody type, removing all rivers, reservoirs, lakes, wastewater treatment effluent, and playas. For all of the stream data, Level III and IV Omernik ecoregions (Omernik 2006) as well as the designated aquatic life use were assigned using GIS coverages and the station's latitude and longitude. Medians were calculated for each ecoregion/aquatic life use group. For comparison purposes, values below the detection limit were estimated in two ways; using the substitution method (one half the detection limit) in Excel and using the nonparametric Kaplan-Meier method in Minitab. The threshold values from the SWQB Stream Nutrient Assessment Protocol are shown in Table 5.1. They were generated with the complete dataset using the substitution method given that the substitution and Kaplan-Meier methods produced similar results.

Table 5.1. SWQB's recommended nutrient targets for streams (in mg/L)

	ECOREGION										
Parameter	21-Southern Rockies		23-AZ/NM Mountains		22-AZ/NM Plateau		24-Chihuahuan Desert	26-SW Tablelands			
TP	0.02		0.02		0.05		0.04	0.03			
TN	0.25		0.25		0.35		0.53	0.38			
ALU	CW	T/WW (volcanic)	CW	T/WW	CW	T/WW	T/WW	CW	T	WW	
TP	0.02	0.02 (0.05)	0.02	0.05	0.04	0.09	0.04	0.02	0.03	0.03	
TN	0.25	0.25	0.25	0.29	0.28	0.48	0.53	0.25	0.38	0.45	

NOTES:

TN = Total Nitrogen
TP = Total Phosphorus
ALU = Designated Aquatic Life Use

CW = Coldwater (those water quality (WQ) segments having only CW uses)
T = Transitional (those WQ segments with marginal CW or both CW and WW uses)
WW = Warmwater (those WQ segments having only WW uses)

Cimarron River (Turkey Creek to Eagle Nest Lake), Moreno Creek (Eagle Nest Lake to headwaters), Ponil Creek (US 64 to confluence of North and South Ponil Creeks), and Sixmile Creek (Eagle Nest Lake to headwaters) are located in Ecoregion 21 (Southern Rockies). These assessment units are designated as high quality coldwater aquatic life (20.6.4.309 NMAC). According to Table 5.1, these waters have nutrient targets of 0.02 mg/L for total phosphorus and 0.25 mg/L for total nitrogen.

Cimarron River (Canadian River to Cimarron Village) and Rayado Creek (Cimarron River to Miami Lake diversion) are located in Ecoregion 26 (Southwestern Tablelands). These assessment units have a designated use of warmwater aquatic life (20.6.4.306 NMAC).

According to Table 5.1, these waters have nutrient targets of 0.03 mg/L for total phosphorus and 0.45 mg/L for total nitrogen.

Cieneguilla Creek (Eagle Nest Lake to headwaters) is designated as high quality coldwater aquatic life (20.6.4.309 NMAC) and is located in Ecoregion 21 (Southern Rockies). According to Table 5.1, this creek has nutrient targets of 0.02 mg/L for total phosphorus and 0.25 mg/L for total nitrogen. However, SWQB's nutrient survey and assessment indicated the stream is fully supporting its designated uses in the upper portion of the creek where average nutrient concentrations were 0.06 mg/L for total phosphorus and 0.56 mg/L for total nitrogen and not supporting its designated uses in the lower portion of the creek where average concentrations were 0.12 mg/L and 0.86 mg/L, respectively. Since the upstream values have proven to be effective at maintaining water quality standards and fully supporting the designated uses, they are being recommended as the in-stream target concentrations for Cieneguilla Creek.

Table 5.2. In-stream nutrient target concentrations

Assessment Unit	Total Phosphorus	Total Nitrogen
Cieneguilla Creek (Eagle Nest Lake to headwaters)	0.06 mg/L	0.56 mg/L
Cimarron River (Canadian River to Cimarron Village)	0.03 mg/L	0.45 mg/L
Cimarron River (Turkey Creek to Eagle Nest Lake)	0.02 mg/L	0.25 mg/L
Moreno Creek (Eagle Nest Lake to headwaters)	0.02 mg/L	0.25 mg/L
Ponil Creek (US 64 to confluence of North and South Ponil)	0.02 mg/L	0.25 mg/L
Rayado Creek (Cimarron River to Miami Lake diversion)	0.03 mg/L	0.45 mg/L
Sixmile Creek (Eagle Nest Lake to headwaters)	0.02 mg/L	0.25 mg/L

5.2 Flow

The presence of plant nutrients in a stream can vary as a function of flow. Higher nutrient concentrations typically occur during low-flow conditions because there is reduced stream capacity to assimilate discharges due to less streamflow available for dilution. In other words, as flow decreases, the stream cannot effectively dilute its constituents causing the concentration of plant nutrients to increase. Thus, a TMDL is calculated for each assessment unit at a specific flow.

The critical flow condition for these TMDLs occurs when the ratio of nutrient concentrations to stream flow is the greatest and was obtained using a 4Q3 regression model. The 4Q3 is the minimum average four consecutive day flow that occurs with a frequency of at least once every 3 years. Low flow was chosen as the critical flow because of the adverse effect low flows have on water quality due to increased nutrient concentrations and algal growth.

Table 5.3. USGS gages in the Cimarron Watershed (HUC 11080002)

Agency	Site Number	Site Name	Period of Record
USGS	7204000	Moreno Creek at Eagle Nest, NM	1928 - 2008
USGS	7204500	Cieneguilla Creek near eagle Nest. NM	1928 - 2008
USGS	7205000	Sixmile Creek near Eagle Nest, NM	1958 - 2008
USGS	7205500	Eagle Nest Lake near Eagle Nest, NM	1987 - present
USGS	7206000	Cimarron River below Eagle Nest Dam, NM	1950 - present
USGS	7207000	Cimarron River near Cimarron, NM	1950 - present
USGS	7207500	Ponil Creek near Cimarron, NM	1916 - present
USGS	7208500	Rayado Creek near Cimarron, NM	1911 - present
USGS	7211000	Cimarron River at Springer, NM	1907 - 2004

When available, USGS gages are used to estimate flow. There are nine gages that were active in the Cimarron Watershed around the time of the water quality survey and data collection efforts (Table 5.3). The 4Q3 flows for Cieneguilla Creek, Cimarron River, Moreno Creek, Ponil Creek, and Sixmile Creek were estimated using the appropriate gage data and DFLOW software, Version 3.1b (USEPA 2006). DFLOW 3.1b is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis by utilizing algorithms based on Log Pearson Type III distribution.

A climatic year starting April 1 of the prior year and ending March 31 is often used when examining critical low flow conditions in the United States. This choice reduces the likelihood of splitting low flow periods - typically found in the summer or fall - across different years and thereby affecting the results of Log Pearson Type III analysis of series of annual low flows. A different climatic year or shorter season may be used if low flow periods occur at other times of the year or overlap the boundaries of the climatic year.

DFLOW 3.1 allows the user to specify a season that lasts less than a year by indicating the start date and end date of the season. A seasonal component was added to the higher elevation reaches (i.e. Cieneguilla Creek, Moreno Creek, and Sixmile Creek) because cold temperatures and freezing conditions combine to create zero dischage during the winter months. The 4Q3 flows for Cieneguilla Creek, Moreno Creek, and Sixmile Creek were calculated using gage data from the typical growing season for the ecoregion and elevation (July 1 – September 30). The growing seasons were established for three general regions by using the median annual dates of the last and first frost from the National Weather Service (Table 5.4). If a full year's worth of data were included in the critical flow calculations for these high elevation streams then the 4Q3 values would be zero.

Table 5.4. Growing season definitions for ecoregion and elevation classes

Regions	Ecoregion Names	Ecoregion	Begin	End	Length
Mountain >7500 ft	S. Rockies & AZ/NM Mountains	22 & 23	1-July	1-Oct	3 months
Mountains <7500 ft & Plateau	S. Rockies, AZ/NM Mountains & AZ/NM Plateau	20, 21, 22 & 23	15-Jun	1-Nov	4 ½ months
S. Deserts and Plains	SW Tablelands & Chihuahuan Desert	24, 25, 26, & 79	15-May	15-Nov	6 months

A seasonal component was also added to the Cimarron River (Turkey Creek to Eagle Nest Lake) because streamflow in this reach is dependent on releases from Eagle Nest Dam. Eagle Nest Water is released from Eagle Nest Dam because of irrigation demands downstream. The 4Q3 flow for this portion of the Cimarron River was calculated using gage data from the Cimarron River near Cimarron, NM (USGS 07207000) during the typical growing season for the ecoregion and elevation (June 15 – October 31). Consistent water releases of 45 to 50 cubic feet per second occur throughout the growing season and can be expected until October. However, in the winter months when water is stored up in Eagle Nest Lake, flows in the Cimarron River can slow to a trickle.

More than 80 percent of the water used in Colfax County goes into agricultural activities and surface water is the primary source of water for irrigated agriculture in the county (DBS&A 2003). Water is diverted from Ponil Creek to Chase Ranch Ditch near Cimarron, NM. Assuming a 1.5 acre-foot allotment, the estimated maximum amount of water diverted from Ponil Creek is 462 acre-feet (ac-ft) per year, or roughly 1.28 cfs during the growing season; however the ranch has never received their full 1.5 acre-foot allotment. The most they have ever received is 9.5 inches per acre, and in a typical year they receive about 4 inches per acre (DBS&A 2003) translating to approximately 0.67 cfs (highest diversion) and 0.28 cfs (average diversion) during the growing season. The 4Q3 flow for this portion of Ponil Creek was calculated using gage data from the typical growing season for the ecoregion and elevation (May 15 – November 15). The typical amount of water diverted from Ponil Creek during the growing season (0.28 cfs) was added to the calculated 4Q3 value (0.04 cfs) to obtain an estimate of the actual critical flow.

The calculated 4Q3s using DFLOW software are as follows:

- Cieneguilla Creek (Eagle Nest Lake to headwaters) = 0.31 cfs
- Cimarron River (Canadian River to Cimarron Village) = 0.39 cfs
- Cimarron River (Turkey Creek to Eagle Nest Lake) = 3.30 cfs
- Moreno Creek (Eagle Nest Lake to headwaters) = 0.18 cfs
- Ponil Creek (US 64 to confl of North & South Ponil) = 0.32 cfs
- Sixmile Creek (Eagle Nest Lake to headwaters) = 0.17 cfs

It is necessary to estimate a critical flow for a portion of a watershed where there is no active flow gage such as lower Rayado Creek. 4Q3 derivations for ungaged streams are 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):

$$4Q3 = 1.2856 \times 10^{-4}\ DA^{0.42}\ P_w^{3.16} \qquad \text{(Eq. 5-1)}$$

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 4Q3 for lower Rayado Creek was estimated using the statewide regression equation (Eq. 5-1) because the mean elevation for this assessment unit was below 7,500 feet in elevation (Table 5.5).

Table 5.5 Calculation of 4Q3 Low-Flow Frequencies

Assessment Unit	Average Elevation (ft.)	Drainage Area (mi^2)	Mean Winter Precipitation (in.)	4Q3 (cfs)
Rayado Creek (Cimarron River to Miami Lake diversion)	7428	202	6.4	0.42

The 4Q3 value for Rayado Creek (Cimarron River to Miami Lake diversion) was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows:

$$0.42\,\frac{ft^3}{\sec} \times 1{,}728\,\frac{in^3}{ft^3} \times 0.004329\,\frac{gal}{in^3} \times 86{,}400\,\frac{\sec}{day} \times 10^{-6} = 0.27 mgd$$

The 4Q3 values for the other waterbodies were calculated in a similar manner.

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.

5.3 Calculations

This section describes the relationship between the numeric target and the allowable pollutant-level by determining the waterbody's total assimilative capacity, or loading capacity, for the pollutant. The loading capacity is the maximum amount of pollutant loading that a waterbody can receive while meeting its water quality objectives.

As a river flows downstream it has a specific carrying capacity for nutrients. This carrying capacity, or TMDL, is defined as the mass of pollutant that can be carried under critical low-flow conditions without violating the target concentration for that constituent. These TMDLs were developed based on simple dilution calculations using 4Q3 flow, the numeric target, and a conversion factor. The specific carrying capacity of a receiving water for a given pollutant, may be estimated using Eq. 5-2.

4Q3 (in mgd) x Numeric Target (in mg/L) x 8.34 = TMDL (pounds per day [lbs/day]) (Eq. 5-2)

The daily target loads for TP and TN are summarized in Table 5.6.

Table 5.6 Daily Target Loads for TP & TN

Assessment Unit	Parameter	4Q3 Flow (mgd)	Numeric Target (mg/L)	Conversion Factor	Target Load (lbs/day)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.70+	0.06	8.34	0.35
	Total Nitrogen	0.70+	0.56	8.34	3.3
Cimarron River (Canadian R to Cimarron, NM)	Total Phosphorus	0.55*	0.03	8.34	0.14
	Total Nitrogen	0.55*	0.45	8.34	2.1
Cimarron River (Turkey Crk to Eagle Nest Lake)	Total Phosphorus	2.13	0.02	8.34	0.36
	Total Nitrogen	2.13	0.25	8.34	4.4
Moreno Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.12	0.02	8.34	0.02
	Total Nitrogen	0.12	0.25	8.34	0.25
Ponil Creek (US 64 to confl of N & S Ponil)	Total Phosphorus	0.21	0.02	8.34	0.04
	Total Nitrogen	0.21	0.25	8.34	0.44
Rayado Creek (Cimarron R to Miami Lake div)	Total Phosphorus	0.27	0.03	8.34	0.07
	Total Nitrogen	0.27	0.45	8.34	1.02
Sixmile Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.11	0.02	8.34	0.02
	Total Nitrogen	0.11	0.25	8.34	0.23

Notes:
+ *Combined Flow = 4Q3 low-flow (0.20 mgd) + Angel Fire WWTP design capacity (0.50 mgd)*
* *Combined Flow = 4Q3 low-flow (0.25 mgd) + Springer WWTP design capacity (0.30 mgd)*

The measured loads for TP and TN were similarly calculated. In order to achieve comparability between the target and measured loads, the same flow value was used for both calculations. The arithmetic mean of the collected data was substituted for the target in Equation 5-2. The same conversion factor of 8.34 was used. The results are presented in Table 5.7.

Table 5.7 Measured Loads for TP and TN

Assessment Unit	Parameter	4Q3 Flow (mgd)	Arithmetic Mean Conc.^ (mg/L)	Conversion Factor	Measured Load (lbs/day)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.70+	0.09	8.34	0.53
	Total Nitrogen	0.70+	0.71	8.34	4.1
Cimarron River (Canadian R to Cimarron, NM)	Total Phosphorus	0.55*	0.04	8.34	0.18
	Total Nitrogen	0.55*	0.71	8.34	3.3
Cimarron River (Turkey Crk to Eagle Nest Lake)	Total Phosphorus	2.13	0.08	8.34	1.4
	Total Nitrogen	2.13	0.64	8.34	11.4
Moreno Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.12	0.04	8.34	0.04
	Total Nitrogen	0.12	0.41	8.34	0.41
Ponil Creek (US 64 to confl of N & S Ponil)	Total Phosphorus	0.21	0.05	8.34	0.09
	Total Nitrogen	0.21	0.45	8.34	0.79
Rayado Creek (Cimarron R to Miami Lake div)	Total Phosphorus	0.27	0.06	8.34	0.14
	Total Nitrogen	0.27	0.60	8.34	1.35
Sixmile Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.11	0.04	8.34	0.04
	Total Nitrogen	0.11	0.32	8.34	0.29

Notes:

\+ *Combined Flow = 4Q3 low-flow (0.20 mgd) + Angel Fire WWTP design capacity (0.50 mgd)*

* *Combined Flow = 4Q3 low-flow (0.25 mgd) + Springer WWTP design capacity (0.30 mgd)*

^ *Arithmetic mean of TP and TN concentrations from SWQB's 2006 water quality survey.*

5.4 Waste Load Allocations and Load Allocations

5.4.1 Waste Load Allocation

There are no Municipal Separate Storm Sewer System (MS4) storm water permits in these AUs. However, excess nutrient loading may be a component of some storm water discharges covered under general NPDES permits, so the load from these dischargers should be addressed.

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 National Pollutant Discharge Elimination System (NPDES) Construction General 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. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of an SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation (LA).

There are no active point source dischargers on the upper Cimarron River, Moreno Creek, Ponil Creek, Rayado Creek, or Sixmile Creek AUs. However, there are existing point sources with individual NPDES permits in the Cieneguilla Creek and lower Cimarron River assessment units. Each NPDES-permitted facility that discharges into an impaired reach has a WLA included in this TMDL (Tables 5.8 – 5.10).

The City of Springer's Water Treatment Plant (WTP) discharges into the Cimarron River near its confluence with the Canadian River. Currently, the City's NPDES permit does not have limitations or monitoring requirements for nutrients. Effluent from water treatment plants has never been noted to be a significant source contributor of nutrients and should not have an impact on nutrient concentrations in the stream, thus the WLA for the WTP is zero (Table 5.8).

Table 5.8 Wasteload Allocation for City of Springer WTP (NM0030627)

Facility	Parameter	Design Capacity (mgd)	Effluent Limit[(a)] (mg/L)	Conversion Factor	Wasteload Allocation (lbs/day)
NM0030627 City of Springer Water Treatment Plant⊕ (expires September 30, 2012)	Total Phosphorus	variable	n/a	8.34	0
	Total Nitrogen	variable	n/a	8.34	0

Notes:
⊕ Effluent from water treatment plants has never been noted to be a significant source contributor of nutrients.

The Village of Angel Fire wastewater treatment plant (WWTP) (NM0030503) is authorized to discharge directly into Cieneguilla Creek under the stipulations described in its NPDES permit. The City of Springer WWTP (NM0030295) is authorized to discharge to the Cimarron River, however this facility has been under construction and the outfall pipe to the river has not yet been completed. The facility currently discharges to a series of lined and unlined lagoons. Currently, these WWTPs are not designed to treat effluent for the removal of nitrogen and phosphorus. The facilities will need to develop and implement treatment to remove nutrients and improve water quality. It is the policy of the Water Quality Control Commission to allow schedules of compliance in NPDES permits when facility modifications are necessary to meet new water quality based requirements.

Nutrient removal is one of the most pressing challenges facing wastewater treatment facilities. Nutrients can be removed from wastewater via biological, chemical, or combined biological and chemical processes. There are theoretical limits that can be achieved with different removal mechanisms. The limit of technology, based on annual averages, is generally considered to be 0.1 mg/L for total phosphorus (TP) and 3 mg/L for total nitrogen (TN) (Jeyanayagam 2005). TP concentrations in treated effluent typically range from 0.1 to 1.0 mg/L, while TN concentrations typically range from 3.0 to 10.0 mg/L, depending on the removal process and site-specific conditions. Some facilities may be able to achieve lower concentrations by using a combination of biological and chemical treatments, however biological treatment is highly temperature dependent therefore seasonal limits may need to be considered in some cases. The choice of technology to be used as well as the option and use of seasonal limits depend on the site-specific conditions, such as temperature, dissolved oxygen levels, and pH in combination with the economic feasibility.

NMED believes that a TMDL should be written to targets that are protective of the stream and scientifically defensible however there should also be some recognition of the limits of technology for nutrient removal. Even though the limits of technology preclude the attainment of the target concentrations defined in this TMDL, advanced treatment would significantly reduce the load of TP and TN that is introduced into the stream. After implementation of effluent limits based on the limits of technology and given enough time to allow the aquatic to system to respond, NMED will reevaluate the condition of Cieneguilla Creek and the Cimarron River. At that time, if the waterbodies are still impaired for plant nutrients and there is no substantial improvement observed in the water quality of these waters, the WWTPs would be required to enhance the treatment of the effluent by adding more effective treatment or find other means of disposal (Figure 5.1; Tables 5.9 and 5.10).

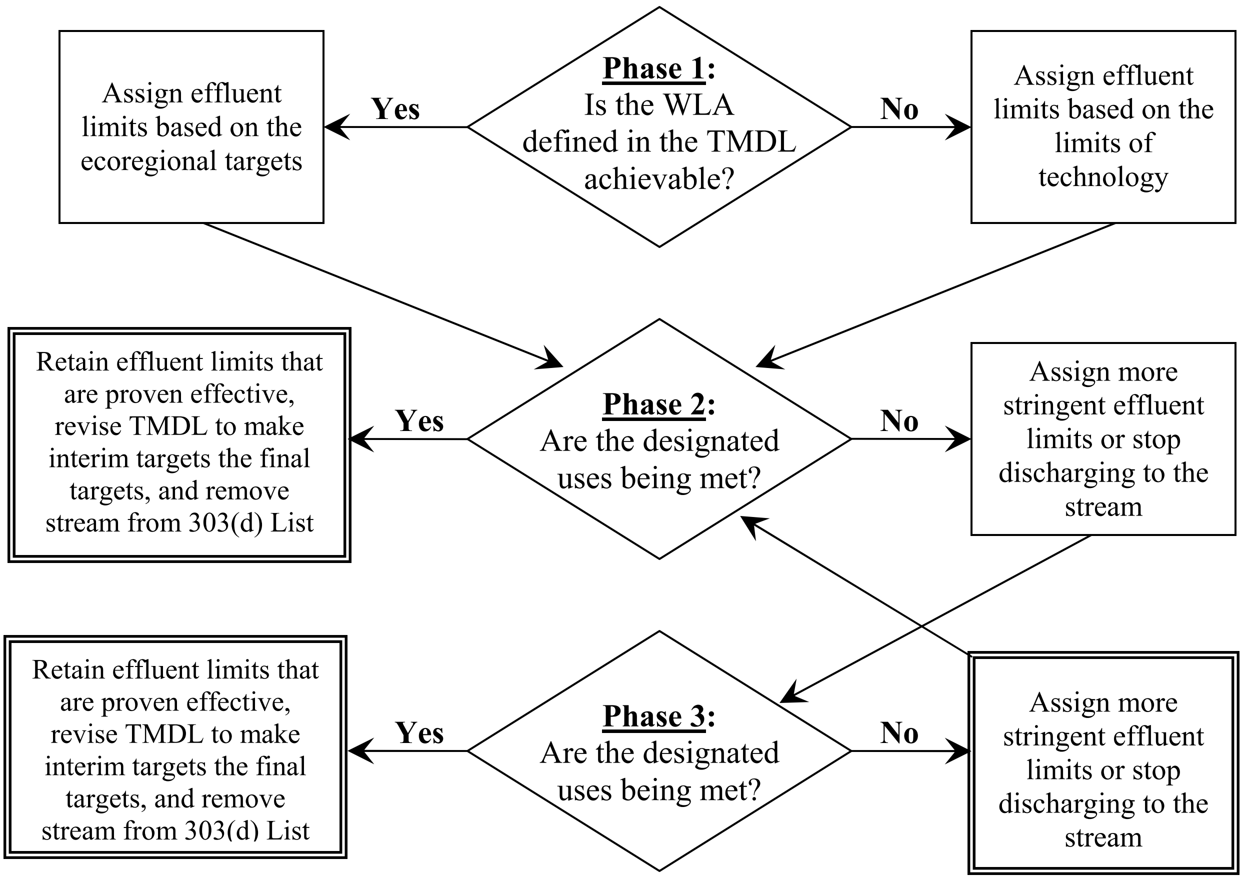


Figure 5.1. Decision process for assigning effluent limits in a phased TMDL

A phased strategy is an iterative process and will require future data collection and analysis to determine if the load reductions achieved using effluent limits that are based on alternative target concentrations actually lead to attainment of water quality standards. Please refer to "Clarification Regarding "Phased" Total Maximum Daily Loads," an August 2, 2006 memorandum from the USEPA, for more information on this topic. The next scheduled monitoring date for the Cimarron Watershed is 2016 at which time the water quality of this watershed will be re-examined, designated use attainment will be re-assessed, and target concentrations and waste load allocations re-evaluated.

Table 5.9 *Phase 1* Nutrient Wasteload Allocations

Phase	Facility	Parameter	Design Capacity (mgd)	Effluent Limit (mg/L)	Conversion Factor	Wasteload Allocation[d] (lbs/day)
1st	**NM0030503** Village of Angel Fire WWTP (expires October 31, 2012)	Total Phosphorus	0.50	0.1[a]	8.34	0.42
		Total Nitrogen	0.50	3.0[a]	8.34	12.5
1st	**NM0030295** City of Springer WWTP* (expires February 28, 2013)	Total Phosphorus	0.30	0.1[a]	8.34	0.25
		Total Nitrogen	0.30	3.0[a]	8.34	7.5

Table 5.10 *Target* Nutrient Wasteload Allocations *(Phase "n")*

Phase	Facility	Parameter	Design Capacity (mgd)	Effluent Limit (mg/L)	Conversion Factor	Wasteload Allocation[d] (lbs/day)
nth	**NM0030503** Village of Angel Fire WWTP	Total Phosphorus	0.50	0.06[b]	8.34	0.25
		Total Nitrogen	0.50	0.56[b]	8.34	2.3
nth	**NM0030295** City of Springer WWTP	Total Phosphorus	0.30	0.03[c]	8.34	0.075
		Total Nitrogen	0.30	0.45[c]	8.34	1.1

Notes:
* Currently, the Springer WWTP is not discharging to the Cimarron River.

(a) Phase 1 effluent limits are based on annual averages for the limits of technology. Biological treatment is highly temperature dependent therefore the permit may need to consider seasonal targets based on WWTP design.
(b) Phase "n" effluent limits based on in-stream nutrient concentrations that are proven effective at maintaining water quality standards and fully supporting the designated uses of the stream. As of 2010, these values are technologically unachievable.
(c) Phase "n" effluent limits based on in-stream target concentrations from Table 5.2. As of 2010, these values are technologically unachievable.
(d) WLA = (design capacity) x (effluent limit) x (conversion factor)

5.4.2 Load Allocation

In order to calculate the LA for phosphorus and nitrogen, the WLA and MOS were subtracted from the target capacity (TMDL) using the following equation:

$$WLA + LA + MOS = TMDL \quad \text{(Eq. 5-3)}$$

The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors in flow calculations. Results using an explicit MOS of 10% (see Section 5.7 for details) are presented in Table 5.11.

Table 5.11 Calculation of TMDL for TP and TN

Assessment Unit	Parameter	WLA (lbs/day)	LA (lbs/day)	MOS (10%)	TMDL (lbs/day)
Cieneguilla Creek	Total Phosphorus	0.25	0.065	0.035	0.35
(Eagle Nest Lake to headwaters)	Total Nitrogen	2.3	0.67	0.33	3.3
Cimarron River	Total Phosphorus	0.075	0.051	0.014	0.14
(Canadian R to Cimarron, NM)	Total Nitrogen	1.1	0.79	0.21	2.1
Cimarron River	Total Phosphorus	0	0.324	0.036	0.36
(Turkey Crk to Eagle Nest Lake)	Total Nitrogen	0	3.96	0.44	4.4
Moreno Creek	Total Phosphorus	0	0.018	0.002	0.02
(Eagle Nest Lake to headwaters)	Total Nitrogen	0	0.225	0.025	0.25
Ponil Creek	Total Phosphorus	0	0.036	0.004	0.04
(US 64 to confl of N & S Ponil)	Total Nitrogen	0	0.396	0.044	0.44
Rayado Creek	Total Phosphorus	0	0.063	0.007	0.07
(Cimarron R to Miami Lake div)	Total Nitrogen	0	0.918	0.102	1.02
Sixmile Creek	Total Phosphorus	0	0.018	0.002	0.02
(Eagle Nest Lake to headwaters)	Total Nitrogen	0	0.207	0.023	0.23

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated annual target load (Table 5.6) and the measured load (Table 5.7), and are shown in Table 5.12.

Table 5.12 Calculation of Load Reduction for TP and TN

Assessment Unit	Parameter	Target Load[(a)] (lbs/day)	Measured Load (lbs/day)	Load Reduction (lbs/day)	Percent Reduction[(b)]
Cieneguilla Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.315	0.525	0.210	40%
	Total Nitrogen	2.97	4.14	1.18	28%
Cimarron River (Canadian R to Cimarron, NM)	Total Phosphorus	0.126	0.183	0.057	31%
	Total Nitrogen	1.89	3.26	1.37	42%
Cimarron River (Turkey Crk to Eagle Nest Lake)	Total Phosphorus	0.324	1.42	1.10	77%
	Total Nitrogen	3.96	11.4	7.41	65%
Moreno Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.018	0.040	0.022	55%
	Total Nitrogen	0.225	0.410	0.185	45%
Ponil Creek (US 64 to confl of N & S Ponil)	Total Phosphorus	0.036	0.088	0.052	59%
	Total Nitrogen	0.396	0.788	0.392	50%
Rayado Creek (Cimarron R to Miami Lake div)	Total Phosphorus	0.063	0.135	0.072	53%
	Total Nitrogen	0.918	1.35	0.433	32%
Sixmile Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.018	0.037	0.019	51%
	Total Nitrogen	0.207	0.294	0.087	29%

Note: 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 = TMDL – MOS (refer to Table 5.10)
(b) Percent reduction is the percent the existing measured load must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

5.5 Identification and Description of Pollutant Sources

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/ stakeholder input during the TMDL public meeting and comment period.

Table 5.13 Pollutant Source Summary for Total Phosphorus

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	Point: NM0030503 Nonpoint:	0.89[a] 0.31[b]	74% Municipal Point Source Discharge 26% Rangeland grazing, other recreational pollution sources
Cimarron River (Canadian R to Cimarron, NM)	Point: NM0030295 NM0030627 Nonpoint:	0[c] 0.18	0% Municipal Point Source Discharges 100% Flow alterations from water diversions, on-site treatment systems (septic systems and other decentralized systems), impervious surface/parking lot runoff, rangeland grazing
Cimarron River (Turkey Crk to Eagle Nest Lake)	Point: Nonpoint:	n/a 0.89	0% 100% Dam or impoundment, on-site treatment systems (septic systems and other decentralized systems), other recreational pollution sources, wildlife other than waterfowl
Moreno Creek (Eagle Nest Lake to headwaters)	Point: Nonpoint:	n/a 0.04	0% 100% On-site treatment systems (septic systems and other decentralized systems), rangeland grazing, wastes from pets
Ponil Creek (US 64 to confl of N & S Ponil)	Point: Nonpoint:	n/a 0.09	0% 100% Livestock (grazing or feeding operations), on-site treatment systems (septic systems and other decentralized systems), rangeland grazing, wastes from pets
Rayado Creek (Cimarron R to Miami Lake div)	Point: Nonpoint:	n/a 0.14	0% 100% Dam or impoundment, rangeland grazing,
Sixmile Creek (Eagle Nest Lake to headwaters)	Point: Nonpoint:	n/a 0.05	0% 100% Animal feeding operations (NPS), livestock (grazing or feeding operations), natural sources, on-site treatment systems (septic systems and other similar decentralized systems), rangeland grazing, wildlife other than waterfowl.

Notes:
- [a] The magnitude for NM0030503 was calculated by multiplying the mean TP concentration (1.34 mg/L for the WWTP), the average annual daily discharge in 2006 (0.08 mgd), and the 8.34 conversion factor to get a result in lbs/day.
- [b] The magnitude for nonpoint sources is the average TP load above the WWTP (Cieneguilla Creek at Angel Fire Road).
- [c] The Springer WWTP currently is not discharging to the Cimarron River. In addition, effluent from water treatment plants has never been noted to be a significant source contributor of nutrients. Therefore the magnitude from point sources is zero.
- * From the Integrated CWA §303(d)/§305(b) List (NMED/SWQB 2010a). This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed nor quantified at this time.

Table 5.14 Pollutant Source Summary for Total Nitrogen

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	Point: NM0030503 Nonpoint:	3.18[a] 3.34[b]	49% Municipal Point Source Discharge 51% Rangeland grazing, other recreational pollution sources
Cimarron River (Canadian R to Cimarron, NM)	Point: NM0030295 NM0030627 Nonpoint:	0[c] 3.3	0% Municipal Point Source Discharges 100% Flow alterations from water diversions, on-site treatment systems (septic systems and other decentralized systems), impervious surface/parking lot runoff, rangeland grazing
Cimarron River (Turkey Crk to Eagle Nest Lake)	Point: Nonpoint:	n/a 7.2	0% 100% Dam or impoundment, on-site treatment systems (septic systems and other decentralized systems), other recreational pollution sources, wildlife other than waterfowl
Moreno Creek (Eagle Nest Lake to headwaters)	Point: Nonpoint:	n/a 0.41	0% 100% On-site treatment systems (septic systems and other decentralized systems), rangeland grazing, wastes from pets
Ponil Creek (US 64 to confl of N & S Ponil)	Point: Nonpoint:	n/a 0.79	0% 100% Livestock (grazing or feeding operations), on-site treatment systems (septic systems and other decentralized systems), rangeland grazing, wastes from pets
Rayado Creek (Cimarron R to Miami Lake div)	Point: Nonpoint:	n/a 1.35	0% 100% Dam or impoundment, rangeland grazing
Sixmile Creek (Eagle Nest Lake to headwaters)	Point: Nonpoint:	n/a 0.40	0% 100% Animal feeding operations (NPS), livestock (grazing or feeding operations), natural sources, on-site treatment systems (septic systems and other similar decentralized systems), rangeland grazing, wildlife other than waterfowl

Notes:

[a] The magnitude for NM0030503 was calculated by multiplying the mean TN concentration (4.76 mg/L for the WWTP), the average annual daily discharge in 2006 (0.08 mgd), and the 8.34 conversion factor to get a result in lbs/day.

[b] The magnitude for nonpoint sources is the average TN load above the WWTP (Cieneguilla Creek at Angel Fire Road).

[c] The Springer WWTP currently is not discharging to the Cimarron River. In addition, effluent from water treatment plants has never been noted to be a significant source contributor of nutrients. Therefore the magnitude from point sources is zero.

* From the Integrated CWA §303(d)/§305(b) List (NMED/SWQB 2010a). This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed nor quantified at this time.

The Probable Source Identification Sheets in Appendix B provide 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 probable sources of impairment in a watershed. The list of “Probable Sources” is not intended to single out any particular land owner or single land management activity and has therefore been labeled “Probable” and generally includes several sources for each known impairment. Table 5.13 and Table 5.14 display probable sources of impairment along each reach as determined by field reconnaissance and assessment. Probable sources of nutrients will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

5.6 Linkage between Water Quality and Pollutant Sources

The source assessment phase of TMDL development identifies sources of nutrients that may contribute to both elevated nutrient concentrations and the stimulation of algal growth in a waterbody. 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.

Phosphorus and nitrogen generally drive the productivity of algae and macrophytes in aquatic ecosystems, therefore they are regarded as the primary limiting nutrients in freshwaters. The main reservoirs of natural phosphorus are rocks and natural phosphate deposits. Weathering, leaching, and erosion are all processes that breakdown rock and mineral deposits allowing phosphorus to be transported to aquatic systems via water or wind. The breakdown of mineral phosphorus produces inorganic phosphate ions ($H_2PO_4^-$, HPO_4^{2-}, and PO_4^{3-}) that can be absorbed by plants from soil or water (USEPA 1999). Phosphorus primarily moves through the food web as organic phosphorus (after it has been incorporated into plant or algal tissue) where it may be released as phosphate in urine or other waste by heterotrophic consumers and reabsorbed by plants or algae to start another cycle (Nebel and Wright 2000).

The largest reservoir of nitrogen is the atmosphere. About 80 percent of the atmosphere by volume consists of nitrogen gas (N_2). Although nitrogen is plentiful in the environment, it is not readily available for biological uptake. Nitrogen gas must be converted to other forms, such as ammonia (NH_3 and NH_4^+), nitrate (NO_3^-), or nitrite (NO_2^-) before plants and animals can use it. Conversion of gaseous nitrogen into usable mineral forms occurs through three biologically mediated processes of the nitrogen cycle: nitrogen fixation, nitrification, and ammonification (USEPA 1999). Mineral forms of nitrogen can be taken up by plants and algae and incorporated into plant or algal tissue. Nitrogen follows the same pattern of food web incorporation as phosphorus and is released in waste primarily as ammonium compounds. The ammonium compounds are usually converted to nitrates by nitrifying bacteria, making it available again for uptake, starting the cycle anew (Nebel and Wright 2000).

Rain, overland runoff, groundwater, drainage networks, and industrial and residential waste effluents transport nutrients to receiving waterbodies. Once nutrients have been transported into a waterbody they can be taken up by algae, macrophytes, and microorganisms either in the water column or in the benthos; they can sorb to organic or inorganic particles in the water column and/or sediment; they can accumulate or be recycled in the sediment; or they can be transformed and released as a gas from the waterbody (Figure 5.2).

As noted above, phosphorus and nitrogen are essential for proper functioning of ecosystems. However, excess nutrients cause conditions unfavorable for the proper functioning of aquatic ecosystems. Nuisance levels of algae and other aquatic vegetation (macrophytes) can develop rapidly in response to nutrient enrichment when other factors (e.g., light, temperature, substrate, etc.) are not limiting (Figure 5.1). The relationship between nuisance algal growth and nutrient enrichment in stream systems has been well documented in the literature (Welch 1992; Van Nieuwenhuyse and Jones 1996; Dodds et al. 1997; Chetelat et al. 1999). Unfortunately, the magnitude of nutrient concentration that constitutes an "excess" is difficult to determine and varies by ecoregion.

As described in Section 5.2, the presence of plant nutrients in a stream can vary as a function of flow. As flow decreases through water diversions and/or drought-related stressors, the stream cannot effectively dilute its constituents, which causes the concentration of plant nutrients to increase. Nutrients generally reach a waterbody from land uses that are in close proximity to the stream because the hydrological pathways are shorter and have fewer obstacles than land uses located away from the riparian corridor. However, during the growing season (i.e. in agricultural return flow) and in storm water runoff, distant land uses can become hydrologically connected to the stream, thus transporting nutrients from the hillslopes to the stream during these time periods.

In addition to agriculture, there are several other human-related activities that influence nutrient concentrations in rivers and streams. Residential areas contribute nutrients from septic tanks, landscape maintenance, as well as backyard livestock (e.g. cattle, horses) and pet wastes. Urban development contributes nutrients by disturbing the land and consequently increasing soil erosion, by increasing the impervious area within the watershed, and by directly applying nutrients to the landscape. Recreational activities such as hiking and biking can also contribute nutrients to the stream by reducing plant cover and increasing soil erosion (e.g. trail network, streambank destabilization), direct application of human waste, campfires and/or wildfires, and dumping trash near the riparian corridor.

Undeveloped, or natural, landscapes also can deliver nutrients to a waterbody through decaying plant material, soil erosion, and wild animal waste. Another geographically occurring nutrient source is atmospheric deposition, which adds nutrients directly to the waterbody through dryfall and rainfall. Atmospheric phosphorus and nitrogen can be found in both organic and inorganic particles, such as pollen and dust. The contributions from these natural sources are generally considered to represent background levels.

Water pollution caused by on-site septic systems is a widespread problem in New Mexico (McQuillan 2004). Septic system effluents have contaminated more water supply wells, and more acre-feet of ground water, than all other sources in the state combined. Groundwater contaminated by septic system effluent can discharge into streams gaining from groundwater inflow. Nutrients such as phosphorous and nitrogen released into gaining streams from aquifers contaminated by septic systems can contribute to eutrophic conditions.

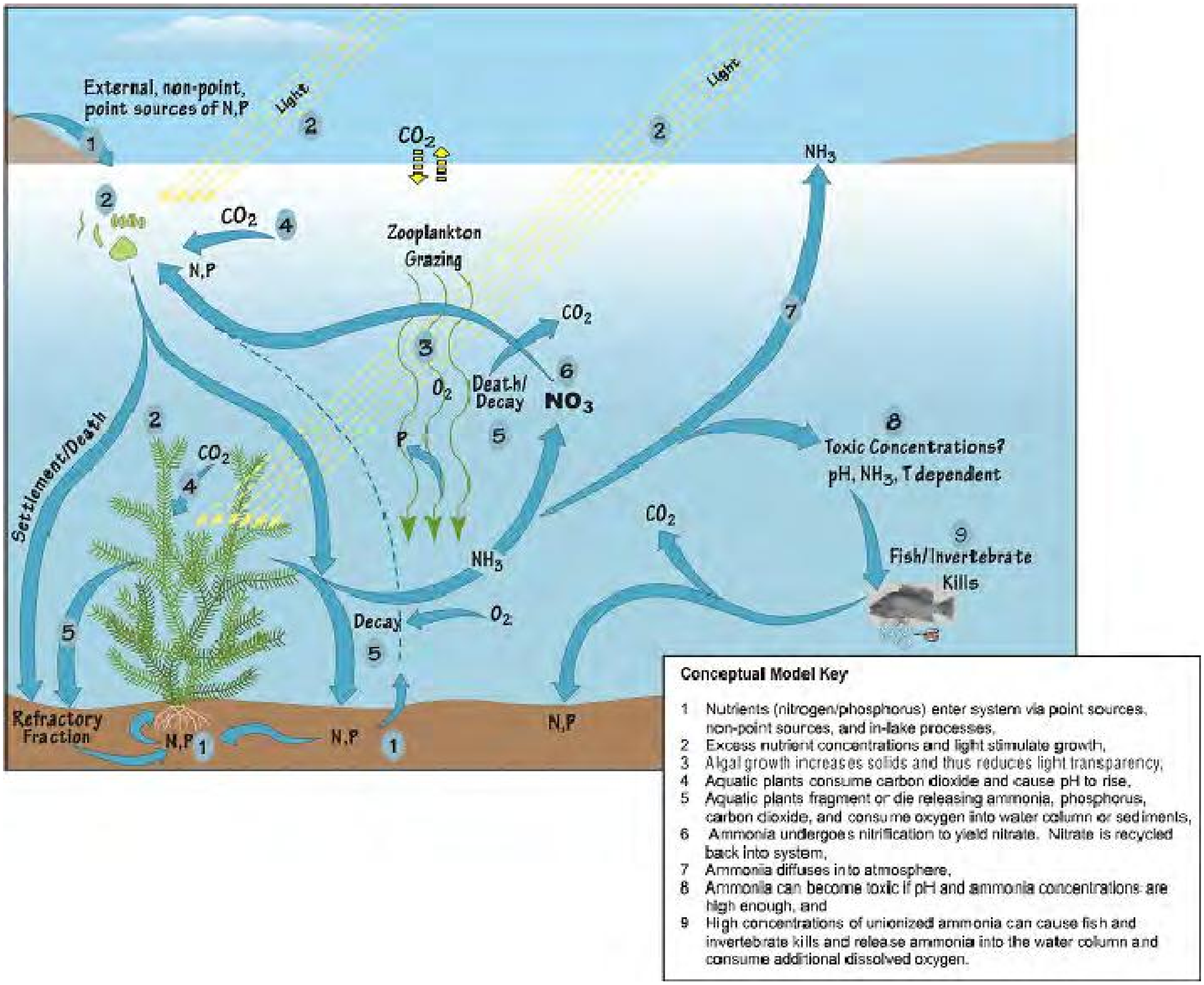


Figure 5.2. Nutrient Conceptual Model (USEPA 1999)

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. The MOS can be expressed either implicitly or explicitly. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

For these nutrient TMDLs, the margin of safety was developed using a combination of conservative assumptions and explicit recognition of potential errors. Therefore, this margin of safety is the sum of the following two elements:

- *Conservative Assumptions*

  Treating phosphorus and nitrogen as pollutants that do not readily degrade in the environment.

  Using the 4Q3 critical low flow "worst case scenario" to calculate the allowable loads.

  Using the design capacity for calculating the point source loading even though under most conditions the treatment plants do not discharge continuously and are not operating at full capacity.

- *Explicit recognition of potential errors*

  A level of uncertainty exists in water quality sampling. Accordingly, a conservative MOS for this element is **10 percent** of the TMDL.

5.8 Consideration of Seasonal Variability

Section 303(d)(1) of the CWA requires TMDLs to be "established at a level necessary to implement the applicable WQS with seasonal variation." Data used in the calculation of this TMDL were collected during spring, summer, and fall in order to ensure coverage of any potential seasonal variation in the system. Exceedences were observed from March through October, during all seasons, which captured flow alterations related to snowmelt, the growing season, and summer monsoonal rains. The critical condition used for calculating the TMDL was low-flow. Calculations made at the critical low-flow (4Q3), in addition to using other conservative assumptions as described in the previous section on MOS, should be protective of the water quality standards designed to preserve aquatic life in the stream. It was assumed that if critical conditions were met during this time, coverage of any potential seasonal variation would also be met.

5.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2035. Growth estimates for Colfax County project a 14% growth rate through 2035. However, as of 2008, the largest incorporated town in the county, Raton, had an estimated population of 6,465 people. This showed a decrease of 11.22 percent from the 2000 census population and Raton's population is not expected to have much growth in the future.

Nutrient loading in this watershed is due to both point and nonpoint sources. Since future projections indicate that nonpoint sources of nutrients will more than likely increase as the region continues to grow and develop, it is imperative that BMPs continue to be utilized in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.

6.0 TEMPERATURE

Monitoring for temperature was conducted by SWQB in 2006. Based on available data, several exceedences of the New Mexico WQS for temperature were noted throughout the watershed (Figure 6.1). Thermographs were set to record once every hour for several months during the warmest time of the year (generally May through October). Thermograph data are assessed using Appendix C of the *State of New Mexico Procedures for Assessing Standards Attainment for the Integrated CWA §303(d)/§305(b) Water Quality Monitoring and Assessment Report [Assessment Protocol]* (NMED/SWQB 2009). Based on 2006 data, temperature listings were added to the *2010-2012 State of NM §303(d) List for Impaired Waters* (NMED/SWQB 2010a) for Cieneguilla Creek (Eagle Nest Lake to headwaters), Cimarron River (Cimarron Village to Turkey Creek), Moreno Creek (Eagle Nest Lake to headwaters), Rayado Creek (Miami Lake diversion to headwaters), Sixmile Creek (Eagle Nest Lake to headwaters), South Ponil Creek (Ponil Creek to headwaters), and Ute Creek (Cimarron River to headwaters). The following assessment units have a previous temperature TMDL and were still found to be impaired for temperature based on the assessment of 2006 data: Middle Ponil Creek (South Ponil Creek to Greenwood Creek), North Ponil Creek (South Ponil Creek to Seally Canyon), and Ponil Creek (US 64 to confluence of North and South Ponil Creeks). Temperature data from 2006 were used to develop these TMDLs.

6.1 Target Loading Capacity

For this TMDL document, target values for temperature are based on the reduction in solar radiation necessary to achieve numeric criteria as predicted by a temperature model. Because all seven AUs with temperature impairments are classified in 20.6.4.309 NMAC and have the designated use of high quality coldwater aquatic life, the applicable temperature criterion is 20°C (68°F). Table 6.1 and Figure 6.1 highlight the 2006 thermograph deployments. This TMDL addresses seven reaches where temperatures exceeded the criterion (**Appendix C** of this document provides a graphical representation of thermograph data):

<u>Cieneguilla Creek (Eagle Nest Lake to headwaters):</u> One thermograph was deployed on this reach in 2006 at Cieneguilla Creek above Eagle Nest Lake at USGS gage (site A). Recorded temperatures from May 16 through August 29 exceeded the HQCW aquatic life use criterion 581 of 2,518 times (23%) with a maximum temperature of 27.063°C on July 20. An air thermograph was deployed at this station during the same time period.

<u>Cimarron River (Cimarron Village to Turkey Creek):</u> One thermograph was deployed on this reach in 2006 at Cimarron River above Cimarron Village at gage (site B). Recorded temperatures from May 16 through September 13 exceeded the HQCW aquatic life use criterion 401 of 2,879 times (13.9%) with a maximum temperature of 26.2°C on July 16. An air thermograph was deployed at this station during the same time period.

<u>Moreno Creek (Eagle Nest Lake to headwaters):</u> One thermograph was deployed on this reach in 2006 at Moreno Creek on NM 64 at gage (site D. Recorded temperatures from May 16 through September 13 exceeded the HQCW aquatic life use criterion 567 of 3,900 times (20%) with a maximum temperature of 27.4°C on Aug 10.

Rayado Creek (Miami Lake Diversion to headwaters): One thermograph was deployed on this reach in 2006 at Rayado Creek at NM 21 (site H). Recorded temperatures from May 16 through September 14 exceeded the HQCW aquatic life use criterion 873 of 2,899 times (30%) with a maximum temperature of 27.3°C on July 16.

Sixmile Creek (Eagle Nest Lake to headwaters): One thermograph was deployed on this reach in 2006 at Sixmile Creek above US 64 at gage (site J). Recorded temperatures from May 16 through September 13 exceeded the HQCW aquatic life use criterion 483 of 2,876 times (19.8%) with a maximum temperature of 28.1°C on July 16.

South Ponil Creek (Ponil Creek at Middle Ponil Creek): One thermograph was deployed on this reach in 2006 at South Ponil Creek above North Ponil (site L). Recorded temperatures from May 16 through June 14 exceeded the HQCW aquatic life use criterion 72 of 689 times (10%) with a maximum temperature of 24.6°C on June 2.

Ute Creek (Cimarron River to headwaters): One thermograph was deployed on this reach in 2006 at Ute Creek above US 64 at Ute Park (site M). Recorded temperatures from May 16 through September 13 exceeded the HQCW aquatic life use criterion 198 of 2,879 times (6.9%) with a maximum temperature of 24.75°C on July 16.

Table 6.1 Cimarron River watershed thermograph sites (2006)

Site Number	STORET ID	Site Name	Deployment Dates (2006)
A	05Cieng006.3	Cieneguilla Creek above Eagle Nest Lake at gage [a]	16 May – 29 Aug
B	05Cimarr050.8	Cimarron River above Cimarron Village at gage [a]	16 May - 13 Sep
C	05MPonil000.1	Middle Ponil Creek above South Ponil Creek	16 May - 14 Sep
D	05Moreno003.7	Moreno Creek on NM 64 at gage	16 May - 13 Sep
E	05NPonil000.1	North Ponil Creek above South Ponil	16 May - 14 Sep
F	05PonilC014.9	Ponil Creek above NM 64	16 May - 13 Sep
G	05PonilC000.1	Ponil Creek above Cimarron River	16 May - 13 Sep
H	05Rayado033.8	Rayado Creek on NM 21	16 May - 14 Sep
I	05Rayado001.8	Rayado Creek above Cimarron River	16 May - 14 Sep
J	05Sixmil001.4	Sixmile Creek above US 64 near gage	16 May - 13 Sep
K	05SPonil008.5	South Ponil above Middle Ponil [a]	16 May – 14 June
L	05SPonil000.1	South Ponil above North Ponil	16 May – 14 June
M	05UteCre000.6	Ute Creek above US 64 at Ute Park	16 May - 13 Sep

[a] air thermographs also deployed

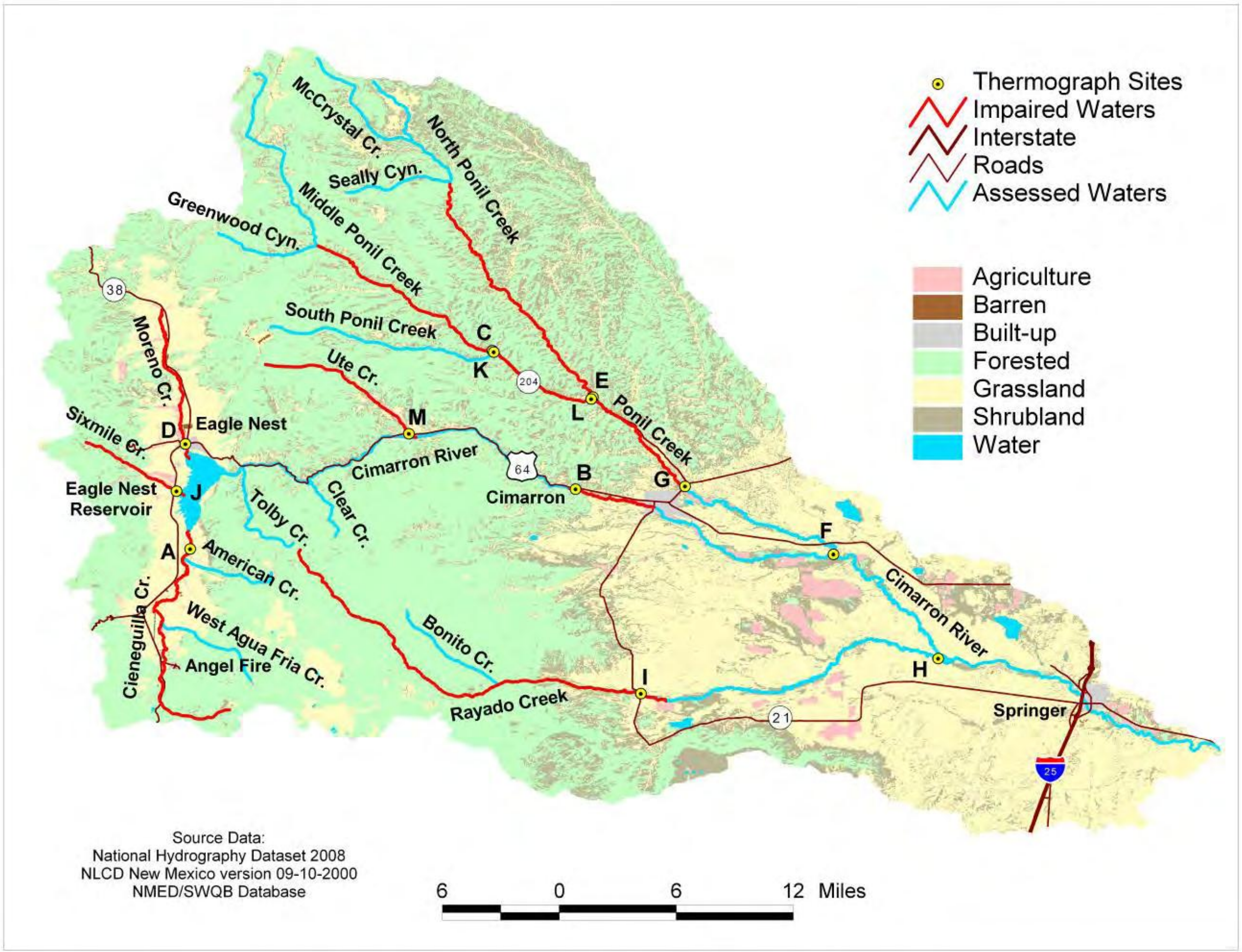


Figure 6.1 Cimarron River watershed thermograph sites (2006)

6.2 Flow

The critical flow condition for these TMDLs was obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the minimum average four consecutive day flow that occurs with a frequency of at least once every 3 years. Low flow was chosen as the critical flow because of the negative effect low flows have on temperatures.

Table 6.2. USGS gages in the Cimarron Watershed (HUC 11080002)

Agency	Site Number	Site Name	Period of Record
USGS	7204000	Moreno Creek at Eagle Nest, NM	1928 - 2008
USGS	7204500	Cieneguilla Creek near eagle Nest. NM	1928 - 2008
USGS	7205000	Sixmile Creek near Eagle Nest, NM	1958 - 2008

USGS	7205500	Eagle Nest Lake near Eagle Nest, NM	1987 - present
USGS	7206000	Cimarron River below Eagle Nest Dam, NM	1950 - present
USGS	7207000	Cimarron River near Cimarron, NM	1950 - present
USGS	7207500	Ponil Creek near Cimarron, NM	1916 - present
USGS	7208500	Rayado Creek near Cimarron, NM	1911 - present
USGS	7211000	Cimarron River at Springer, NM	1907 - 2004

When available, USGS gages are used to estimate flow. There are nine gages that were active in the Cimarron Watershed around the time of the water quality survey and data collection efforts (Table 6.2). The 4Q3 flows for Cieneguilla Creek, Cimarron River, Moreno Creek, Rayado Creek, and Sixmile Creek were estimated using the appropriate gage data and DFLOW software, Version 3.1b (USEPA 2006). DFLOW 3.1b is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis by utilizing algorithms based on Log Pearson Type III distribution.

A climatic year starting April 1 of the prior year and ending March 31 is often used when examining critical low flow conditions in the United States. This choice reduces the likelihood of splitting low flow periods - typically found in the summer or fall - across different years and thereby affecting the results of Log Pearson Type III analysis of series of annual low flows. A different climatic year or shorter season may be used if low flow periods occur at other times of the year or overlap the boundaries of the climatic year.

DFLOW 3.1 allows the user to specify a season that lasts less than a year by indicating the start date and end date of the season. A seasonal component was added to the higher elevation reaches (i.e. Cieneguilla Creek, Moreno Creek, and Sixmile Creek) because cold temperatures and freezing conditions combine to create zero dischage during the winter months. The 4Q3 flows for Cieneguilla Creek, Moreno Creek, and Sixmile Creek were calculated using gage data from the typical growing season for the ecoregion and elevation (July 1 – October 31). The growing seasons were established for three general regions by using the median annual dates of the last and first frost from the National Weather Service (Table 6.3). If a full year's worth of data were included in the critical flow calculations for these high elevation streams then the 4Q3 values would be zero.

Table 6.3. Growing season definitions for ecoregion and elevation classes

Regions	Ecoregion Names	Ecoregion	Begin	End	Length
Mountain >7500 ft	S. Rockies & AZ/NM Mountains	22 & 23	1-July	1-Oct	3 months
Mountains <7500 ft & Plateau	S. Rockies, AZ/NM Mountains & AZ/NM Plateau	20, 21, 22 & 23	15-Jun	1-Nov	4 ½ months
S. Deserts and Plains	SW Tablelands & Chihuahuan Desert	24, 25, 26, & 79	15-May	15-Nov	6 months

A seasonal component was also added to the Cimarron River (Cimarron Village to Turkey Creek) because streamflow in this reach is dependent on releases from Eagle Nest Dam. Eagle Nest Water is released from Eagle Nest Dam because of irrigation demands downstream. The 4Q3 flow for this portion of the Cimarron River was calculated using gage data from the Cimarron River near Cimarron, NM (USGS 07207000) during the typical growing season for the ecoregion and elevation (June 15 – October 31). Consistent water releases of 45 to 50 cubic feet per second occur throughout the growing season and can be expected until October. However, in the winter months when water is stored up in Eagle Nest Lake, flows in the Cimarron River can slow to a trickle.

The specific inflow and outflow values used in the SSTEMP model are discussed in detail in Appendix D.

6.3 Calculations

The Stream Segment Temperature (SSTEMP) Model, Version 2.0, developed by the USGS Biological Resource Division (Bartholow 2002) was used to predict stream temperatures based on watershed geometry, hydrology, and meteorology. The model predicts mean, minimum, and maximum daily water temperatures throughout a stream reach by estimating the heat gained or lost from a parcel of water as it passes through a stream segment (Bartholow 2002). The predicted temperature values are compared to actual thermograph readings measured in the field in order to calibrate the model. The SSTEMP model identifies current stream and/or watershed characteristics that control stream temperatures. The model also quantifies the maximum loading capacity of the stream to meet water quality criteria for temperature. This model is important for estimating the effect of changing controls, or constraints, (such as riparian grazing, stream channel alteration, and reduced streamflow) on stream temperature. The model can also be used to help identify possible implementation activities to improve stream temperature by targeting those factors causing impairment to the stream.

6.4 Waste Load Allocations and Load Allocations

6.4.1 Waste Load Allocation

With the exception of the Cienguilla Creek (Eagle Nest Lake to headwaters), there are no point source contributions associated with these TMDLs.

The Angel Fire Wastewater Treatment Plant (WWTP) discharges directly into Cienguilla Creek. There is some debate regarding whether or not effluent from WWTPs has an impact on temperature. The Angel Fire WWTP NPDES permit (NM0030503) does not have limitations or monitoring requirements for temperature. WWTP effluent has never been noted to be a significant source contributor of temperature impairment. Data indicate that the Angel Fire WWTP is not contributing to elevated temperature in Cienguilla Creek. Figure 6.2 displays the temperature data collected in 2006. Site 05Cieneg19.3 is 1.6 miles upstream of the WWTP and

05Cieng006.3 is 6.7 miles downstream of the WWTP. During the eight discrete sampling events during 2006, the differences between the upstream and downstream sites ranged from 4.24°C (June 13) to 0.39°C (March 14) with the average difference between the sites being 2°C.

According to discharge records, the Angel Fire WWTP was not discharging to Cienguilla Creek from February-November 2006. There is a diminutive change in temperature between the two monitoring sites and no significant temperature contribution is assumed from the WWTP. Although no WLA is assigned to the Angel Fire WWTP, a monitoring requirement should be added to the NM0030503 NPDES permit to ensure that that the discharge meets the WQS of 20oC at the discharge point to Cienguilla Creek.

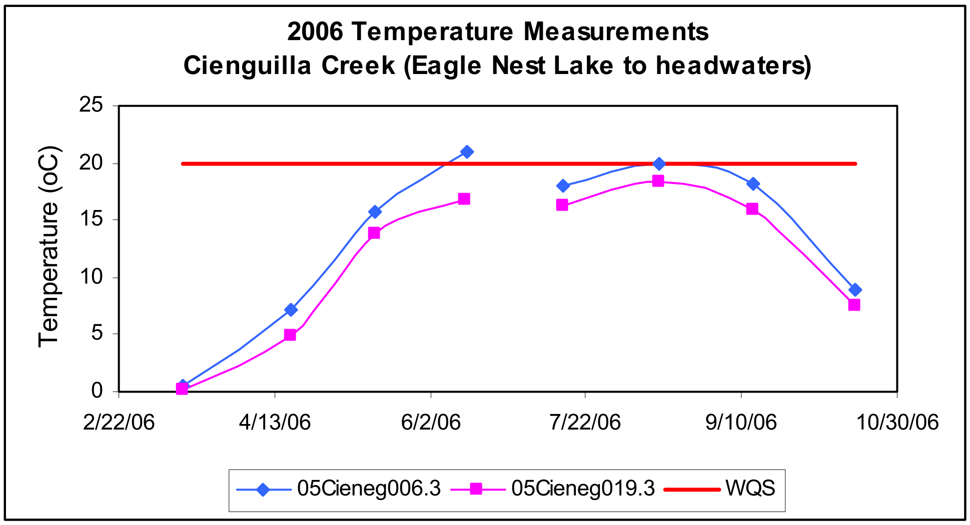


Figure 6.2 Temperature Measurements at Cienguilla Creek (2006)

6.4.2 Load Allocation

Water temperature can be expressed as heat energy per unit volume. SSTEMP provides an estimate of heat energy expressed in joules per square meter per second ($j/m^2/s$) and Langley's per day. The following information relevant to the model runs used to determine temperature TMDLs is taken from the SSTEMP documentation (Bartholow 2002). Please refer to the SSTEMP User's Manual for complete text. Various notes have been added below in brackets to clarify local sources of input data.

The program will predict the minimum, mean, and maximum daily water temperature for the set of variables you provide. The theoretical basis for the model is strongest for the mean daily temperature. The maximum is largely an estimate and likely to vary widely with the maximum daily air temperature. The minimum is computed by subtracting the difference between maximum and mean from the mean; but the minimum is always positive. (Bartholow 2002).

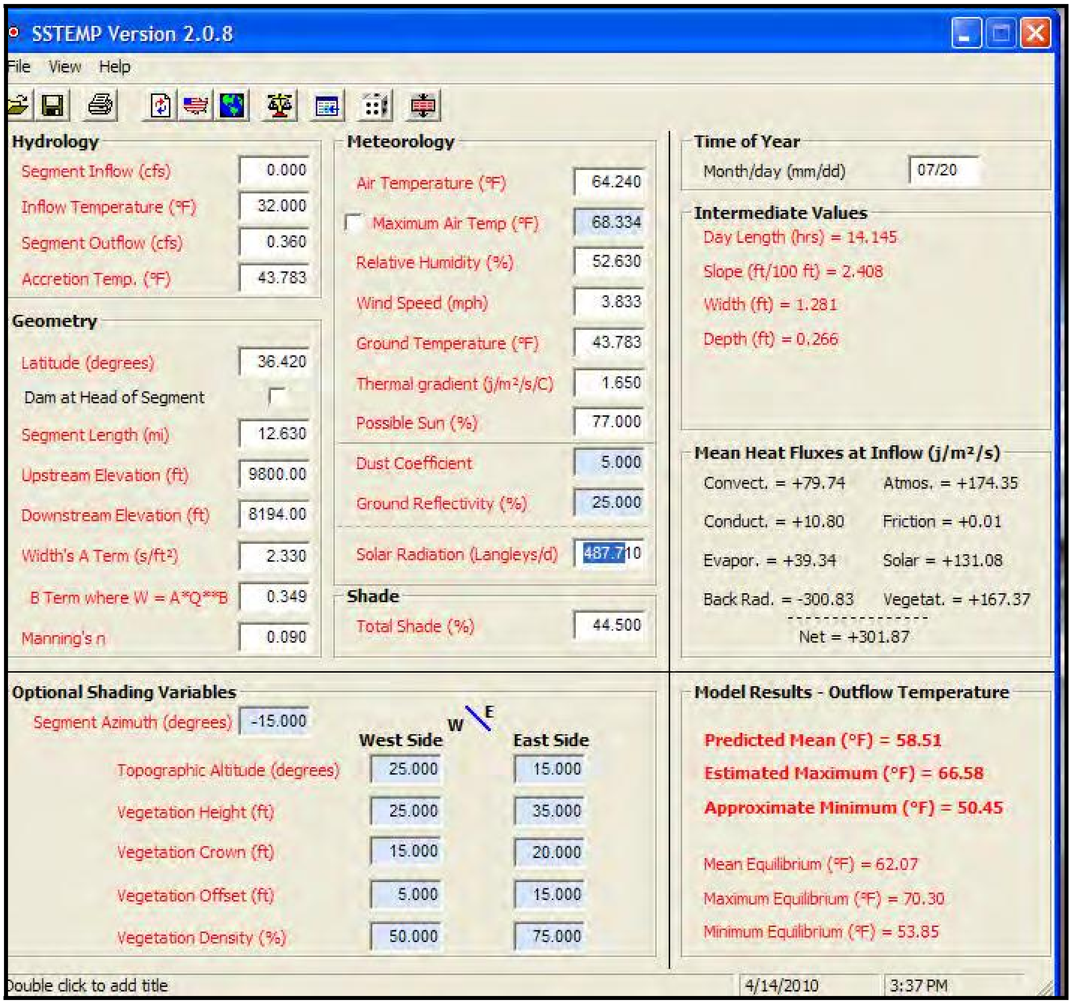


Figure 6.3 Example of SSTEMP input and output for Cienguilla Creek

SSTEMP may be used to compute, one-at-a-time, the sensitivity input values. This simply increases and decreases most active input (i.e., non-grayed out values) by 10% and displays a screen for changes to mean and maximum temperatures. The schematic graph that accompanies the display gives an indication of which variables most strongly influence the results (Bartholow 2002). See Figure 6.4 for an example of a sensitivity analysis.

6.4.2.1 Temperature Allocations as Determined by % Total Shade and Width-to-Depth Ratios

Tables 6.4-6.10 detail model run outputs for segments on Cienguilla Creek, Cimarron River, Moreno Creek, Rayado Creek, Sixmile creek, South Ponil, and Ute Creek. SSTEMP was first calibrated against thermograph data to determine the standard error of the model. Initial conditions were determined. As the percent total shade was increased and the Width's A term was decreased, the maximum 24-hour temperature decreased until the segment-specific standard of 20ºC was achieved. The calculated 24-hour solar radiation component is the maximum solar load that can occur in order to meet the WQS (i.e., the target capacity). In order to calculate the actual load allocation (LA), the waste load allocation (WLA) and margin of safety (MOS) were subtracted from the target capacity (TMDL) following **Equation 6-1**.

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 6-1)}$$

The allocations for each assessment unit requiring a temperature TMDL are provided in the following tables:

<u>Temperature Load Allocation for Cienguilla Creek (Eagle Nest Lake to headwaters)</u>

For Cienguilla Creek (Eagle Nest Lake to headwaters) the WQS for temperature is achieved when the percent total shade is increased to 38%. According to the SSTEMP model, the actual LA of 131.79 j/m²/s is achieved when the shade is further increased to 44% (Table 6.4).

Table 6.4 SSTEMP Model Results for Cienguilla Creek (Eagle Nest Lake to headwaters)

Rosgen (1996) Channel Type	WQS (HQCW Aquatic Life)	Model Run Date	Segment Length (miles)	Solar Radiation Component per 24-Hours (+/-)	% Total Shade	Width's A Term	Modeled Temperature °C (24 hour)
---	20°C (68°F)	7/20/06	12.63	**Current Field Condition** +207.83 j/m²/s	12	2.33	Minimum: 10.53 Mean: 16.80 Maximum: 23.07
TEMPERATURE ALLOCATIONS FOR Cienguilla Creek (Eagle Nest Lake to headwaters) [a] **24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE** [b] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY Actual reduction in solar radiation necessary to meet surface WQS for temperature: Current Condition – Load Allocation = 207.83 j/m²/s – 131.79 j/m²/s **= 76.04 j/m²/s**				**Run 1** +188.94 j/m²/s	20	2.33	Minimum: 10.45 Mean: 16.30 Maximum: 22.15
				Run 2 +146.43 [a] j/m²/s	38	2.33	Minimum: 10.29 Mean: 15.15 Maximum: 20.01
				Actual LA 131.79 [b] j/m²/s	44	2.33	Minimum: 10.25 Mean: 14.73 Maximum: 19.21

Temperature Load Allocation for Cimarron River (Cimarron Village to Turkey Creek)

For Cimarron River (Cimarron Village to Turkey Creek), the WQS for temperature is achieved when the percent total shade is increased to 60%. According to the SSTEMP model, the actual LA of 104.70 j/m^2/s is achieved when the shade is further increased to 64% (Table 6.5).

Table 6.5 SSTEMP Model Results for Cimarron River (Cimarron Village to Turkey Creek)

Rosgen (1996) Channel Type	WQS (Coldwater Aquatic Life)	Model Run Date	Segment Length (miles)	Solar Radiation Component per 24-Hours (+/-)	% Total Shade	Width's A Term	Modeled Temperature °C (24 hour)
---	20°C (68°F)	7/16/06	4.25	**Current Field Condition** +157.05 j/m^2/s	46	5.78	Minimum: 12.05 Mean: 16.98 Maximum: 21.92
TEMPERATURE ALLOCATIONS FOR Cimarron River (Cimarron Village to Turkey Creek) [a] **24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE** [b] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY Actual reduction in solar radiation necessary to meet surface WQS for temperature: Current Condition – Load Allocation = 157.05 j/m^2/s – 104.70 j/m^2/s **= 52.35 j/m^2/s**				**Run 1** +130.88 j/m^2/s	55	5.78	Minimum: 11.96 Mean: 16.32 Maximum: 20.69
				Run 2 +116.33 [a] j/m^2/s	60	5.78	Minimum: 11.92 Mean: 15.96 Maximum: 19.98
				Actual LA 104.70 [b] j/m^2/s	64	5.78	Minimum: 11.90 Mean: 15.66 Maximum: 19.42

Temperature Load Allocation for Moreno Creek (Eagle Nest Lake to headwaters)

For Moreno Creek (Eagle Nest Lake to headwaters), the WQS for temperature is achieved when the percent total shade is increased to 41%. According to the SSTEMP model, the actual LA of 97.35 j/m^2/s is achieved when the shade is further increased to 47% (Table 6.6).

Table 6.6 SSTEMP Model Results for Moreno Creek (Eagle Nest Lake to headwaters)

Rosgen (1996) Channel Type	WQS (HQCW Aquatic Life)	Model Run Date	Segment Length (miles)	Solar Radiation Component per 24-Hours (+/-)	% Total Shade	Width's A Term	Modeled Temperature °C (24 hour)
---	20°C (68°F)	8/10/06	9.0	**Current Field Condition** +170.48 j/m^2/s	7	2.18	Minimum: 12.79 Mean: 18.04 Maximum: 23.28
				Run 1 +146.65 j/m^2/s	20	2.18	Minimum: 12.59 Mean: 17.32 Maximum: 22.04
				Run 2 +108.16 [a] j/m^2/s	41	2.18	Minimum: 12.31 Mean: 16.13 Maximum: 19.95
				Actual LA +97.35 [b] j/m^2/s	47	2.18	Minimum: 12.24 Mean: 15.78 Maximum: 19.32

TEMPERATURE ALLOCATIONS FOR Moreno Creek (Eagle Nest Lake to headwaters)

[a] **24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE**

[b] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

170.48 j/m^2/s – 97.35 j/m^2/s

= 73.13 j/m^2/s

Temperature Load Allocation for Rayado Creek (Miami Lake Diversion to headwaters)

For Rayado Creek (Miami Lake Diversion to headwaters), the WQS for temperature is achieved when the percent total shade is increased to 45%. According to the SSTEMP model, the actual LA of 143.96 $j/m^2/s$ is achieved when the shade is further increased to 51% (Table 6.7).

Table 6.7 SSTEMP Model Results for Rayado Creek (Miami Lake Diversion to headwaters)

<table>
<tr><th>Rosgen (1996) Channel Type</th><th>WQS (HQCW Aquatic Life)</th><th>Model Run Date</th><th>Segment Length (miles)</th><th>Solar Radiation Component per 24-Hours (+/-)</th><th>% Total Shade</th><th>Width's A Term</th><th>Modeled Temperature °C (24 hour)</th></tr>
<tr><td>---</td><td>20°C (68°F)</td><td>7/16/06</td><td>24.26</td><td>Current Field Condition
+226.85 $j/m^2/s$</td><td>22</td><td>3.95</td><td>Minimum: 11.31
Mean: 17.14
Maximum: 22.97</td></tr>
<tr><td colspan="4" rowspan="3">TEMPERATURE ALLOCATIONS FOR Rayado Creek
(Miami Lake Diversion to headwaters)

(a) 24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE

(b) 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

226.85 $j/m^2/s$ – 143.96 $j/m^2/s$

=82.89 $j/m^2/s$</td><td>Run 1
+203.58
$j/m^2/s$</td><td>30</td><td>3.95</td><td>Minimum: 11.15
Mean: 16.53
Maximum: 21.92</td></tr>
<tr><td>Run 2
+159.96 (a)
$j/m^2/s$</td><td>45</td><td>3.95</td><td>Minimum: 10.86
Mean: 15.37
Maximum: 19.87</td></tr>
<tr><td>Actual LA
143.96 (b)
$j/m^2/s$</td><td>51</td><td>3.95</td><td>Minimum: 10.75
Mean: 14.89
Maximum: 19.03</td></tr>
</table>

Temperature Load Allocation for Sixmile Creek (Eagle Nest Lake to headwaters)

For Sixmile Creek (Eagle Nest Lake to headwaters), the WQS for temperature is achieved when the percent total shade is increased to 44%. According to the SSTEMP model, the actual LA of 171.46 $j/m^2/s$ is achieved when the shade is further increased to 50% (Table 6.8).

Table 6.8 SSTEMP Model Results for Sixmile Creek (Eagle Nest Lake to headwaters)

Rosgen (1996) Channel Type	WQS (HQCW Aquatic Life)	Model Run Date	Segment Length (miles)	Solar Radiation Component per 24-Hours (+/-)	% Total Shade	Width's A Term	Modeled Temperature °C (24 hour)
---	20°C (68°F)	7/15/06	4.6	**Current Field Condition** +265.36 $j/m^2/s$	22	0.735[c]	Minimum: 4.28 Mean: 13.92 Maximum: 23.55
				Run 1 +255.15 $j/m^2/s$	25	0.735[c]	Minimum: 4.40 Mean: 13.73 Maximum: 23.07
				Run 2 +190.51 [a] $j/m^2/s$	44	0.735[c]	Minimum: 5.26 Mean: 12.59 Maximum: 19.92
				Actual LA 171.46 [b] $j/m^2/s$	50	0.735[c]	Minimum: 5.56 Mean: 12.23 Maximum: 18.89

TEMPERATURE ALLOCATIONS FOR Sixmile Creek (Eagle Nest Lake to headwaters)

[a] **24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE**

[b] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

265.36 $j/m^2/s$ – 171.46 $j/m^2/s$

=93.90 $j/m^2/s$

[c] rounded to 1.00 by SSTEMP

Temperature Load Allocation for South Ponil Creek (Ponil Creek to Middle Ponil)

For South Ponil Creek (Ponil Creek to Middle Ponil), the WQS for temperature is achieved when the percent total shade is increased to 9%. According to the SSTEMP model, the actual LA of 143.09 j/m^2/s is achieved when the shade is further increased to 18% (Table 6.9).

Table 6.9 SSTEMP Model Results for South Ponil Creek (Ponil Creek to Middle Ponil) [1]

Rosgen (1996) Channel Type	WQS (HQCW Aquatic Life)	Model Run Date	Segment Length (miles)	Solar Radiation Component per 24-Hours (+/-)	% Total Shade	Width's A Term	Modeled Temperature °C (24 hour)
---	20°C (68°F)	6/2/06	5.3	**Current Field Condition** +165.98 j/m^2/s	5 [c]	6.98	Minimum: 8.81 Mean: 14.57 Maximum: 20.34
				Run 1 +160.74 j/m^2/s	8	6.98	Minimum: 8.76 Mean: 14.41 Maximum: 20.07
				Run 2 +158.99 [(a)] j/m^2/s	9	6.98	Minimum: 8.74 Mean: 14.36 Maximum: 19.98
				Actual LA 143.09 [(b)] j/m^2/s	18	6.98	Minimum: 8.61 Mean: 13.88 Maximum: 19.15

TEMPERATURE ALLOCATIONS FOR South Ponil Creek (Ponil Creek to Middle Ponil)

[(a)] **24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE**

[(b)] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

165.98 j/m^2/s – 143.09 j/m^2/s

=22.89 j/m^2/s

[c] Actual measured densiometer reading used (11%). The % shade parameter was then adjusted so the conditions closer to actual temperatures (as recorded by the thermograph) were reflected in SSTEMP.

Temperature Load Allocation for Ute Creek (Cimarron River to headwaters)

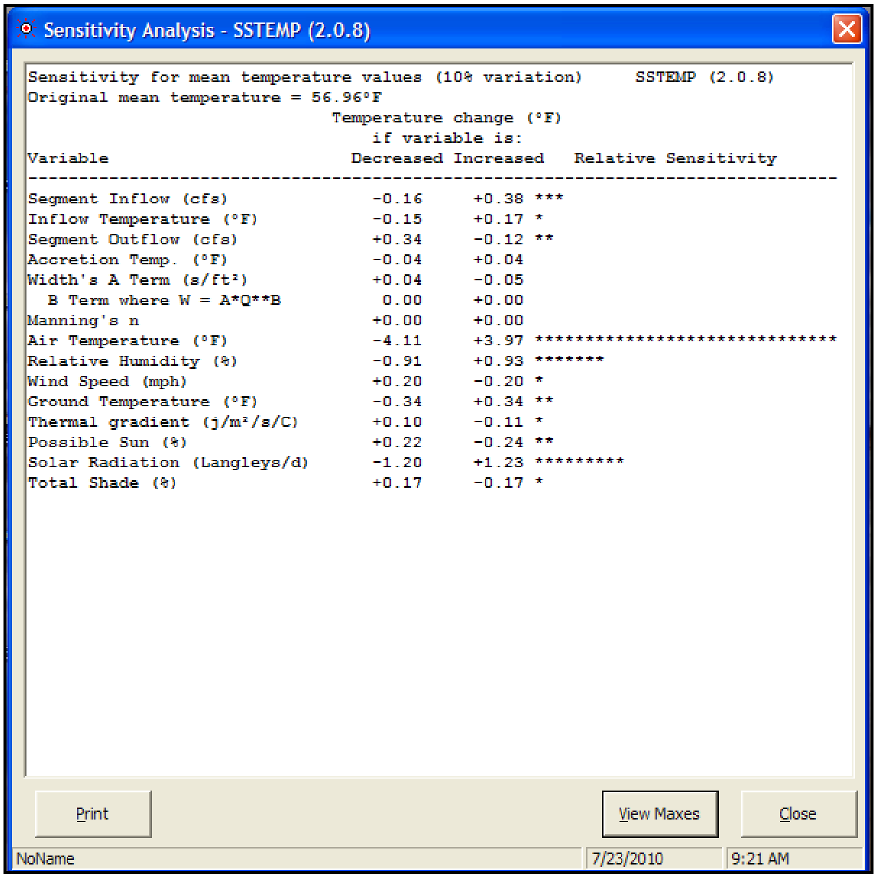
For Ute Creek (Cimarron River to headwaters), the WQS for temperature is achieved when the percent total shade is increased to 32%. According to the SSTEMP model, the actual LA of 177.99 $j/m^2/s$ is achieved when the shade is further increased to 39% (Table 6.10).

Table 6.10 SSTEMP Model Results for Ute Creek (Cimarron River to headwaters)

Rosgen (1996) Channel Type	WQS (HQCW Aquatic Life)	Model Run Date	Segment Length (miles)	Solar Radiation Component per 24-Hours (+/-)	% Total Shade	Width's A Term	Modeled Temperature °C (24 hour)
---	20°C (68°F)	7/16/06	8.04	**Current Field Condition** +232.67 $j/m^2/s$	20 [c]	0.748 [d]	Minimum: 4.96 Mean: 13.28 Maximum: 21.61
TEMPERATURE ALLOCATIONS FOR Ute Creek (Cimarron River to headwaters) [(a)] **24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE** [(b)] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY Actual reduction in solar radiation necessary to meet surface WQS for temperature: Current Condition – Load Allocation = 232.67 $j/m^2/s$ – 177.99 $j/m^2/s$ **=54.68 $j/m^2/s$**				**Run 1** +218.13 $j/m^2/s$	25	0.748 [d]	Minimum: 5.12 Mean: 13.02 Maximum: 20.93
				Run 2 +197.77 [(a)] $j/m^2/s$	32	0.748 [d]	Minimum: 9.73 Mean: 14.86 Maximum: 19.98
				Actual LA 177.99 [(b)] $j/m^2/s$	39	0.748 [d]	Minimum: 5.59 Mean: 12.30 Maximum: 19.01

[c] lowest densiometer reading used (76%). The % shade parameter was then adjusted so the actual recorded conditions (as recorded by the thermograph) were reflected in SSTEMP.
[d] rounded to 1.00 by SSTEMP

According to the Sensitivity Analysis feature of the model runs (Figure 6.4), mean daily air temperature and inflow temperatures had the greatest influences on the predicted outflow temperatures and total shade values have the greatest influence on temperature reduction.



Sensitivity Analysis - SSTEMP (2.0.8)

Sensitivity for mean temperature values (10% variation)   SSTEMP (2.0.8)
Original mean temperature = 56.96°F

Variable	Temperature change (°F) if variable is: Decreased	Increased	Relative Sensitivity
Segment Inflow (cfs)	-0.16	+0.38	***
Inflow Temperature (°F)	-0.15	+0.17	*
Segment Outflow (cfs)	+0.34	-0.12	**
Accretion Temp. (°F)	-0.04	+0.04	
Width's A Term (s/ft²)	+0.04	-0.05	
B Term where W = A*Q**B	0.00	+0.00	
Manning's n	+0.00	+0.00	
Air Temperature (°F)	-4.11	+3.97	******************************
Relative Humidity (%)	-0.91	+0.93	*******
Wind Speed (mph)	+0.20	-0.20	*
Ground Temperature (°F)	-0.34	+0.34	**
Thermal gradient (j/m²/s/C)	+0.10	-0.11	*
Possible Sun (%)	+0.22	-0.24	**
Solar Radiation (Langleys/d)	-1.20	+1.23	*********
Total Shade (%)	+0.17	-0.17	*

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Figure 6.4   Example of SSTEMP sensitivity analysis for South Ponil

The estimate of total shade used in the model calibration was based on densiometer readings (field notes) and examination of aerial photographs (see **Appendix D**). Target loads as determined by the modeling runs are summarized in Tables 6.4 – 6.10. The MOS is estimated to be 10% of the target load calculated by the modeling runs. Results are summarized in Table 6.11. Additional details on the MOS are presented in Section 6.7 below.

Table 6.11 Calculation of TMDLs for Temperature

Assessment Unit	WLA ($j/m^2/s$)	LA ($j/m^2/s$)	MOS (10%)[a] ($j/m^2/s$)	TMDL ($j/m^2/s$)
Cieneguilla Creek (Eagle Nest to headwaters)	0[b]	131.79	14.64	146.43
Cimarron River (Cimarron Village to Turkey Creek)	0	104.70	11.63	116.33
Moreno Creek (Eagle Nest Lake to headwaters)	0	97.35	10.82	108.16
Rayado Creek (Miami Lake Diversion to headwaters)	0	143.96	16.00	159.96
Sixmile Creek (Eagle Nest Lake to headwaters)	0	171.46	19.05	190.51
South Ponil Creek (Ponil Creek to Middle Ponil)	0	143.09	15.90	158.99
Ute Creek (Cimarron River to headwaters)	0	177.99	19.78	197.77

Notes: [a] Actual MOS values may be slightly greater than 10% because the final MOS is back calculated after the Total Shade value is increased enough to reduce the modeled solar radiation component to a value less than the target load minus 10%.
[b] See discussion in Section 6.4.1.
* Values rounded to three significant figures.

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated target load and the measured load (i.e., current field condition in Tables 6.4 – 6.10), and are shown in Table 6.12.

Table 6.12 Calculation of Load Reduction for Temperature

Location	Target Load[a] ($j/m^2/s$)	Measured Load ($j/m^2/s$)	Load Reduction ($j/m^2/s$)	Percent Reduction[b]
Cieneguilla Creek (Eagle Nest to headwaters)	131.79	207.83	76.04	37
Cimarron River (Cimarron Village to Turkey Creek)	104.70	157.05	52.35	33
Moreno Creek (Eagle Nest Lake to headwaters)	97.35	170.48	73.13	43
Rayado Creek (Miami Lake Diversion to headwaters)	143.96	226.85	82.89	37
Sixmile Creek (Eagle Nest Lake to headwaters)	171.46	265.36	93.90	35
South Ponil Creek (Ponil Creek to Middle Ponil)	143.09	165.98	22.89	14
Ute Creek (Cimarron River to headwaters)	177.99	232.67	54.68	24

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 target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

6.5 Identification and Description of pollutant source(s)

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/ stakeholder input during the TMDL public meeting and comment period.

Table 6.13 Pollutant source summary for Temperature

Pollutant Sources	Magnitude[a]	Location	Probable Sources[b] (% from each)
Point:			
None	0	--------	0%
Nonpoint:			
	207.83	**Cieneguilla Creek** (Eagle Nest to headwaters)	100% Loss of Riparian Habitat Rangeland Grazing Streambank Modifications/destablization
	157.05	**Cimarron River** (Cimarron Village to Turkey Creek)	100% Baseflow Depletion from Groundwater Withdrawals Loss of Riparian Habitat Rangeland Grazing
	170.48	**Moreno Creek** (Eagle Nest Lake to headwaters)	100% Rangeland Grazing
	226.85	**Rayado Creek** (Miami Lake Diversion to headwaters)	100% Baseflow Depletion from Groundwater Withdrawals Rangeland Grazing
	265.36	**Sixmile Creek** (Eagle Nest Lake to headwaters)	100% Habitat Modification - other than Hydromodification Livestock (grazing or feeding operations) Rangeland Grazing
	165.98	**South Ponil Creek** (Ponil Creek to Middle Ponil)	100% Rangeland Grazing
	232.67	**Ute Creek** (Cimarron River to headwaters)	100% Loss of Riparian Habitat Rangeland Grazing

Notes:
(a) Measured Load as $j/m^2/s$. Expressed as solar radiation.
(b) From the 2008-2010 Integrated CWA §303(d)/305(b) list unless otherwise noted.

Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of "Probable Sources" is not intended to single out any single land owner or particular land management activity and generally includes several sources for each known impairment. Table 6.13 displays pollutant sources that may contribute to each segment as determined by field reconnaissance and evaluation. Probable sources of temperature impairments will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

6.6 Linkage of Water Quality and Pollutant Sources

Water temperature influences the metabolism, behavior, and mortality of fish and other aquatic organisms. Natural temperatures of a waterbody fluctuate daily and seasonally. These natural fluctuations do not eliminate indigenous populations, but may affect existing community structure and geographical distribution of species. In fact, such temperature cycles are often necessary to induce reproductive cycles and may regulate other aspects of life history (Mount 1969). Behnke and Zarn (1976) in a discussion of temperature requirements for endangered western native trout recognized that populations cannot persist in waters where maximum temperatures consistently exceed 21-22°C, but they may survive brief daily periods of higher temperatures (25.5-26.7°C). Anthropogenic impacts can lead to modifications of these natural temperature cycles, often leading to deleterious impacts on the fishery. Such modifications may contribute to changes in geographical distribution of species and their ability to persist in the presence of introduced species. Of all the environmental factors affecting aquatic organisms in a waterbody, temperature is always a factor. Heat, which is a quantitative measure of energy of molecular motion that is dependent on the mass of an object or body of water is fundamentally different than temperature, which is a measure (unrelated to mass) of energy intensity. Organisms respond to temperature, not heat.

Temperature increases, as observed in SWQB thermograph data, show temperatures that exceed the State Standards for the protection of aquatic habitat, namely the HQCW and CW aquatic life designated uses. Through monitoring, and pollutant source documentation, it has been observed that the most probable cause for these temperature exceedences are due to the alteration of the stream's hydrograph, removal of riparian vegetation, livestock grazing, and natural causes such as geothermal inputs. Alterations can be historical or current in nature.

A variety of factors impact stream temperature (Figure 6.5). Decreased effective shade levels result from reduction of riparian vegetation. When canopy densities are compromised, thermal loading increases in response to the increase in incident solar radiation. Likewise, it is well documented that many past hydromodification activities have lead to channel widening. Wider stream channels also increase the stream surface area exposed to sunlight and heat transfer. Riparian area and channel morphology disturbances are attributed to past and to some extent current rangeland grazing practices that have resulted in reduction of riparian vegetation and streambank destabilization. These nonpoint sources of pollution primarily affect the water temperature through increased solar loading by: (1) increasing stream surface solar radiation and (2) increasing stream surface area exposed to solar radiation.

Riparian vegetation, stream morphology, hydrology, climate, geographic location, and aspect influence stream temperature. Although climate, geographic location, and aspect are outside of human control, the condition of the riparian area, channel morphology and hydrology can be affected by land use activities. Specifically, the elevated summertime stream temperatures attributable to anthropogenic causes in the Cimarron basin result from the following conditions:

1. Channel widening (i.e., increased width to depth ratios) that has increased the stream surface area exposed to incident solar radiation,
2. Riparian vegetation disturbance that has reduced stream surface shading, riparian vegetation height and density, and
3. Reduced summertime base flows that result from instream withdrawals and/or inadequate riparian vegetation. Base flows are maintained with a functioning riparian system so that loss of a functioning riparian system may lower and sometimes eliminate baseflows. Although removal of upland vegetation has been shown, in some cases, to increase water yield, studies show that removal of riparian vegetation along the stream channel subjects the water surface and adjacent soil surfaces to wind and solar radiation, partially offsetting the reduction in transpiration with evaporation. In losing stream reaches, increased temperatures can result in increased streambed infiltration, which can result in lower base flow (Constantz et al. 1994).

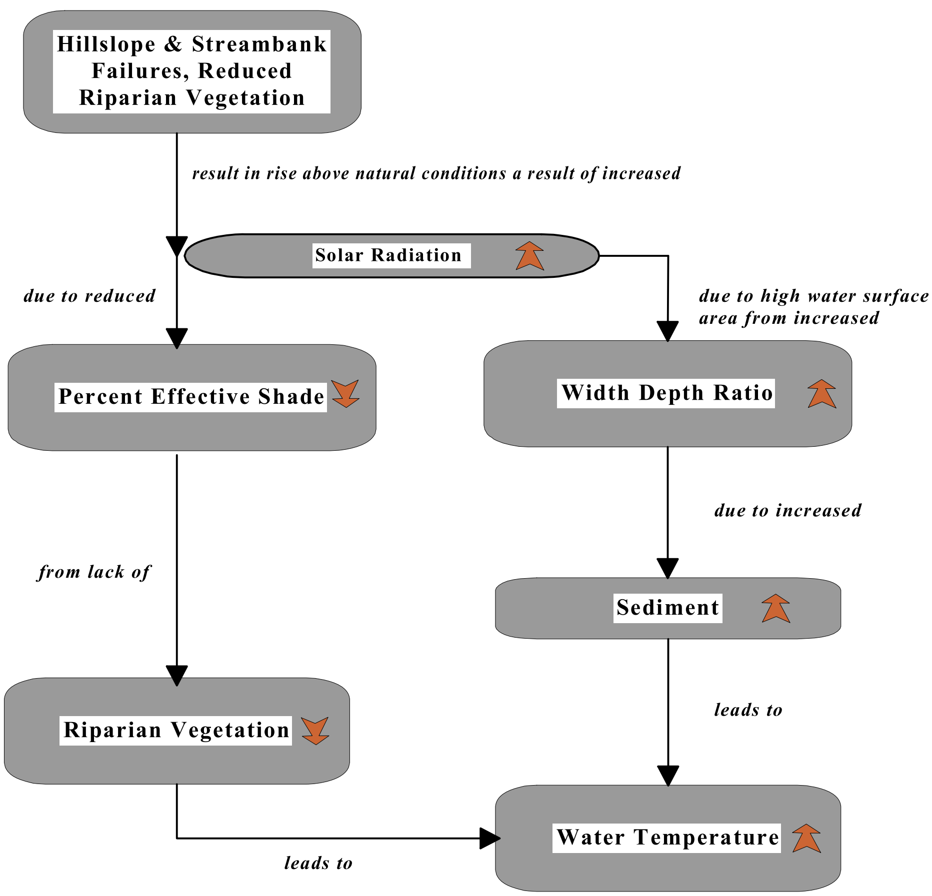

Figure 6.5 Factors That Impact Water Temperature

Through monitoring and pollutant source documentation (Table 6.13) it has been observed that the most probable causes for these temperature exceedences are due to alteration of the stream's hydrograph, removal of riparian vegetation, livestock grazing, and natural causes such as geothermal inputs. Alterations can be historical or current in nature.

Analyses presented in these TMDLs demonstrate that the target loading capacities will result in attainment of New Mexico WQS. Specifically, the relationship between shade and water temperature was demonstrated. Vegetation density increases will provide necessary shading, as well as encourage bank-building processes in severe hydrologic events. However, the presentation of percent total shade in Tables 6.4 – 6.10 is only one avenue which may be pursued to decrease water temperature and ultimately meet WQS. Changes in geomorphological paramters might also prove useful. SWQB encourages stakeholders to pursue whichever options seem to be the best fit for each particular watershed or project with the ultimate goal being that the stream temperature meets the WQS.

Where available data are incomplete or where 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.

6.7 Margin of Safety (MOS)

The CWA requires that each TMDL be calculated with a MOS. This statutory requirement that TMDLs incorporate a MOS is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A MOS may be expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions). The MOS may be implicit, utilizing conservative assumptions for calculation of the loading capacity, WLAs, and LAs. The MOS may also be explicitly stated as an added separate quantity in the TMDL calculation.

For this TMDL, there were no MOS adjustments for point sources since there are none.

In order to develop this temperature TMDL, the following conservative assumptions were used to parameterize the model:

- Data from the warmest time of the year were used in order to capture the seasonality of temperature exceedences.
- Critical upstream and downstream low flows were used because assimilative capacity of the stream to absorb and disperse solar heat is decreased during these flow conditions.
- Low flow was modeled using formulas developed by the USGS. One formula (Thomas et al. 1997) is recommended when the ratio between the gaged watershed area and the ungaged watershed area is between 0.5 and 1.5. When the ratio is outside of this range, a different regression formula is used (Waltemeyer 2002). See **Appendix D** for details.

As detailed in **Appendix D,** a variety of high quality hydrologic, geomorphologic, and meteorological data were used to parameterize the SSTEMP model. Because of the high quality of data and information that was put into this model and the continuous field monitoring data used to verify these model outputs, an explicit MOS of 10% is assigned to this TMDL.

6.8 Consideration of seasonal variation

Section 303(d)(1) of the CWA requires TMDLs to be "…established at a level necessary to implement the applicable WQS with seasonal variations". Both stream temperature and flow vary seasonally and from year to year. Water temperatures are coolest in winter and early spring months.

Thermograph records show that temperatures exceed State of New Mexico WQS in summer and early fall. Warmest stream temperatures corresponded to prolonged solar radiation exposure, warmer air temperature, and low flow conditions. These conditions occur during late summer and early fall and promote the warmest seasonal instream temperatures. It is assumed that if critical conditions are met, coverage of any potential seasonal variation will also be met.

6.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2035. Growth estimates for Colfax County project a 14% growth rate through 2035. However, as of 2008, the largest incorporated town in the county, Raton, had an estimated population of 6,465 people. This showed a decrease of 11.22 percent from the 2000 census population and Raton's population is not expected to have much growth in the future.

Estimates of future growth are not anticipated to lead to a significant increase in water temperature that cannot be controlled with best management practices (BMPs) in this watershed. However, it is imperative that BMPs continue to be utilized in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.

7.0 MONITORING PLAN

Pursuant to CWA Section 106(e)(1), the SWQB has established appropriate monitoring methods, systems and procedures in order to compile and analyze data on the quality of the surface waters of New Mexico. In accordance with the New Mexico Water Quality Act, the SWQB has developed and implemented a comprehensive water quality monitoring strategy for the surface waters of the State.

The monitoring strategy establishes the methods of identifying and prioritizing water quality data needs, specifies procedures for acquiring and managing water quality data, and describes how these data are used to progress toward three basic monitoring objectives: to develop water quality-based controls, to evaluate the effectiveness of such controls, and to conduct water quality assessments.

The SWQB utilizes a rotating basin system approach to water quality monitoring. In this system, a select number of watersheds are intensively monitored each year with an established return frequency of approximately every eight years. The next scheduled monitoring date for the Cimarron Watershed is 2016. The SWQB maintains current quality assurance and quality control plans to cover all monitoring activities. This document, called the QAPP, is updated and certified annually by USEPA Region 6 (NMED/SWQB 2006). In addition, the SWQB identifies the data quality objectives required to provide information of sufficient quality to meet the established goals of the program. Current priorities for monitoring in the SWQB are driven by the CWA Section 303(d) list of streams requiring TMDLs. Short-term efforts were directed toward those waters that are on the USEPA TMDL consent decree list (U.S. District Court for the District of New Mexico 1997), however NMED/SWQB completed the final remaining TMDL on the consent decree in December 2006 and USEPA approved this TMDL in August 2007. The U.S. District Court dismissed the Consent Decree on April 21, 2009.

Once assessment monitoring is completed, those reaches showing impacts and requiring a TMDL will be targeted for more intensive monitoring. The methods of data acquisition include fixed-station monitoring, intensive surveys of priority assessment units (including biological assessments), and compliance monitoring of industrial, federal, and municipal dischargers, as specified in the SWQB Assessment Protocols (NMED/SWQB 2009).

Long-term monitoring for assessments will be accomplished through the establishment of sampling sites that are representative of the waterbody and which can be revisited approximately every seven years. This information will provide time relevant information for use in CWA Section 303(d) listing and 305(b) report assessments and to support the need for developing TMDLs. The approach provides:

- a systematic, detailed review of water quality data which allows for a more efficient use of valuable monitoring resources;
- information at a scale where implementation of corrective activities is feasible;
- an established order of rotation and predictable sampling in each basin which allows for enhanced coordinated efforts with other programs; and
- program efficiency and improvements in the basis for management decisions.

SWQB revised its 10-year monitoring and assessment strategy and submitted it to EPA Region 6 for review on March 23, 2010. The strategy details both the extent of monitoring that can be accomplished with existing resources plus expanded monitoring strategies that could be implemented given additional resources. According to the watershed rotation described in the strategy, the next time SWQB will conduct a water quality survey in the Cimarron watershed is 2016.

It should be noted that a watershed would not be ignored during the years in between water quality surveys. The rotating basin program will be supplemented with other data collection efforts such as the funding of long-term USGS water quality gaging stations for long-term trend data and on-going studies being performed by the USGS and USEPA. Data will be analyzed and field studies will be conducted to further characterize acknowledged problems and TMDLs will be developed and implemented accordingly. Both long-term and intensive field studies can contribute to the State's Integrated §303(d)/§305(b) listing process for waters requiring TMDLs.

8.0 IMPLEMENTATION OF TMDLS

8.1 Point Sources – NPDES Permitting

Nutrient removal is one of the most pressing challenges facing wastewater treatment facilities. The Village of Angel Fire WWTP contributes approximately 74% of the measured phosphorus load and 49% of the measured nitrogen load in Cieneguilla Creek. Current loading from the WWTP was estimated from eight effluent grab samples collected by SWQB staff during 2006. The TP and TN effluent concentrations averaged 1.34 and 4.76 mg/L, respectively. Using the average annual daily discharge rate (0.08 mgd), the current phosphorus loading from the plant is 0.89 lbs/day and the current nitrogen loading is 3.18 lbs/day. The current phosphorus loading from the WWTP is approximately 3 times the level that it should be to maintain the chemical and biological integrity of the stream. Additionally, the nitrogen loading from the plant is essentially the entire target load defined in this TMDL with no allowances for loading from other sources.

The Village of Angel Fire WWTP discharges to Cieneguilla Creek under authorization of an NPDES permit, but the facility is currently not designed to treat effluent for total phosphorus and total nitrogen. Federal regulations (40 CFR 130.12(a) and 40 CFR 122.44(d)(1)(vii)) clearly require that NPDES permits must be consistent with the wasteload allocation (WLA) of an adopted and approved TMDL. The facility will need to develop and implement treatment to meet the new effluent requirements that will result from this TMDL. It is the policy of the WQCC to allow schedules of compliance in NPDES permits on a case-by-case basis where facility modifications need to be made to meet new water quality based requirements (20.6.4.12 NMAC).

8.2 Nonpoint Sources – WBP and BMP Coordination

Public awareness and involvement will be crucial to the successful implementation of these plans and improved water quality. Staff from SWQB will work with stakeholders to provide guidance in developing the Watershed-Based Plan (WBP). The WBP is a written plan intended to provide a long-range vision for various activities and management of resources in a watershed. It includes opportunities for private landowners and public agencies in reducing and preventing nonpoint source impacts to water quality. This long-range strategy will become instrumental in coordinating efforts to achieve water quality standards in the watershed. The WBP is essentially the Implementation Plan, or Phase Two of the TMDL process. The completion of the TMDLs and WBP leads directly to the development of on-the-ground projects to address surface water impairments in the watershed.

SWQB staff will assist with any technical assistance such as selection and application of BMPs needed to meet WBP goals. Stakeholder public outreach and involvement in the implementation of this TMDL will be ongoing. Stakeholders in this process will include SWQB, and other members of the WBP.

8.3 Time Line

Table 8.1 details the proposed implementation timeline.

Table 8.1 Proposed Implementation Timeline

Implementation Actions	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Public Outreach and Involvement	X	X	X	X	X	X	X	X
TMDL Development					X	X	X	X
WBP Development				X	X	X		
Revise any NPDES permits as necessary			X					X
Establish Performance Targets				X				
Secure Funding			X	X				
Implement Management Measures (BMPs)			X	X	X	X	X	X
Monitor BMPs			X	X	X			
Determine BMP Effectiveness					X	X	X	X
Re-evaluate Performance Targets						X	X	X

8.4 Clean Water Act §319(h) Funding Opportunities

The Watershed Protection Section of the SWQB provides USEPA §319(h) funding to assist in implementation of BMPs to address water quality problems on reaches listed as category 4 or 5 waters on the Integrated §303(d)/ §305(b) list. These monies are available to all private, for profit and nonprofit organizations that are authenticated legal entities, or governmental jurisdictions including: cities, counties, tribal entities, Federal agencies, or agencies of the State. Proposals are submitted by applicants two times a year through a Request for Proposal (RFP) process and require a non-federal match of 40% of the total project cost consisting of funds and/or in-kind services. Funding is available for both watershed group formation (which includes WBP development) and on-the-ground projects to improve surface water quality and associated habitat. Further information on funding from the CWA §319 (h) can be found at the SWQB website: http://www.nmenv.state.nm.us/swqb/.

8.5 Other Funding Opportunities and Restoration Efforts in the Cimarron River Basin

Several other sources of funding existing to address impairments discussed in this TMDL document. NMED's Construction Programs Bureau assists communities in need of funding for WWTP upgrades and improvements to septic tank configurations. They can also provide matching funds for appropriate CWA §319(h) projects using state revolving fund monies. The

USDA Environmental Quality Incentive Program (EQIP) program can provide assistance to private land owners in the basin. The USDA Forest Service aligns their mission to protect lands they manage with the TMDL process, and are another source of assistance. The BLM has several programs in place to provide assistance to improve unpaved roads and grazing allotments.

9.0 APPLICABLE REGULATIONS and STAKEHOLDER ASSURANCES

New Mexico's Water Quality Act (Act) authorizes the WQCC to "promulgate and publish regulation to prevent or abate water pollution in the state" and to require permits. The Act authorizes a constituent agency to take enforcement action against any person who violates a water quality standard. Several statutory provisions on nuisance law could also be applied to NPS water pollution. The Water Quality Act also states in §74-6-12(a):

> *The Water Quality Act (this article) does not grant to the commission or to any other entity the power to take away or modify the property rights in water, nor is it the intention of the Water Quality Act to take away or modify such rights.*

In addition, the State of New Mexico Surface Water Quality Standards (see Subsection C of 20.6.4.6 NMAC) (NMAC 2007) states:

> *Pursuant to Subsection A of Section 74-6-12 NMSA 1978, this part does not grant to the water quality control commission or to any other entity the power to take away or modify property rights in water.*

New Mexico policies are in accordance with the federal Clean Water Act §101(g):

> *It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources.*

New Mexico's CWA §319 Program has been developed in a coordinated manner with the State's 303(d) process. All 319 watersheds that are targeted in the annual RFP process coincide with the State's biennial impaired waters list as approved by USEPA. The State has given a high priority for funding, assessment, and restoration activities to these watersheds.

As a constituent agency, NMED has the authority under Chapter 74, Article 6-10 NMSA 1978 to issue a compliance order or commence civil action in district court for appropriate relief if NMED determines that actions of a "person" (as defined in the Act) have resulted in a violation of a water quality standard including a violation caused by a NPS. The NMED NPS water quality management program has historically strived for and will continue to promote voluntary compliance to NPS water pollution concerns by utilizing a voluntary, cooperative approach. The State provides technical support and grant monies for implementation of BMPs and other NPS prevention mechanisms through §319 of the Clean Water Act. Since portions of this TMDL will be implemented through NPS control mechanisms, the New Mexico Watershed Protection Program will target efforts to this and other watersheds with TMDLs.

In order to obtain reasonable assurances for implementation in watersheds with multiple landowners, including federal, state and private land, NMED has established Memoranda of

Understanding (MOUs) with various federal agencies, in particular the Forest Service and the Bureau of Land Management. MOUs have also been developed with other state agencies, such as the New Mexico Department of Transportation. These MOUs provide for coordination and consistency in dealing with NPS issues.

The time required to attain standards for all reaches is estimated to be approximately 10-20 years. This estimate is based on a five-year time frame implementing several watershed projects that may not be starting immediately or may be in response to earlier projects. Stakeholders in this process will include SWQB, and other parties identified in the WBP. The cooperation of watershed stakeholders will be pivotal in the implementation of these TMDLs as well.

10.0 PUBLIC PARTICIPATION

Public participation was solicited in development of this TMDL (see **Appendix E**). The draft TMDL was made available for a 30-day comment period beginning on June 7, 2010. The draft document notice of availability was extensively advertised via newsletters, email distribution lists, webpage postings (http://www.nmenv.state.nm.us), and press releases to area newspapers. A public meeting will be held on Thursday, June 17 from 6-8pm at the Cimarron Watershed Alliance Offices at 301 East 9th Street, Cimarron, NM. Five sets of comments were received and the *Response to Comments* are included as **Appendix F** of this document.

Once the TMDL was approved by the Water Quality Control Commission, the next step for public participation involves revising the Cimarron WBP as described in Section 8.0 and participating in watershed protection projects including those that may be funded by Clean Water Act Section 319(h) grants. The WBP development process is open to any member of the public who wants to participate.

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APPENDIX A
CONVERSION FACTOR DERIVATION

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Flow (as million gallons per day [mgd]) and concentration values (milligrams per liter [mg/L]) must be multiplied by a conversion factor in order to express the load in units "pounds per day." The following expressions detail how the conversion factor was determined:

TMDL Calculation:

$$Flow\,(mgd) \times Concentration\left(\frac{mg}{L}\right) \times ConversionFactor\left(\frac{L-lb}{gal-mg}\right) = Load\left(\frac{lb}{day}\right)$$

Conversion Factor (CF) Derivation:

$$CF = 10^6 \times \frac{3.785\,L}{gal} \times \frac{1\,lb}{454{,}000\,mg} = 8.34\,\frac{L-lb}{gal-mg}$$

Flow (as million gallons per day [mgd]) and concentration values (micrograms per liter [ug/L]) must be multiplied by a conversion factor in order to express the load in units "pounds per day." The following expressions detail how the conversion factor was determined:

TMDL Calculation:

$$Flow\,(mgd) \times Concentration\left(\frac{ug}{L}\right) \times ConversionFactor\left(\frac{L-lb}{gal-ug}\right) = Load\left(\frac{lb}{day}\right)$$

Conversion Factor (CF) Derivation:

$$CF = 10^6 \times \frac{3.785\,L}{gal} \times \frac{1\,lb}{454{,}000{,}000\,ug} = 0.00834\,\frac{L-lb}{gal-ug}$$

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APPENDIX B
PROBABLE SOURCES OF IMPAIRMENT

“Sources” are defined as activities that may contribute pollutants or stressors to a water body (USEPA 1997). The list of “Probable Sources of Impairment” in the Integrated 303(d)/305(b) List, Total Maximum Daily Load documents (TMDL’s), and Watershed-Based Plans (WBP’s) is intended to include any and all activities that could be contributing to the identified cause of impairment. Data on Probable Sources is routinely gathered by Monitoring and Assessment Section staff and Watershed Protection Section staff during water quality surveys and watershed restoration projects and is housed in the Assessment Database (ADB version 2). ADB was developed by USEPA to help states manage information on surface water impairment and to generate §303(d)/ §305(b) reports and statistics. More specific information on Probable Sources of Impairment is provided in individual watershed planning documents (e.g., TMDL’s, WBP’s, etc) as they are prepared to address individual impairments by assessment unit.

USEPA through guidance documents strongly encourages states to include a list of Probable Sources for each listed impairment. According to the 1998 305(b) report guidance, “…, states must always provide aggregate source category totals…” in the biennial submittal that fulfills CWA section 305(b)(1)(C) through (E) (USEPA 1997). The list of “Probable Sources” is not intended to single out any particular land owner or single land management activity and has therefore been labeled “Probable” and generally includes several sources for each known impairment.

The approach for identifying “Probable Sources of Impairment” was recently modified by SWQB. Any new impairment listing will be assigned a Probable Source of “Source Unknown.” Probable Source Sheets will continue to be filled out during watershed surveys and watershed restoration activities by SWQB staff. Information gathered from the Probable Source Sheets will be used to generate a draft Probable Source list in consequent TMDL planning documents. These draft Probable Source lists will be finalized with watershed group/stakeholder input during the pre-survey public meeting, TMDL public meeting, WBP development, and various public comment periods. The final Probable Source list in the approved TMDL will be used to update the subsequent Integrated List.

Literature Cited:

USEPA. 1997. Guidelines for preparation of the comprehensive state water quality assessments (305(b) reports) and electronic uptakes. EPA-841-B-97-002A. Washington, D.C.

Figure B1. Probable Source Development Process and Public Particpation Flowchart

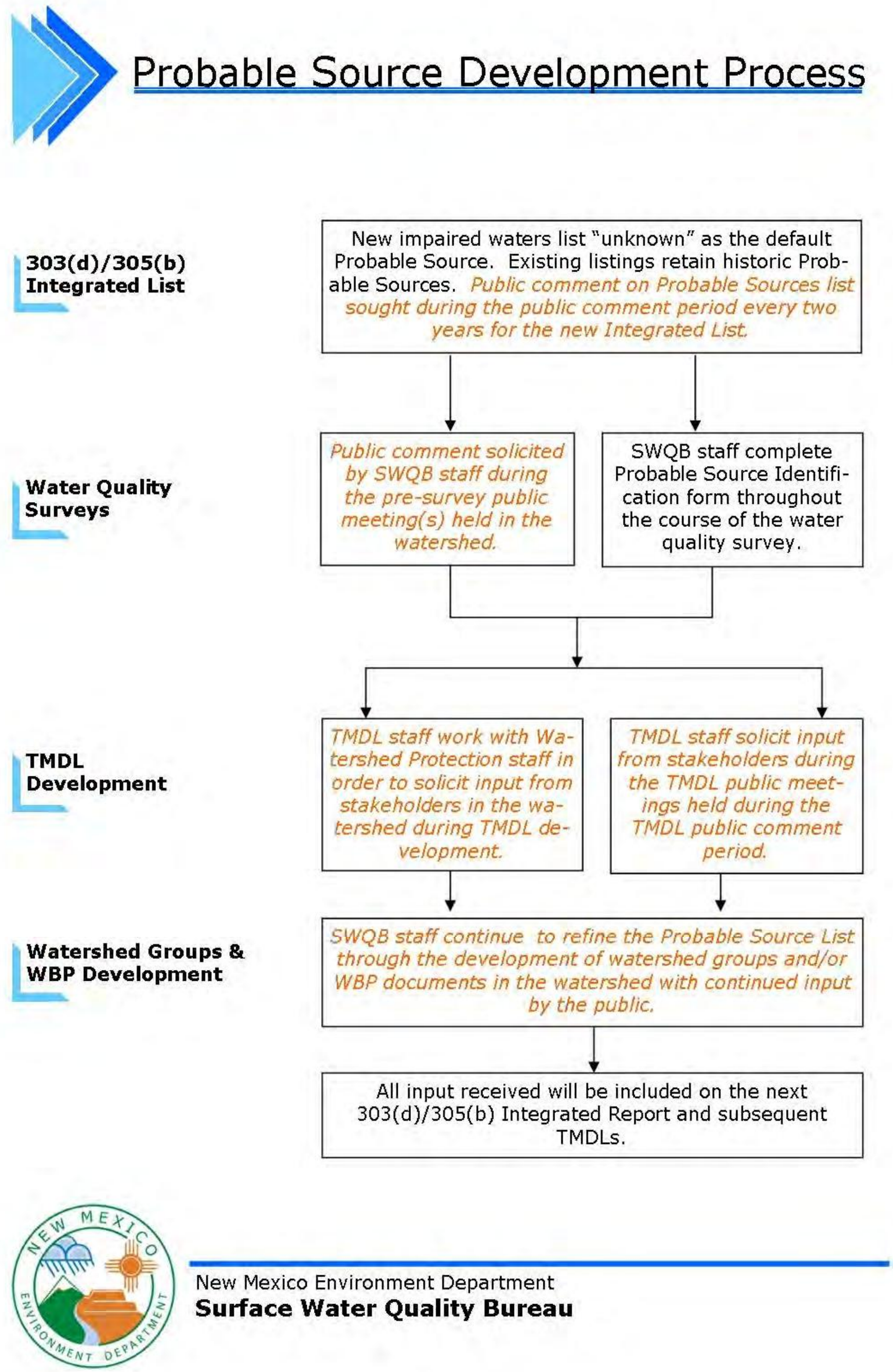

Figure B2. Probable Source Identification Sheet for the Public

Help Us Identify Probable Sources of Impairment

Name:
Phone Number (optional):
Email or Mailing Address (optional):
Date:
Waterbody Name/ Watershed Name/ Location of concern:

From the list below, please check the items you believe are sources of water quality impairment in the watershed or waterbody of concern. In the spaces next to each item you check, please use the following scale to indicate how much of a concern that item is to you by specifying a number between 1 and 3.

(1 - Slight Concern) (2 – Moderate Concern) (3 – High Concern)

✓	ACTIVITY	Scale of Concern			✓	ACTIVITY	Scale of Concern		
☐	Feedlots	1	2	3	☐	Pavement and Other Impervious Surfaces	1	2	3
☐	Livestock Grazing	1	2	3	☐	Roads/Bridges/Culverts	1	2	3
☐	Agriculture	1	2	3	☐	Habitat Modification(s)	1	2	3
☐	Flow Alterations (water withdrawal)	1	2	3	☐	Mining/Resource Extraction	1	2	3
☐	Stream/River Modification(s)	1	2	3	☐	Logging/Forestry Operations	1	2	3
☐	Storm Water Runoff	1	2	3	☐	Housing or Land Development	1	2	3
☐	Flooding	1	2	3	☐	Exotic species	1	2	3
☐	Landfill(s)	1	2	3	☐	Waterfowl	1	2	3
☐	Industry/Wastewater Treatment Plant	1	2	3	☐	Wildlife and domesticated animals other than waterfowl	1	2	3
☐	Inappropriate Waste Disposal	1	2	3	☐	Recreational Use	1	2	3
☐	Improperly maintained Septic Systems	1	2	3	☐	Natural Disturbances *(please describe)*	1	2	3
☐	Other: *(please describe)*	1	2	3	☐	Other: *(please describe)*	1	2	3

Comments:

Figure B3. Probable Source Identification Sheet for NMED and Other Agencies

16 Mar 09

Probable Source Field Sheet & Site Condition Class Verification

Ver. 2

Station ID:	Station Name/Description:	
Field Crew:	Comments:	
Date:	Watershed protection staff reviewer:	Date of WPS review:
WQS Segment from 20.6.4 NMAC:	Assessment Unit:	

Score the proximity and certainty of occurance of the following activities in the watershed upstream of the site. Consult with the appropriate staff at NMED and other agencies to score shaded cells. Fill out after recon during 1st or 2nd site visit, review and revise at the end of the survey, and have it reviewed by Watershed Protection Staff with knowledge of the particular watershed. Maintain completed forms in Survey Binder.

Activity Checklist

Agriculture				
Permitted CAFOs	0	1	3	5
Crop Production (Cropland or Dry Land)	0	1	3	5
Drains	0	1	3	5
Irrigated Crop Production (Irrigation Equip)	0	1	3	5
Permitted Aquaculture	0	1	3	5
Other:	0	1	3	5
Rangeland				
Livestock Grazing or Feeding Operation	0	1	3	5
Rangeland Grazing (dispersed)	0	1	3	5
Other:	0	1	3	5
Industrial/ Municipal				
Industrial Stormwater Discharge (permitted)	0	1	3	5
Storm water Runoff due to Construction	0	1	3	5
Industrial Point Source Discharge	0	1	3	5
Landfill	0	1	3	5
Municipal Point Source Discharge	0	1	3	5
On-Site Treatment Systems (Septic, etc.)	0	1	3	5
Pavement/ /Impervious Surfaces	0	1	3	5
Inappropriate Waste Disposal	0	1	3	5
RCRA/Superfund Site	0	1	3	5
Residences/Buildings	0	1	3	5
Site Clearance (Land Development)	0	1	3	5
Urban Runoff/Storm Sewers	0	1	3	5
Power Plants	0	1	3	5
Other:	0	1	3	5
Resource Extraction				
Abandoned Mines (Inactive)/Tailings	0	1	3	5
Acid Mine Drainage	0	1	3	5
Active Mines (Placer/Potash/Other -- circle)	0	1	3	5
Oil/Gas Activities (Permitted/Legacy – circle)	0	1	3	5
Reclamation of Inactive Mines	0	1	3	5
Other:	0	1	3	5
Roads				
Bridges/Culverts/RR Crossings	0	1	3	5
Low Water Crossing	0	1	3	5
Paved Roads	0	1	3	5
Gravel or Dirt Roads	0	1	3	5
Other:	0	1	3	5

Silviculture				
Logging Ops – Active Harvesting	0	1	3	5
Logging Ops – Legacy	0	1	3	5
Fire Suppression (Thinning/Chemicals)	0	1	3	5
Other:	0	1	3	5
Hydromodifications				
Channelization	0	1	3	5
Dams/Diversions	0	1	3	5
Draining/Filling Wetlands	0	1	3	5
Dredging	0	1	3	5
Irrigation Return Drains	0	1	3	5
Riprap/Wall/Dike/Jetty Jack -- circle	0	1	3	5
Flow Alteration (from Water Diversions/Dam Ops – circle)	0	1	3	5
Highway/Road/Bridge Runoff	0	1	3	5
Other:	0	1	3	5
Miscellaneous				
Angling Pressure	0	1	3	5
Dumping/Garbage/Trash/Litter	0	1	3	5
Exotic Plant Species	0	1	3	5
Fish Stocking	0	1	3	5
Hiking Trails	0	1	3	5
Campgrounds (Dispersed/Defined – circle)	0	1	3	5
Surface Films/Odors	0	1	3	5
Pesticide Application (Algaecide/Insecticide)	0	1	3	5
Waste From Pets (high concentration)	0	1	3	5
Other:	0	1	3	5
Habitat Modification				
Exotics Removal	0	1	3	5
Incised	0	1	3	5
Mass Wasting	0	1	3	5
Restoration	0	1	3	5
Other:	0	1	3	5
Natural Disturbance or Occurrence				
Waterfowl	0	1	3	5
Drought-related Impacts	0	1	3	5
Watershed Runoff Following Forest Fire	0	1	3	5
Recent Bankfull or Overbank Flows	0	1	3	5
Wildlife other than Waterfowl	0	1	3	5
Other Natural Sources:	0	1	3	5

Legend – Proximity Score

Activity believed to be Absent	0	Activity observed or known to be present within 1 km of the channel	3
Activity believed to be present in Watershed	1	Activity observed or known to be present in the riparian zone	5

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APPENDIX C
THERMOGRAPH SUMMARY DATA AND GRAPHICS

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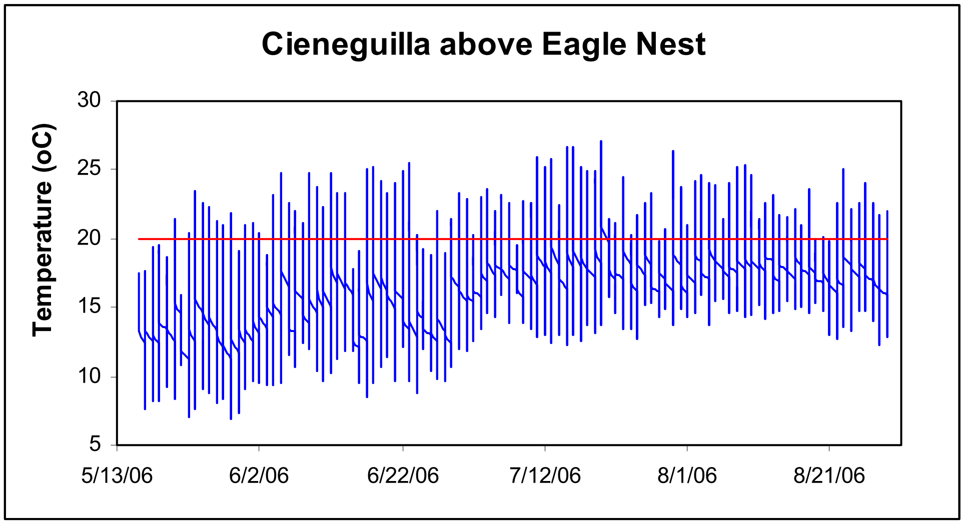
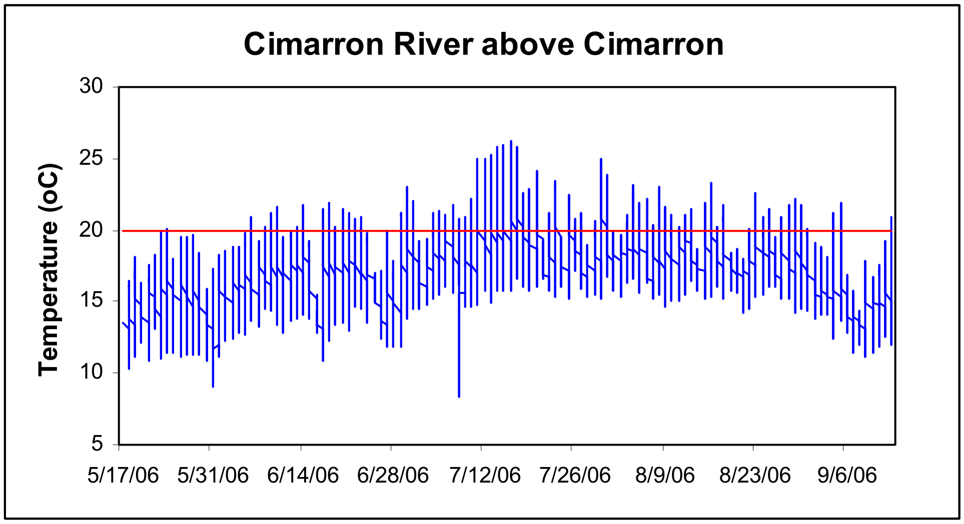
C1.0 Cieneguilla Creek (Eagle Nest Lake to headwaters)

May 16, 2006 through August 29, 2006:	
Total Number of Data Points:	2,518
Number of Measurements >20°C:	581
Percentage Data Points >20°C:	23%
Number of Data Points (June-August):	2,152
Number of Measurements >20°C (June-August):	544
Percentage Data Points >20°C (June-August):	25.3%
Minimum Water Temperature (°C):	6.914
Maximum Water Temperature (°C):	27.063



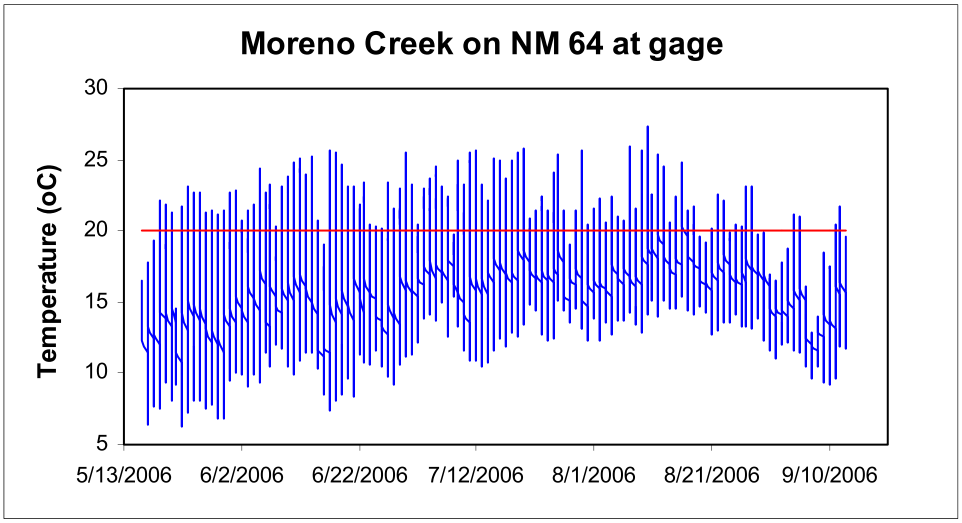
C2.0 Cimarron River (Cimarron Village to Turkey Creek)

May 16, 2006 through September 13, 2006:	
Total Number of Data Points:	2,879
Number of Measurements >20°C:	401
Percentage Data Points >20°C:	13.9%
Number of Data Points (June-August):	2,208
Number of Measurements >20°C (June-August):	390
Percentage Data Points >20°C (June-August):	17.7%
Minimum Water Temperature (°C):	8.295
Maximum Water Temperature (°C):	26.207



C3.0 Moreno Creek (Eagle Nest Lake to headwaters)

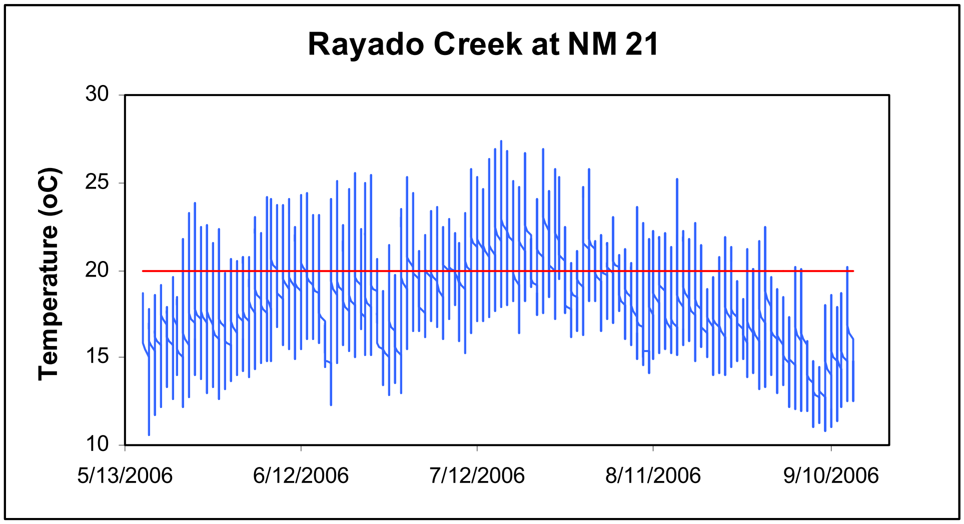
May 16, 2006 through September 13, 2006:	
Total Number of Data Points:	2,877
Number of Measurements >20°C:	576
Percentage Data Points >20°C:	20%
Number of Data Points (June-August):	2,208
Number of Measurements >20°C (June-August):	509
Percentage Data Points >20°C (June-August):	23.1%
Minimum Water Temperature (°C):	6.306
Maximum Water Temperature (°C):	27.382



C4.0 Rayado Creek (Miami Lake Diversion to headwaters)

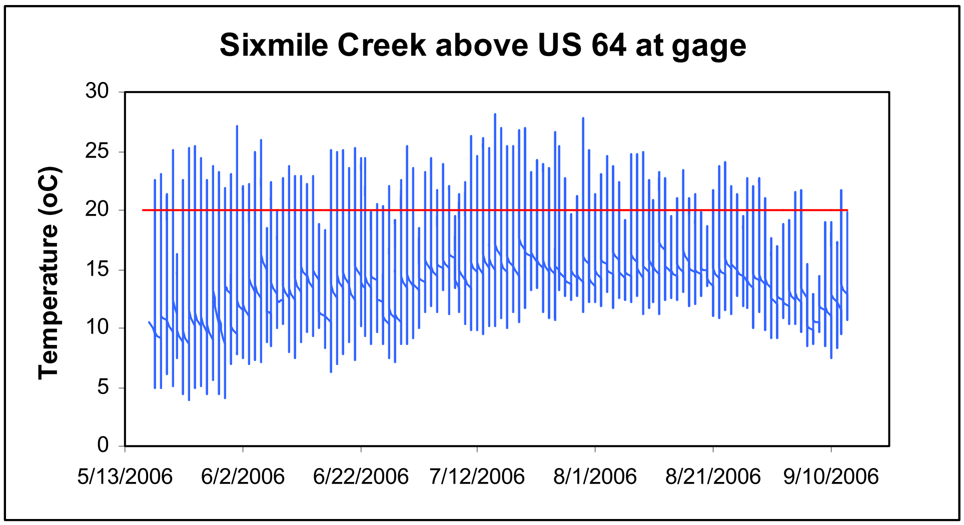
May 16, 2006 through September 14, 2006:

Total Number of Data Points:	2899
Number of Measurements >20°C:	873
Percentage Data Points >20°C:	30.1%
Number of Data Points (June-August):	2,208
Number of Measurements >20°C (June-August):	817
Percentage Data Points >20°C (June-August):	37%
Minimum Water Temperature (°C):	10.59
Maximum Water Temperature (°C):	27.333



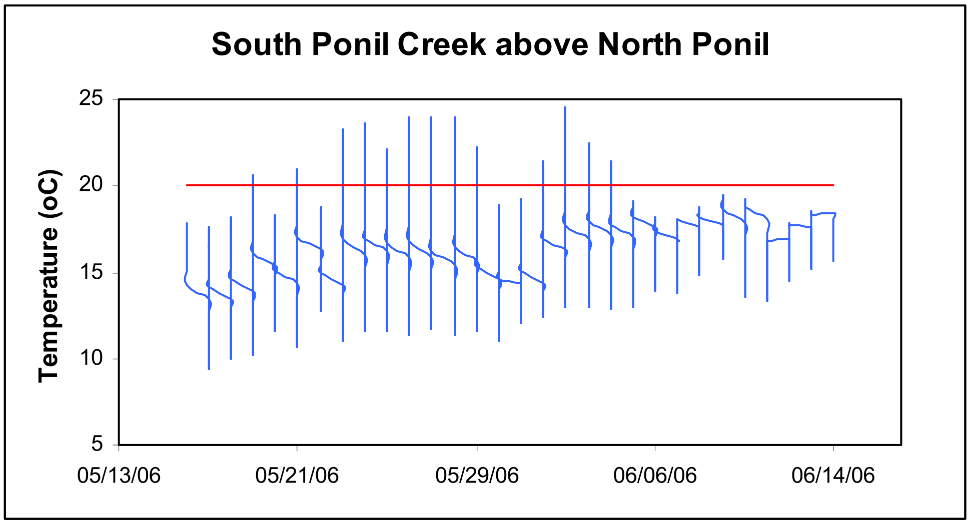
C5.0 Sixmile Creek (Eagle Nest Lake to headwaters)

May 16, 2006 through September 13, 2006:	
Total Number of Data Points:	2,876
Number of Measurements >20°C:	483
Percentage Data Points >20°C:	19.8%
Number of Data Points (June-August):	2,208
Number of Measurements >20°C (June-August):	406
Percentage Data Points >20°C (June-August):	18.4%
Minimum Water Temperature (°C):	3.932
Maximum Water Temperature (°C):	28.097



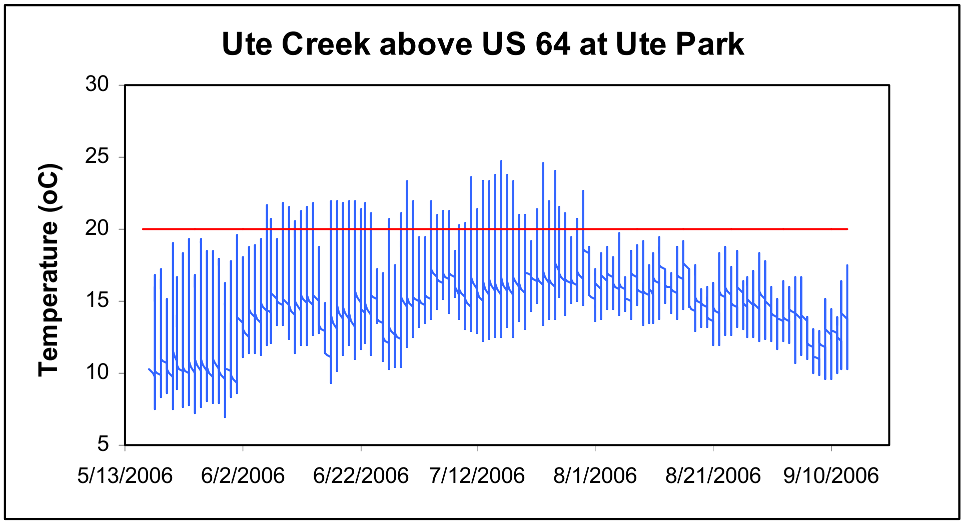
C6.0 South Ponil Creek (Ponil Creek to Middle Ponil Creek)

May 16, 2006 through June 14, 2006:	
Total Number of Data Points:	689
Number of Measurements >20°C:	72
Percentage Data Points >20°C:	10.4%
Number of Data Points (June-August):	323
Number of Measurements >20°C (June-August):	24
Percentage Data Points >20°C (June-August):	7.4%
Minimum Water Temperature (°C):	9.361
Maximum Water Temperature (°C):	24.581



C7.0 Ute Creek (Cimarron River to headwaters)

May 16, 2006 through September 13, 2006:	
Number of Data Points:	2,879
Number of Measurements >20°C:	198
Percentage Data Points >20°C:	6.9%
Number of Data Points (June-August):	2,208
Number of Measurements >20°C (June-August):	198
Percentage Data Points >20°C (June-August):	9.0%
Minimum Water Temperature (°C):	6.864
Maximum Water Temperature (°C):	24.75



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APPENDIX D
HYDROLOGY, GEOMETRY, AND METEROLOGICAL INPUT DATA FOR SSTEMP

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LIST OF ACRONYMS

4Q3	Four-consecutive day discharge that has a recurrence interval of three years
cfs	Cubic Feet per Second
GIS	Geographic Information Systems
GPS	Global Positioning System
IOWDM	Input and Output for Watershed Data Management
mi^2	Square Miles
^oC	Degrees Celcius
SEE	Standard Error of Estimate
SSTEMP	Stream Segment Temperature
SWSTAT	Surface-Water Statistics
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WinXSPRO	Windows-Based Stream Channel Cross-Section Analysis

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D 1.0 INTRODUCTION

This appendix provides site-specific hydrology, geometry, and meteorological data for input into the Stream Segment Temperature (SSTEMP) Model (Bartholow 2002). Hydrology variables include segment inflow, inflow temperature, segment outflow, and accretion temperature. Geometry variables are latitude, segment length, upstream and downstream elevation, Width's A-term, Width's B-term, and Manning's n. Meterological inputs to SSTEMP Model include air temperature, relative humidity, windspeed, ground temperature, thermal gradient, possible sun, dust coefficient, ground reflectivity, and solar radiation. In the following sections, these parameters are discussed in detail for each assessment unit to be modeled using SSTEMP Model. The assessment units were modeled on the day of the maximum recorded thermograph measurement. The assessment units and modeled dates are defined as follows:

Table D.1 Assessment Units and Modeled Dates

Assessment Unit ID	Assessment Unit Description	Modeled Date
NM-2306.A_065	Cienguilla Creek (Eagle Nest to headwaters)	7/20/2006
NM-2306.A_040	Cimarron River (Cimarron Village to Turkey Creek)	7/16/2006
NM-2305.A_060	Moreno Creek (Eagle Nest Lake to headwaters)	8/10/2006
NM-2306.A_051	Rayado Creek (Miami Lake Diversion to headwaters)	7/16/2006
NM-2306.A_064	Sixmile Creek (Eagle Nest Lake to headwaters)	7/15/2006
NM-2306.A_120	South Ponil Creek (Ponil Creek to Middle Ponil)	6/2/2006
NM-2306.A_068	Ute Creek (Cimarron River to headwaters)	7/16/2006

D 2.0 HYDROLOGY

D2.1 Segment Inflow

This parameter is the *mean daily* flow at the top of the stream segment. If the segment begins at an effective headwater, the flow is entered into SSTEMP Model as zero. Flow data from USGS gages were used when available. To be conservative, the lowest four-consecutive-day discharge that has a recurrence interval of three years but that does not necessarily occur every three years (4Q3) was used as the inflow instead of the mean daily flow. These critical low flows were used to decrease assimilative capacity of the stream to adsorb and disperse solar energy. The 4Q3 would be determined for gaged sites 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).

Discharges for ungaged sites on gaged streams were estimated based on methods published by Thomas *et al.* (1997). If the drainage area of the ungaged site is between 50 and 150 percent of the drainage area of the gaged site, the following equation is used:

$$Q_u = Q_g \left(\frac{A_u}{A_g} \right)^{0.5}$$

where,

Q_u = Area weighted 4Q3 at the ungaged site (cubic feet per second [cfs])
Q_g = 4Q3 at the gaged site (cfs)
A_u = Drainage area at the ungaged site (square miles [mi^2])
A_g = Drainage area at the gaged site (mi^2)

Drainage areas for assessment units to which this method was applied are summarized in the following table:

Table D.2 Drainage Areas for Estimating Flow by Drainage Area Ratios

Assessment Unit	USGS Gage	Drainage Area from Gage (mi^2)	Drainage Area from Top of AU (mi^2)	Drainage Area from Bottom of AU (mi^2)	Ratio of DA of Ungaged (upstream) to Gaged Site	Ratio of DA of Ungaged (downstream) to Gaged Site
NM-2306.A_065	07204500	56	– [(b)]	74.74	– [(b)]	133%
NM-2306.A_040	07207000	294	87.15	97.25	**29.6%** [(c)]	**33%** [(c)]
NM-2305.A_060	07204000	73.8	27.12	79.53	**37%** [(c)]	108%
NM-2306.A_051	07208500	65	– [(b)]	69.75	– [(b)]	107%
NM-2306.A_064	07205000	10.5	– [(b)]	13.88	– [(b)]	132%
NM-2306.A_120	– [(a)]	–	87.33	95.64	–	–
NM-2306.A_068	– [(a)]	–	– [(b)]	15.86	–	–

Notes:
(a) Regression method developed by Waltemeyer (2002) was used to estimate flows since this is an ungaged stream.
(b) Assessment unit begins at headwaters.
(c) The method developed by Thomas et al. (1997) is not applicable because the drainage area of the ungaged site is less than 50 percent of the drainage area of the gaged site. Therefore, the method developed by Waltemeyer (2002) was used to estimate flows for this assessment unit.

mi^2 = Square miles
USGS = U.S. Geological Survey
AU = Assessment Unit

4Q3 derivations for ungaged streams were based on analysis methods described by Waltemeyer (2002). Two regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico (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):

$$4Q3 = 1.2856 \times 10^{-4}\ DA^{0.42}\ P_w^{\ 3.16}$$

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):

$$4Q3 = 7.3287 \times 10^{-5} \; DA^{0.70} \; P_w^{3.58} \; S^{1.35}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
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 drainage areas, average basin mean winter precipitation, and average basin slope for assessment units where this regression method was used are presented in the following table:

Table D.3 Parameters for Estimating Flow using USGS Regression Model

Assessment Unit	Regression Model[(a)]	Average Elevation for Assessment Unit (feet)	Mean Basin Winter Precipitation (inches)	Average Basin Slope (unitless)
NM-2306.A_065	Mountainous	8997	8.65	0.174
NM-2306.A_040	Statewide	6525	8.22	0.248
NM-2305.A_060	Mountainous	8394	9.43	0.244
NM-2306.A_051	Mountainous	8368	9.11	0.219
NM-2306.A_064	Mountainous	9024	8.00	0.272
NM-2306.A_120	Statewide	6914	8.79	0.303
NM-2306.A_068	Mountainous	9143	10.01	0.299

Notes:
mi^2 = Square miles
[(a)] Waltemeyer (2002)

Based on the methods described above, the following values were estimated for inflow:

Table D.4 Inflow

Assessment Unit	Ref.	4Q3 (cfs)	DAt (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Inflow (cfs)
NM-2306.A_065	N/A	–	–	56	8.65	0.174	0.00[(3)]
NM-2306.A_040	(a)	3.30 [(1)]	87.15	294	8.22	0.248	0.65
NM-2305.A_060	(b)	0.18 [(2)]	27.12	73.8	9.43	0.244	0.34

Assessment Unit	Ref.	4Q3 (cfs)	DAt (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Inflow (cfs)
NM-2306.A_051	N/A	–	–	65	9.11	0.219	0.00[3]
NM-2306.A_064	N/A	–	–	10.5	8.00	0.272	0.00[3]
NM-2306.A_120	(a)	–	87.33	–	8.79	0.303	0.81
NM-2306.A_068	N/A	–	–	–	10.01	0.299	0.00[3]

Notes:
N/A = Not applicable, assessment unit begins at headwaters.
Ref. = Reference
(a) Waltemeyer (2002), statewide
(b) Waltemeyer (2002), mountainous

cfs = cubic feet per second
mi^2 = Square miles
in = Inches
Pw = Mean winter precipitation
DAt = Drainage area from top of segment
DAb = Drainage area from bottom of segment
DAg = Drainage area from USGS gage
S = Average basin slope
(1) Based on period of record for USGS gage-Cimarron River near Cimarron, NM (07207000)
(2) Based on period of record for USGS gage-Moreno Creek at Eagle Nest, NM (07204000)
(3) Inflow is zero because assessment unit begins at headwaters.

D2.2 Inflow Temperature

This parameter represents the *mean daily* water temperature at the top of the segment. 2006 data from thermographs positioned at the top of the assessment unit were used when possible. If the segment began at a true headwater, the temperature entered was zero degrees Celcius (°C) (zero flow has zero heat). The following inflow temperatures for impaired assessment units were modeled in SSTEMP:

Table D.5 Mean Daily Water Temperature

Assessment Unit	Upstream Thermograph Location	Inflow Temp.[1] (°C)	Inflow Temp. (°F)
NM-2306.A_065	None (headwaters)	0	32.0
NM-2306.A_040	Cimarron River above Cimarron Village- 05Cimarr050.8	16.98	62.56
NM-2305.A_060	Moreno Creek on NM 64 at USGS gage- 05Moreno003.7	16.36	61.45
NM-2306.A_051	None (headwaters)	0	32.0
NM-2306.A_064	None (headwaters)	0	32.0
NM-2306.A_120	South Ponil above North Ponil- 05SPonil000.1	16.21	61.18
NM-2306.A_068	None (headwaters)	0	32.0

Notes:
°C = Degrees Celcius
°F = Degrees Farenheit
[1] Mean daily average for May 16-September 13, 2006, except South Ponil which was May 16-June 14.

D2.3 Segment Outflow

Flow data from USGS gages were used when available. To be conservative, the 4Q3 was used as the segment outflow. These critical low flows were used to decrease assimilative capacity of the stream to adsorb and disperse solar energy. Outflow was estimated using the methods described in Section D2.1. The following table summarizes 4Q3s used in the SSTEMP Model:

Table D.6 Segment Outflow

Assessment Unit	Ref.	4Q3 (cfs)	DAb (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Outflow (cfs)
NM-2306.A_065	(a)	0.31 [(1)]	74.74	56	8.65	0.174	0.36
NM-2306.A_040	(b)	3.30 [(2)]	281.52	294	8.22	0.248	1.07
NM-2305.A_060	(a)	0.18 [(3)]	79.53	73.8	9.43	0.244	0.19
NM-2306.A_051	(a)	1.88 [(4)]	69.75	65	9.11	0.219	1.95
NM-2306.A_064	(a)	0.17 [(5)]	13.88	10.5	8.00	0.272	0.20
NM-2306.A_120	(b)	–	95.64	–	8.79	0.303	0.84
NM-2306.A_068	(c)	–	15.86	–	10.01	0.299	0.38

Notes:
Ref. = Reference
(a) Thomas et al. (1997)
(b) Waltemeyer (2002), statewide
(c) Waltemeyer (2002), mountainous

cfs = cubic feet per second
mi^2 = Square miles
in = Inches
Pw = Mean winter precipitation
DAb = Drainage area from bottom of segment
DAg = Drainage area from USGS gage
S = Average basin slope
[(1)] Based on period of record for USGS gage-Cieneguilla Creek near Eagle Nest, NM (07204500)
[(2)] Based on period of record for USGS gage-Cimarron River near Cimarron, NM (07207000)
[(3)] Based on period of record for USGS gage-Moreno Creek at Eagle Nest, NM (07204000)
[(4)] Based on period of record for USGS gage-Rayado Creek near Cimarron, NM (07208500)
[(5)] Based on period of record for USGS gage-Sixmile Creek near Eagle Nest, NM (07205000)

D2.4 Accretion Temperature

The temperature of the lateral inflow, barring tributaries, generally should be the same as groundwater temperature. In turn, groundwater temperature may be approximated by the mean annual air temperature. Mean annual air temperature for 2006 was used in the absence of measured data. The following table presents the mean annual air temperature for each assessment unit:

Table D.7 Mean Annual Air Temperature as an Estimate for Accretion Temperature

Assessment Unit	Ref.	Mean Annual Air Temperature (°C)	Mean Annual Air Temperature (°F)
NM-2306.A_065	(a)	6.55	43.783
NM-2306.A_040	(a)	6.55	43.783
NM-2305.A_060	(a)	6.55	43.783
NM-2306.A_051	(a)	6.55	43.783
NM-2306.A_064	(a)	6.55	43.783
NM-2306.A_120	(a)	6.55	43.783
NM-2306.A_068	(a)	6.55	43.783

Notes:
Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (Cimarron RAWS, Elevation 2,665 meters; Latitude 36.606100 N, Longitude 105.120300 W),* ***2006***

ºF = Degrees Farenheit
ºC = Degrees Celciu

D 3.0 GEOMETRY

D3.1 Latitude

Latitude refers to the position of the stream segment on the earth's surface. Latitude is generally determined in the field with a global positioning system (GPS) unit. Latitude for each assessment unit is summarized below:

Table D.8 Assessment Unit Latitude

Assessment Unit	Latitude (decimal degrees)
NM-2306.A_065	36.42
NM-2306.A_040	36.52
NM-2305.A_060	36.60
NM-2306.A_051	36.42
NM-2306.A_064	36.54
NM-2306.A_120	36.63
NM-2306.A_068	36.59

D3.2 Dam at Head of Segment

The following assessment units have a dam at the upstream end of the segment with a constant, or nearly constant diel release temperature:

Table D.9 Presence of Dam at Head of Segment

Assessment Unit	Dam?
NM-2306.A_065	No
NM-2306.A_040	No[1]
NM-2305.A_060	No
NM-2306.A_051	No
NM-2306.A_064	No
NM-2306.A_120	No
NM-2306.A_068	No

[1] Eagle Nest Lake is upstream but not at the head of the segment.

D3.3 Segment Length

Segment length was determined with National Hydrographic Dataset Reach Indexing GIS tool. The segment lengths are as follows:

Table D.10 Segment Length

Assessment Unit	Length (miles)
NM-2306.A_065	12.63
NM-2306.A_040	4.25
NM-2305.A_060	9.0
NM-2306.A_051	24.26
NM-2306.A_064	4.6
NM-2306.A_120	5.3
NM-2306.A_068	8.04

D3.4 Upstream Elevation

The following upstream elevations were determined with National Hydrographic Dataset Reach Indexing GIS tool.

Table D.11 Upstream Elevations

Assessment Unit	Upstream Elevation (feet)
NM-2306.A_065	9,800
NM-2306.A_040	6,629
NM-2305.A_060	8,620
NM-2306.A_051	10,320
NM-2306.A_064	9,880
NM-2306.A_120	7,128
NM-2306.A_068	10,960

D3.5 Downstream Elevation

The following downstream elevations were determined with National Hydrographic Dataset Reach Indexing GIS tool.

Table D.12 Downstream Elevations

Assessment Unit	Downstream Elevation (feet)
NM-2306.A_065	8,194
NM-2306.A_040	6,420
NM-2305.A_060	8,167
NM-2306.A_051	6,415
NM-2306.A_064	8,167
NM-2306.A_120	6,700
NM-2306.A_068	7,325

D3.6 Width's A and Width's B Term

Width's B Term was calculated as the slope of the regression of the natural log of width and the natural log of flow. Width-versus-flow regression analyses were prepared by entering cross-section field data into a Windows-Based Stream Channel Cross-Section Analysis (WINXSPRO 3.0) Program (U.S. Department of Agriculture [USDA] 2005). Theoretically, the Width's A Term is the untransformed Y-intercept. However, because the width versus discharge relationship tends to break down at very low flows, the Width's B-Term was first calculated as the slope and Width's A-Term was estimated by solving for the following equation:

$$W = A \times Q^B$$

where,

W = Known width (feet)
A = Width's A-Term (seconds per square foot)
Q = Known discharge (cfs)
B = Width's B-Term (unitless)

The following table summarizes Width's A- and B-Terms for assessment units requiring temperature TMDLs:

Table D.13 Width's A and Width's B Terms

Assessment Unit	Width's B-Term	Width's A-Term [(1)]
NM-2306.A_065	0.349	2.33
NM-2306.A_040	0.356	5.78
NM-2305.A_060	0.361	2.18
NM-2306.A_051	0.450	3.95
NM-2306.A_064	0.505	0.735
NM-2306.A_120	0.327	6.98
NM-2306.A_068	0.484	0.748

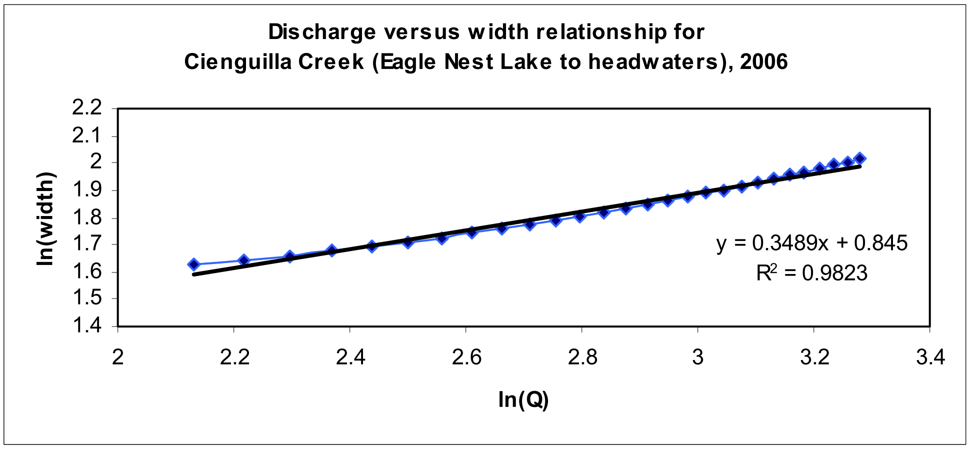
[(1)] A=e^constant from regression

The following figures present the detailed calculations for the Width's B-Term.

Measurements were collected at one site within these assessment units. The regression of natural log of width and natural log of flow for each location is as follows:

Figure D.1 Wetted Width versus Flow for Assessment Unit NM-2306.A_065*

**Cross-section E from 8/30/2006 data collection*



SUMMARY OUTPUT

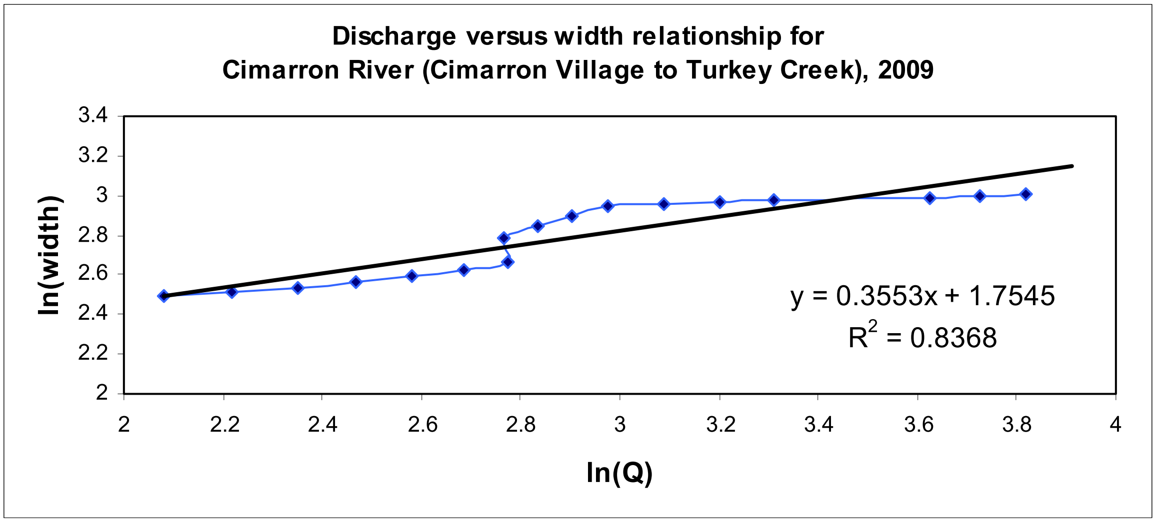
Regression Statistics	
Multiple R	0.991088109
R Square	0.982255641
Adjusted R Square	0.981573165
Standard Error	0.016116291
Observations	28

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.373824506	0.373825	1439.254	2.70191E-24
Residual	26	0.006753106	0.00026		
Total	27	0.380577612			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.844989479	0.026220739	32.226	1.73E-22	0.791091979	0.898887	0.791091979	0.898886979
X Variable 1	0.34891012	0.00919697	37.93751	2.7E-24	0.330005476	0.367815	0.330005476	0.367814763

Figure D.2 Wetted Width versus Flow for Assessment Unit NM-2306.A_040



SUMMARY OUTPUT

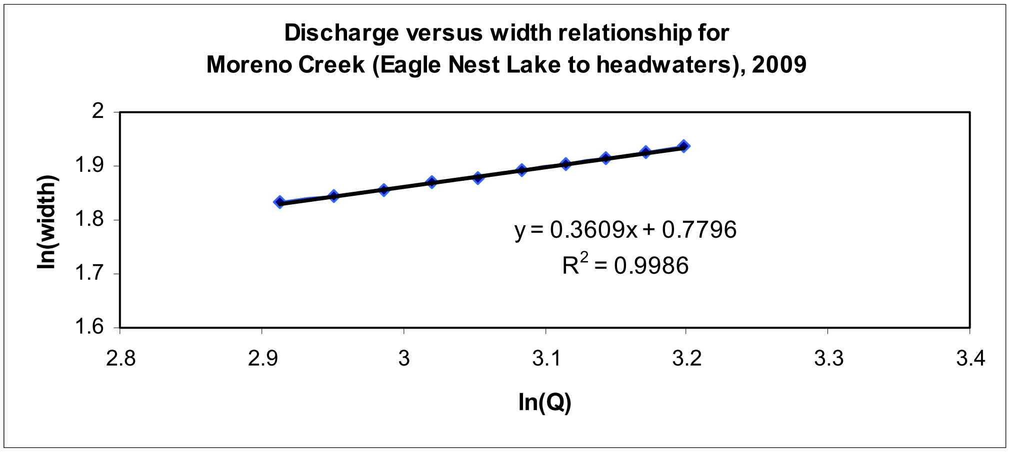
Regression Statistics	
Multiple R	0.91245644
R Square	0.83257675
Adjusted R	0.82211279
Standard E	0.0843572
Observatio	18

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regressior	1	0.566203855	0.566204	79.56618	1.31424E-07
Residual	16	0.113858202	0.007116		
Total	17	0.680062058			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.8147014	0.112269493	16.1638	2.48E-11	1.57670071	2.052702	1.57670071	2.052702092
X Variable	0.33270732	0.03729908	8.919987	1.31E-07	0.253636805	0.411778	0.253636805	0.411777838

Figure D.3 Wetted Width versus Flow for Assessment Unit NM-2306.A_060



SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.999305274
R Square	0.998611031
Adjusted R Square	0.99843741
Standard Error	0.001365942
Observations	10

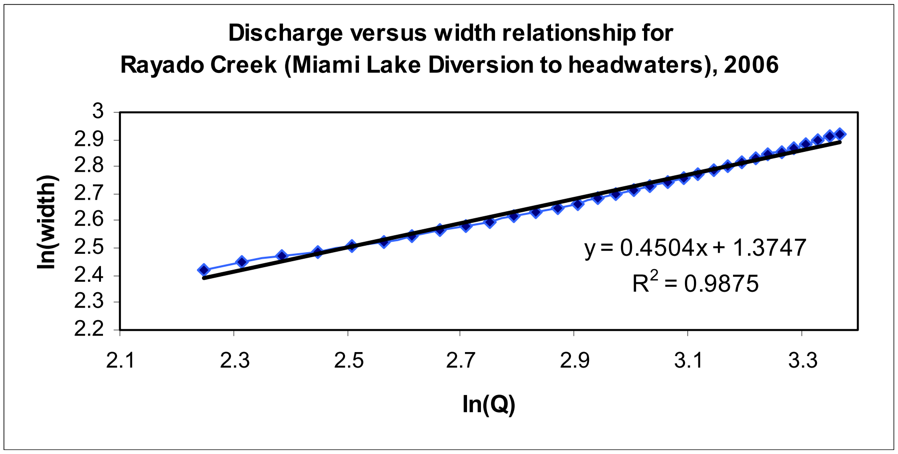
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.010731449	0.010731	5751.669	1.01828E-12
Residual	8	1.49264E-05	1.87E-06		
Total	9	0.010746375			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.779552422	0.014582709	53.45731	1.66E-11	0.745924634	0.813180209	0.745924634	0.813180209
X Variable 1	0.360856981	0.00475815	75.83976	1.02E-12	0.349884666	0.371829295	0.349884666	0.371829295

Figure D.4 Wetted Width versus Flow for Assessment Unit NM-2306.A_051*

**Cross-section E from 8/30/2006 data collection*



SUMMARY OUTPUT

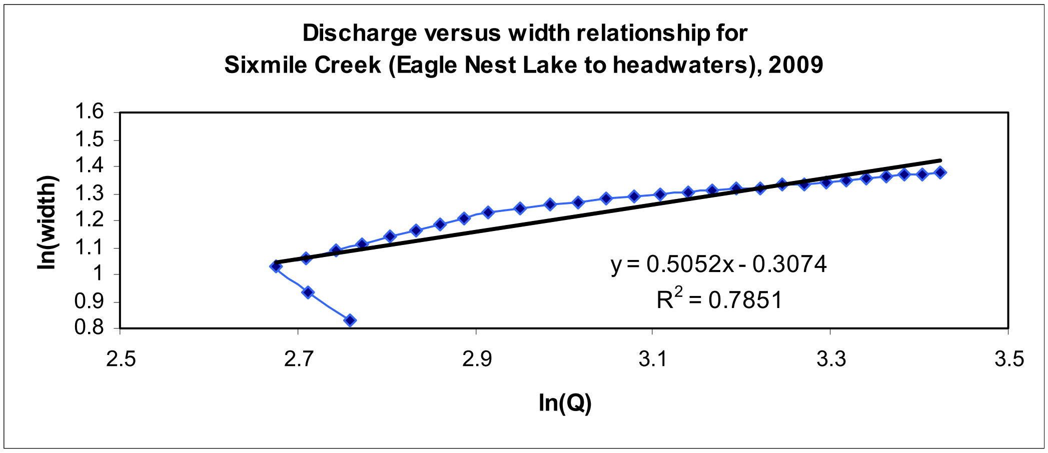
Regression Statistics	
Multiple R	0.993725024
R Square	0.987489423
Adjusted R Square	0.987072403
Standard Error	0.016891255
Observations	32

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.6756164	0.675616	2367.971	4.18296E-30
Residual	30	0.008559435	0.000285		
Total	31	0.684175835			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.374697383	0.027279292	50.39344	1.48E-30	1.318985636	1.430409	1.318985636	1.430409129
X Variable 1	0.450430134	0.009256339	48.6618	4.18E-30	0.431526168	0.469334	0.431526168	0.469334101

Figure D.5 Wetted Width versus Flow for Assessment Unit NM-2306.A_064



SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.88603531
R Square	0.78505857
Adjusted R Square	0.77738209
Standard Error	0.064739671
Observations	30

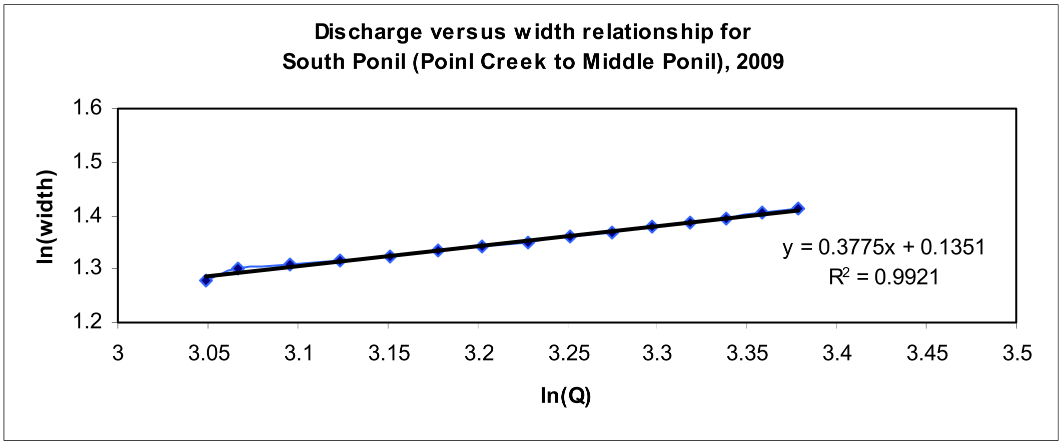
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.428628384	0.428628	102.268	7.50986E-11
Residual	28	0.117354299	0.004191		
Total	29	0.545982682			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.307435809	0.153027609	-2.009022	0.054264	-0.620898651	0.006027	-0.620898651	0.006027034
X Variable 1	0.505215031	0.049958143	10.11277	7.51E-11	0.402880416	0.60755	0.402880416	0.607549646

Figure D.6 Wetted Width versus Flow for Assessment Unit NM-2306.A_120*

**data collections from 05SPonil008.5*



SUMMARY OUTPUT

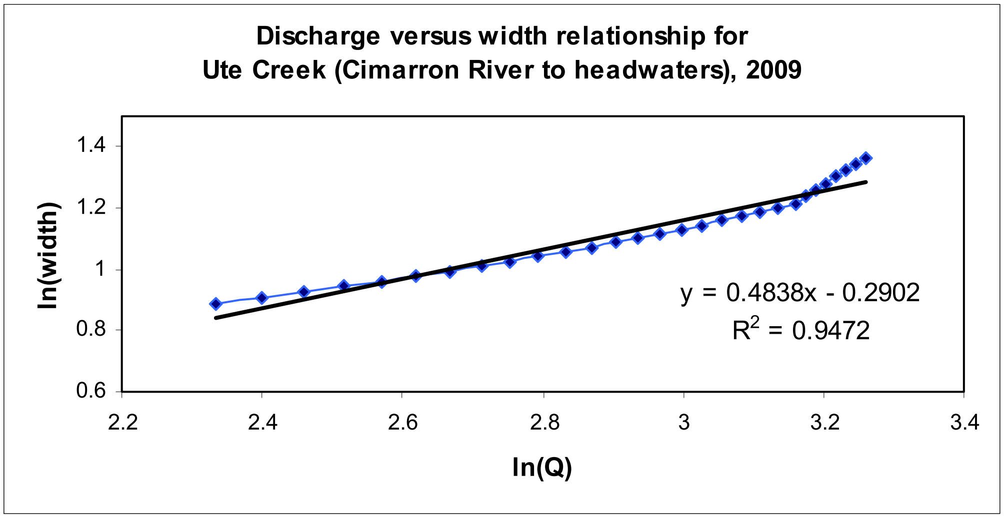
Regression Statistics	
Multiple R	0.996048114
R Square	0.992111845
Adjusted R Square	0.991505064
Standard Error	0.00376334
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.02315664	0.023157	1635.041	4.66074E-15
Residual	13	0.000184115	1.42E-05		
Total	14	0.023340755			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.13508656	0.030088474	4.489645	0.000609	0.070084364	0.200088755	0.070084364	0.200088755
X Variable 1	0.377528127	0.00933652	40.43564	4.66E-15	0.357357802	0.397698452	0.357357802	0.397698452

Figure D.7 Wetted Width versus Flow for Assessment Unit NM-2306.A_068



SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.973233872
R Square	0.947184169
Adjusted R	0.945228028
Standard E	0.032513581
Observatio	29

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regressior	1	0.511874716	0.511875	484.2104	8.92287E-19
Residual	27	0.028542589	0.001057		
Total	28	0.540417305			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.290161845	0.064290113	-4.51332	0.000113	-0.422074258	-0.158249432	-0.422074258	-0.158249432
X Variable	0.483756271	0.021984144	22.00478	8.92E-19	0.438648534	0.528864009	0.438648534	0.528864009

D3.7 Manning's n or Travel Time

Site-specific values were calculated using Strickler's equation to estimate Manning's roughness based on prevailing sediment sizes in the streambed:

$$n = \frac{(d_{50})^{1/6}}{21.0}$$

where d_{50} is the median sediment size in meters.

The following table summarizes the Manning's n input values for each assessment unit:

Table D.14 Manning's n

Assessment Unit	d_{50} (in meters)	Manning's n
NM-2306.A_065	46	0.090
NM-2306.A_040	19	0.078
NM-2305.A_060	20.5	0.079
NM-2306.A_051	75.5	.098
NM-2306.A_064	5.5	0.063
NM-2306.A_120	45.5	0.090
NM-2306.A_068	4.5	0.061

D 4.0 METEOROLOGICAL PARAMETERS

D4.1 Air Temperature

This parameter is the mean daily air temperature for the assessment unit (or average daily temperature at the mean elevation of the assessment unit). Air temperature will usually be the single most important factor in determining mean daily water temperature. Air temperatures are usually measured directly (in the shade) using air thermographs and adjusted to what the temperature would be at the mean elevation of the assessment unit. The following table summarizes mean daily air temperatures for each assessment unit (for its modeled date) requiring a temperature TMDL:

Table D.15 Mean Daily Air Temperature

Assessment Unit	Elevation at Air Thermograph Location (meters)	Measured Mean Daily Air Temperature (°C)	Mean Elevation for Assessment Unit (meters)	Adjusted Mean Daily Air Temperature (°C)	Adjusted Mean Daily Air Temperature (°F)
NM-2306.A_065	2510	19.43	2742	17.91	64.24
NM-2306.A_040	2018	23.64	1989	23.83	74.89
NM-2305.A_060	2510 [b]	16.36	2558	16.05	60.89
NM-2306.A_051	2018 [a]	23.64	2551	20.14	68.25
NM-2306.A_064	2510 [b]	18.34	2751	16.76	62.17
NM-2306.A_120	2192	17.00	2787	13.10	55.58
NM-2306.A_068	2192 [c]	20.84	2107	21.40	70.52

Notes:

ºF = Degrees Farenheit
ºC = Degrees Celcius
[a] *No air thermographs deployed. Air thermograph at Cimarron River above Cimarron Village was used.*
[b] *No air thermographs deployed. Air thermograph at Cienguilla Crek above Eagle Nest Lake was used.*
[c] *No air thermographs deployed. Air thermograph at South Ponil above Middle Ponil was used.*

The adiabatic lapse rate was used to correct for elevational differences from the met station:

$$T_a = T_o + C_t \times (Z - Z_o)$$

where,

T_a = air temperature at elevation E (°C)
T_o = air temperature at elevation E_o (°C)
Z = mean elevation of segment (meters)
Z_o = elevation of station (meters)
C_t = moist-air adiabatic lapse rate (-0.00656 °C/meter)

D4.2 Maximum Air Temperature

Unlike the other variables, the maximum daily air temperature overrides only if the check box is checked. If the box is not checked, the SSTEMP Model estimates the maximum daily air temperature from a set of empirical coefficients (Theurer et al., 1984 as cited in Bartholow 2002) and will print the result in the grayed data entry box. A value cannot be entered unless the box is checked.

D4.3 Relative Humidity

Relative humidity data were obtained from the New Mexico State University Climate Network (http://weather.nmsu.edu/data/data.htm). The data were corrected for elevation and temperature using the following equation:

$$R_h = R_o \times \left(1.0640^{(To-Ta)}\right) \times \left(\frac{T_a + 273.16}{T_o + 273.16}\right)$$

where,

R_h = relative humidity for temperature T_a (decimal)
R_o = relative humidity at station (decimal)
T_a = air temperature at segment (°C)
T_o = air temperature at station (°C)

The following table presents the adjusted mean daily relative humidity for each assessment unit:

Table D.16 Mean Daily Relative Humidity

Assessment Unit	Ref.	Mean Daily Air Temp. at Weather Station (°C)	Mean Daily Air Temperature at AU (°C)	Mean Daily Relative Humidity at Weather Station (percent)	Mean Daily Relative Humidity for AU (percent)
NM-2306.A_065	(a)	19.17	17.91	48.88	52.63
NM-2306.A_040	(a)	19.98	23.83	34	27.13
NM-2305.A_060	(a)	14.38	16.05	78.54	71.22
NM-2306.A_051	(a)	19.98	20.14	34	33.68
NM-2306.A_064	(a)	19.07	16.76	66.32	75.93
NM-2306.A_120	(a)	14.11	13.10	57.40	60.90
NM-2306.A_068	(a)	19.98	21.40	34	31.28

Notes:
Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (Cimarron RAWS, Elevation 2,665 meters; Latitude 36.606100 N, Longitude 105.120300 W),* ***modeled dates in 2006***
AU = Assessment Unit
°C = Degrees Celcius

D4.4 Wind Speed

Average daily wind speed data were obtained from the New Mexico State University Climate Network (http://weather.nmsu.edu/data/data.htm). The following table presents the mean daily wind speed for each assessment unit:

Table D.17 Mean Daily Wind Speed

Assessment Unit	Ref.	Mean Daily Wind Speed (miles per hour)	Date
NM-2306.A_065	(a)	3.833	7/20/2006
NM-2306.A_040	(a)	4.273	7/16/2006
NM-2305.A_060	(a)	3.750	8/10/2006
NM-2306.A_051	(a)	4.273	7/16/2006
NM-2306.A_064	(a)	4.773	7/15/2006
NM-2306.A_120	(a)	3.25 [(b)]	6/2/2006
NM-2306.A_068	(a)	4.273	7/16/2006

Notes:
Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (Cimarron RAWS, Elevation 2,665 meters; Latitude 36.606100 N, Longitude 105.120300 W)*
(b) No windspeed available for 6/2/2006. The average of the values for June 1 and June 3 was used.

D4.5 Ground Temperature

Mean annual air temperature data for 2006 were used in the absence of measured data. The following table presents the mean annual air temperature for each assessment unit:

Table D.18 Mean Annual Air Temperature as an Estimate for Ground Temperature

Assessment Unit	Ref.	Mean Annual Air Temperature (°C)	Mean Annual Air Temperature (°F)
NM-2306.A_065	(a)	14.11	43.783
NM-2306.A_040	(a)	14.11	43.783
NM-2305.A_060	(a)	14.11	43.783
NM-2306.A_051	(a)	14.11	43.783
NM-2306.A_064	(a)	14.11	43.783
NM-2306.A_120	(a)	14.11	43.783
NM-2306.A_068	(a)	14.11	43.783

Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (Cimarron RAWS, Elevation 2,665 meters; Latitude 36.606100 N, Longitude 105.120300 W)*

°F = Degrees Farenheit
°C = Degrees Celcius

D4.6 Thermal Gradient

The default value of 1.65 was used in the absence of measured data.

D4.7 Possible Sun

Percent possible sun for Albuquerque is found at the Western Regional Climate Center web site http://www.wrcc.dri.edu/htmlfiles/westcomp.sun.html#NEW%20MEXICO. The percent possible sun is 83 percent for June, 77 for July, and 73 for August for the Clayton station.

D4.8 Dust Coefficient

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and "override' the internal calculation of solar radiation. Solar radiation data are available from the New Mexico State University Climate Network (see Section 4.10).

D4.9 Ground Reflectivity

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and "override' the internal calculation of solar radiation. Solar radiation data are available from the New Mexico State University Climate Network (see Section 4.10).

D4.10 Solar Radiation

Because solar radiation data were obtained from an external source of ground level radiation, it was assumed that about 90% of the ground-level solar radiation actually enters the water. Thus, the recorded solar measurements were multiplied by 0.90 to get the number to be entered into the SSTEMP Model. The following table presents the measured solar radiation at Cimarron for 2006:

Table D.19 Mean Daily Solar Radiation

Assessment Unit	Ref.	Date	Mean Solar Radiation (L/hour)	Mean Solar Radiation x 0.90 (L/day)
NM-2306.A_065	(a)	7/20/2006	22.579	487.71
NM-2306.A_040	(a)	7/16/2006	27.805	600.59
NM-2305.A_060	(a)	8/10/2006	17.526	378.56
NM-2306.A_051	(a)	7/16/2006	27.805	600.59
NM-2306.A_064	(a)	7/15/2006	32.525	702.54
NM-2306.A_120	(a)	6/2/2006	15.432 [(b)]	360.805
NM-2306.A_068	(a)	7/16/2006	27.805	600.59

Ref. = References for Weather Station Data are as follows:

(a) *New Mexico State University Climate Network (Cimarron RAWS, Elevation 2,665 meters; Latitude 36.606100 N, Longitude 105.120300 W)*

(b) No solar radiation values available for 6/2/2006. The averaged value for 5/26-6/9 was used.

D 5.0 SHADE

Percent shade was estimated for the assessment units using field estimations per geomorphological survey field notes from 2006 and 2009. The value in Table D.20 reflects the average of 6 measurements taken at the cross-section of the primary site in the AU, unless otherwise noted. The measurements may have also been averaged along with visual estimates using USGS digital orthophoto quarter quadrangles downloaded from New Mexico Resource Geographic Information System Program (RGIS), online at http://rgis.unm.edu/. This parameter refers to how much of the segment is shaded by vegetation, cliffs, etc. The following table summarizes percent shade for each assessment unit:

Table D.20 Percent Shade

Assessment Unit	Percent Shade
NM-2306.A_065	12%
NM-2306.A_040	46%
NM-2305.A_060	7%
NM-2306.A_051	22% [a]
NM-2306.A_064	22%
NM-2306.A_120	11%
NM-2306.A_068	86%

[a] Rayado Creek 3 miles above NM 21 – 05Rayado38.4

D 6.0 REFERENCES

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APPENDIX E
PUBLIC PARTICIPATION FLOWCHART

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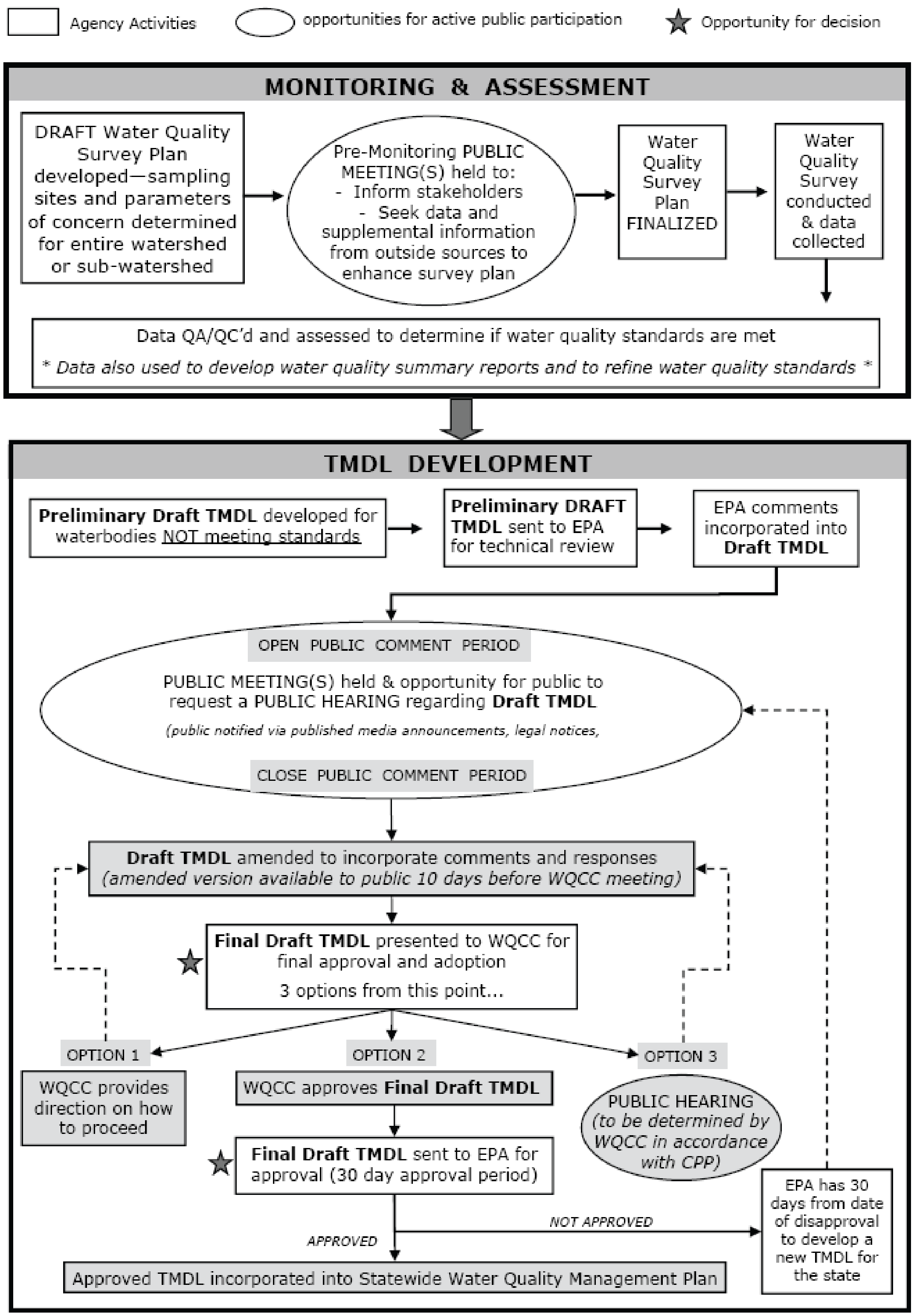
Monitoring, Assessment, & TMDL Development Process



New Mexico Environment Department
Protecting Our Environment, Preserving The Enchantment
Surface Water Quality Bureau
1190 St. Francis Dr, Santa Fe, NM 87106 / 505-827-0187 / www.nmenv.state.nm.us/swqb

The NMED Surface Water Quality Bureau invites you to attend a:

COMMUNITY MEETING

Thursday, June 17, 2010
6:00 - 8:00 PM
Cimarron Watershed Alliance Offices
301 East 9th Street
Cimarron, New Mexico

Cimarron River Watershed

♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦

TMDL Document Presentation

DISCUSSION TOPICS

Total Maximum Daily Load (TMDL) development for the Cimarron River watershed

•

Discussion of survey results from water quality monitoring

•

Current and future water quality projects in watershed.

For more information contact:

Shelly Lemon at 505-827-2814 shelly.lemon@state.nm.us

BILL RICHARDSON
Governor
DIANE DENISH
Lieutenant Governor

NEW MEXICO
ENVIRONMENT DEPARTMENT

Surface Water Quality Bureau

Harold Runnels Building, N2050
1190 South St. Francis Drive (87505)
P.O. Box 5469, Santa Fe, NM 87502-5469
Phone (505) 827-0187   Fax (505) 827-0160
www.nmenv.state.nm.us

RON CURRY
Secretary
SARAH COTTRELL
Deputy Secretary

NEW MEXICO ENVIRONMENT DEPARTMENT, SURFACE WATER QUALITY BUREAU PROPOSES TOTAL MAXIMUM DAILY LOADS (TMDLs) FOR CIMARRON RIVER WATERSHED

NOTICE OF A 30-DAY PUBLIC COMMENT PERIOD AND COMMUNITY MEETINGS

The New Mexico Environment Department's (NMED) Surface Water Quality Bureau (SWQB) is inviting the public to comment on the draft "total maximum daily load" (TMDL) document for the Cimarron River Watershed. Draft TMDLs in this document include:

Cienguilla Creek (Eagle Nest to headwaters)- , *E.coli,* Plant nutrients, temperature
Cimarron River (Canadian River to Cimarron Village)- Plant nutrients
Cimarron River (Cimarron Village to Turkey Creek)- Arsenic, temperature
Cimarron River (Turkey Creek to Eagle Nest Lake)- Arsenic, plant nutrients
Moreno Creek (Eagle Nest Lake to headwaters)- Plant nutrients, temperature
North Ponil Creek (South Ponil Creek to Seally Canyon)- *E.coli*
Ponil Creek (Cimarron River to US 64)- *E.coli*
Ponil Creek (US 64 to confl of North and South Ponil)- *E.coli*, plant nutrients
Rayado Creek (Cimarron River to Miami Lake Diversion)- Plant nutrients
Rayado Creek (Miami Lake Diversion to headwaters)- *E.coli*, temperature
Sixmile Creek (Eagle Nest Lake to headwaters)- *E.coli*, plant nutrients, temperature
South Ponil (Ponil Creek to Middle Ponil)- Temperature
Ute Creek (Cimarron River to headwaters)- Arsenic, *E.coli*, temperature

A TMDL is a planning document that establishes specific goals to meet water quality standards in waterbodies where pollutant limits are exceeded. It includes current pollution loadings, reduction estimates for pollutants, information on probable sources of pollution, and suggestions to restore or protect the health of the waterbody.

The 30-day comment period on this document will open June 7, 2010 and will close July 7, 2010 at 5:00 p.m. MDT. Formal comments for inclusion in the public record must be submitted in writing, to **Shelly Lemon** mailing address **NMED SWQB, P.O. Box 5469, Santa Fe, NM, 87502; voice: 505-827-2814; fax number (505) 827-0160; or e-mail: shelly.lemon@state.nm.us** (if possible, please submit an electronic copy in addition to paper).

A public meeting will be held to summarize the information and to provide a forum for interested parties to ask questions and provide comments. The meeting date will allow the public time to review the document and generate questions or comments. The meeting will be held in Cimarron on Thursday, June 17 from 6-8pm at the Cimarron Watershed Alliance Offices at 301 East 9th Street.

Following the close of the comment period, copies of the draft final document will be:

- mailed to all persons who submitted written comments by July 7, 2010 at 5:00 p.m. and
- available electronically on the bureau's website or by contacting the bureau at the address above.

The SWQB plans to request approval of the draft final TMDLs at the Water Quality Control Commission's (WQCC) regularly scheduled meeting on August 10, 2010. WQCC agendas are available at: http://www.nmenv.state.nm.us/wqcc/index.html.

Persons having a disability and needing help in being a part of this hearing process should contact Judy Bentley at least 10 days before event, at the NMED, Human Resources Bureau, P.O. Box 5469, 1190 St. Francis Drive, Santa Fe, New Mexico, 87502, telephone 505-827-9872. TDY users please access her number via the New Mexico Relay Network at 1-800-659-8331.

For more information, please contact Shelly Lemon at the address or phone number provided above.

APPENDIX F
RESPONSE TO COMMENTS

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Comment Set A:
Sent via email on Tuesday, June 15, 2010 at 11:44 am.

SWQB's usual process during TMDL development is to solicit comments and suggestions from bureau staff and EPA and incorporate these comments into the draft TMDL before it is released for public comment. SWQB had been in communication with EPA Region 6 throughout the drafting of this TMDL, however we did not receive official written comments from EPA before the opening of the public comment period so EPA's comments are included here for reference.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TEXAS 75202-2733

MEMORANDUM

Subject: Comments on the Draft Cimarron River Watershed Total Maximum Daily Load

From: Linda K. Adams, Environmental Scientist
TMDL Section (6WQ-PT)

Thru: Curry Jones, Chief
TMDL Section (6WQ-PT)

Thank you for the opportunity to review the Draft Cimarron River Watershed Total Maximum Daily Load for Arsenic, Bacteria, Temperature, and Nutrients. EPA offers the following comments on the draft TMDLs.

Nutrient TMDL for Cieneguilla Creek and Cimarron River

1. Section 5.4.1, Page 59, Paragraph 3, This paragraph cites an article by Jeyanayagam (2005), which indicates that the limit of technology (LOT) for total phosphorus and total nitrogen removal is generally considered 0.1 mg/L and 3 mg/L, respectively. Currently, there are two EPA studies which suggest that a lower limit of technology for phosphorus removal. The EPA publications entitled, "Advance Wastewater Treatment to Achieve Low Concentration of Phosphorus" (2007), and "Office of Wastewater – Municipal Nutrient Removal Technology" show that the limit of technology for total phosphorus was less than 0.01 mg/L. EPA suggest that this section be updated to consider more recent studies on nutrient removal. These documents can be found at the following web addresses: http://www.epa.gov/owm/mtb/mnrt-volume1.pdf , and http://yosemite.epa.gov/r10/water.nsf/Water+Quality+Standards/AWT-Phosphorus/$FILE/AWT+Report.pdf).

SWQB Response: The limits of technology (LOT) for nutrient removal vary depending on the process or combination of processes used. Most of the research on LOT levels is from larger facilities (> 10 mgd capacity); data from smaller facilities (< 1 mgd capacity) are relatively limited. In addition, higher unit costs are generally associated with smaller facilities compared to larger facilities because of the economies of scale. Taking these factors into account, SWQB recommended a phased strategy to reduce nutrient loading, incorporating the lowest limits that were still feasible for these municipalities to implement.

In order to achieve the target effluent limits outlined in the NPDES permit, treatment processes need to be consistent and reliable. Advanced treatment technologies are available to reliably attain an annual average of 0.1 mg/L for TP and 3 mg/L for TN (EPA 2008). Other technologies may achieve lower nutrient concentrations; however they tend to be less reliable because they are more variable. As more municipalities are required to meet stringent nutrient load limits to protect receiving waterbodies, upgrading existing facilities with appropriate and sustainable technologies is an important challenge. SWQB is trying to provide municipalities with feasible yet creative solutions to meet these challenges while taking into consideration compliance schedules and individual site requirements.

Municipal Nutrient Removal Technologies Reference Document (Volume 1 – Technical Report). United States Environmental Protection Agency – Office of Wastewater Management, Municipal Support Division. Washington, DC. EPA 832-R-08-006. September 2008.

2. Section 5.4.1, Page 59, Paragraph 4. The phased approach, as written, only involves the Village of Angel Fire. Why is the phased approach not applicable to the City of Springer? The TMDL should provide a clear rationale of why the phased approach is not appropriate for Springer.

SWQB Response: The City of Springer should have been included in the phased approach. Corrections were made to Section 5.4.1 and a phased waste load allocation was assigned to the City of Springer (Tables 5.9 and 5.10).

3. Section 5.4.1, Page 60, Paragraph 1. The TMDL should include the programmatic reference to the phased approach. This reference and subsequent new guidance helps to support NMED's adaptive implementation approach for nutrients to implement the wasteload allocation for the Village of Angel Fire in step-wise manner. This new reference can be found at the following web address: http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.html

SWQB Response: The following sentence was added to Section 5.4.1, Page 60, Paragraph 1: "Please refer to "Clarification Regarding "Phased" Total Maximum Daily Loads," an August 2, 2006 memorandum from the USEPA, for more information on this topic."

4. Section 5.4.1, Page 61, Table 5.9. Table 5.9, as currently presented, shows "Phased Wasteload Allocations". When you connect Section 5.4.1 (4th paragraph) with Table 5.9, it may not be clear to the permit writer what to implement. EPA recommends that Table 5.9 be split into two tables.

<u>SWQB Response</u>: As stated in the TMDL, "NMED believes that a TMDL should be written to targets that are protective of the stream and scientifically defensible however there should also be recognition of the limits of technology for nutrient removal. Even though the limits of technology (in this particular case) preclude the attainment of the target concentrations defined in this TMDL, advanced treatment would significantly reduce the load of TP and TN that is introduced into the stream."

Since nutrient cycling is dynamic and dose-response relationships are often location and season specific, it is difficult to pinpoint well-defined numeric thresholds for proper ecosystem functioning. Therefore, NMED is recommending that the Phase 1 effluent limits be based on best available technology/limits of technology. After implementation of this TMDL, NMED will reevaluate the condition of Cieneguilla Creek and the Cimarron River to determine if water quality has improved to the point that the designated use is attained. If substantial improvements are not observed and the use is not attained, the TMDL would move to a second phase with lower nutrient targets which may necessitate that the WWTPs enhance the treatment of the effluent by adding tertiary treatment or find other means of disposal.

Table 5.9 was adapted to include only the Phase 1 WLAs for the WWTPs. Phase 1 effluent limits are based on annual averages for the limits of technology. Because this is an iterative process, Table 5.10 was created to outline the <u>target</u> WLAs for each facility. Target effluent limits are based on either in-stream concentrations that are proven effective at maintaining water quality standards or in-stream concentrations based on ecoregion thresholds. Given current technology, the target effluent limits in Table 5.10 are unachievable.

Temperature TMDL

5. Section 6.4, Page 75-76, Wasteload Allocation Section, The TMDL identifies the Village of Angel Fire as a point source to Cieneguilla Creek. The TMDL provided a WLA of zero to the Village of Angel Fire. The TMDL should explain why a numeric WLA is not needed. In addition, the TMDL should explain what conditions are needed for the Village of Angel Fire to demonstrate compliance with NMED temperature criterion.

<u>SWQB Response</u>: In reference to the Temperature TMDL (Section 6.4.1), the following was changed to better explain SWQB's reasoning (presented in redline-strikeout to view changes more effectively):

6.4.1 Waste Load Allocation

With the exception of the Cieneguilla Creek (Eagle Nest Lake to headwaters), there are no point source contributions associated with these TMDLs.

The Angel Fire Wastewater Treatment Plant (WWTP) discharges directly into Cieneguilla Creek. There is some debate regarding whether or not effluent from WWTPs has an impact on temperature. The Angel Fire WWTP NPDES permit (NM0030503) does not have limitations or monitoring requirements for temperature. WWTP effluent has never been noted to be a significant source contributor of temperature impairment. ~~Data indicate that the Angel Fire WWTP is not contributing to elevated temperature in Cieneguilla Creek.~~ Figure 6.2 displays the temperature data collected in 2006. Site 05Cieneg19.3 is 1.6 miles upstream of the WWTP and 05Cieng006.3 is 6.7 miles downstream of the WWTP. During the eight discrete sampling events during 2006, the differences between the upstream and downstream sites ranged from 4.24°C (June 13) to 0.39°C (March 14) with the average difference between the sites being 2°C. ~~The data does not indicate that there is a significant difference between the sites above and below the WWTP, therefore, the WLA is zero.~~

The data show that there is a change in temperature between the two monitoring sites. However, according to discharge records, the Angel Fire WWTP was not discharging to Cieneguilla Creek from February-November 2006, therefore the variation in temperature at the two monitoring locations is assumed to be from other sources. ~~Although no WLA is assigned to the Angel Fire WWTP, a monitoring requirement should be added to the NM0030503 NPDES permit to ensure that that the discharge meets the WQS of 20°C at the discharge point to Cieneguilla Creek.~~

Comment Set B:

From: Peter Fant [peter.fant@soudermiller.com]
Sent: Friday, June 18, 2010 4:10 PM
To: Lemon, Shelly, NMENV; Henderson, Heidi, NMENV
Subject: Comments for Town of Springer

Shelly and Heidi, thanks for holding the meeting to present the TMDL information for the Cimarron River Watershed.

While the Town of Springer may submit more comments before the July 7 deadline, there are a few we wanted to make sure got on the list as soon as possible.

1) The Town of Springer is located below the confluence of the Cimarron river, Rayado and Ponil Creeks. The Target Loading Capacity and Waste Load allocation were calculated utilizing a 4Q3 flow of 0.25 MGD. This flow, however, only accounts for the Cimarron River. The flows should also include the 4Q3 flows from Rayado and Ponil Creek which would put the total flow at 0.99 MGD. This change would likely change the allowable nutrient loading in the reach of the River that passes Springer.

<u>SWQB Response</u>: *When available, USGS gages are used to estimate flow. USGS gage 07211000 (Cimarron River at Springer, NM) has a period of record from 1907 – 2004. This gage station is located downstream of the confluence of Rayado and Ponil Creeks, thus their flow has been included in this estimate. The 4Q3 flow for the Cimarron River (Canadian River to Cimarron, NM) was estimated using the gage data from Springer and DFLOW software, Version 3.1b (USEPA 2006). DFLOW 3.1b is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis by utilizing algorithms based on Log Pearson Type III distribution.*

2) At the meeting, you mentioned that we would be able to get access to the SWQB's 2006 water survey to evaluate the water quality data collected above and below the Town of Springer. This information should be on EPA's STORET web site, but it isn't. Can we please get a copy of the data? This will be critical in aiding the Town in determining the present impact of the lagoons on the River Water Quality.

<u>SWQB Response</u>: *Yes, SWQB is always willing to provide the water quality data we have to stakeholders and the public. The data were sent on Friday, July 16, 2010.*

We also checked EPA's STORET site and were able to download the water quality data from the Springer area collected in 2006. We understand EPA's interface can be difficult to use so please do not hesitate to contact SWQB if you cannot find the data you are looking for.

3) The Town appreciates EPA and SWQB's new approach mentioned at the meeting that would allow the Town to operate its existing disposal system until its permit expires in 2013 and then negotiate a timeline with EPA and/or SWQB to come in to compliance. For the record, however, it should be noted that modifications to the plant and disposal system to meet tighter plant discharge limits will likely cost between $500K and $1 million and

annual monitoring costs will cost $20K. The total costs will be inversely proportional to the allowable loading limits set on the Town (ie the lower the limits, the higher the cost). The Town's ability to come in to compliance will also be dependent on its ability to find grant funds to cover these costs.

SWQB Response: As explained in Section 8.0 (Implementation of TMDLs), several sources of funding exist to address impairments discussed in the TMDL document, the two main sources being the Clean Water Act (CWA) Section 319(h) and NMED's Construction Program Bureau. For nonpoint source pollution, monies are available through the CWA §319(h) for on-the-ground projects aimed at improving surface water quality and associated habitat, such as implementing best management practices that reduce runoff and/or capture stormflow. NMED's Construction Programs Bureau (CPB) can also provide matching funds for appropriate CWA §319(h) projects using state revolving fund monies. For point source pollution, CPB also assists communities in need of funding for WWTP upgrades. SWQB will work with CPB and the Town of Springer to help provide the necessary resources to implement this TMDL and meet water quality standards.

Thank you again for this opportunity to provide our input. If you need any additional information regarding any of the items presented above (such as a cost breakdown for the estimates), please don't hesitate to call or email.

Peter Fant.

Peter Fant
Souder Miller & Associates
1201 Parkway Drive
Santa Fe, NM 87507
(505) 473-9211
(505) 471-6675 FAX
(505) 690-5032 cell
peter.fant@soudermiller.com

Comment Set C:

From: JAMES P MORGAN [heydoc@q.com]
Sent: Friday, July 02, 2010 11:12 AM
To: Lemon, Shelly, NMENV
Subject: Cimarron River Watershed TMDL Meeting Public Comments

Ms. Lemon,

I would offer a few comments with regard to the information presented by your office at Cimarron on June 17, 2010 relating to pollution monitoring and remedian proposals for the Cimarron River and its tributaries.

1. Drainage vs. stream assesment

I feel that the study should have been done with extensive data on the reservoirs as well as with information on the streams. An integrated drainage assesment would have been more meaningful.

2. Dewatered lower Cimarron

As happens at this time of year, late June/early July, the Cimarron River at Springer has stopped flowing, a few stagnant pools remain, which will dry leaving a dry riverbed for the rest of the summer. The reason for this situation is, of course, that upstream permitees are allowed to divert all of the water from the stream during this period of time.

Under these conditions TMDLs are meaningless, as are the requirements of the Clean Water Act.

3. Nonpoint pollution sources

Truly, without addressing the issue of nonpoint pollution, the stream water quality will never meet the standards set forth.

I do thank you and others in your department for the fine presentation as well as for the important work that you do.

Regards,

James P. Morgan

P.O. Box 897
Springer, NM 87747

575-483-2890

SWQB Response: Thank you for your written comments.

A study was done on Eagle Nest Lake in 2005. You can access the water quality survey report at:
http://www.nmenv.state.nm.us/swqb/Surveys/LakeWaterQualityAssessments2005.pdf
The major findings of that report indicate low levels of dissolved oxygen and elevated levels of arsenic in Eagle Nest Lake. Mercury in fish tissue continues to be a concern although no further fish tissue data were collected during the 2005 survey. Results from the lake survey were taken into consideration when planning and evaluating the greater Cimarron Watershed survey. Currently, the SWQB does not write TMDLs for lakes, but this process is likely to begin in 2012.

SWQB agrees that nonpoint source pollution is a major cause of concern and has a significant impact on water quality. There is an active watershed group in the Cimarron Watershed that works with SWQB to develop watershed-based plans designed to improve water quality. This collaboration of stakeholders also devises and implements on-the-ground projects aimed at reducing nonpoint source pollution and improving water quality. Here is the contact information:

Cimarron Watershed Alliance, Inc.	*Chris Cudia*
P.O. Box 626	*Surface Water Quality Bureau*
Cimarron, NM 87714	*Watershed Protection Section*
	Las Vegas, NM
(505) 376-2270 (voice)	
(866) 676-2270 (toll free)	*(505) 454-2810*

Comments regarding water rights and water credits need to be directed to Office of the State Engineer (OSE) and the Interstate Stream Commission (ISC). The OSE and the ISC are separate but companion agencies charged with administering the state's water resources. The agencies have jurisdiction over the supervision, measurement, appropriation and distribution of essentially all surface and ground water in New Mexico, including streams and rivers that cross state boundaries. For the purpose of assessing designated use attainment in ambient surface waters, water quality standards apply at all times under all flow conditions.

Comment Set D:

From: Alan C. Huerta [mailto:Ach121052@aol.com]
Sent: Tuesday, July 06, 2010 7:51 AM
To: Carlson, Don, NMENV
Subject: Comment process TMDL Draft

Date June 30, 2010
Re comments regarding the new TMDL draft.

TMDL Staff,

Thank you for your presentation at the CWA offices. You do great work and you are sincere in your efforts. We all appreciate the work you do at SWQB.

I have been re-reading, looking at my notes and applying further study to the Draft TMDL presented at the CWA meeting, I am aware of staffing and budget constraints. I am also aware that given all the water ways in this state it is also difficult to cover everything. I do not think your work is finished though. Setting TMDL's for specific stretches of the Cimarron Watershed does not do justice to the watershed as a whole. TMDL listings should provide a system understanding of what each listed stream does to the Cimarron River and what Eagle Nest Lake does to the rest of the watershed. I would like to suggest that a river/creek is not the same as an impoundment of water; ie.; Eagle Nest Lake. An impoundment either has a spill-way or a gate/opening in the dam that lets water pass through. If the dam is considered a faucet, then is it not a Point Source that affects water quality below the dam every time water releases are called for? Is this a violation of the Clean Water Act? This body of water is a major part of the Cimarron Watershed system and one of the most affected by impairments. We need to go beyond what the specific symptoms of individual stretches of our watershed and understand what the effects of flow from Eagle Nest Dam are on the rest of the watershed. The Watershed is an organism and not just a collection of creeks, and river stretches. Releases are just quantities called for by the irrigators as adjudicated by Permit 71, and then put into motion by OSE staff. A list of TMDL's does not tell us what the real effect of releasing a flow of eutrophied water into the Cimarron River, it should recommend action strategies that can mitigate pollution and lead to protocols for impounded waters throughout the state.

What needs to be quantified are: 1. level of dissolved oxygen at various depths, 2. what is the extent of or lack of lake water turn-over during daily heating and cooling of surface water, and 3. can the water from different depths be mixed in the water tower to reduce impairment loads released down stream. If you cannot provide a modeling study can you strongly suggest that this be made possible through Section 319 grant funds? Can you suggest that more needs to be done to solve the conundrum of water quality, water rights adjudication, and inter-agency cooperation? It would be wise generate additional data at the dam, from both sides of the structure to better inform the TMDL draft process. The present TMDL Draft is definitely inadequate and needs revision stating that the Cimarron River has the same impairments that Eagle Nest Lake does below the dam. Releasing impaired water downstream does not get rid of the impairment. It just adds to the water of other non impaired tributaries, water and sediment that continue the legacy of impairment Eagle Nest Lake stores. The TMDL is inadequate in its present form. I would also like to suggest some solutions.

a. Produce data from within the lake that measures for impairments by depth.
b. Collect data that measures impairment levels by intake gate depth and amount of flow generated from that depth.
c. Model data to asses what the impacts are of the releasing water from various intake gate depths and that of mixing water from intake gates in the intake tower.
d. Collect data indicating what the cold/warm depth turnover effects are daily.
e. Compile data and offer conclusions that will codify actions in the TMDL report so organizations and concerned individuals push for cross-agency changes.
f. The TMDL Report must reflect and address the need for creating data, conducting modeling, and most importantly, defining the deficiencies of the report in a way that opens up new avenues for improving the quality and quantity on the Cimarron River.

These issues must be resolved before the TMDL report is finalized. Needless to say, our efforts, our money sources, the viability of our natural resources and the future of watershed management are at stake. Let us work for you, let us all work together.

Respectfully,

Alan C. Huerta
CWA Board member
Cimarron Conservation Camp President
Cimarroncita Ranch, Owner / General Manager;
Natural Resources and Facilities

<u>SWQB Response</u>: Thank you for your written comments.

A study was done on Eagle Nest Lake in 2005. You can access the water quality survey report at: http://www.nmenv.state.nm.us/swqb/Surveys/LakeWaterQualityAssessments2005.pdf
The major findings of that report indicate low levels of dissolved oxygen and elevated levels of arsenic in Eagle Nest Lake. Mercury in fish tissue continues to be a concern although no further fish tissue data were collected during the 2005 survey. Results from the lake survey were taken into consideration when planning and evaluating the greater Cimarron Watershed survey. Currently, the SWQB does not write TMDLs for lakes, but this process is likely to begin in 2012.

TMDLs are designed to be the first step towards watershed restoration, essentially identifying the pollutant of concern and opening up opportunities for funding. What types of restoration activities to implement are generally left up to the watershed group and local citizen groups with recommendations and guidance from the SWQB and other state and federal agencies, as appropriate. The SWQB agrees that impoundments can have a significant impact on water quality downstream, however it is the watershed-based plan (WBP) that identifies specific action strategies to mitigate pollution and improve water quality. WBPs, which are typically created by the active watershed group, are dynamic documents designed to characterize the watershed, finalize goals and identify solutions, define a timeline, implement various management strategies, and measure the progress of these strategies such that adjustments can be made if needed. The WBP is generally considered the second step towards TMDL implementation and watershed restoration. The types of activities you outline are appropriate considerations for the Cimarron Watershed WBP.

Comment Set E:

From: Mark Rivera [markr@afgov.org]
Sent: Wednesday, July 07, 2010 8:55 AM
To: Lemon, Shelly, NMENV
Subject: TMDL for Cimarron Watershed

Village of Angel Fire
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06 July 2010

Ms. Shelly Lemon
NMED SWQB
PO Box 5469, Santa Fe, NM,
87502-5469

Re: TMDL for Cimarron River Watershed

Dear Ms. Lemon,

We have reviewed the TMDL draft proposal for the Cimarron Watershed and the new rules regarding nitrates and phosphorus levels.

It appears that the Village of Angel Fire as a municipal point source is going to obligated to make up for non-point sources. The proposal is for Angel Fire to go from 10 ppm to 0.56 ppm for nitrates and the introduction of monitoring phosphorus at 0.06 ppm.

The Village of Angel Fire is very concerned about our ability to meet these proposed requirements without Federal and State financial aid to up grade our wastewater treatment facilities. It is not clear to us that the technology exists to achieve these levels. Thank you.

Sincerely,

Mark Rivera

Mark Rivera, AICP
Community Development Director
PO Box 610
Village of Angel Fire, NM

<u>SWQB Response</u>: Thank you for your written comments.

Based on SWQB's 2006 data, the Village of Angel Fire WWTP contributes approximately 0.89 lbs/day total phosphorus (TP) and 3.18 lbs/day total nitrogen (TN) to Cieneguilla Creek. These loading values were calculated by multiplying the average nutrient concentrations in the effluent by the average annual daily discharge in 2006. This equates to a point source contribution of approximately 74% of the measured TP load and 49% of the measured TN load (see Section 5.5 and Tables 5.13 and 5.14 for more information). Based on these results, the WWTP is a significant contributor to the overall nutrient load in Cieneguilla Creek. Furthermore, the WWTP was assigned 71% of the Total Phosphorus TMDL and 70% of the Total Nitrogen TMDL, therefore NMED does not agree that the Village is going to be obligated to make up for non-point sources – the WWTP is actually being allocated the majority of the TMDL.

As stated in the TMDL, "NMED believes that a TMDL should be written to targets that are protective of the stream and scientifically defensible however there should also be some recognition of the limits of technology for nutrient removal. Even though the limits of technology (in this particular case) preclude the attainment of the target concentrations defined in this TMDL, advanced treatment would significantly reduce the load of TP and TN that is introduced into the stream." Since nutrient cycling is dynamic and dose-response relationships are often location and season specific, it is difficult to pinpoint well-defined numeric thresholds for proper ecosystem functioning. Therefore, NMED is recommending that the Phase 1 effluent limits be based on annual averages for the limits of technology.

As explained in Section 8.0 (Implementation of TMDLs), several sources of funding exist to address impairments discussed in the TMDL document, the two main sources being the Clean Water Act (CWA) Section 319(h) and NMED's Construction Program Bureau. For nonpoint source pollution, monies are available through the CWA §319(h) for on-the-ground projects aimed at improving surface water quality and associated habitat, such as implementing best management practices that reduce runoff and/or capture stormflow. NMED's Construction Programs Bureau (CPB) can also provide matching funds for appropriate CWA §319(h) projects using state revolving fund monies. For point source pollution, CPB also assists communities in need of funding for WWTP upgrades. SWQB will work with CPB and the Village of Angel Fire to help provide the necessary resources to implement this TMDL and meet water quality standards.