FINAL DRAFT

TOTAL MAXIMUM DAILY LOADS

FOR THE

UPPER PECOS RIVER WATERSHED

OCTOBER 2, 2026

Prepared by

New Mexico Environment Department, Surface Water Quality Bureau

Monitoring, Assessment, and Standards Section

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For Additional Information please visit:

https://www.env.nm.gov/surface-water-quality/
~or~

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List of Abbreviations

4Q3	4-Day, 3-year low-flow frequency
4T3	Four-day, three-year temperature exceedance frequency
6T3	Temperature not to be exceeded for 6 or more consecutive hours on more than 3 consecutive days
ALU	Aquatic life use
AU	Assessment Unit
BMP	Best management practices
^{o}C	Degrees Celsius
CALM	Comprehensive Assessment and Listing Methodology
CFR	Code of Federal Regulations
cfs	Cubic feet per second
cfu	Colony forming units
CGP	Construction general storm water permit
CoolWAL	Cool Water Aquatic Life
CWA	Clean Water Act
DFLOW	USEPA low-flow statistics software
DMR	Discharge Monitoring Report
DO	Dissolved oxygen
ECHO	USEPA Enforcement and Compliance History Online
^{o}F	Degrees Fahrenheit
HQCWAL	High Quality Coldwater Aquatic Life
HUC	Hydrologic Unit Code
IR	Integrated Report
$j/m^2/s$	Joules per square meter per second
km^2	Square kilometers
LA	Load allocation
lb/day	Pounds per day
LRBS	Log relative bed stability
mg/L	Milligrams per Liter
mgd	Million gallons per day
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
NMDGF	New Mexico Department of Game and Fish (now the New Mexico Department of Wildlife; see NMDW)
NMDW	New Mexico Department of Wildlife (formerly NM Department of Game and Fish)
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
NTU	Nephelometric turbidity unit
ONRW	Outstanding National Resource Water
QAPP	Quality Assurance Project Plan

Reserve WLA	A waste load allocation calculated the same as a typical WLA but held in reserve for a permitted facility until monitoring confirms the parameter causes or contributes to the impairment of the receiving water
SC	Specific conductance
SDL	Sample detection limit
SFNF	Santa Fe National Forest
SOP	Standard operating procedure
SSTEMP	Stream Segment Temperature Model
SWPPP	Storm water pollution prevention plan
SWQB	Surface Water Quality Bureau
TDS	Total dissolved solids
TKN	Total Kjeldahl nitrogen
TMAX	Maximum temperature criterion
TMDL	Total Maximum Daily Load
TN	Total nitrogen
TP	Total phosphorus
TSS	Total suspended solids
UAA	Use Attainability Analysis
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WBP	Watershed-based plan
WLA	Waste load allocation
WQCC	Water Quality Control Commission
WQS	Water quality standards (20.6.4 NMAC as amended through 8/15/2025)
WTP	Water treatment plant
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

Section 303(d), or 33 U.S.C. § 1313(d), of the Federal Water Pollution Control Act, also known as the Clean Water Act (CWA), 33 U.S.C. § 1251 et seq., requires states to develop Total Maximum Daily Load (TMDL) management plans for water bodies determined to be water quality limited. A TMDL is defined as "*a written plan and analysis established to ensure that a water body will attain and maintain water quality standards including consideration of existing pollutant loads and reasonably foreseeable increases in pollutant loads*" (USEPA, 1999a). A TMDL defines the amount of a pollutant a water body 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. It further identifies potential methods, actions, or limitations that could be implemented to achieve water quality standards. TMDLs are defined in the Code of Federal Regulations at Title 40, Part 130 (40 C.F.R. § 130.2(i)) as the sum of individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint source and natural background conditions. TMDLs are developed with a Margin of Safety (MOS) in acknowledgement of various sources of uncertainty in the analysis (40 C.F.R. § 130.7(c)).

The New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) conducted a water quality survey of the Upper Pecos watershed in 2019 and 2020. Water quality monitoring stations were located to evaluate the impact of tributary streams and ambient water quality conditions. Impairments addressed in this TMDL document, as well as existing approved TMDLs, are shown on **Tables ES-1** to **ES-14**, below. Allocation components shown in these tables are rounded for presentation and may not sum exactly to the corresponding TMDL.

The 2019-2020 SWQB water quality survey for the Upper Pecos Watershed was completed prior to the 2022 Hermit's Peak/Calf Canyon Fire, which caused extensive and severe burn impacts throughout the basin. As a result, the current Integrated Report reflects assessment decisions based solely on these pre-fire data, recognizing that post-fire conditions may differ substantially from those documented during the survey period.

This report addresses all water quality impairments in the project area first listed in 2022. Information regarding additional impairments in the project area is available in the EPA-approved 2026-2028 Clean Water Act § 303(d)/§ 305(b) Integrated Report and List (IR) (NMED/SWQB, 2026). Existing approved TMDLs can be accessed from the SWQB website at https://www.env.nm.gov/surface-water-quality/tmdl/. Citations to the Integrated Report in the parameter chapters that follow refer to the IR cycle in which each impairment was first listed. The SWQB interactive Mapper (https://gis.web.env.nm.gov/oem/?map=swqb) provides a convenient interface to see where impairments exist, and to search for information about particular water bodies of interest using the Identify Features tool.

The next water quality monitoring survey of the Upper Pecos is scheduled for 2028, at which time TMDLs 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 TMDL will be adjusted accordingly. When a water body achieves water quality standards (WQS), found at 20.6.4 NMAC, it will be assigned to the appropriate category in the IR.

Table ES-1. TMDL for El Porvenir Creek (SFNF bnd to Hollinger Canyon)	
New Mexico Standards Segment	20.6.4.215 NMAC
Assessment Unit Identifier	NM-2212_05
NPDES Permit(s)	None
Segment Length	4.89 mi
Parameters of Concern	Dissolved oxygen*, Temperature *DO addressed via plant nutrient TMDL
Designated Uses Affected	High Quality Coldwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	28.2 sq mi
Land Type	21c – Crystalline Mid-Elevation
Land Use/Cover	92.6% Forest, 6.9% Shrub/Scrub
Land Management	88.5% Forest Service, 11.5% Private
Geology	36.2% Sedimentary, 34.1% Metamorphic, 22.4% Igneous, 7.3% Igneous and Metamorphic
Probable Sources	Drought; Forest Fire (Hermit's Peak–Calf Canyon, 2022); Highway/Road/Bridge Runoff; On-site Treatment Systems; Rangeland Grazing; Wildlife Other than Waterfowl
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
	WLA + MOS + LA = TMDL
Plant Nutrients (lb/day) Temperature (kJ/day)	TP: 0 + 0.01 + 0.09 = 0.10 TN: 0 + 0.10 + 0.93 = 1.03 $0 + (3.00 \times 10^{7}) + (1.20 \times 10^{8}) = (1.50 \times 10^{8})$

Table ES-2. TMDL for Gallinas River (Pecos Arroyo to Las Vegas Diversion)	
New Mexico Standards Segment	20.6.4.220 and 20.6.4.13(E) NMAC
Assessment Unit Identifier	NM-2213_23
NPDES Permit(s)	NM0030341- City of Las Vegas WTP (no WLA assigned)
Segment Length	11.1 mi
Parameters of Concern	Dissolved oxygen* *DO addressed via plant nutrient TMDL
Designated Uses Affected	Marginal Coldwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	196.2 sq mi
Land Type	21f - Sedimentary Mid-Elevation; 21d -Foothill Shrublands; 26l -Upper Canadian Plateau
Land Use/Cover	50.2% Forest, 26.7% Shrub/Scrub, 16.7% Grassland, 3.9% Developed, 1.7% Wetland
Land Management	74.4% Private, 24.8% Forest Service
Geology	76.4% Sedimentary, 7.2% Igneous, 7.1% Igneous and Metamorphic, 6.8% Metamorphic, 2.4% Unconsolidated
Probable Sources	Dam or Impoundment; Highway /Road/Bridge Runoff; Inappropriate Waste Disposal; Municipal Urbanized High Density Area; Natural Sources (hot springs); Other Recreation (walking/bicycle trail); Rural Residential Area; Streambank Modifications/Destabilization; Urban Runoff/Storm Sewers; Water Diversions
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
WLA + MOS + LA = TMDL	
Plant Nutrients (lb/day)	TP: 0 + 0.03 + 0.22 = 0.25 TN: 0 + 0.17 + 1.53 = 1.70

Table ES-3. TMDL for Gallinas River (USGS Gage 08382000 to Pecos Arroyo)	
New Mexico Standards Segment	20.6.4.220 and 20.6.4.13(E) NMAC
Assessment Unit Identifier	NM-2213_21
NPDES Permit(s)	NM0028827 - Las Vegas WWTP
Segment Length	4.75 mi
Parameters of Concern	Plant nutrients
Designated Uses Affected	Marginal Coldwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	319 sq mi
Land Type	26l -Upper Canadian Plateau;
Land Use/Cover	46.4% Forest, 33.1% Shrub/Scrub, 16.3% Grassland, 2.7% Developed, 1.5% Wetland
Land Management	79.9% Private, 15.1% Forest Service, 4.6% Fish & Wildlife Service
Geology	85.4% Sedimentary, 4.6% Igneous, 4.3% Igneous and Metamorphic, 4.2% Metamorphic, 1.4% Unconsolidated
Probable Sources	Grazing in Riparian Zone; Highway/Road/Bridge Runoff; Loss of Riparian Habitat; Municipal Point Source; Rangeland Grazing; Water Diversions
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
	WLA + MOS + LA = TMDL
Plant Nutrients (lb/day)	TP: 0.59 + 0.08 + 0.90 = 1.57 TN: 4.06 + 0.54 + 6.22 = 10.82

Table ES-4. TMDL for Gallinas River (Aguilar Creek to USGS Gage 08382000)	
New Mexico Standards Segment	20.6.4.220, 20.6.4.13(E) and 20.6.4.13(J) NMAC
Assessment Unit Identifier	NM-2213_211
NPDES Permit(s)	None
Segment Length	37.85 mi
Parameters of Concern	*E. coli*, Plant nutrients, Temperature, Turbidity
Designated Uses Affected	Primary contact; Marginal Coldwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	478 sq mi
Land Type	26m -Canadian Canyons;
Land Use/Cover	46.4% Shrub/Scrub, 38.3% Forest, 11.7% Grassland, 1.9% Developed, 1.1% Wetland
Land Management	85.9% Private, 10.1% Forest Service, 3.0% Fish & Wildlife Service
Geology	90.3% Sedimentary, 3.1% Igneous, 2.9% Igneous and Metamorphic, 2.8% Metamorphic, 1.0% Unconsolidated
Probable Sources	Dam or Impoundment; Drought; Forest Fire (Hermit's Peak–Calf Canyon, 2022); Grazing in Riparian Zone; Highway/Road/Bridge Runoff; Inappropriate Waste Disposal (junkyards); Loss of Riparian Habitat; Low Water Crossing; On-site Treatment Systems; Rangeland Grazing; Streambank Modifications/Destabilization
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
WLA + MOS + LA = TMDL	
E. coli (cfu/day)	$0 + (1.99 \times 10^{8}) + (1.79 \times 10^{9}) = (1.99 \times 10^{9})$
Plant Nutrients (lb/day)	TP: 0 + 0.02 + 0.19 = 0.21 TN: 0 + 0.24 + 2.16 = 2.40
Temperature (kJ/day)	$0 + (3.96 \times 10^{7}) + (1.58 \times 10^{8}) = (1.98 \times 10^{8})$

Table ES-4. TMDL for Gallinas River (Aguilar Creek to USGS Gage 08382000)

Turbidity (lb TSS/day)

Duration (consecutive days)	WLA	MOS (15%)	LA	TMDL
3	0	8.64	49.0	57.6
4	0	7.66	43.4	51.1
5	0	7.01	39.7	46.7
6	0	6.36	36.0	42.4
7	0	6.03	34.2	40.2
14	0	4.72	26.8	31.5
30	0	3.42	19.4	22.8

Table ES-5. TMDL for Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)	
New Mexico Standards Segment	20.6.4.217 and 20.6.4.13(E) NMAC
Assessment Unit Identifier	NM-2214.A_081
NPDES Permit(s)	Glorieta Adventure Camps WWTP - NM0028088
Segment Length	8.98 mi
Parameters of Concern	Plant nutrients* *also 5B for specific conductance; TMDL not developed at this time, see Section 6.7
Designated Uses Affected	High Quality Coldwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	33.5 sq mi
Land Type	21d - Foothill Shrublands
Land Use/Cover	88.0% Forest, 6.1% Developed, 5.4% Shrub/Scrub
Land Management	45.4% Private, 43.7% Forest Service, 10.9% National Park Service
Geology	81.8% Sedimentary, 9.3% Metamorphic, 4.5% Igneous and Metamorphic, 3.4% Igneous, 1.0% Unconsolidated
Probable Sources	Highway/Road/Bridge Runoff; Inappropriate Waste Disposal (junkyard); Industrial (Private) Point Source Discharge; Loss of Riparian Habitat; Low Water Crossing; On-site Treatment Systems; Rural Residential Area; Wildlife other than Waterfowl
IR Category	5/5B
Priority Ranking	High
Existing TMDLs	None
	WLA + MOS + LA = TMDL
Plant Nutrients (lb/day)	TP: 0.20 + 0.04 + 0.19 = 0.43 TN: 1.40 + 0.29 + 1.25 = 2.94

Table ES-6. TMDL for Indian Creek Subwatershed	
New Mexico Standards Segment	20.6.4.217 NMAC
Assessment Unit Identifier	W_NM-2217_002
NPDES Permit(s)	None
Segment Length	6.63 mi
Parameters of Concern	Specific conductance
Designated Uses Affected	High Quality Coldwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	7.83 sq mi
Land Type	21b - Crystalline Subalpine Forests; 21f - Sedimentary Mid-Elevation
Land Use/Cover	96.7% Forest, 1.9% Shrub/Scrub, 1.5% Grassland
Land Management	95.8% Forest Service, 2.7% State, 1.5% Private
Geology	85.8% Sedimentary, 14.2% Igneous
Probable Sources	Forest Fire (Tres Lagunas, 2013); Highway/Road/Bridge Runoff; Subsurface Mining; Wildlife Other than Waterfowl
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
	WLA + MOS + LA = TMDL
Specific Conductance (lb TDS/day)	0 + 13.85 + 124.63 = 138.48

Table ES-7. TMDL for Pecos River (Alamitos Canyon to Jack's Creek)	
New Mexico Standards Segment	20.6.4.217 NMAC
Assessment Unit Identifier	NM-2214.A_002
NPDES Permit(s)	NM0030121 - Lisboa Springs Fish Hatchery
Segment Length	21.83 mi
Parameters of Concern	Temperature
Designated Uses Affected	High Quality Coldwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	242.0 sq mi
Land Type	21f - Sedimentary Mid-Elevation; 21d - Foothill Shrublands
Land Use/Cover	85.4% Forest, 7.7% Shrub/Scrub, 5.6% Grassland
Land Management	92.6% Forest Service, 6.7% Private
Geology	70.9% Sedimentary, 11.5% Metamorphic, 11.2% Igneous, 6.0% Igneous and Metamorphic, 0.5% Unconsolidated
Probable Sources	Forest Fire (Jaroso, 2013; Tres Lagunas, 2013; Hermit's Peak–Calf Canyon, 2022); Forest Roads; Highway/Road/Bridge Runoff; Off-road Vehicles; Other recreation (angling, camping); Rural Residential Area; Wildlife Other Than Waterfowl
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	Turbidity (2005)
WLA + MOS + LA = TMDL	
Temperature (kJ/day) **	$(2.21 \times 10^8) + (5.94 \times 10^8) + (2.16 \times 10^9) = (2.97 \times 10^9)$

**This is a reserve WLA. For further details see Implementation Section 10.1.1(E).

Table ES-8. TMDL for Pecos River (Canon de Manzanita to Alamitos Canyon)	
New Mexico Standards Segment	20.6.4.217 and 20.6.4.13(E) NMAC
Assessment Unit Identifier	NM-2214.A_003
NPDES Permit(s)	NM0029041 - Village of Pecos WWTP
Segment Length	5.74 mi
Parameters of Concern	Dissolved oxygen* *DO addressed via plant nutrient TMDL
Designated Uses Affected	High Quality Coldwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	299.3 sq mi
Land Type	21d - Foothill Shrublands
Land Use/Cover	85.7% Forest, 7.6% Shrub/Scrub, 4.6% Grassland
Land Management	83.5% Forest Service, 12.9% Private, 3.1% National Park Service
Geology	74.0% Sedimentary, 10.3% Metamorphic, 9.4% Igneous, 5.4% Igneous and Metamorphic, 0.8% Unconsolidated
Probable Sources	Forest Fire (Tres Lagunas, 2013); Municipal Point Source; On-site Treatment Systems
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	Temperature, Turbidity (2005)
WLA + MOS + LA = TMDL	
Plant Nutrients (lb/day)	TP: 0.08 + 0.22 + 1.90 = 2.20 TN: 0.53 + 1.52 + 13.12 = 15.17

Table ES-9. TMDL for Pecos River (Santa Rosa Reservoir to Tecolote Creek)	
New Mexico Standards Segment	20.6.4.211 and 20.6.4.13(E) NMAC
Assessment Unit Identifier	NM-2211.A_10
NPDES Permit(s)	None
Segment Length	54.28 mi
Parameters of Concern	Plant nutrients
Designated Uses Affected	Marginal Warmwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	2360.8 sq mi
Land Type	26h - Pinyon-Juniper Woodlands; 26n - Conchas/Pecos Plains
Land Use/Cover	50.8% Shrub/Scrub, 41.3% Forest, 6.1% Grassland
Land Management	66.6% Private, 25.7% Forest Service, 5.6% State
Geology	87.5% Sedimentary, 4.3% Unconsolidated, 3.9% Igneous, 2.1% Igneous and Metamorphic, 2.1% Metamorphic
Probable Sources	Forest Fire (Tres Lagunas, 2013); Grazing in Riparian Zone; Highway/Road/Bridge Runoff; Inappropriate Waste Disposal; Loss of Riparian Habitat; On-site Treatment Systems; Rangeland Grazing; Rural Residential Area; Streambank Modification; Water Diversion
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	*E. coli* (2013)
	WLA + MOS + LA = TMDL
Plant Nutrients (lb/day)	TP: 0 + 0.08 + 1.61 = 1.69 TN: 0 + 0.96 + 18.20 = 19.16

Table ES-10. TMDL for Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	
New Mexico Standards Segment	20.6.4.211 and 20.6.4.13(E) NMAC
Assessment Unit Identifier	NM-2211.A_00
NPDES Permit(s)	NM0030155 - NMDGF/Rock Lake Fish Hatchery
Segment Length	54.52 mi
Parameters of Concern	*E. coli*, Plant nutrients
Designated Uses Affected	Primary contact, Marginal Warmwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	3481.1 sq mi
Land Type	26n - Conchas/Pecos Plains
Land Use/Cover	64.8% Shrub/Scrub, 28.1% Forest, 5.3% Grassland
Land Management	73.3% Private, 17.4% Forest Service, 6.6% State, 1.0% Bureau of Land Management
Geology	75.4% Sedimentary, 19.0% Unconsolidated, 2.7% Igneous, 1.5% Metamorphic, 1.4% Igneous and Metamorphic
Probable Sources	Crop Production; Dam or Impoundment; Highway/Road/Bridge Runoff; Loss of Riparian Habitat; Municipal Point Source; On-site Treatment Systems; Other Recreation (spring-fed swimming lake); Rangeland Grazing; Rural Residential Area; Urban High Density Area; Water Diversion
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
	WLA + MOS + LA = TMDL
E. coli (cfu/day) Plant nutrients (lb/day)	$0 + (8.62 \times 10^{9}) + (1.64 \times 10^{11}) = (1.72 \times 10^{11})$ TP: 2.84 + 0.92 + 14.60 = 18.36 TN: 32.11 + 10.38 + 165.19 = 207.68

Table ES-11. TMDL for Pecos River (Tecolote Creek to Villanueva State Park)	
New Mexico Standards Segment	20.6.4.216 and 20.6.4.13(J) NMAC
Assessment Unit Identifier	NM-2213_00
NPDES Permit(s)	None
Segment Length	19.46 mi
Parameters of Concern	Aluminum, *E. coli,* Turbidity
Designated Uses Affected	Marginal Coldwater Aquatic Life, Primary Contact
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	715 sq mi
Land Type	26h - Pinyon-Juniper Woodlands
Land Use/Cover	68.1% Forest, 24.5% Shrub/Scrub, 5.3% Grassland, 1.1% Developed
Land Management	58.8% Forest Service, 34.0% Private, 4.4% State, 1.4% Bureau of Land Management, 1.4% National Park Service
Geology	80.6% Sedimentary, 7.9% Igneous, 5.2% Metamorphic, 5.0% Igneous and Metamorphic, 1.3% Unconsolidated
Probable Sources	Crop Production; Dam or Impoundment; Forest Fire (Tecolote, 2010; Hermit's Peak–Calf Canyon, 2022); Grazing in Riparian Zone; Highway/Road/Bridge Runoff; Loss of Riparian Habitat; On-site Treatment Systems; Other Recreation (campground, hiking trail); Rangeland Grazing; Rural Residential Area; Water Diversion
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
	WLA + MOS + LA = TMDL
Aluminum (lb/day)	0 + 3.4 + 19.3 = 22.7
E. coli (cfu/day)	$0 + (1.23 \times 10^{9}) + (2.34 \times 10^{10}) = (2.46 \times 10^{10})$

Table ES-11. TMDL for Pecos River (Tecolote Creek to Villanueva State Park)

Turbidity (lb TSS/day)

Duration (consecutive days)	WLA	MOS (15%)	LA	TMDL
3	0	156	883	1039
4	0	141	801	943
5	0	132	747	879
6	0	122	693	815
7	0	117	665	783
14	0	98	557	655
30	0	79	448	527

*Note: These values represent combined-reach TMDLs. The turbidity TMDL is calculated for the combined Pecos River (Tecolote Creek to Cow Creek) reach; the E. coli TMDL is the 2013 TMDL applied to the combined Pecos River (Santa Rosa Reservoir to Cow Creek) reach. Both apply to the component reaches (this reach and the adjacent reach shown in **Table ES-12**). See Section 8 for turbidity and Section 3 for E. coli.*

Table ES-12. TMDL for Pecos River (Villanueva State Park to Cow Creek)	
New Mexico Standards Segment	20.6.4.216 and 20.6.4.13(J) NMAC
Assessment Unit Identifier	NM-2213_01
NPDES Permit(s)	None
Segment Length	20.01 mi
Parameters of Concern	*E. coli*, Turbidity
Designated Uses Affected	Primary Contact, Marginal Coldwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	623.3 sq mi
Land Type	26h - Pinyon-Juniper Woodlands
Land Use/Cover	75.9% Forest, 16.0% Shrub/Scrub, 5.7% Grassland, 1.3% Developed
Land Management	64.8% Forest Service, 29.5% Private, 2.8% State, 1.6% National Park Service, 1.3% Bureau of Land Management
Geology	78.0% Sedimentary, 9.1% Igneous, 6.0% Metamorphic, 5.8% Igneous and Metamorphic, 1.1% Unconsolidated
Probable Sources	Crop production; Dam or Impoundment; Grazing in Riparian Zone; Highway/Road/Bridge Runoff; Loss of Riparian Habitat; On-site Treatment Systems; Rural Residential Area; Water Diversions
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
	WLA + MOS + LA = TMDL
E. coli (cfu/day)	$0 + (1.23 \times 10^{9}) + (2.34 \times 10^{10}) = (2.46 \times 10^{10})$

Table ES-12. TMDL for Pecos River (Villanueva State Park to Cow Creek)

Turbidity (lb TSS/day)

Duration (consecutive days)	WLA	MOS (15%)	LA	TMDL
3	0	156	883	1039
4	0	141	801	943
5	0	132	747	879
6	0	122	693	815
7	0	117	665	783
14	0	98	557	655
30	0	79	448	527

*Note: These values represent combined-reach TMDLs. The turbidity TMDL is calculated for the combined Pecos River (Tecolote Creek to Cow Creek) reach; the E. coli TMDL is the 2013 TMDL applied to the combined Pecos River (Santa Rosa Reservoir to Cow Creek) reach. Both apply to the component reaches (this reach and the adjacent reach shown in **Table ES-11**). See Section 8 for turbidity and Section 3 for E. coli.*

Table ES-13. TMDL for Tecolote Creek (I-25 to Blue Creek)	
New Mexico Standards Segment	20.6.4.230 NMAC
Assessment Unit Identifier	NM-2212_10
NPDES Permit(s)	None
Segment Length	22.68 mi
Parameters of Concern	*E. coli*
Designated Uses Affected	Primary contact
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	120 sq mi
Land Type	21f -- Sedimentary Mid-Elevation; 21d - Foothill Shrublands; 26h - Pinyon-Juniper Woodlands
Land Use/Cover	71.6% Forest, 26.3% Shrub/Scrub, 1.5% Grassland
Land Management	71.4% Private, 27.6% Forest Service, 1.0% State
Geology	84.6% Sedimentary, 15.4% Igneous, 0.1% Igneous and Metamorphic
Probable Sources	Channelization; Forest Fire (Tecolote, 2010; Hermit's Peak–Calf Canyon, 2022); Highway /Road/Bridge Runoff; Low Water Crossing; Rangeland Grazing; Streambank Modifications/Destabilization; Wildlife Other than Waterfowl
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	Temperature (2018)
WLA + MOS + LA = TMDL	
E. coli (cfu/day)	$0 + (1.07 \times 10^8) + (9.67 \times 10^8) = (1.07 \times 10^9)$

Table ES-14. TMDL for Willow Creek Subwatershed	
New Mexico Standards Segment	20.6.4.217 and 20.6.4.13(A) NMAC
Assessment Unit Identifier	W_NM-2217_004
NPDES Permit(s)	None
Segment Length	5.89 mi
Parameters of Concern	Sedimentation/siltation
Designated Uses Affected	High Quality Coldwater Aquatic Life
USGS Hydrologic Unit Code	13060001 – Pecos Headwaters
Scope/size of Watershed	8.17 sq mi
Land Type	21e - Sedimentary Subalpine; 21f -Sedimentary Mid-Elevation
Land Use/Cover	88.6% Forest, 10.6% Shrub/Scrub
Land Management	91.2% Forest Service, 5.2% State, 3.6% Private
Geology	79.4% Sedimentary, 20.6% Metamorphic
Probable Sources	Mine Tailings; Off-road Vehicles; Wildlife Other Than Waterfowl
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	Specific conductance (2013)
	WLA + MOS + LA = TMDL
Sedimentation (lb TSS/day)	0 + 2.7 + 11.0 = 13.7

1.0 BACKGROUND

1.1 Watershed Description

This document establishes TMDLs for fourteen Assessment Units (AUs) in the Upper Pecos River watershed (**Figures 1.1-1.3**). Assessments of impairment were based on data collected during the 2019-2020 SWQB water quality survey of the upper Pecos River and its tributaries. SWQB monitoring stations where water quality impairments were assessed in the 2026-2028 Integrated CWA § 303(d)/§ 305(b) List for the TMDL Assessment Units are in **Table 1.1** (locations shown on **Figure 1.1**) and NPDES permits are in **Table 1.2**. Major tributaries include Cow Creek, Tecolote Creek, and the Gallinas River. The Pecos Headwaters Hydrologic Unit Code (HUC) 13060001 covers 3,481 square miles of northeastern New Mexico, mostly in San Miguel and Guadalupe Counties, NM with small portions of the HUC extending into Mora, Santa Fe, Quay and De Baca Counties. The main population centers are Pecos, Las Vegas and Santa Rosa.

Water to supply the City of Las Vegas drinking water plant and multiple irrigation ditches is diverted from the Gallinas River and stored in Storrie Lake and in Peterson and Bradner reservoirs. There are seven acequias (irrigation ditches) in the upper reach of the Gallinas, between the headwaters and the USGS Montezuma Gage (OSE, 2019). The AU **Gallinas River (Pecos Arroyo to Las Vegas Diversion)** is in the upper reach in this TMDL. There are another twelve diversions in the middle reach, between the USGS Montezuma and Lourdes gages (OSE, 2019). The TMDL AU **Gallinas River (USGS Gage 08382000 to Pecos Arroyo)** constitutes the middle reach. The Lourdes gage (USGS 08382000) delineates this AU from the downstream TMDL AU **Gallinas River (Aguilar Creek to USGS Gage 08382000)**, which begins just below the gage. Several ditch diversions are metered by the Office of the State Engineer (OSE).

Table 1.1 SWQB monitoring stations.

Site #	Station ID	Station name
1	50ElPorv004.8	El Porvenir Creek at Christian Camp, USGS 08380075
2	50Gallin104.8	Gallinas River at Grand Avenue
3	50Gallin101.8	Gallinas River 0.25 miles below Las Vegas WWTF
4	50Gallin057.8	Gallinas River at La Liendre
5	50Glorie011.4	Glorieta Creek @ NM 50
6	50Glorie001.8	Glorieta Creek above confluence with Pecos River
7	Indian-NM19-10030	Probabilistic*
8	50Indian000.1	Indian Creek 3m West of Hwy 63 Brdg
9	None**	David Lemke property
10	50PecosR763.6	Pecos R blw Glorieta Cr
11	50PecosR722.0	Pecos River at San Jose
12	Pecos-NM19-10043	Probabilistic*
13	50PecosR697.0	Pecos abv Villanueva State Park
14	Pecos-NM19-10136	Probabilistic*
15	50PecosR666.7	Pecos River above confluence with Tecolote Creek
16	50PecosR657.3	Pecos R @ NM 119 bridge nr Anton Chico
17	50PecosR593.1	Pecos River near Colonias, NM
18	50PecosR575.0	Pecos River below Santa Rosa Dam

19	50PecosR540.8	Pecos R at Puerto de Luna
20	Tecolote-NM19-10068	Probabilistic*
21	50Tecolo041.2	Tecolote Creek at I-25 near Tecolote
22	Willow-NM19-10202	Probabilistic*
23	50Willow000.1	Willow Cr blw White Drain
24	Pecos-NM19-10046	Probabilistic*** (Appendix D)

** Probabilistic monitoring stations do not have a name other than the station number*

*** Data contributed by stakeholder. Not a SWQB monitoring station. *** Physical habitat station in the Pecos River (Alamitos Canyon to Jack's Creek) AU, used for SSTEMP model input only (Appendix D); not used for impairment assessment. Note: Locations in* ***Figure 1.1***

Table 1.2 NPDES permits.

Site #	NPDES Permit Number	Site name
A	NM0029041	Village of Pecos WWTP
B	NM0028088	Glorieta Adventure Camps WWTP
C	NM0028827	Las Vegas WWTP
D	NM0030155	NMDGF/Rock Lake Fish Hatchery
E	NM0030121	Lisboa Springs Fish Hatchery
F	NM0030341	City of Las Vegas WTP

Note: Locations in Figure 1.1

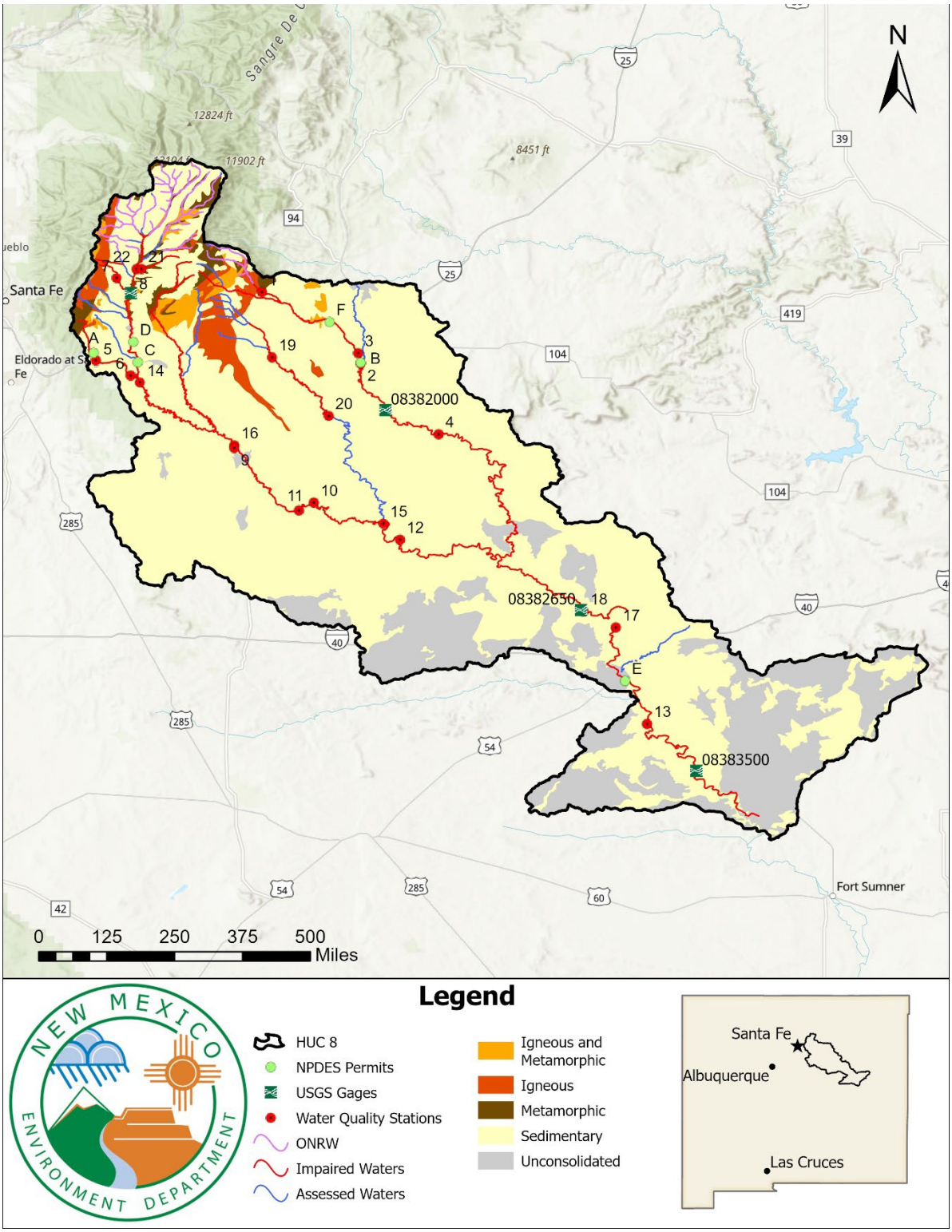


Figure 1.1 Pecos Headwaters (13060001) geology

The Pecos River originates at over 2,510 meters above mean sea level in the alpine and sub-alpine forests of the Southern Rockies. General surface geology of the HUC-8 is 75.4% Sedimentary, 19.0% Unconsolidated, 2.7% Igneous, 1.5% Metamorphic, and 1.4% Igneous and Metamorphic. Most of the project area that lies north of Interstate 25 is *Santa Fe National Forest* managed by the *U.S. Forest Service*, and the highest elevations are part of the Pecos Wilderness. The area is heavily utilized by the public for fishing, hunting, camping, swimming and off-road vehicles.

The upper Pecos Canyon at Willow Creek is also home to the Terrero Mine, a historical underground lead and zinc mine which operated from 1903-1907 and 1926-1939. Ore was moved by overhead tram to Alamitos Canyon, where it was milled. The mine and the Alamitos mill and tailings ponds were reclaimed in a project managed by NMED from 1999 through 2003. Just south of the Village of Pecos, the Pecos River flows through Pecos National Historical Park, site of the now abandoned Pecos Pueblo.

South of I-25, land ownership is mostly private. The Pecos River flows through Villanueva State Park, and is impounded by the Santa Rosa and Sumner dams. At the City of Santa Rosa, a system of springs supports extensive wetlands and contribute groundwater to the river. Land ownership in the project area as a whole is 73.3% Private, 17.4% Forest Service, 6.6% State Land Office, 1.0% Bureau of Land Management.

Outstanding National Resource Waters (ONRW) are streams, lakes and wetlands that receive additional protection against degradation under the State of New Mexico's Standards for Interstate and Intrastate Surface Waters and the federal Clean Water Act. An ONRW designation is the highest level of protection against degradation that can be afforded a waterbody under the State of New Mexico's Water Quality Standards. Water bodies in the Pecos Wilderness were designated as Outstanding National Resource Waters (ONRWs; 20.6.4.9 D(2) NMAC) as of January 2011. Additional non-Wilderness water bodies were designated as of September 2022. The 2022 designations include 16 named tributaries to the Pecos River including the Pecos River itself, 96 unnamed tributaries, and 16 unnamed wetlands.

Table 1.3 TMDL Assessment Units designated as Outstanding National Resource Waters

Assessment Unit	ONRW portion
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	upstream from the Wilderness boundary
Indian Creek subwatershed	all
Pecos River (Alamitos Canyon to Jack's Creek)	upstream from Dalton Canyon
Willow Creek subwatershed	all

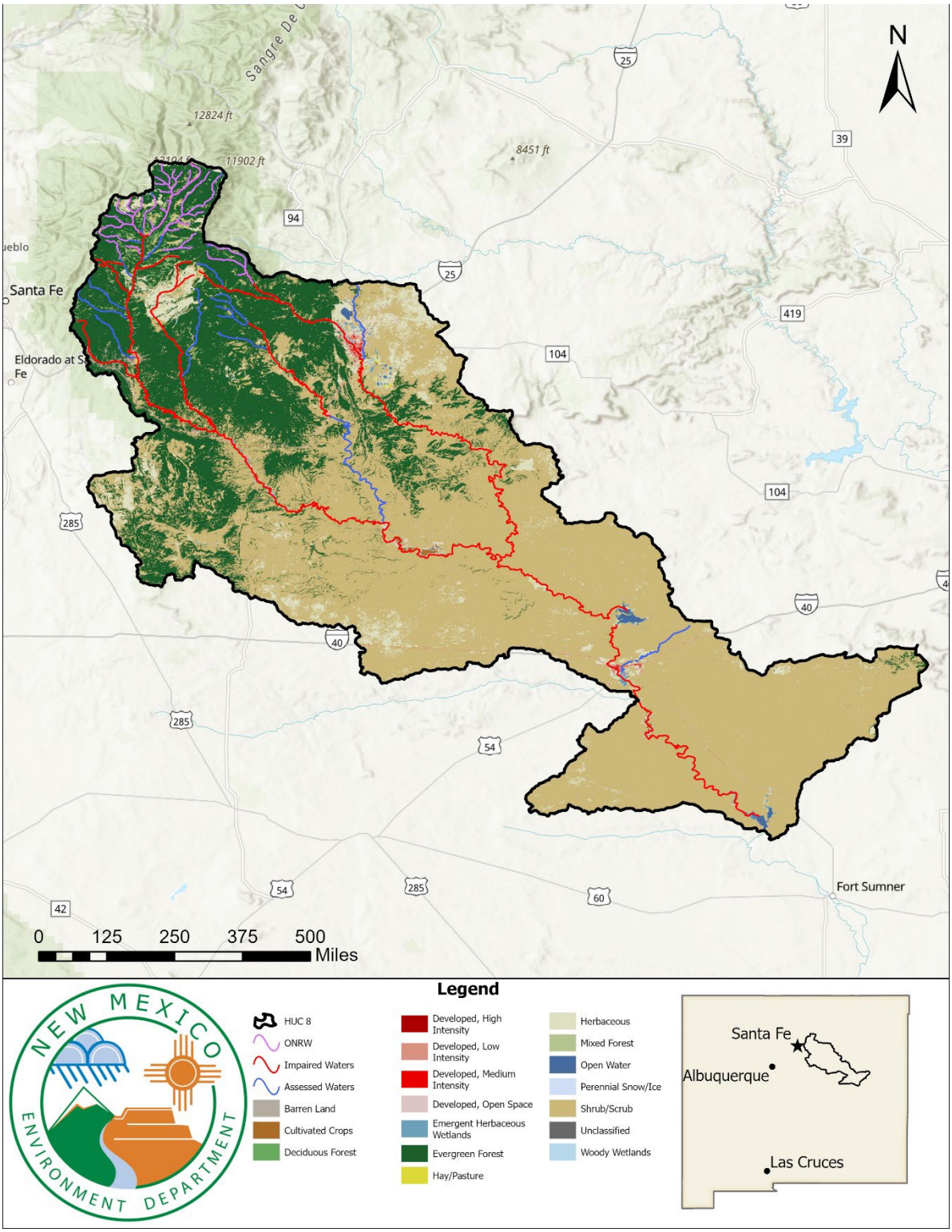


Figure 1.2 Pecos Headwaters (13060001) land use

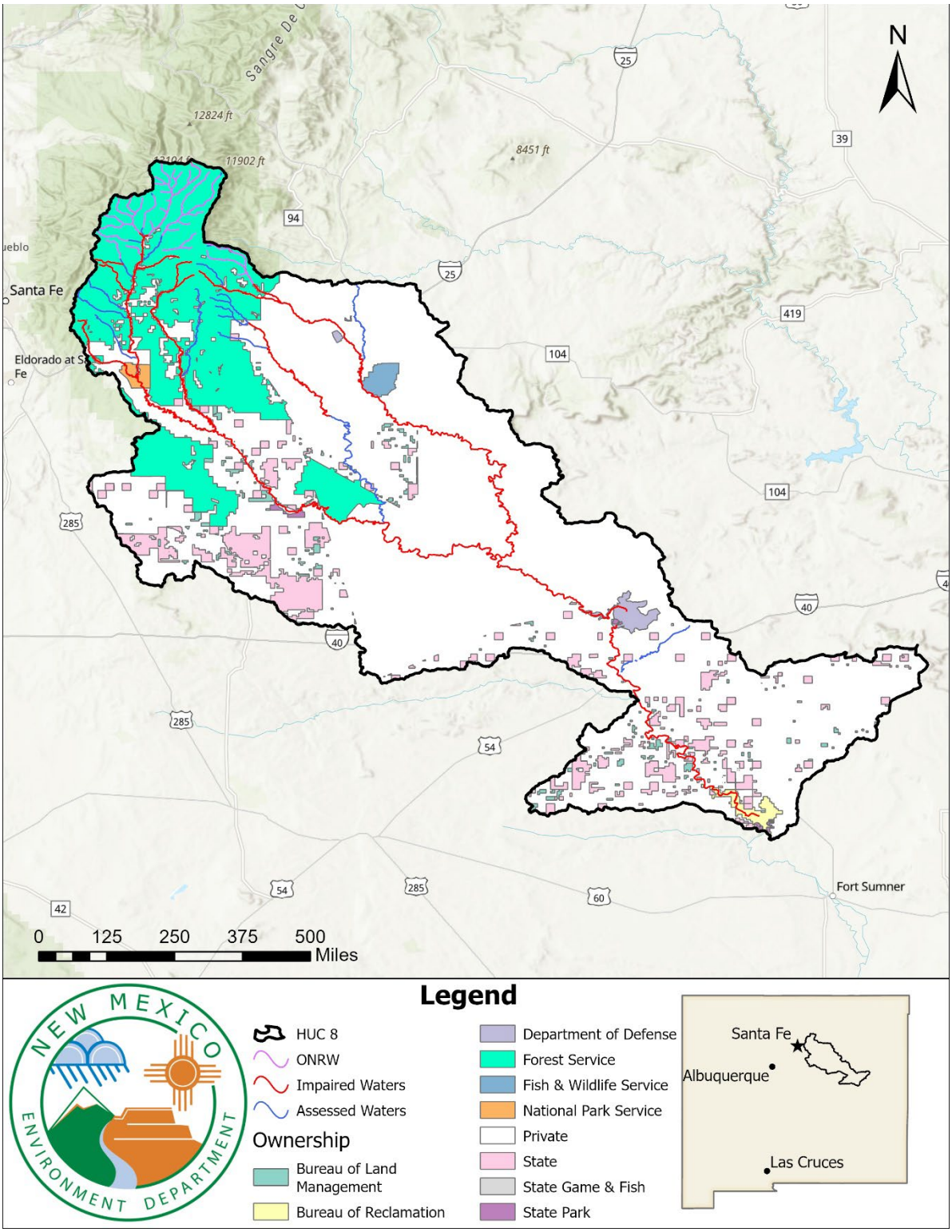


Figure 1.3 Pecos Headwaters (13060001) land ownership

Table 1.4 Federal and state listed species known to occur in San Miguel and Guadalupe Counties (Biota Information System of New Mexico, accessed July 8, 2026)

Common Name	Scientific Name	NMDW	USFWS	Critical Habitat
Least Shrew	*Cryptotis parvus*	T		
Pacific Marten	*Martes caurina*	T		
White-tailed Ptarmigan	*Lagopus leucura*	E		
Yellow-billed Cuckoo (western pop)	*Coccyzus americanus occidentalis*		T	Y
Broad-billed Hummingbird	*Cynanthus latirostris*	T		
Least Tern	*Sternula antillarum*	E		
Neotropic Cormorant	*Phalacrocorax brasilianus*	T		
Bald Eagle	*Haliaeetus leucocephalus*	T		
Common Black Hawk	*Buteogallus anthracinus*	T		
Mexican Spotted Owl	*Strix occidentalis lucida*		T	Y
Boreal Owl	*Aegolius funereus*	T		
Peregrine Falcon	*Falco peregrinus*	T		
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	E	E	Y
Gray Vireo	*Vireo vicinior*	T		
Baird's Sparrow	*Centronyx bairdii*	T		
Arkansas River Shiner (Native pop.)	*Notropis girardi*	E	T	Y
Suckermouth Minnow	*Phenacobius mirabilis*	T		
Mexican Tetra	*Astyanax mexicanus*	T		
Bigscale Logperch (Native pop.)	*Percina macrolepida*	T		
Paper Pondshell	*Utterbackia imbecillis*	E		
Lake Fingernailclam	*Musculium lacustre*	T		
Long Fingernailclam	*Musculium transversum*	T		

T – Threatened; E – Endangered; Y – denotes "Yes" for Critical Habitat

Species listed by the federal Fish & Wildlife Service (USFWS) and/or the New Mexico Department of Wildlife as Threatened or Endangered, which are known to occur in San Miguel and Guadalupe Counties, are shown on **Table 1.4**. In addition to listed animal species there is one listed plant species in San Miguel County: *Ipomopsis sancti-spiritus,* Holy Ghost Ipomopsis, Federal and State Endangered. Holy Ghost Ipomopsis occurs in Holy Ghost Canyon and other Pecos River tributary canyons north of the village of Pecos to which it has been transplanted. There are three listed plant species in Guadalupe County: *Helianthus paradoxus*, Pecos Sunflower, Federal Threatened and State Endangered; *Cirsium wrightii*, Wright's Marsh Thistle, State Endangered; and *Spiranthes magnicamporum*, Great Plains Lady's-Tresses, State Endangered. All the Guadalupe County listed plants occur in the wetlands at Santa Rosa.

The 2022 Hermit's Peak/Calf Canyon Fire was the largest and most destructive wildfire in the history of the state of New Mexico, burning over 340,000 acres between early April and late June in the Sangre de Cristo Mountains in northern New Mexico. Many of the watersheds impacted by the fire were intensively monitored during 2019-2020 as part of the SWQB rotational surveys and related probabilistic surveys in the area. There are several current impairments for temperature within the fire perimeter, including two assessment units (AUs) within this TMDL, **El Porvenir Creek (SFNF bnd to Hollinger Canyon) and Tecolote Creek (I-25 to Blue Creek)**. SWQB collected a very limited sampling dataset from the fire area in 2022 as resources allowed. That dataset, which was collected in late July, included temperature grab data from Coyote Creek, the Gallinas, Mora, Sapello and Pecos Rivers, all of which were well below the maximum temperature standards (with ash and recent flooding noted in several of the streams). However, there were not enough data points to formally assess the data for temperature. SWQB is working with FEMA, EPA, USGS, and NM Department of Homeland Security and Emergency Management (DHSEM) to stand up a multi-year monitoring initiative in the burn scar to evaluate post-fire conditions, identify priority areas for restoration projects, and verify trends in water quality as the watersheds recover. Although the fire post-dates the 2019-2020 survey, it has been added as a probable source for TMDL AUs within or downstream of the burn scar (El Porvenir Creek, Tecolote Creek, Gallinas River (Aguilar Creek to USGS Gage 08382000), Pecos River (Alamitos Canyon to Jack's Creek), and the Pecos River from Tecolote Creek to Cow Creek) because post-fire runoff, sediment, and loss of riparian shade will continue to affect these waters as TMDL implementation proceeds.

For more information on Wildfire Impacts on Surface Water Quality in New Mexico, visit: https://www.env.nm.gov/surface-water-quality/wildfire-impacts-on-surface-water-quality/.

1.2 Water Quality Standards

Water quality standards for **Pecos River (Santa Rosa Reservoir to Tecolote Creek)** and **Pecos River (Sumner Reservoir to Santa Rosa Reservoir)** are set forth in the following sections of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC), 2025, https://www.env.nm.gov/surface-water-quality/wqs/):

> **20.6.4.211 PECOS RIVER BASIN: The main stem of the Pecos River from the headwaters of Sumner reservoir upstream to Tecolote creek excluding Santa Rosa reservoir.**
> **A. Designated uses:** fish culture, irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and primary contact.
> **B. Criteria:**
> **(1)** The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses.
> **(2)** At all flows above 50 cfs: TDS 3,000 mg/L or less, sulfate 2,000 mg/L or less and chloride 400 mg/L or less.
> [20.6.4.211 NMAC - Rp 20 NMAC 6.1.2211, 10/12/2000; A, 5/23/2005; A, 12/1/2010; A, 7/10/2012]
> [**NOTE:** The standards for Santa Rosa reservoir are in 20.6.4.225 NMAC, effective 7/10/2012]

Water quality standards for **El Porvenir Creek (SFNF bnd to Hollinger Canyon)** are set forth in the following sections of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC), 2025, https://www.env.nm.gov/surface-water-quality/wqs/):

20.6.4.215 PECOS RIVER BASIN: Perennial reaches of the Gallinas river upstream of the diversion for the Las Vegas municipal reservoir, perennial reaches of tributaries to the Gallinas river upstream of the diversion for the Las Vegas municipal reservoir, perennial reaches of Tecolote creek upstream of Blue creek and all perennial reaches of tributaries to Tecolote creek upstream of Blue creek.

A. Designated uses: domestic water supply, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat, industrial water supply and primary contact; and public water supply on the Gallinas river.

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: specific conductance 300 µS/cm or less (450 µS/cm or less in Wright Canyon creek); the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

[20.6.4.215 NMAC - Rp 20 NMAC 6.1.2212, 10/12/2000; A, 5/23/2005; A, 12/1/2010; A, 2/13/2018; A, 4/23/2022]

[**NOTE:** This segment was divided effective 2/13/2018. The standards for Tecolote creek from I-25 to Blue creek are under 20.6.4.230 NMAC.]

Water quality standards for **Pecos River (Cow Creek to Canon de Manzanita)**, **Pecos River (Tecolote Creek to Villanueva State Park)**, and **Pecos River (Villanueva State Park to Cow Creek)** are set forth in the following sections of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC), 2025, https://www.env.nm.gov/surface-water-quality/wqs/):

20.6.4.216 PECOS RIVER BASIN: The main stem of the Pecos river from Tecolote creek upstream to Cañon de Manzanita.

A. Designated uses: irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life and primary contact.

B. Criteria:

(1) The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criterion applies: temperature 30°C (86°F) or less.

(2) At all flows above 10 cfs: TDS 250 mg/L or less, sulfate 25 mg/L or less and chloride 5 mg/L or less.

[20.6.4.216 NMAC - Rp 20 NMAC 6.1.2213, 10/12/2000; A, 5/23/2005; A, 12/1/2010]

Water quality standards for **Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)**, **Indian Creek subwatershed**, **Pecos River (Alamitos Canyon to Jack's Creek)**, **Pecos River (Canon de Manzanita to Alamitos Canyon)**, and **Willow Creek subwatershed** are set forth in the following sections of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC), 2025, https://www.env.nm.gov/surface-water-quality/wqs/):

20.6.4.217 PECOS RIVER BASIN: Perennial reaches of Cow creek and all perennial reaches of its tributaries and the main stem of the Pecos river from Cañon de Manzanita upstream to its headwaters, including perennial reaches of all tributaries thereto except lakes identified in 20.6.4.222 NMAC.

A. Designated uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and primary contact; and public water supply on the main stem of the Pecos river.

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: specific conductance 300 µS/cm or less; the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.
[20.6.4.217 NMAC - Rp 20 NMAC 6.1.2214, 10/12/2000; A, 5/23/2005; A, 12/1/2010; A, 7/10/2012]
[**NOTE:** The segment covered by this section was divided effective 5/23/2005. The standards for the additional segments are under 20.6.4.220 and 20.6.4.221 NMAC.]

Water quality standards for **Gallinas River (Pecos Arroyo to Las Vegas Diversion)**, **Gallinas River (USGS Gage 08382000 to Pecos Arroyo)**, and **Gallinas River (Aguilar Creek to USGS Gage 08382000)** are set forth in the following sections of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC), 2025, https://www.env.nm.gov/surface-water-quality/wqs/):

20.6.4.220 PECOS RIVER BASIN: Perennial reaches of the Gallinas river and perennial reaches of tributaries to the Gallinas river from its mouth upstream to the diversion for the Las Vegas municipal reservoir, except Pecos Arroyo.
A. Designated uses: irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life and primary contact.
B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criterion applies: temperature 30°C (86°F) or less.
[20.6.4.220 NMAC - N, 5/23/2005; A, 12/1/2010; A, 4/23/2022]

Water quality standards for **Tecolote Creek (I-25 to Blue Creek)** are set forth in the following sections of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC), 2025, https://www.env.nm.gov/surface-water-quality/wqs/):

20.6.4.230 PECOS RIVER BASIN: Perennial reaches of Tecolote creek from I-25 to Blue Creek.
A. Designated uses: domestic water supply, coolwater aquatic life, irrigation, livestock watering, wildlife habitat, and primary contact.
B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.
[20.6.4.230 NMAC - N, 2/13/2018]

Criteria applicable to existing, attainable or designated uses unless otherwise specified in an AU's specific segment are set forth at 20.6.4.900 NMAC. General criteria that apply to all surface waters of the state at all times, unless a specified standard is provided elsewhere in the NMAC, are set forth at 20.6.4.13 NMAC.

1.3 Antidegradation and TMDLs

New Mexico's antidegradation policy, which is based on the requirements of 40 C.F.R. § 131.12, describes how waters are to be protected from degradation (20.6.4.8(A) NMAC). At a minimum, the policy

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." Furthermore, the policy's requirements must be met whether or not a segment is impaired. TMDLs are consistent with this policy because implementation of a TMDL restores water quality so that existing uses are protected and water quality criteria are achieved.

The Antidegradation Policy Implementation Procedure establishes the process for implementing the antidegradation policy (Appendix A of NMED/SWQB, 2020, https://www.env.nm.gov/surface-water-quality/wqmp-cpp/). However, certain specific requirements in the Antidegradation Policy Implementation Procedure do not apply to the Water Quality Control Commission's (WQCC) establishment of TMDLs because these types of water quality-related actions already are subject to extensive requirements for review and public participation, as well as various limitations on degradation imposed by state and federal law (NMED/SWQB, 2020).

An Outstanding National Resource Water (ONRW) is a stream, lake, or wetland that receives special protection against future degradation under New Mexico's Standards for Interstate and Intrastate Surface Waters (Surface Water Quality Standards or WQS), codified at 20.6.4 NMAC. This designation affords the highest protection of water quality under the State's antidegradation policy and mirrors the protections established under federal regulations at 40 C.F.R. Part 131 and the federal Clean Water Act (CWA). More information is available on the SWQB ONRWs webpage (https://www.env.nm.gov/surface-water-quality/onrws/).

In 2022 and 2024 the SWQB petitioned the WQCC for rulemaking hearings to consider adopting amendments to 20.6.4.9 NMAC designating certain nominated waters as ONRWs. As a result, the following waters are designated as ONRWs in the headwaters Pecos River watershed:

> (a) The Pecos river from Dalton Canyon creek to the Pecos wilderness boundary;
>
> (b) In the Dry Gulch-Pecos river subwatershed, Dalton Canyon creek from the Pecos river upstream to the headwaters, Wild Horse creek from Dalton Canyon creek upstream to the headwaters, Macho Canyon creek from the Pecos river upstream to the headwaters and Sawyer creek from the Pecos river upstream to the headwaters;
>
> (c) In the Indian creek-Pecos river subwatershed, Indian creek from the Pecos river upstream to the headwaters, Holy Ghost creek from the Pecos river upstream to the Pecos wilderness boundary, Doctor creek from Holy Ghost creek upstream to the headwaters, Davis creek from the Pecos river upstream to the headwaters and Willow creek from the Pecos river upstream to the headwaters;
>
> (d) In the Rio Mora subwatershed, Rio Mora from the Pecos river upstream to the Pecos wilderness boundary and Bear creek from the Rio Mora upstream to the Pecos wilderness boundary;
>
> (e) In the Rio Mora-Pecos river subwatershed, Carpenter creek from the Pecos river upstream to the Pecos wilderness boundary, Winsor creek from the Pecos river upstream to the Pecos wilderness boundary and Jack's creek from the Pecos river upstream to the Pecos wilderness boundary; and,
>
> (f) In the Panchuela creek subwatershed, Panchuela creek from the Pecos river upstream to the Pecos wilderness boundary;
>
> (g) Unnamed tributaries to waters in Subparagraphs (a) through (f) as identified in the *Maps and Lists for Unnamed Tributaries to Perennial Waters and Wetlands in the Headwaters Pecos River*

Watershed, published at the New Mexico state library and available on the department's website; and

(h) Unnamed wetlands adjacent to waters in Subparagraphs (a) through (f) as identified in the same *Maps and Lists for Unnamed Tributaries to Perennial Waters and Wetlands in the Headwaters Pecos River Watershed*.

Because these designations extend ONRW protection to entire named tributaries and their headwater subwatersheds—including Indian creek and Willow creek—several assessment units addressed in this TMDL were delineated at the subwatershed scale (for example, the **Indian Creek subwatershed** and **Willow Creek subwatershed** AUs) so that the assessment and TMDL boundaries align with the ONRW-protected waters. TMDLs developed for these and other ONRW-designated segments remain consistent with the antidegradation policy, because implementation restores and maintains water quality at or above the level necessary to protect existing uses and the exceptional quality for which the waters were designated.

1.4 Water Quality Monitoring Survey

The 2019-20 survey included the Pecos River and its tributaries from Sumner Reservoir, in De Baca County, to the headwaters in the Sangre de Cristo mountain range. Streams were divided into AUs based on differing geological and hydrological properties, and each AU was assessed individually using data from one or more monitoring sites located within the AU. Based on a variety of factors, selected monitoring locations were sampled for water quality constituents several times over the two years, and geomorphology and continuously logged data were collected at selected perennial AUs. Geomorphology parameters were measured following the then-current revision of the SWQB Standard Operating Procedure 5.0, Physical Habitat Measurements (https://www.env.nm.gov/surface-water-quality/sop/). Data-logged parameters may include temperature, turbidity, dissolved oxygen, pH, and/or conductivity, and were measured following the then-current revision of the SWQB Standard Operating Procedures 6.1-6.4, Sondes and Thermographs. Impaired AUs addressed in this TMDL are shown on **Figures 1.1 through 1.3, and the associated monitoring stations are shown on Figure 1.1**.

Monitoring occurs during the non-winter months (March through November); focuses on physical, chemical, and biological conditions in perennial waters; and includes sampling for most pollutants that have numeric and/or narrative criteria in the WQS. More detail about the 2019-20 water quality survey can be found in the survey summary report (NMED/SWQB, 2021, https://www.env.nm.gov/surface-water-quality/water-quality-monitoring/). Data submitted by the Upper Pecos Watershed Association was also used for assessments and TMDL development.

1.5 Hydrologic Conditions

To characterize streamflow conditions in which the thermograph and water chemistry data were collected, discharge data were obtained for 2019 and 2020 from several USGS gages in the basin. A representative sampling of gage discharge data (**Figures 1.4-1.6**) shows that 2019 was a year with higher than normal spring run-off, with flows becoming somewhat lower than normal from August onward, while

2020 flows were much lower than normal after a normal to above-normal snowmelt. None of the Upper Pecos HUC experienced drought conditions during the 2019 season, between April and October. In March to April of 2020 the entire area was abnormally dry, with drought becoming moderate to severe from May through August, severe to extreme in September, and extreme to exceptional (the highest category) in October (https://droughtmonitor.unl.edu/Maps/MapArchive.aspx).

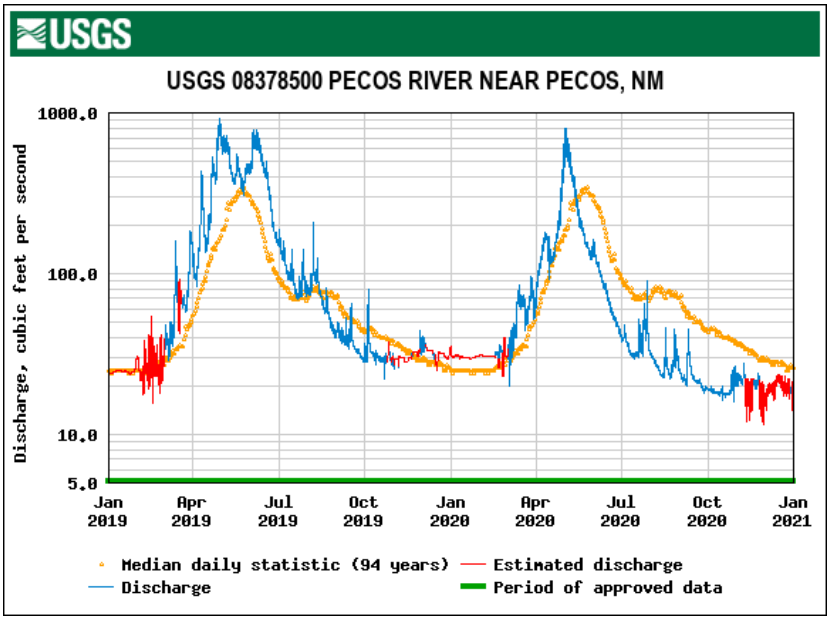


Figure 1.4 Daily discharge in 2019 and 2020 for the Pecos River near Pecos, NM.

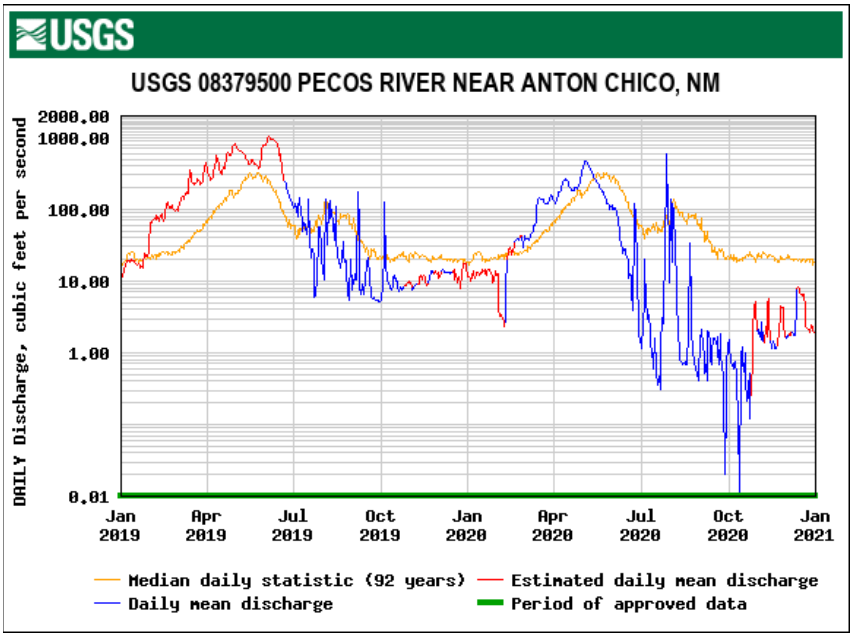


Figure 1.5 Daily discharge in 2019 and 2020 for the Pecos River near Anton Chico, NM.

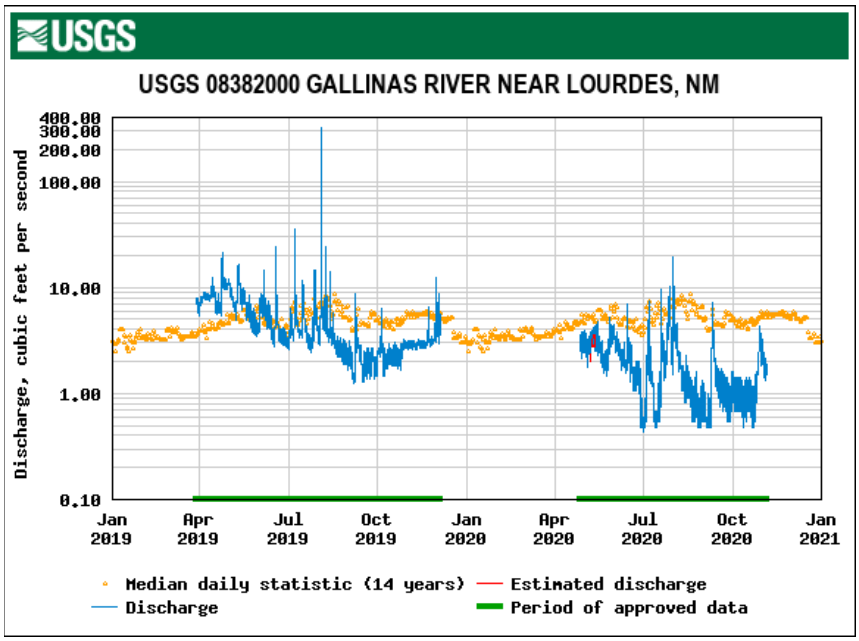


Figure 1.6 Daily discharge in 2019 and 2020 for the Gallinas River near Lourdes, NM.

The Office of the State Engineer administers rotation agreements among users to manage resource use in the Gallinas River Basin during low flow conditions (OSE, 2019; OSE, 2020). A voluntary rotation schedule was implemented on June 22, 2019, and continued for the remainder of the season, except for a few high flow events (OSE, 2019). However, thanks to a large snowpack, acequia diversions were "healthy" for the season. In a couple of cases, middle reach diverted amounts were more than adjudicated limits.

By contrast, the 2020 water year compared to "some of the worst in New Mexico's history." The USGS Gage at Colonias 08382500, located at the confluence of the Gallinas River and Pecos River, recorded zero flow for the entire year for the first time in its 69-year history. A voluntary rotation schedule was implemented on May 17 and continued for the remainder of the season. Despite the severe drought conditions, the OSE water master documented continued "blatant" and "habitual" over-use and waste of water by the San Augustin Ditch, located just downstream of the USGS Lourdes gage, at the upper end of the **Gallinas River (Aguilar Creek to USGS Gage 08382000)** AU. As requested by the OSE water master, the City of Las Vegas, which is authorized to divert the entire river during extreme low flows, consistently left a small amount of water in the river to preserve the riparian vegetation and natural habitat (OSE, 2020).

1.6 TMDL Uncertainties

Per EPA guidance (USEPA, 2002), TMDLs "should contain documentation supporting the TMDL analysis, including the basis for any assumptions; a discussion of strengths and weaknesses in the analytical process; and results from any water quality modeling." Uncertainties and assumptions in the TMDL process are detailed in the individual Margin of Safety subsections for each TMDL parameter. Uncertainties and assumptions related to the size of the available datasets and/or flow are detailed in the

Target Loading Capacity and Flow subsections for each TMDL parameter. When modeling is used to develop a TMDL, water quality modeling results are summarized in the individual TMDL parameter sections and detailed in an appendix to the TMDL. In general, weaknesses in the TMDL analytical process include the limited availability of water quality data during the assessment process, limited flow and habitat measurements for TMDL development, and limited flow and water quality long-term gaging sites to be used during both the assessment and TMDL processes. Strengths in the TMDL analytical process include the robust assessment processes outlined in the Comprehensive Assessment and Listing Methodology (CALM; NMED/SWQB, 2025) especially related to assessments of narrative water quality standards, such as nutrients, sedimentation, and turbidity. Additional strengths include the use of regression equations to calculate TMDLs such as turbidity and specific conductance as well as the collection and subsequent discussion of National Pollutant Discharge Elimination System (NPDES) permit effluent data as part of the TMDL development process.

Gallinas River (USGS Gage 08382000 to Pecos Arroyo) [AU NM-2213_21] is listed on the current Integrated Report as impaired for *E. coli*, temperature, and turbidity. This listing was carried forward from the prior combined assessment unit when it was split into NM-2213_21 and NM-2213_211 in SWQB's assessment database (SQUID) in 2023; the data supporting the impairment determination is associated with the station now representing NM-2213_211 (Gallinas River at La Liendre - 50Gallin057.8), not the station representing this AU (Gallinas River 0.25 mile below Las Vegas WWTF - 50Gallin101.8). Data collected at 50Gallin101.8 during the 2019-2020 survey (Appendix A) did not indicate impairment for these parameters, but data collected within the past 5 years (per CALM) has not yet been re-assessed according to the new assessment unit. NMED/SWQB will re-assess this AU's status for *E. coli*, temperature, and turbidity using representative-station data at the next Integrated Report cycle (2028) and will develop a TMDL at that time if warranted.

2.0 ALUMINUM

Chronic high levels of aluminum (Al) can be toxic to fish, benthic invertebrates, and some single-celled plants. Aluminum concentrations from 0.1 to 0.3 mg/L (100 to 300 µg/L) increase mortality and retard growth, gonadal development, and egg production of fish. Information on the toxic forms of aluminum in natural waters suggests that soluble trivalent aluminum (Al^{3+}) exerts a toxic effect on fish by binding to the negative charge of gill tissues, thereby disrupting ionoregulatory and respiratory balance (Exley et al., 1991; Gensemer and Playle, 1999). This charge interaction is complicated by subsequent polymerization of insoluble, positive-charged Al oxyhydroxides to fish gill tissues, and thus both soluble and insoluble forms are implicated in the toxic response of fish to Al (Gensemer and Playle, 1999).

In 2010, the WQCC updated the aquatic life use (ALU) criteria for aluminum from dissolved aluminum to hardness-dependent total recoverable aluminum (TR Al). In 2012, USEPA approved the change for use in waters where the pH is above 6.5. Aluminum-impaired waters of the Upper Pecos River basin were within the applicable pH range during all the 2019-2020 sampling events. The term "total recoverable" refers to the analytical method used in laboratory analysis and is essentially interchangeable with the term "total." "Total recoverable" is used here to reflect the language in 20.6.4.900(I) NMAC, specifically, "For aluminum, the criteria are based on analysis of total recoverable aluminum in a sample that is filtered to minimize the mineral phase as specified by the department." Based on recommendations from an aluminum filtration study conducted by SWQB staff (NMED/SWQB, 2012), if the turbidity exceeds 30 NTU, samples that will be analyzed for TR Al are filtered using a filter of 10 µm pore size that minimizes mineral-phase aluminum without restricting amorphous or colloidal phases. The **Pecos River (Tecolote Creek to Villanueva State Park)** was listed as impaired based on exceedances of the acute and chronic criteria observed during the 2019-2020 survey. To be conservative, the TMDL is calculated to protect against exceedance of the chronic criterion, which is more stringent than the acute criterion.

2.1 Target Loading Capacity

To meet aquatic life designated uses, the SWQB Comprehensive Assessment and Listing Methodology (NMED/SWQB, 2025) states that for any one chemical/physical pollutant, there shall be no more than one exceedance of the acute criterion, and no more than one exceedance of the chronic criterion in three years. Exceedances of the acute and chronic WQS were identified in the **Pecos River (Tecolote Creek to Villanueva State Park)** by assessment of the data from the 2019-2020 SWQB Upper Pecos intensive water quality survey, as shown in **Table 2.1**. Consequently, this AU was listed on the 2022-2024 Integrated CWA § 303(d)/§ 305(b) List (NMED/SWQB, 2022) for aluminum. Results of laboratory analyses of the samples are shown in **Appendix A**.

Table 2.1 Total recoverable aluminum exceedances

Assessment Unit	Exceedances (Acute)	Exceedances (Chronic)
Pecos River (Tecolote Creek to Villanueva State Park)	2/7	2/7

2.2 Flow

According to the New Mexico Water Quality Standards, the low flow critical condition for numeric criteria (excluding human health-organism only criteria), set out in 20.6.4.97 through 20.6.4.900 NMAC and 20.6.4.13(F) NMAC, is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC). The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years.

Total recoverable aluminum exceedances tend to occur at higher flows for a given water body. However, that relationship did not hold true for the **Pecos River (Tecolote Creek to Villanueva State Park)** during the 2019-2020 water quality survey, when the exceedances were documented at low and moderate flows. Therefore, the 4Q3 was selected as the critical flow for TR Al.

Because the AU in this section is ungaged, an analysis method developed by USGS in partnership with NMED, authored by Bell and Tillery (2023), was used to estimate the critical low flow. In the Bell & Tillery analysis, six regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico and stream basin characteristics (i.e., statewide and mountainous regions above 8,000 ft in elevation, or basins with less than 75 square mile drainage areas). The average elevation of the **Pecos River (Tecolote Creek to Villanueva State Park)** is 8,011 ft; however, this AU has a large drainage area, and the watershed is not the San Juan River nor a tributary to the San Juan, so the 4Q3-4 statewide regression equation for a drainage area of 200-1,000 mi^2 was used. The following regression equation is based on data from 26 gaging stations with non-zero discharge (Bell and Tillery, 2023):

Equation 2.1: $4Q3 = DA^{1.24} \times P^{7.27} \times e^{(-29.02)}$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)

DA = Drainage area (mi^2)

P = Mean annual basin-wide precipitation (inches)

e = Mathematical constant, Euler's number

The 4Q3 value calculated using the Bell & Tillery method is presented in **Table 2.2**. Parameters used in the calculation were obtained using the StreamStats online GIS application developed by the USGS (US Geological Survey, 2016; https://streamstats.usgs.gov/ss/). The flow was converted from cfs to million gallons per day (mgd) using a conversion factor of 0.646. The TMDL itself is a value calculated at a defined critical condition 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. Management of the load to improve instream water quality is the goal of SWQB efforts.

Table 2.2 Calculation of 4Q3

Assessment Unit	Mean Basin Elevation (ft)	Drainage Area (mi^2)	Mean Basin Slope (ft/ft)	Mean Annual Basin-wide Precipitation (in)	4Q3 (cfs)	4Q3 (mgd)
Pecos River (Tecolote Creek to Villanueva State Park)	8,011	715	0.22	20.84	3.35	2.161

2.3 TMDL Calculations

The TMDL is defined as the mass of pollutant that can be carried under critical flow conditions without violating the target concentration for that constituent. A conversion factor is used to correct the TMDL units to lbs/day. The TMDL is calculated based on simple dilution using **Equation 2.2**:

Equation 2.2: *WQS (mg/L) x Critical flow (mgd) x Conversion Factor (8.34) = TMDL (lb/day)*

A TMDL is presented in **Table 2.3** for the critical flow condition. The chronic total recoverable aluminum criterion of 1.26 mg/L was calculated at a hardness of 94 mg/L, the average of the hardness values measured during the two survey sampling events that resulted in exceedances of the WQS (101 mg/L on 8/8/2019 and 87 mg/L on 6/24/2020, the hardness values used for assessment; data shown in **Appendix A**).

Table 2.3 Total Recoverable Aluminum TMDL Calculations (chronic)

Assessment Unit	Chronic TR Al Criterion (mg/L)	Flow (mgd)	Conversion Factor	TMDL (lbs/day)
Pecos River (Tecolote Creek to Villanueva State Park)	1.26	2.161	8.34	22.71

The TMDL is a planning tool to be used to achieve water quality standards. Since flows vary throughout the year in these systems the target load will vary based on the changing flow. Management of the load to improve stream water quality and meet water quality criteria at all times is the goal. The TMDL is further allocated to a MOS, WLA (permitted point sources), and LA (non-point sources), according to the formula:

Equation 2.3: *WLA + LA + MOS = TMDL*

2.3.1 Margin of Safety

The CWA requires that each TMDL be calculated with a MOS. 33 U.S.C. § 1313(d)(1). 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 aluminum TMDL, the MOS was developed using a combination of conservative assumptions and explicit allocations. Therefore, this MOS is the sum of the following elements:

- **Conservative assumptions:**
    - Treating aluminum as a conservative pollutant, meaning a pollutant that does not readily degrade in the environment, was used as a conservative assumption in developing these loading limits.
    - Calculating the TMDL based on the chronic rather than the acute WQS criterion.
    - Using the average hardness value measured during exceedance events, rather than the average hardness of all samples. Hardness is often, though not always, lower at high flows, leading to a lower calculated chronic TR Al criterion and a smaller TMDL.
- **Explicit recognition of potential error:**
    - An explicit MOS of 15% was assigned to the aluminum-impaired AU to account for the low number of sampling events, the inherent error in flow estimates, and the naturally elevated aluminum in the Upper Pecos watershed.

The total MOS for this TMDL is 15%.

2.3.2 Waste Load Allocation

There are no active individual National Pollutant Discharge Elimination System (NPDES) permits that discharge to the aluminum-impaired AU; therefore, the WLA for this TMDL is zero.

Sediment and associated contaminants are considered components of industrial storm water discharges covered under NPDES General Permits. Stormwater discharges from construction activities are transient, occurring mainly during the construction itself, and then only during storm events. Coverage under the NPDES Construction General Permit (CGP) for construction sites greater than one acre, or less than one acre if they are part of a common plan of development, 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 2022 CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, and managerial and structural solids, erosion, and sediment control Best Management Practices (BMPs), and/or other controls. The SWPPP must include site-specific interim and permanent stabilization, managerial, and structural solids, erosion and sediment control BMPs and/or other controls that are designed to prevent to the maximum extent practicable an increase in the sediment yield and flow velocity from pre-construction, pre-development conditions to assure that applicable standards in 20.6.4 NMAC, including the antidegradation policy, and TMDL WLAs are met. This requirement applies to discharges both during construction and after construction operations have been completed. Currently in the 2022 CGP, EPA defines “sediment-related parameter” as a pollutant parameter that is closely related to sediment such as turbidity, total suspended solids (TSS), total suspended sediment, transparency, sedimentation, and

siltation. For discharge covered under the CGP to a water that is impaired for a parameter other than a sediment-related parameter or nutrients, EPA will inform the operator if any additional controls are necessary to meet water quality standards.

Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES Multi-Sector General Permit (MSGP). The MSGP also requires preparation of a SWPPP. Based on the industrial sector, some of the industrial facilities and activities covered under the MSGP have technology based effluent limitations and/or benchmark monitoring for pollutants. The current MSGP includes state-specific requirements that the benchmark values reflect State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. While these sources are not given individual allocations, they are addressed through other means, including BMPs and other stormwater pollution prevention conditions. Implementation of a SWPPP that meets the requirements of a General Permit is generally assumed to be consistent with this TMDL. Loads that are in compliance with the General Permits are therefore currently included as part of the LA.

2.3.3 Load Allocation

Load Allocation is pollution from any nonpoint source(s) or natural background and is addressed through Best Management Practices (BMPs). To calculate the LA, the WLA and the MOS were subtracted from the TMDL using **Equation 2.3**, as shown in **Table 2.4**. The MOS was developed using a combination of conservative assumptions and explicit recognition of potential error (see Section 2.3.1 for details).

Table 2.4 TMDL Allocations for Total Recoverable Aluminum (units in lbs/day)

Assessment Unit	WLA	LA	15% MOS	TMDL
Pecos River (Tecolote Creek to Villanueva State Park)	0	19.30	3.41	22.71

2.3.4 Load Reduction

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

Table 2.5 Load Reduction Estimated to Meet WQS for Total Recoverable Aluminum

Assessment Unit	Target Load (lbs/day)[a]	Measured Load (lbs/day)[b]	Load Reduction (%)[c]
Pecos River (Tecolote Creek to Villanueva State Park)	19.30	77.50	75.09

(a) Target Load = TMDL – MOS. 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.

(b) The measured load is the magnitude of point and nonpoint sources. It is calculated at the TMDL critical flow using the mean measured TR Al concentration from sampling events that resulted in exceedances of WQS criteria (Appendix A).

(c) 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) × 100.

2.4 Identification and Description of Pollutant Sources

SWQB conducted an assessment of the probable sources of impairment in the AU drainage area, according to Standard Operating Procedure 4.1, Revision 2, Probable Source(s) Determination (https://www.env.nm.gov/surface-water-quality/sop/; see also **Appendix B**). Probable Source Sheets are filled out by SWQB monitoring staff during watershed surveys. The sheets are then reviewed by watershed protection staff familiar with the location, and the TMDL writer conducts a search of aerial imagery, GIS files, and other available resources. The list of probable sources is not intended to single out any particular landowner or land management activity and generally includes several sources per pollutant.

Table 2.6 displays probable pollutant sources that have the potential to contribute to aluminum impairment within the AU in the TMDL study area, as determined by field reconnaissance and knowledge of watershed 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 of impairment will be further evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

Table 2.6 Probable sources of excessive total recoverable aluminum

Assessment Unit	Probable Source(s)
Pecos River (Tecolote Creek to Villanueva State Park)	Crop production; Dams/diversion; Forest fire (Tecolote, 2010 and Hermit's Peak–Calf Canyon, 2022); Loss of riparian habitat; Other recreational pollution sources; Rangeland grazing; Roads/bridges; Rural residential area

In general, increased metals in the water column can commonly be linked to sediment transport and accumulation where the metals are a constituent part of the watershed geology. Aluminum (Al) is the third most common element in the Earth's crust and the most common metal. Aluminum is present in natural waters in a complex of chemical forms. There is an exchangeable fraction of Al with soils, sediments, and precipitated organic material. However, the Geochemical Atlas of Europe (FOREGS, 2005) found that "[p]atterns in stream water (Al) data are markedly different from distributions in the solid sample media, indicating predominance of exogenic factors (topography, climate, vegetation) over bedrock geology control for Al in streams." Anthropogenic surface disturbance may be considered an exogenic factor. The AU newly listed for TR Al impairment in 2022 is in an area of surface geology which is high in aluminum oxide content, including mafic volcanic rocks (14-18% Al), felsic volcanic rocks (12-16% Al)[1], and alluvium derived from those sources (**Figure 1.1**).

Aluminum is relatively insoluble at pH 6 to 8, but the solubility of Al increases under more acidic and more alkaline conditions, in the presence of complexing ligands, and at lower temperatures (Gensemer and Playle, 1999). Therefore, in addition to sediment mobilized by overland flow, normal aqueous chemical processes enhanced by the slight natural acidity of snow and rain can dissolve some of the abundant, naturally-occurring aluminum and deliver it into a river system. Aqueous Al is comprised of

inorganic Al hydroxy species, of which gibbsite is the most abundant in the pH range (7.76-8.45) encountered during the 2019-2020 Upper Pecos survey. At pH values greater than 7, aluminum concentration would be expected to increase with increasing pH. However, no correlation of TR Al with pH was apparent in the TMDL AUs (see monitoring data in **Appendix A**).

Wildfire can affect the physical, chemical, and biological quality of streams, rivers, and lakes. After a fire, increased runoff provides a pathway for the transport of chemical-laden sediment to surface water, which may have substantial water quality impacts. Forest fires can also result in increased water temperature due to reduced infiltration and loss of shading vegetation. Potential wildfire impacts to water quality are discussed on the SWQB website at https://www.env.nm.gov/surface-water-quality/wildfire-impacts-on-surface-water-quality/. Most watershed effects will naturally recover within 5 to 10 years after the fire, but some aspects of watershed structure and function, as well as areas of most severe fire intensity, may continue to recover for 15-20 years (Bixby et al., 2015). Runoff following forest fire has therefore been added to the Probable Source list for those TMDL AUs where fires occurred during the 20 years preceding the 2019-2020 water quality survey. The Hermit's Peak–Calf Canyon Fire of 2022 post-dates the 2019-2020 survey and is included as a probable source for the **Pecos River (Tecolote Creek to Villanueva State Park)** because the burn area continues to influence runoff, sediment transport, and aluminum loading in this reach as TMDL implementation moves forward.

1 https://opentextbc.ca/geology/chapter/3-3-crystallization-of-magma/

2.5 Consideration of Seasonal Variation

Normal aqueous chemical processes, enhanced by the slight natural acidity of snow and rain, can render some of the abundant, naturally-occurring aluminum available to a river system, and, as a result of snowmelt, one might expect to see higher aluminum concentrations during spring sampling events in mountainous AUs. However, there was no apparent seasonal pattern to the exceedances documented in the **Pecos River (Tecolote Creek to Villanueva State Park)**.

2.6 Future Growth

Growth estimates by county are available from the University of New Mexico Geospatial and Population Studies (GPS) (https://gps.unm.edu/pop/population-projections.html). The estimates project growth to the year 2050. The Pecos Headwaters HUC extends over portions of six counties — Guadalupe, San Miguel, Santa Fe, Mora, Quay, and De Baca — however most of the HUC is within San Miguel and Guadalupe counties. GPS projects Guadalupe and San Miguel county populations to decline through 2050, as detailed in **Table 2.7**. These projections account for the 2020 census results, also accessed through GPS (https://gps.unm.edu/pop/population-estimates.html). TMDL implementation planners should seek out the most current projections if the information is relevant to their project.

Table 2.7 Guadalupe and San Miguel county population estimates

County	2020 (Census)[B]	2025	2030	2035	2040	2045	2050[A]	% Change
Guadalupe	4,452	4,326	4,179	3,996	3,762	3,492	3,177	-28.64
San Miguel	27,201	26,064	24,902	23,435	21,577	19,470	17,036	-37.37

% Change: [(A – B) / B] × 100

Estimates of future growth are not anticipated to lead to a significant increase in aluminum that cannot be controlled with BMP implementation. BMPs should be utilized and improved upon while continuing to improve watershed conditions and adhering to SWPPP requirements related to construction and industrial activities covered under the general permit.

3.0 *E. COLI*

Escherichia coli (*E. coli*) is a species of coliform bacteria that is present in the intestinal tracts and feces of warm-blooded animals. Most *E. coli* are harmless and are an important part of a healthy human intestinal tract. However, some strains of *E. coli* are pathogenic, meaning they can cause illness, either diarrhea or illness outside of the intestinal tract. *E. coli* is also used as an indicator of the potential presence of other pathogens that may present human health concerns.

Bacterial data collected from the impaired AUs during the 2019-2020 SWQB water quality survey of the Upper Pecos River (UPR) watershed are shown in **Appendix A** and summarized in **Table 3.1**, below. Samples were assessed by comparing the *E. coli* results to the applicable single sample criterion. Assessment of the data identified exceedances of the New Mexico water quality standards for *E. coli* bacteria. As a result, these AUs are listed on the CWA § 303(d)/§ 305(b) Integrated List with *E. coli* as an impairment of the primary contact designated use (NMED/SWQB, 2022).

Table 3.1 *E. coli* exceedances documented during the 2019-2020 UPR water quality survey

Assessment Unit	Water Quality Criterion* (single sample, cfu/100mL)	Number of Exceedances
Gallinas River (Aguilar Creek to USGS Gage 08382000)	410	2/8
Tecolote Creek (I-25 to Blue Creek)	235*	3/9
Pecos River (Villanueva State Park to Cow Creek)	410	2/8
Pecos River (Tecolote Creek to Villanueva State Park)	410	2/8
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	410	2/10

Although the default single sample criterion for primary contact is 410 cfu/100mL, this assessment unit has a segment-specific single sample criterion of 235 cfu/100 mL or less (20.6.4.230 NMAC**).*

3.1 Target Loading Capacity

The TMDL is a value calculated at a defined critical flow condition as part of a planning process designed to achieve water quality standards. For these *E. coli* TMDLs, the appropriate critical flow condition is at low flow to be protective when the assimilative capacity of a stream is at its lowest. For this TMDL document, target values for *E. coli* bacteria are based on achievement of the monthly geometric mean numeric criterion of 126 cfu/100 mL associated with the primary contact designated use. The monthly geometric mean criterion is utilized in TMDL calculations to provide a conservative protective value. If the single sample criterion were used and achieved as a target, the geometric mean criterion may still not be achieved.

SWQB completed a TMDL for *E. coli* in the **Pecos River (Santa Rosa Res to Tecolote Creek)** assessment unit in 2013. Rather than calculating separate TMDLs for the two additional contiguous AUs immediately upstream, the 2013 TMDL (2.46×10^{10} cfu/day) is assigned to all three AUs (see **Table 3.2**, below). The combined AU is referred to as **Pecos River (Santa Rosa Reservoir to Cow Creek)** for the remainder of this chapter but represents the individual assessment units identified below.

Several lines of evidence support applying the 2013 TMDL across the three contiguous AUs. Hydrologically, the three AUs form a single, uninterrupted riverine reach of the Pecos River with no major tributaries or impoundments between them that would substantially alter loading characteristics or assimilative capacity. The AUs share similar low-flow regimes, channel morphology, and gradient. No NPDES point sources discharge to any of the three AUs, so there are no permit-driven differences in bacterial loading between segments. Land cover, land ownership, and probable non-point sources, including rangeland grazing, grazing in the riparian zone, dispersed recreation, and low-density rural residential development are consistent along the corridor. The 2013 TMDL used 4Q3 as the critical flow (calculated using DFLOW software). Applying a single TMDL across the three AUs ensures a consistent target load, MOS, and implementation framework across the impaired waters.

The 4Q3 used in the 2013 TMDL (7.97 cfs, or 5.15 mgd) was derived with DFLOW from the USGS gage record. It is higher than both the 4Q3 subsequently calculated for Pecos River (Santa Rosa Reservoir to Tecolote Creek) from the current gage record (5.15 cfs, or 3.33 mgd; Table 4.3) and the Bell and Tillery (2023) regression estimates for the two upstream reaches (3.35 cfs for Pecos River [Tecolote Creek to Villanueva State Park] and 5.38 cfs for Pecos River [Villanueva State Park to Cow Creek]). Carrying the 2013 TMDL forward therefore yields a larger allowable daily load than a TMDL recalculated at present-day critical flows would produce. SWQB has retained the EPA-approved 2013 TMDL to preserve regulatory continuity for an existing approved load and to avoid assigning two different *E. coli* loads to a single continuous reach. This does not weaken the underlying target: the applicable criterion remains the monthly geometric mean of 126 cfu/100 mL, which must be attained under all flow conditions, and, as noted in Section 3.3.3, the WLA and LA are estimates at a single critical flow condition that will change under differing hydrologic conditions. SWQB may re-evaluate the critical flow and the resulting load for these AUs after the next Upper Pecos water quality survey and Integrated Report cycle.

Table 3.2 Application of the 2013 *E. coli* TMDL to two additional contiguous upstream Pecos River assessment units

Individual Assessment Units	Combined Assessment Unit for TMDL Purposes
Pecos River (Santa Rosa Res to Tecolote Creek) (*2013*)	Pecos River (Santa Rosa Reservoir to Cow Creek)
Pecos River (Tecolote Creek to Villanueva State Park)	
Pecos River (Villanueva State Park to Cow Creek)	

3.2 Flow

According to the New Mexico Water Quality Standards, the low flow critical condition for numeric criteria (excluding human health-organism only criteria), set out in 20.6.4.97 through 20.6.4.900 NMAC

and 20.6.4.13(F) NMAC, is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC). The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years.

Critical flow for the **Pecos River (Sumner Reservoir to Santa Rosa Reservoir)** was determined from daily discharge data (1938-2025) of USGS Gage 08383500, Pecos River near Puerto de Luna, NM, using the Hydrologic Toolbox software program (USGS gage locations are shown in **Figure 1.1**). The calculated 4Q3 is 55.87 cfs, or 36.09 mgd.

Because the **Gallinas River (Aguilar Creek to USGS Gage 08382000)** and **Tecolote Creek (I-25 to Blue Creek)** are ungaged, an analysis method developed by USGS in partnership with NMED, authored by Bell and Tillery (2023), was used to estimate the critical low flow. In the Bell & Tillery analysis, six regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico and stream basin characteristics (i.e., statewide and mountainous regions above 8,000 ft in elevation, or basins with less than 75 square mile drainage areas). The average elevation of **Gallinas River (Aguilar Creek to USGS Gage 08382000)** is less than 8,000 ft, so the 4Q3-4 statewide regression equation for a drainage area between 200 and 1,000 mi² was used. The **Tecolote Creek (I-25 to Blue Creek)** AU also has an average elevation of less than 8,000 ft but a smaller drainage area, so the 4Q3-3 statewide regression equation for a drainage area between 70 and 250 mi² was used.

The following regression equations are based on data from 26 (Equation 3.1) and 23 (Equation 3.2) gaging stations with non-zero discharge (Bell and Tillery, 2023):

Equation 3.1 (4Q3-4): $4Q3 = DA^{1.24} \times P^{7.27} \times e^{(-29.02)}$

Equation 3.2 (4Q3-3): $4Q3 = DA^{1.64} \times P^{6.72} \times e^{(-28.80)}$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)

DA = Drainage area (mi²)

P = Mean annual basin-wide precipitation (inches)

e = Mathematical constant, Euler's number

The 4Q3 values calculated using the Bell & Tillery method are presented in **Table 3.3**. Parameters used in the calculation were obtained using the StreamStats online GIS application developed by the USGS (https://streamstats.usgs.gov/ss/). The flow was converted from cfs to million gallons per day (mgd) using a conversion factor of 0.646. The TMDL itself is a value calculated at a defined critical condition 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. Management of the load to improve instream water quality is the goal of SWQB efforts.

Table 3.3 Critical flow for *E. coli* impaired AUs

Assessment Unit	Mean Basin Elevation (ft)	Drainage Area (mi^2)	Mean Basin Slope (ft/ft)	Mean Annual Basin-wide Precipitation (in)	4Q3 (cfs)	4Q3 (mgd)
Gallinas River (Aguilar Creek to USGS Gage 08382000)	6,868	478	N/A	17.8	0.65	0.417
Tecolote Creek (I-25 to Blue Creek)	7,374	120	0.17	19.3	0.35	0.225
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	—	—	—	—	55.87[a]	36.09[a]
Pecos River (Santa Rosa Reservoir to Cow Creek)	—	—	—	—	7.97[b]	5.15[b]

(a) 4Q3 calculated using USGS Hydrologic Toolbox version 1.1.3.

*(b) Value comes from the 2013 TMDL for **Pecos River (Santa Rosa Reservoir to Tecolote Creek)**; 4Q3 was calculated using DFLOW software. Applied to the combined **Pecos River (Santa Rosa Reservoir to Cow Creek)** per Section 3.1.*

3.3 TMDL Calculations

The WQS for bacteria are expressed as colony forming units (cfu) per unit volume. TMDLs for bacteria (**Table 3.4**) were calculated based on critical flow values (**Table 3.3**), water quality standards, and a conversion factor, using **Equation 3.3**.

Equation 3.3: $$C\ as\ \frac{cfu}{100mL} * 1000\frac{mL}{L} * \frac{L}{0.264\ gallons} * Q\ in\ 1{,}000{,}000\frac{gallons}{day} = cfu/day$$

Where:

C = Water quality criterion for bacteria

Q = Critical stream flow in million gallons per day (mgd)

Table 3.4 ***E. coli*** **TMDL calculations**

Assessment Unit	Geometric Mean *E. coli* Criterion (cfu/100 mL)	Critical Flow (mgd)	Conversion Factor	TMDL (cfu/day)
Gallinas River (Aguilar Creek to USGS Gage 08382000)	126	0.417	3.79×10^7	1.99×10^9
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	126	36.09	3.79×10^7	1.72×10^{11}
Tecolote Creek (I-25 to Blue Creek)	126	0.225	3.79×10^7	1.07×10^9
Pecos River (Santa Rosa Reservoir to Cow Creek)	126	5.15[a]	3.79×10^7	2.46×10^{10} [a]

(a) Value comes from the 2013 TMDL; 4Q3 was calculated using DFLOW software.

The TMDL is a planning tool to be used to achieve water quality standards. Since flows vary throughout the year in these systems the target load will vary based on the changing flow. Management of the load to improve stream water quality and meet water quality criteria at all times is the goal. The TMDL is further allocated to a MOS, WLA (permitted point sources), and LA (non-point sources), according to the formula:

Equation 3.4: $WLA + LA + MOS = TMDL$

3.3.1 Margin of Safety

The CWA requires that each TMDL be calculated with a MOS. 33 U.S.C. § 1313(d)(1). 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 these bacteria TMDLs, the MOS was developed using a combination of conservative assumptions and explicit allocations. Therefore, this MOS is the sum of the following elements:

- **Conservative assumptions:**
  - *E. coli* bacteria do not readily degrade in the environment.
  - Basing the target load capacity on the geometric mean criterion rather than the higher-concentration single sample criterion.
- **Explicit recognition of potential error:**
  - There is inherent error in flow estimation. The size of the explicit MOS assigned for this element depends on the source of the critical flow statistic (whether it was measured from a gage record or estimated by regression from basin characteristics) rather than on

whether an individual AU physically contains a gage. A conservative MOS for this element is 5% where the critical flow was derived from the USGS gage record: the Pecos River (Sumner Reservoir to Santa Rosa Reservoir) 4Q3 was computed from the gage record at USGS 08383500 using Hydrologic Toolbox, and the 4Q3 inherited from the 2013 TMDL and applied to the combined Pecos River (Santa Rosa Reservoir to Cow Creek) AU was computed with DFLOW, which likewise derives low-flow statistics directly from the USGS gage record. A conservative MOS of 10% is applied where the critical flow was estimated with the Bell and Tillery (2023) regional regression equations (Gallinas River, Tecolote Creek), which carry the additional uncertainty of a regression estimate.

The total MOS for these TMDLs is therefore 5% for AUs based on USGS gage data and 10% for AUs based on regression-estimated flow.

3.3.2 Waste Load Allocation

There are no National Pollutant Discharge Elimination System (NPDES) individual permits that discharge to **Tecolote Creek (I-25 to Blue Creek)**, the **Gallinas River (Aguilar Creek to USGS Gage 08382000)**, or the combined **Pecos River (Santa Rosa Reservoir to Cow Creek)**. Therefore, no WLA is assigned for those *E. coli* TMDLs. NMDGF/Rock Lake Fish Hatchery (NPDES Permit No. NM0030155) discharges into the **Pecos River (Sumner Reservoir to Santa Rosa Reservoir)**; however, no WLA is assigned because fish do not produce *E. coli* bacteria.

Stormwater discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the USEPA NPDES Construction General Permit (CGP) for construction sites of one or more acres, or smaller if part of a common plan of development, 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 ensure that waste load allocations and/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.

Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES Multi-Sector General Permit (MSGP). The MSGP also requires preparation of a SWPPP. Some of the industrial facilities and activities covered under the MSGP have technology based effluent limitations and/or benchmark monitoring for pollutants. The current MSGP includes state-specific requirements that the benchmark values be protective of State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. The discharges from these permits are typically transitory as the activities are temporary. Loads that are in compliance with the General Permits are therefore currently included as part of the Load Allocation (LA). While these sources are not given individual allocations, they are

addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

3.3.3 Load Allocation

Load Allocation is pollution from any nonpoint source(s) or natural background and is addressed through Best Management Practices (BMPs). To calculate the LA, the WLA and MOS are subtracted from the TMDL using **Equation 3.4**. Since there is no WLA, the LA is equal to the TMDL minus the MOS. Results of the load calculations are presented in **Table 3.5**. The extensive data collection and analyses necessary to determine background *E. coli* loads are beyond the resources available for this study. It is assumed that a portion of the LA is made up of natural background loads. 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. Successful implementation of this TMDL will be determined based on achievement of the *E. coli* standards under all flow conditions.

Table 3.5 Load allocations for *E. coli* (units in cfu/day)

Assessment Unit	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)	TMDL (cfu/day)
Gallinas River (Aguilar Creek to USGS Gage 08382000)	0	1.79×10^{9}	1.99×10^{8}	1.99×10^{9}
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	0	1.64×10^{11}	8.62×10^{9}	1.72×10^{11}
Tecolote Creek (I-25 to Blue Creek)	0	9.67×10^{8}	1.07×10^{8}	1.07×10^{9}
Pecos River (Santa Rosa Reservoir to Cow Creek)[a]	0	2.34×10^{10}	1.23×10^{9}	2.46×10^{10}

*(a) Values from the 2013 TMDL for **Pecos River (Santa Rosa Reservoir to Tecolote Creek)**, applied across the combined **Pecos River (Santa Rosa Reservoir to Cow Creek)** per Section 3.1.*

3.3.4 Load Reduction

E. coli impairment determinations were based on exceedances of the State's single sample criteria, and the TMDL is written to address the monthly geometric mean standard. As such, a simple comparison of the numbers would not necessarily represent an amount of contaminant reduction that would result in removing the impairment and would instead result in an overestimation of the actual reduction necessary. Neither Section 303 of the Clean Water Act nor 40 C.F.R. § 130.7 requires states to include discussions of percent reductions in TMDL documents. Although NMED believes that it is often useful to discuss the magnitude of water quality exceedances in the TMDL report, the "percent reduction" value can be calculated in multiple ways and as a result is often misinterpreted. Therefore, a percent reduction value is not provided for *E. coli* TMDLs.

3.4 Identification and Description of Pollutant Sources

SWQB fieldwork includes an assessment of the probable sources of impairment in the AU drainage area, according to Standard Operating Procedure 4.1, Revision 2, Probable Source(s) Determination (https://www.env.nm.gov/surface-water-quality/sop/; see also **Appendix B**). Probable Source Sheets are filled out by SWQB monitoring staff during watershed surveys. The sheets are then reviewed by watershed protection staff familiar with the location, and the TMDL writer conducts a search of aerial imagery, GIS files, and other available resources. The list of probable sources is not intended to single out any particular landowner or land management activity and generally includes several sources per pollutant. Pollutant sources that may contribute to each impairment were determined by field reconnaissance and evaluation (**Table 3.6**). Probable sources of bacterial impairments will be evaluated, refined, and changed as necessary through the Watershed-Based Plans.

Table 3.6 Probable sources of excessive *Escherichia coli* for Upper Pecos River basin TMDL assessment units

Assessment Unit	Probable Source(s)
Gallinas River (Aguilar Creek to USGS Gage 08382000)	Dams/diversion; Drought; Forest fire (Hermit's Peak–Calf Canyon, 2022); Grazing in riparian zone; Loss of riparian habitat; Low water crossing; On-site treatment systems; Rangeland grazing; Roads/bridges; Streambank modifications/destabilization
Pecos River (Santa Rosa Reservoir to Cow Creek)	Crop production; Dams/diversion; Forest fire (Tecolote, 2010; Hermit's Peak–Calf Canyon, 2022); Grazing in riparian zone; Loss of riparian habitat; On-site treatment systems; Other recreational pollution sources; Rangeland grazing; Roads/bridges; Rural residential area
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	Crop production; Dams/diversion; Loss of riparian habitat; On-site treatment systems; Other recreational pollution sources; Rangeland grazing; Roads/bridges; Rural residential area; Urban high-density area
Tecolote Creek (I-25 to Blue Creek)	Channelization; Forest fire (Tecolote, 2010; Hermit's Peak–Calf Canyon, 2022); Low water crossing; Rangeland grazing; Roads/bridges; Streambank modifications/destabilization; Wildlife other than waterfowl

3.5 Consideration of Seasonal Variation

Federal regulations (40 C.F.R. § 130.7(c)(1)) require that TMDLs take into consideration seasonal variation in watershed conditions and pollutant loading. Data used in the assessment of these impairments were collected during the spring, summer, and fall of 2019 and 2020, to ensure coverage of potential seasonal variation in the system.

In the **Gallinas River (Aguilar Creek to USGS Gage 08382000)**, exceedances of the WQS were documented in late May and July of 2020. Both exceedances occurred at low flows (1.0 cfs or less), when the water body is least able to assimilate contaminants.

In the **Pecos River (Sumner Reservoir to Santa Rosa Reservoir)** and the **Pecos River (Santa Rosa Reservoir to Cow Creek)**, exceedances were documented only in the summer of both years. Exceedances occurred at flow levels ranging 14 to 1,270 cfs. The observed seasonal pattern in the Pecos River is consistent with the findings of Hulvey et al. (2021) that *E. coli* peaked in midsummer in Utah streams running through grazed or ungrazed grasslands, with higher peaks in the grazed meadows. Exceedances distributed throughout the sampling period would indicate a persistent source of bacteria, such as faulty wastewater treatment or septic systems or year-round riparian grazing.

In **Tecolote Creek (I-25 to Blue Creek)**, exceedances of the WQS were documented in the fall of 2019 and the summer and fall of 2020. *E. coli* exceedances in Tecolote Creek only occurred at the lowest measured flow levels, when the water body is least able to assimilate contaminants.

3.6 Future Growth

Growth estimates by county are available from the University of New Mexico Geospatial and Population Studies (GPS) (https://gps.unm.edu/pop/population-projections.html). The estimates project growth to the year 2050. The Pecos Headwaters HUC extends over portions of six counties — Guadalupe, San Miguel, Santa Fe, Mora, Quay, and De Baca — however most of the HUC is within San Miguel and Guadalupe counties. GPS projects Guadalupe and San Miguel county populations to decline through 2050, as detailed in **Table 3.7**. These projections account for the 2020 census results, also accessed through GPS (https://gps.unm.edu/pop/population-estimates.html). TMDL implementation planners should seek out the most current projections if the information is relevant to their project.

Table 3.7 Guadalupe and San Miguel county population estimates

County	2020 (Census)[B]	2025	2030	2035	2040	2045	2050[A]	% Change
Guadalupe	4,452	4,326	4,179	3,996	3,762	3,492	3,177	-28.64
San Miguel	27,201	26,064	24,902	23,435	21,577	19,470	17,036	-37.37

% Change: [(A – B) / B] × 100

Estimates of future growth are not anticipated to lead to a significant increase in *E. coli* that cannot be controlled with BMP implementation. BMPs should be utilized and improved upon while continuing to improve watershed conditions and adhering to SWPPP requirements related to construction and industrial activities covered under the general permit.

4.0 PLANT NUTRIENTS

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) are not limiting (**Figure 4.1**). However, the magnitude of nutrient concentration that constitutes an "excess" is difficult to determine and varies by ecoregion.

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, 1999b). 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 global reservoir of nitrogen is the atmosphere. About 80% 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, 1999b). Mineral forms of nitrogen can be taken up by plants and algae and incorporated into their 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 4.1**).

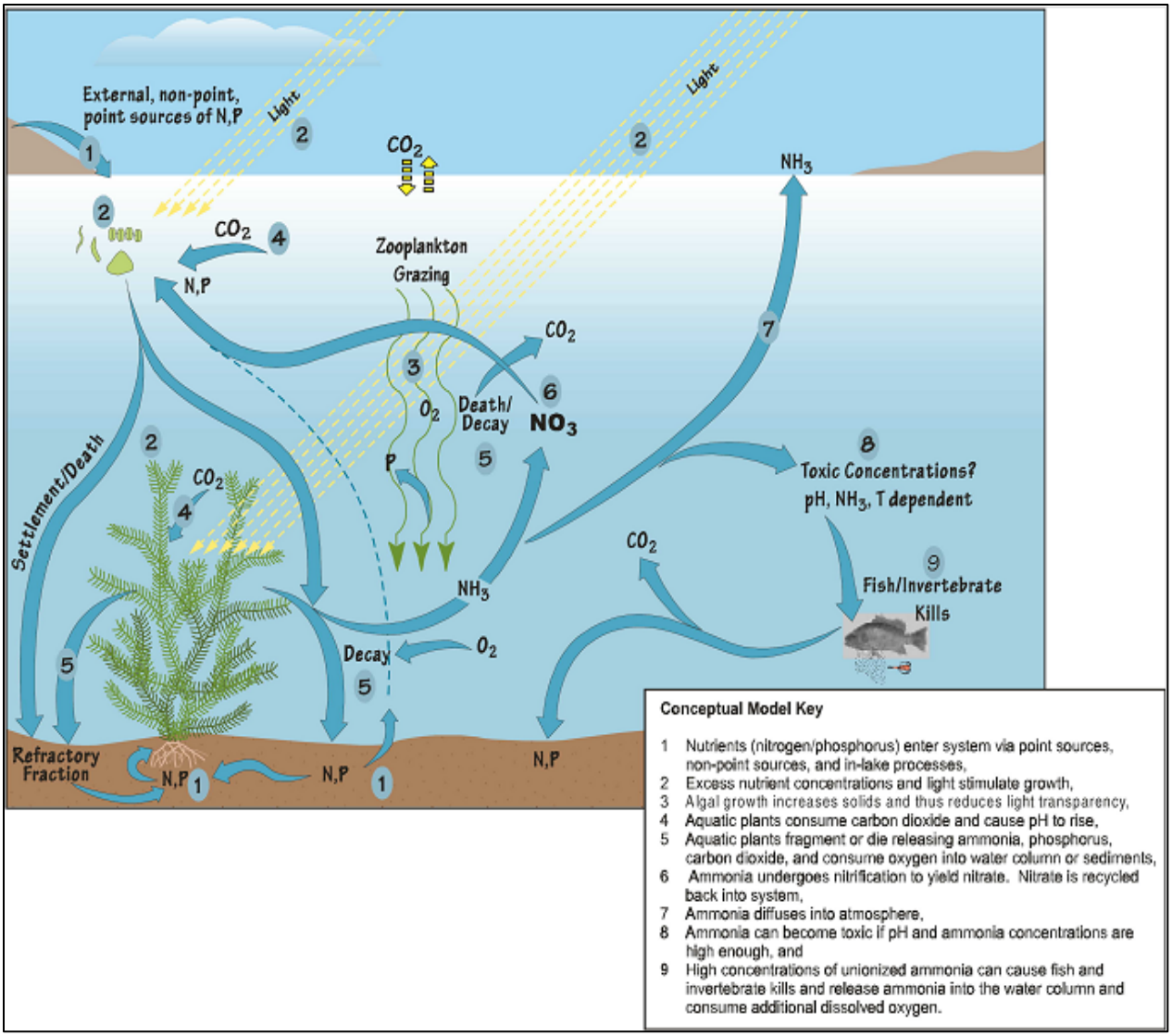


Figure 4.1 Nutrient conceptual model (USEPA, 1999b)

4.1 Target Loading Capacity

The intent of nutrient criteria, whether numeric or narrative, is to limit nutrient inputs to control the excessive growth of attached algae and higher aquatic plants. Controlling algae and plant growth preserves aesthetic and ecologic characteristics along the waterway. While conceptually there may be several possible combinations of total nitrogen (TN) and total phosphorus (TP) concentrations that are protective of water quality, the application of simple chemical limitation concepts to a complex biologic system to determine these combinations is challenging. One of the primary reasons for this is that different species of algae and higher aquatic plants will have different nutritional needs. Some species will thrive in nitrogen limited environments while others will thrive in phosphorus limited environments. Because of the diversity of nutritional needs amongst organisms, numeric thresholds for both TN and TP are required to preserve the aesthetic and ecologic characteristics along a waterway. Focusing on one nutrient or trading a decrease in one for an increase in the other may simply favor a particular species without achieving water quality standards.

New Mexico has a narrative criterion for plant nutrients 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.*

This narrative criterion can be challenging to assess because the relationships between nutrient levels and impairment of designated uses are not defined, and distinguishing nutrients from "other than natural causes" is difficult. Numeric thresholds 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.

In 2015 and 2016, SWQB collaborated with Tetra Tech, Inc., the EPA Region 6, and EPA's National Nutrient Criteria Program Nutrient Scientific Technical Exchange Partnership and Support (N-STEPS) program on a project to revise nutrient impairment thresholds in New Mexico. This project follows EPA's nutrient criteria guidance (USEPA, 2010) and Empirical Approaches for Nutrient Criteria Derivation (USEPA, 2009). Statistical analyses of available state and regional data were conducted to refine nutrient thresholds using defined reference conditions, relationships between cause and response variables and a verified classification system. The resultant candidate thresholds were evaluated by SWQB staff, and the selected thresholds were used to revise this nutrient listing methodology. The 100+ page report (Jessup et al., 2015) detailing the N-STEPS effort is available at https://www.env.nm.gov/surface-water-quality/nutrients/. SWQB also generated and posted a shorter document which summarizes the steps taken to determine the candidate thresholds, and SWQB's logic regarding final threshold selection (NMED/SWQB, 2016b).

Nutrient assessments were conducted on data collected during the 2019-2020 Upper Pecos River water quality survey. Detailed assessment of various water quality parameters indicated plant nutrient and/or dissolved oxygen (response variable) impairment in eight stream AUs (**Table 4.1**). Data contributing to the impairment determinations are shown in **Appendix A**.

Table 4.1 Nutrient TMDL Assessment Units

AU_ID	Assessment Unit
NM-2212_05*	El Porvenir Creek (SFNF bnd to Hollinger Canyon)
NM-2213_23*	Gallinas River (Pecos Arroyo to Las Vegas Diversion)
NM-2213_21	Gallinas River (USGS Gage 08382000 to Pecos Arroyo)
NM-2213_211	Gallinas River (Aguilar Creek to USGS Gage 08382000)
NM-2214.A_081	Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)
NM-2214.A_003*	Pecos River (Canon de Manzanita to Alamitos Canyon)
NM-2211.A_10	Pecos River (Santa Rosa Reservoir to Tecolote Creek)
NM-2211.A_00**	Pecos River (Sumner Reservoir to Santa Rosa Reservoir)

* *Dissolved oxygen impairment listing, based on excursions of four hours or more below the 6.0 mg/L minimum DO criterion (20.6.4.900 NMAC); TN and TP site medians did not exceed applicable thresholds in the 2019–2020 survey.*

*** Plant nutrient listing established in 2012 on TN and TP causal threshold exceedances and retained in 2022 on a daily delta DO exceedance; TN and TP site medians did not exceed applicable thresholds in the 2019–2020 survey.*

Phosphorus is found in water primarily as orthophosphate. In contrast nitrogen may be found as several dissolved species, all of which must be considered in nutrient loading. Total nitrogen is defined by SWQB

as the sum of nitrate+nitrite (NO_2+NO_3), and Total Kjeldahl Nitrogen (TKN) (NMED/SWQB, 2025). Currently, there is no EPA-approved method to test for total nitrogen, however adding the results of

EPA methods 351.2 (TKN) and 353.2 (NO_2+NO_3) is appropriate for estimating total nitrogen. While not an EPA-approved method, Method SM4500-N for Total Nitrogen using a persulfate digest, was an approved method in the then-current SWQB QAPP (NMED/SWQB, 2018) and is used in cases where a lower detection limit is needed. Daily delta DO, a nutrient response variable, is defined as the difference between the maximum and minimum DO concentration within a 24-hour period. The applicable threshold values for these TMDLs are shown on **Table 4.2**. These threshold values were used for water quality assessments and as a starting point for TMDL development.

In the case of El Porvenir Creek, neither the nutrient nor the delta DO thresholds were exceeded. However, a DO logger deployed in 2020 resulted in multiple 4-hour excursions below the minimum 6.0 mg/L criterion for the designated High Quality Coldwater Aquatic Life Use attainment.

Table 4.2 Causal and response variable thresholds for plant nutrients TMDLs.

AU	Site Class	TN Threshold (mg/L)	TP Threshold (mg/L)	Delta DO Threshold (mg/L)
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	TN (Steep) TP (Steep)	0.30	0.030	1.79
Gallinas River (Pecos Arroyo to Las Vegas Diversion)	TN (Moderate) TP (Flat-Moderate)	0.42	0.061	4.08
Gallinas River (USGS Gage 08382000 to Pecos Arroyo)	TN (Moderate) TP (Flat-Moderate)	0.42	0.061	4.08
Gallinas River (Aguilar Creek to USGS Gage 08382000)	TN (Flat) TP (Flat-Moderate)	0.69	0.061	4.08
Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)	TN (Moderate) TP (Flat-Moderate)	0.42	0.061	4.08
Pecos River (Canon de Manzanita to Alamitos Canyon)	TN (Moderate) TP (Flat-Moderate)	0.42	0.061	4.08
Pecos River (Santa Rosa Reservoir to Tecolote Creek)	TN (Flat) TP (Flat-Moderate)	0.69	0.061	4.08
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	TN (Flat) TP (Flat-Moderate)	0.69	0.061	4.08

4.1.1 Relationship Between Dissolved Oxygen Impairment and Plant Nutrients

Four of the eight assessment units in this section were listed without an exceedance of the in-stream TN or TP threshold in the 2019–2020 survey data. Three of them — El Porvenir Creek (SFNF bnd to Hollinger Canyon; NM-2212_05), Gallinas River (Pecos Arroyo to Las Vegas Diversion; NM-2213_23), and Pecos

River (Canon de Manzanita to Alamitos Canyon; NM-2214.A_003) — are listed for dissolved oxygen (DO) on the basis of excursions of four hours or more below the 6.0 mg/L minimum criterion (20.6.4.900 NMAC), documented by continuous DO loggers and sondes deployed in 2020. The fourth, Pecos River (Sumner Reservoir to Santa Rosa Reservoir; NM-2211.A_00), was listed for plant nutrients in 2012 on TN and TP exceedances and retained in 2022 on a daily delta DO exceedance. Because a plant nutrient TMDL is being developed to address a DO listing in three of these AUs, and because dissolved oxygen is the response variable sustaining the nutrient listing in the fourth, the technical basis for treating dissolved oxygen as a response variable under New Mexico's narrative plant nutrient criterion is set out below.

Dissolved oxygen responds to nutrients rather than acting as an independent stressor. Added nitrogen and phosphorus increase in-stream primary production and the accumulation of organic matter, which raises oxygen production during the day and community respiration at night. The result is a wider daily DO fluctuation and a depressed daily minimum, typically in the hours before dawn. Consistent with Figure 4.1, SWQB has adopted the USEPA (2010) conceptual model linking point and nonpoint sources through nutrients and primary production to dissolved oxygen and, ultimately, to aquatic life use attainment (Jessup et al., 2015; NMED/SWQB, 2016b). New Mexico and regional data support that linkage: in the N-STEPS analysis, total phosphorus was positively correlated with the maximum daily change in DO (delta DO) and with four-hour maximum productivity, and both TP and TN were negatively correlated with minimum DO (Spearman rank correlation, $p < 0.05$). Change-point analysis of those response variables produced candidate nutrient thresholds consistent with thresholds derived independently from benthic macroinvertebrate and diatom metrics (Jessup et al., 2015; NMED/SWQB, 2016b).

Delta DO thresholds were derived concurrently with the TN and TP thresholds from the 90th quantile of the reference-site distribution and are applied by TP site class (Jessup et al., 2015; NMED/SWQB, 2025); the values applicable to the assessment units addressed here are shown in Table 4.2. Minimum DO is likewise a nutrient response variable within this framework. The N-STEPS analysis found that as minimum diel DO decreased, and particularly as it fell below 6 mg/L, the number of intolerant macroinvertebrate taxa decreased across all site classes, with dissolved oxygen taken to be the immediate stressor on that assemblage (Jessup et al., 2015). The excursions documented in the three DO-listed assessment units therefore fall within the range in which a biological response to depressed minimum DO was observed statewide.

Continuous sonde deployments provide direct evidence of nutrient-driven productivity in two of the four assessment units listed without a causal-variable exceedance. Maximum daily delta DO exceeded the applicable 4.08 mg/L site-class threshold in Gallinas River (Pecos Arroyo to Las Vegas Diversion) (4.95 mg/L; 50Gallin104.8; June 25–July 15, 2020) and Pecos River (Sumner Reservoir to Santa Rosa Reservoir) (4.51 mg/L; 50PecosR540.8; June 12–September 19, 2019) (Appendix A). Diel swings of this magnitude reflect elevated daytime photosynthesis and nighttime respiration by attached algae and macrophytes, the mechanism by which nutrient supply depresses the daily DO minimum.

These plant nutrient TMDLs are established as protective TMDLs. A measured in-stream nutrient median below the applicable threshold does not establish that nutrients are absent as a cause of the observed oxygen response. The nutrient datasets supporting these assessments are small — commonly four grab samples per assessment unit over the 2019–2020 survey (Appendix A) — and infrequent grab sampling is unlikely to capture transient enrichment from storm runoff, snowmelt, irrigation return flow, on-site treatment systems, or livestock. More fundamentally, rapid biological uptake can hold water-column TN and TP low even where nutrient supply is sufficient to sustain the benthic algal and macrophyte production driving the documented oxygen slumps. The CALM recognizes this mechanism, noting that a reach with substrate or light exposure conducive to growth can experience excessive vegetative growth

that takes up the nutrients and results in low in-stream TN and TP values, and identifying the resulting masking of nutrient effects as a common and challenging problem in nutrient impairment determinations. The CALM further provides that a DO impairment in an assessment unit downstream of an AU with nutrient threshold exceedances may be attributed to the upstream nutrient impairment (NMED/SWQB, 2025), a circumstance that applies to Pecos River (Canon de Manzanita to Alamitos Canyon) at station 50PecosR763.6, downstream of the confluence with nutrient-impaired Glorieta Creek (Section 4.4). The upstream station in this AU, 50PecosR770.0, is located just below the Village of Pecos WWTP outfall and above the Glorieta Creek confluence. Low in-stream nutrient concentrations and an impaired dissolved oxygen regime are therefore not contradictory observations, and the documented DO excursions are themselves direct evidence that the aquatic life use is not being supported. Because median in-stream TN and TP concentrations in these four AUs did not exceed the applicable targets, the calculated load reductions are 0% (Table 4.12); these TMDLs therefore cap allowable loading at a level expected to protect the aquatic life use against the documented DO response rather than requiring a quantified reduction.

Capping TN and TP loading at the applicable in-stream targets under critical flow conditions limits the nutrient supply available to support that production and is expected to narrow the daily DO fluctuation and raise the daily minimum. Nutrient control is also the most effective management lever available, because the other principal drivers of daily oxygen dynamics — solar radiation, air temperature, and channel form — are either outside management control or are addressed under separate parameters in this document. Setting the allowable load at the in-stream target holds loading at or below the level associated with attainment in reference streams of the same site class, consistent with the antidegradation policy discussed in Section 1.3. SWQB notes that the stressor–response relationships underlying this linkage, while statistically significant, are moderate in strength, and that canopy cover, streamflow, channel morphology, temperature, and turbidity also influence in-stream production and oxygen dynamics. Progress will be tracked through continuous dissolved oxygen monitoring during the next scheduled survey of the Upper Pecos watershed (Section 9.0).

4.2 Flow

According to the New Mexico Water Quality Standards, the low flow critical condition for numeric criteria (excluding human health-organism only criteria), set out in 20.6.4.97 through 20.6.4.900 NMAC and 20.6.4.13(F) NMAC, is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC). The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years.

Critical flow for AUs with USGS discharge gages was determined from historical daily discharge data using the USGS Hydrologic Toolbox (gage locations are shown on **Figure 1.1**). The gages that were used for nutrient and DO impaired AUs are listed in **Table 4.3**. For the **Pecos River (Sumner Reservoir to Santa Rosa Reservoir)**, data starting in 1980 was used, because the Santa Rosa Dam was completed in 1979, resulting in an altered flow regime.

Flow statistics on the Gallinas River are challenging to compute because of the numerous points of diversion and lack of historical flow data. The only available data come from the Montezuma and Lourdes USGS gages, between which are approximately 20 irrigation ditches as well as diversion points for Storrie Lake and the City of Las Vegas drinking water facility. The Las Vegas WWTP is permitted by the NMED Groundwater Quality Bureau to divert up to 0.52 mgd of treated effluent (approximately 20% of the facility design flow) for use on city properties and for sale to private consumers. The gaged 4Q3 at Lourdes is only 10% of the gaged 4Q3 at Montezuma.

A low flow water use rotation scheme was instituted by the NM Office of the State Engineer for the **Gallinas River (USGS Gage 08382000 to Pecos Arroyo)** in 2004 (OSE, 2019; OSE, 2020) to accommodate adjudicated rights which often exceed available water. For that reason, and because there is a gap in the available gage data lasting from 1964 until 2006, only data from 2006 and later was used to derive a flow value for the **Gallinas River (USGS Gage 08382000 to Pecos Arroyo)**. The data was further filtered to only include the months from June through August, because data from that gage is not recorded in winter. As SWQB has done in certain previous nutrient TMDL calculations for heavily effluent-influenced streams, the median summer streamflow was used as the critical flow for this AU.

Table 4.3 Critical flow calculated from discharge gage data

Assessment Unit	USGS Gage	Critical Flow (cfs)	Critical Flow (mgd)
Gallinas River (USGS Gage 08382000 to Pecos Arroyo)	8382000 GALLINAS RIVER NEAR LOURDES, NM	4.78*	3.09*
Pecos River (Santa Rosa Reservoir to Tecolote Creek)	8382650 PECOS RIVER ABOVE SANTA ROSA LAKE, NM	5.15**	3.33**
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	8383500 PECOS RIVER NEAR PUERTO DE LUNA, NM	55.87**	36.09**

** median flow June-August*

*** 4Q3 low flow. The 4Q3 of 5.15 cfs (3.33 mgd) shown here for Pecos River (Santa Rosa Reservoir to Tecolote Creek) is a current gage-derived value and is distinct from the 5.15 mgd (7.97 cfs) critical flow carried forward from the 2013 E. coli TMDL in Sections 3.0 and 8.0.*

Because **El Porvenir Creek (SFNF bnd to Hollinger Canyon)**, **Gallinas River (Aguilar Creek to USGS Gage 08382000)**, **Gallinas River (Pecos Arroyo to Las Vegas Diversion)**, **Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)** and the **Pecos River (Canon de Manzanita to Alamitos Canyon)** are ungaged, an analysis method developed by USGS in partnership with NMED, authored by Bell and Tillery (2023), was used to estimate the critical low flow. El Porvenir Creek has two gages, but they were installed in 2022, after the Hermit's Peak/Calf Canyon fire, and so do not provide historical data. In the Bell & Tillery analysis, six regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico and stream basin characteristics (i.e., statewide and mountainous regions above 8,000 ft in elevation, or basins with less than 75 square mile drainage areas).

The mean basin elevations of **El Porvenir Creek (SFNF bnd to Hollinger Canyon)**, **Gallinas River (Pecos Arroyo to Las Vegas Diversion)**, and **Pecos River (Canon de Manzanita to Alamitos Canyon)** are above 8,000 ft, and these AUs are not the San Juan River nor tributaries to the San Juan, so the 4Q3-1a statewide regression equation was used. The following regression equation is based on data from 44 gaging stations with non-zero discharge (Bell and Tillery, 2023):

Equation 4.1: $4Q3 = DA^{1.08} \times E^{12.20} \times e^{-115.37}$

Where:

4Q3 = four-day, three-year low-flow frequency (cfs)

DA = drainage area (mi^2)

E = mean basin elevation (ft)

e = mathematical constant, Euler's number

The **Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)** contributing watershed has a drainage area of less than 75 mi², so the 4Q3-2 regression equation was used. The following regression equation is based on data from 39 gaging stations with non-zero discharge (Bell and Tillery, 2023):

Equation 4.2: $4Q3 = DA^{1.51} \times S^{1.88} \times e^{-2.66}$

Where:

4Q3 = four-day, three-year low-flow frequency (cfs)

DA = drainage area (mi²)

S = basin slope

e = mathematical constant, Euler's number

The **Gallinas River (Aguilar Creek to USGS Gage 08382000)** has a mean basin elevation below 8,000 ft and a drainage area between 200 and 1,000 mi², so the 4Q3-4 statewide regression equation was used. The following regression equation is based on data from 26 gaging stations with non-zero discharge (Bell and Tillery, 2023):

Equation 4.3: $4Q3 = DA^{1.24} \times P^{7.27} \times e^{-29.02}$

Where:

4Q3 = four-day, three-year low-flow frequency (cfs)

DA = drainage area (mi²)

P = mean annual basin-wide precipitation (inches)

e = mathematical constant, Euler's number

The 4Q3 values calculated using the Bell & Tillery method are presented in **Table 4.4**. Parameters used in the calculation were obtained using the StreamStats online GIS application developed by the USGS (https://streamstats.usgs.gov/ss/). The flow was converted from cubic feet per second (cfs) to million gallons per day (mgd) using a conversion factor of 0.646. Drainage areas shown are the StreamStats-delineated contributing areas at the point of calculation and may differ from the assessment unit watershed areas reported in the Executive Summary tables.

Table 4.4 4Q3 critical flow calculations

Assessment Unit	Average Elevation (ft)	DA (mi²)	S (ft/ft)	P (in)	4Q3 (cfs)	4Q3 (mgd)
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	9,174	28.2	0.38	—	0.64	0.412
Gallinas River (Aguilar Creek to USGS Gage 08382000)	6,868	478	—	17.8	0.65	0.417
Gallinas River (Pecos Arroyo to Las Vegas Diversion)	8,319	99	0.29	—	0.75	0.484

Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)	7,739	33.5	0.20	—	0.68	0.44
Pecos River (Canon de Manzanita to Alamitos Canyon)	8,880	348	0.27	—	6.47	4.18

Flow in Glorieta Creek is augmented by the Glorieta Camps WWTP discharge. The permitted design flow (0.4 mgd) was added to the 4Q3 calculated using the Bell & Tillery equation, for a critical flow value of **0.84 mgd**. Design flow for the Village of Pecos WWTP (0.15 mgd) is added to the 4Q3 for **Pecos River (Canon de Manzanita to Alamitos Canyon)** as determined by the Bell & Tillery equation, for a critical flow of **4.33 mgd**.

The TMDL itself is a value calculated at a defined critical condition as part of a planning process designed to achieve water quality standards. Since flows vary throughout the year, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality is the goal of SWQB efforts.

4.3 TMDL Calculation

This subsection describes the relationship between the numeric nutrient targets and the allowable pollutant level by determining the total assimilative capacity of the waterbody, 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 flow conditions without violating the target concentration for that constituent. These TMDLs were developed based on simple dilution calculations using critical flows, the numeric target, and a conversion factor to correct the TMDL units to lb/day. The specific carrying capacity of a receiving water for a given pollutant, was estimated using **Equation 4.4**. The calculated daily carrying capacities (i.e. TMDLs) for TP and TN are summarized in **Table 4.5**.

The TMDL is a planning tool to be used to achieve water quality standards. Since flows vary throughout the year in these systems the target load will vary based on the changing flow. Management of the load to improve stream water quality and meet water quality criteria at all times is the goal. The TMDL is further allocated to a MOS, WLA (permitted point sources), and LA (non-point sources), according to the formula:

Equation 4.4: *WQS (mg/L) x Critical flow (mgd) x Conversion Factor (8.34) = TMDL (lb/day)*

Equation 4.5: *WLA + LA + MOS = TMDL*

Table 4.5 TMDL calculations for total nitrogen (TN) and total phosphorus (TP)

TMDL Watershed	Parameter	Critical Flow (mgd)	In-Stream Target (mg/L)	Conversion Factor	TMDL (lb/day)
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	TN	0.412	0.30	8.34	1.03
	TP		0.030		0.10
Gallinas River (Pecos Arroyo to Las Vegas Diversion)	TN	0.484	0.42	8.34	1.70
	TP		0.061		0.25
Gallinas River (USGS Gage 08382000 to Pecos Arroyo)	TN	3.09	0.42	8.34	10.82
	TP		0.061		1.57
Gallinas River (Aguilar Creek to USGS Gage 08382000)	TN	0.417	0.69	8.34	2.40
	TP		0.061		0.21
Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)	TN	0.84*	0.42	8.34	2.94
	TP		0.061		0.43
Pecos River (Canon de Manzanita to Alamitos Canyon)	TN	4.33**	0.42	8.34	15.17
	TP		0.061		2.20
Pecos River (Santa Rosa Reservoir to Tecolote Creek)	TN	3.33	0.69	8.34	19.16
	TP		0.061		1.69
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	TN	36.09	0.69	8.34	207.68
	TP		0.061		18.36

**Flow in Glorieta Creek is augmented by the Glorieta Camps WWTP discharge. The permitted design flow (0.4 mgd) was added to the 4Q3 calculated using the Bell & Tillery equation (0.44 mgd), for a critical flow value of 0.84 mgd.*
*** Design flow for the Village of Pecos WWTP (0.15 mgd) is added to the 4Q3 for **Pecos River (Canon de Manzanita to Alamitos Canyon)** as determined by the Bell & Tillery equation (4.18 mgd), for a critical flow of 4.33 mgd.*

Effluent flow was not added to the critical flow for the Gallinas River (USGS Gage 08382000 to Pecos Arroyo). For Glorieta Creek and the Pecos River (Canon de Manzanita to Alamitos Canyon), a 4Q3 estimated from basin characteristics represents the receiving water in the absence of point source contributions, so permitted design flow is additive. Here the critical flow is instead a measured median summer streamflow from the gage record, at a gage located downstream of the Las Vegas WWTP outfall, on a reach where adjudicated diversion rights often exceed the water physically available and the Office of the State Engineer administers a low-flow rotation schedule among users (OSE, 2019; OSE, 2020). The permitted design capacity of the Las Vegas WWTP (2.5 mgd) also substantially exceeds the volume the facility discharges: reported 30-day average effluent flows for May 2022 through March 2026 reached a maximum of 1.55 mgd with a summer median of 1.16 mgd, approximately 46 percent of design capacity,

and up to 0.52 mgd of that capacity is permitted for reuse and is therefore unavailable for discharge to the river. Adding a design-capacity effluent flow to that gaged median would overstate the water actually present at the critical condition and inflate the calculated loading capacity. The same summer median effluent flow is carried into the nth-phase waste load allocation for this facility (**Section 4.3.2**).

The TMDL is further allocated to a MOS, WLA (permitted point sources), and LA (nonpoint sources), according to the formula: *WLA + LA + MOS = TMDL.*

4.3.1 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 this nutrient TMDL, 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.
    - An implicit margin of safety is added by setting a TMDL that, if achieved, would not exceed the threshold at any time, whereas the WQS thresholds are based on the median measured concentration.

- *Explicit Recognition of Potential Errors*
    - There is inherent error in flow estimation, both measured and calculated; a conservative MOS for this element in ungaged streams is **10 %**, a conservative MOS for this element in gaged streams is **5%**.

The total MOS for ungaged stream TMDLs is **10%**; the total MOS for gaged stream TMDLS is **5%**.

4.3.2 Waste Load Allocation

There are no active individual NPDES permits that discharge to **El Porvenir Creek (SFNF bnd to Hollinger Canyon)**, or **Pecos River (Santa Rosa Reservoir to Tecolote Creek)**; therefore the WLA for those TMDLs is zero. The El Porvenir Christian Camp holds a Ground Water Quality Bureau discharge permit (DP-1090) for a land-based wastewater treatment system located near the SWQB water quality monitoring station for that AU. Because the system discharges to ground water rather than to a surface outfall, it is not an NPDES point source and receives no WLA; it is identified here as a potential nonpoint contributor of the

episodic nutrient enrichment discussed in Section 4.1 and is addressed within the load allocation. Drinking water treatment plants are not expected to discharge nutrient concentrations in excess of the influent concentration; therefore, the City of Las Vegas WTP (Permit NM0030341) is not assigned a nutrient WLA.

Table 4.6 Permits Assigned Waste Load Allocations

NPDES Permit Number	Permittee	Discharges to Assessment Unit	Assessment Unit ID	Expiration Date
NM0028827	City of Las Vegas WWTP	Gallinas River (USGS Gage 08382000 to Pecos Arroyo)	NM-2213_21	11/30/2027
NM0028088	Glorieta Adventure Camps WWTP	Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)	NM-2214.A_081	9/30/2028
NM0029041	Village of Pecos WWTP	Pecos River (Canon de Manzanita to Alamitos Canyon)	NM-2214.A_003	5/31/2028
NM0030155	NMDGF Rock Lake State Fish Hatchery	Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	NM-2211.A_00	11/30/2029

There are National Pollution Discharge Elimination System (NPDES) permits for a wastewater treatment plant (WWTP) on the Gallinas River (USGS Gage 08382000 to Pecos Arroyo; AU NM-2213_21), a WWTP on Glorieta Creek (Perennial prt Pecos R to Glorieta Camps WWTP; AU NM-2214.A_081), a WWTP on the Pecos River (Canon de Manzanita to Alamitos Canyon; AU NM-2214.A_003), and a discharge permit for a fish hatchery on the Pecos River (Sumner Reservoir to Santa Rosa Reservoir; AU NM-2211.A_00). The City of Las Vegas holds a permit (NM0028827), for a WWTP with one outfall that is authorized to discharge to the Gallinas River (AU NM-2213_21). Glorieta Adventure Camps holds a permit (NM0028088), for a small WWTP with one outfall that is authorized to discharge to Glorieta Creek (AU NM-2214.A_081). The Village of Pecos holds a permit (NM0029041), for a WWTP with one outfall that is authorized to discharge into the Pecos River (AU NM-2214.A_003). The New Mexico Department of Game & Fish (NMDGF) Rock Lake State Fish Hatchery holds a permit (NM0030155), with one outfall that authorizes the discharge of wastewater into the Pecos River above Sumner Reservoir (AU NM-2211.A_00). **Table 4.6** below outlines the permitted facilities assigned WLAs, and the information below covers design capacity flow, and effluent limits.

Las Vegas WWTP (NM0028827, effective Dec. 1, 2022; expires Nov. 30, 2027) discharges to the Gallinas River (USGS Gage 08382000 to Pecos Arroyo; AU NM-2213_21; New Mexico Water Quality Standards segment 20.6.4.220 NMAC) from a single outfall at a facility located on South Highway 85 approximately 0.5 mile south of Las Vegas in San Miguel County. The permit includes water quality-based final effluent limits for total nitrogen at 13.0 mg/L 30-day average (145 lbs/day) and total phosphorus at 2.14 mg/L 30-day average (23.9 lbs/day). These limits are subject to a 5-year compliance schedule, under which the permittee is currently required to report only and must attain the final limits no later than 60 months from the permit effective date. The permitted design capacity flow is 2.5 mgd. SWQB has typically provided a phased approach to WLAs for WWTPs, using the 85th percentile of monthly average effluent concentration data reported by the permitted facility to determine the first phase, where an eventual nth phase achieves the in-stream nutrient target. Phased WLAs do not authorize effluent limits less stringent

than those in a facility's current permit; any permit limits derived from these WLAs remain subject to the anti-backsliding provisions of CWA Section 402(o) and 40 C.F.R. § 122.44(l). DMR data reported through the ECHO database for the period May 2022 through March 2026 (the available DMR record; the current permit became effective December 1, 2022, so the May–November 2022 months predate it) includes 45 months of TN and 46 months of TP 30-day average concentration data. Over this period, the monthly average effluent concentrations exceeded the in-stream nutrient targets (TN: 0.42 mg/L and TP: 0.061 mg/L) in nearly every reporting month (TN exceeded in 43 of 45 months; TP exceeded in all 46 months). The TN target was exceeded by more than one order of magnitude in 40 of 45 months, and the TP target was exceeded by more than one order of magnitude in 45 of 46 months. The 85th percentile of reported monthly average effluent concentrations over this period was 25.0 mg/L for TN and 3.25 mg/L for TP. The 85th percentile of monthly average effluent flow was 1.29 mgd, and the median summer (June–August) flow was 1.16 mgd. The Phase 1 WLA loading limit, however, is based on the maximum 30-day-average effluent flow of 1.55 mgd (excluding the anomalous 4.94 mgd flow reported for March 2026); the 85th-percentile effluent flow of 1.29 mgd is provided for context only and is not the basis for the WLA. SWQB collected effluent samples in 2019 (see **Appendix A**). The median TN concentration from SWQB samples was 15.4 mg/L, and the median TP concentration from SWQB samples was 1.625 mg/L.

The nth-phase (water quality-based) waste load allocation for the City of Las Vegas WWTP was calculated using the median summer (June–August) 30-day average effluent flow of 1.16 mgd rather than the permitted design capacity of 2.5 mgd. This departure from SWQB's usual practice of allocating at permitted design flow applies only to the nth-phase WLA; as shown in Table 4.9, the Phase 1 loading limits are based on the maximum reported 30-day average effluent flow of 1.55 mgd. The choice of flow basis does not change the effluent quality the nth-phase allocation implies. Because the allocation is the product of an effluent flow and the in-stream target, the end-of-pipe concentration implied by the nth-phase WLA is the in-stream target itself — 0.42 mg/L TN and 0.061 mg/L TP — at either flow. Using the summer median yields a smaller, not a larger, mass-based allocation than design flow would, so the effect of the choice is on how much of the assessment unit's assimilative capacity is reserved to the point source rather than on how stringently the facility must treat.

Three considerations support this flow basis. First, it is consistent with the critical condition used to derive the TMDL for the receiving assessment unit: as described in Section 4.2, the critical flow for Gallinas River (USGS Gage 08382000 to Pecos Arroyo) is a median summer streamflow of 3.09 mgd at USGS Gage 08382000 rather than a 4Q3, and pairing a median summer receiving-water flow with a median summer effluent flow allocates the loading capacity and the waste load under the same hydrologic condition. Second, allocating at the 2.5 mgd design capacity would assign approximately 81 percent of the calculated loading capacity of the assessment unit to a single discharger — 8.76 lb/day of the 10.82 lb/day TN TMDL and 1.27 lb/day of the 1.57 lb/day TP TMDL — leaving, after the 5 percent margin of safety, approximately 1.52 lb/day TN and 0.22 lb/day TP for all nonpoint sources in the 319 mi² contributing watershed, roughly one-quarter of the load allocations shown in Table 4.11. Third, the facility neither discharges at, nor is permitted to discharge the full volume of, its design capacity: reported 30-day average effluent flows for May 2022 through March 2026 reached a maximum of 1.55 mgd with a summer median of 1.16 mgd, or approximately 46 percent of design capacity, and the facility is permitted by the NMED Ground Water Quality Bureau to divert up to 0.52 mgd of treated effluent — approximately 20 percent of design flow — for reuse, so that portion of the design capacity is by permit unavailable for discharge to the Gallinas River.

Service-area demand is also not projected to grow. The University of New Mexico Geospatial and Population Studies program projects that the population of San Miguel County, of which Las Vegas is the county seat and largest community, will decline from 26,064 in 2025 to 24,902 in 2030 and 21,577 in 2040, a reduction of approximately 17 percent over that period (UNM GPS, 2024). Allocating at design capacity

would therefore reserve a substantial share of the assessment unit's assimilative capacity against demand growth that current projections do not anticipate. Effluent volumes are tracked through permit-required monitoring and reporting. If reported flows increase materially above the current summer median, if the reuse authorization under the Ground Water Quality Bureau discharge permit is reduced or discontinued, or if the flow regime at USGS Gage 08382000 changes, SWQB will re-evaluate the flow basis for this waste load allocation at the next Integrated Report cycle and revise the TMDL if warranted (see Sections 9.0 and 10.1.1.A).

Glorieta Adventure Camps WWTP (NM0028088, expires Sept. 30, 2028) discharges to Glorieta Creek (Perennial prt Pecos R to Glorieta Camps WWTP; AU NM-2214.A_081; New Mexico Water Quality Standards segment 20.6.4.217 NMAC) from a single outfall at a facility located at 11 State Road 50 in Santa Fe County. Glorieta Adventure Camps operates a privately owned WWTP, providing sanitary services for a conference center, which includes food service, for Glorieta Camps and for Glorieta Village, with population ranging from 210 to 3,060 people. There is no industrial flow connecting to this facility. The WWTP primarily consists of a bar screen/grid chamber, aeration basin, clarifier, an ultraviolet (UV) disinfection unit, Imhoff tanks for digestion/thickening, and sludge drying beds. Effluent is disinfected by the UV unit and discharged into the receiving creek. Sludge is composted to Class A bio-solids in accordance with 40 CFR Part 503 requirements and is tested for metals and fecal coliform prior to disposal. The facility design flow is 0.40 mgd, comparable to the 4Q3 of 0.44 mgd estimated for Glorieta Creek, so the discharge accounts for approximately half of the 0.84 mgd critical flow used for this assessment unit (**Section 4.2**). The designated uses of the receiving water are domestic water supply, fish culture, high quality cold-water aquatic life, irrigation, livestock watering, wildlife habitat, and primary contact, plus public water supply on the main stem of the Pecos River. The permit requires TN and TP monitoring but does not currently include numeric effluent limits for these parameters.

Quarterly DMR data (downloaded from ECHO) from June 2022 through March 2026 (16 quarters) were used for the WLA calculation. Over this period, the in-stream nutrient targets for TN (0.42 mg/L) and TP (0.061 mg/L) were exceeded in all 16 reporting periods. TN was exceeded by more than one order of magnitude in 11 of 16 quarters, and TP was exceeded by more than one order of magnitude in 11 of 16 quarters. The 85th percentile of the reported 30-day average effluent concentrations over this period was 28.0 mg/L for TN and 3.876 mg/L for TP. Reported 30-day average effluent flows over this period had a median of 0.026 mgd with an 85th percentile of 0.50 mgd. The permitted design flow is 0.40 mgd. Several monthly flow reports during 2024 (max 30-day average of 2.33 mgd) and early 2026 are notably elevated.

Table 4.7 is based on reported data from the permitted facility. The 85th percentile of effluent concentrations was determined from quarterly DMR submissions for June 2022 through March 2026. SWQB collected 4 samples from the effluent during the water quality survey in 2019. The median TN concentration from SWQB samples was 19.93 mg/L, and the median TP concentration from SWQB samples was 3.07 mg/L. TN and TP values from effluent from the Glorieta Adventure Camps WWTP are presented in **Appendix A**. The Phase 1 WLA was determined by applying the 85th percentile of the effluent concentrations reported by the facility (obtained from ECHO) to the permitted design flow of 0.40 mgd, in accordance with Equation 4.6, yielding Phase 1 WLAs of 93.41 lb/day for TN and 12.93 lb/day for TP (Table 4.7). The permitted design flow was used rather than the median reported flow for two reasons. First, low flow in Glorieta Creek is sustained in substantial part by this discharge, so the design flow corresponds directly to the critical flow condition on which the TMDL is based. Second, reported effluent flows at this facility are highly variable, reflecting a seasonal operation serving a population ranging from 210 to 3,060: the median reported 30-day average flow is 0.026 mgd, but the 85th percentile is 0.50 mgd and the maximum reported 30-day average is 2.33 mgd, both at or above the permitted design flow. Because this facility does reach and exceed its design capacity, allocating at design flow is necessary for

the WLA to remain protective, in contrast to the Las Vegas WWTP, which has not approached its permitted capacity over the available DMR record. Reported TN concentrations increase markedly beginning in the third quarter of 2023; the resulting 85th-percentile value of 28.0 mg/L is nevertheless consistent with the median TN concentration of 19.93 mg/L measured by SWQB in the effluent in 2019.

Village of Pecos WWTP (NM0029041, effective June 1, 2023; expires May 31, 2028) discharges to the Pecos River (Canon de Manzanita to Alamitos Canyon; AU NM-2214.A_003; New Mexico Water Quality Standards segment 20.6.4.217 NMAC) from a single outfall at a facility located at 42 Lagoon Lane in San Miguel County. The permit includes water quality-based final effluent limits for total nitrogen at 31.8 mg/L 30-day average (19.6 lbs/day) and total phosphorus at 3.83 mg/L 30-day average (2.36 lbs/day). Per Part I.A footnote *8, these effluent limits take effect one day before the permit expiration date. Nutrient concentrations were not reported in the DMRs, so SWQB monitoring results for the effluent were used in deriving the effluent limit values. The permitted design capacity flow is 0.15 mgd. SWQB collected effluent samples in 2019, presented in **Appendix A**. The median TN concentration from SWQB samples was 31.2 mg/L, and the median TP concentration from SWQB samples was 0.535 mg/L.

Rock Lake State Fish Hatchery (NM0030155, expires Nov. 30, 2029) discharges to the Pecos River (Sumner Reservoir to Santa Rosa Reservoir; AU NM-2211.A_00) from Outfall 001. The permit does not specify a design flow; the permit's final effluent limits at Outfall 001 are based on the highest monthly average flow of 5.58 mgd. The permit requires the facility to report TN and TP in their DMRs but does not currently include numeric effluent limits for these parameters. Based on quarterly DMR reported values for the period June 2022 through March 2026 (16 quarters), the facility effluent exceeded the water quality-based TN WLA (32.11 lb/d) one time out of 16 quarters (6% of the time). The in-stream TN target (0.69 mg/L) was exceeded two times out of 16 quarters (13% of the time). The effluent exceeded the water quality-based TP WLA (2.84 lb/d) five times out of 12 quarters with detectable TP concentrations (approx. 42% of detectable observations; 4 of 16 quarters were reported as < SDL). The in-stream TP target (0.061 mg/L) was exceeded in 6 of 12 quarters with detectable TP (50%); however, many of the reported TP concentrations were at or near the analytical detection limit (typically reported as < 0.10 mg/L), which is higher than the in-stream target itself, so true exceedance frequency cannot be precisely determined from these data. The 95th percentile of the reported 30-day average TN effluent concentration over this period was 0.74 mg/L, and the 85th percentile of TP was 0.1105 mg/L. The 95th percentile (rather than the 85th) was used as the basis for the Phase 1 TN WLA to prevent the WLA phases from being inverted (i.e., to ensure the Phase 1 TN WLA is less stringent than the nth-phase TN WLA). The Phase 1 TN and TP WLAs were determined using these percentiles of effluent data reported by the facility (obtained from ECHO).

Waste Load Allocations for the City of Las Vegas WWTP, Glorieta Adventure Camps WWTP, Village of Pecos WWTP, and the Rock Lake State Fish Hatchery are shown in **Tables 4.7 – 4.10**. Implementation of TMDLs through NPDES permit conditions is further discussed in **Section 10.1.1** of the TMDL.

Water quality-based waste load allocation is calculated using Equation 4.6, except for the Las Vegas WWTP, where the median reported summer flow was substituted for design flow, and the Rock Lake State Fish Hatchery, which has no permitted design flow and for which the highest monthly average flow (5.58 mgd) was used.

Equation 4.6: *WQS (mg/L) x Design flow (mgd) x Conversion Factor (8.34) = WLA (lb/day)*

Table 4.7 Plant nutrients Waste Load Allocation for the Glorieta Adventure Camps Wastewater Treatment Plant, NPDES Permit No. NM0028088

Phase	Parameter	Water Quality Target (mg/L)	Waste Load Allocation (lbs/day)
1st (Initial target)	Total Nitrogen	28.0[a]	93.41 [a]
	Total Phosphorus	3.876 [a]	12.93[a]
2nd (Interim limit)	Total Nitrogen	TBD [b]	TBD [b]
	Total Phosphorus	TBD [b]	TBD [b]
nth (Water quality based)	Total Nitrogen	0.42 [c]	1.40[d]
	Total Phosphorus	0.061 [c]	0.203 [d]

TBD = to be determined

(a) Based on the 85th percentile of quarterly DMR 30-day average effluent concentration data for June 2022 through March 2026 (16 quarters). Phase 1 flow basis is the design flow (0.4 mgd).

(b) To be evaluated next permit cycle and TMDL revised if necessary. See Section 10.1.

(c) Targets based on in-stream nutrient targets discussed in Section 4.1.

(d) WLA calculated using Equation 4.6 and 0.4 mgd permitted design flow

The design flow for the Village of Pecos WWTP is 0.15 mgd. Nutrient concentrations were not reported in the DMRs, so SWQB monitoring results for the effluent were used for effluent concentration values.

Table 4.8 Plant nutrients Waste Load Allocation for the Village of Pecos Wastewater Treatment Plant, NPDES Permit No. NM0029041

Phase	Parameter	Water Quality Target (mg/L)	Waste Load Allocation (lb/day)
1st (Initial target)	Total Nitrogen	31.8 [a]	19.6[a]
	Total Phosphorus	3.83 [a]	2.36 [a]
2nd (Interim limit)	Total Nitrogen	TBD [b]	TBD [b]

Phase	Parameter	Water Quality Target (mg/L)	Waste Load Allocation (lb/day)
	Total Phosphorus	TBD [(b)]	TBD [(b)]
n^{th} (Water quality based)	Total Nitrogen	0.42 [(c)]	0.53 [(d)]
	Total Phosphorus	0.061 [(c)]	0.076 [(d)]

TBD = to be determined

(a) Based on the 85th percentile of 2019 effluent concentration data. The loading limit was based on the maximum 30-day average flow (0.074 mgd) from the reporting period Jan 2019-Sept 2022.

(b) To be evaluated next permit cycle and TMDL revised if necessary. See Section 10.1.

(c) Targets based on in-stream nutrient targets discussed in Section 4.1.

(d) WLA calculated using Equation 4.6 and 0.15 mgd permitted design flow

For the City of Las Vegas WWTP reported data from May 2022 through March 2026 (45 months of TN and 46 months of TP 30-day average concentration data), the monthly average effluent concentrations of both TN and TP exceeded the in-stream nutrient targets in nearly every reporting month, with TN exceeded in 43 of 45 months and TP exceeded in all 46 months. The TN target was exceeded by more than an order of magnitude in 40 of 45 months, and the TP target was exceeded by more than an order of magnitude in 45 of 46 months.

Table 4.9 Plant nutrients Waste Load Allocation for the City of Las Vegas Wastewater Treatment Plant, NPDES Permit No. NM0028827

Phase	Parameter	Water Quality Target (mg/L)	Waste Load Allocation (lb/day)
1^{st} (Initial target)	Total Nitrogen	25.0[(a)]	323.2[(a)]
	Total Phosphorus	3.25[(a)]	42.0[(a)]
2^{nd} (Interim limit)	Total Nitrogen	TBD [(b)]	TBD [(b)]
	Total Phosphorus	TBD [(b)]	TBD [(b)]
n^{th} (Water quality based)	Total Nitrogen	0.42 [(c)]	4.06 [(d)]
	Total Phosphorus	0.061 [(c)]	0.590 [(d)]

TBD = to be determined

(a) Based on the 85th percentile of May 2022-March 2026 effluent concentration data. The total nitrogen and total phosphorus concentrations reported for March 2024 (154.27 mg/L and 17.14 mg/L) are each equal to the load reported for that month multiplied by 8.34, rather than the load divided by the product

of flow and 8.34, and are therefore a unit-conversion error in the reported data. The concentrations for that month were recalculated from the reported loads and flow as 3.24 mg/L TN and 0.36 mg/L TP and 1.55 mgd maximum 30-day average flow (excluding one anomalous March 2026 reported flow of 4.94 mgd).
(b) To be evaluated next permit cycle and TMDL revised if necessary. TMDL limits will be incorporated in the next permit renewal. The current permit includes a compliance schedule for the current permit effluent limits. See Section 10.1.
(c) Targets based on in-stream nutrient targets discussed in Section 4.1.
(d) WLA calculated using Equation 4.6 and 1.16 mgd summer median 30-day average effluent flow vs. using design flow because not enough flow in the river to accommodate all users. The nth-phase TN WLA (4.06 lb/day) and the TN TMDL for this assessment unit (Table 4.5) were both calculated using the 0.42 mg/L in-stream target.

Table 4.10 Plant nutrients Waste Load Allocation for the Rock Lake State Fish Hatchery, NPDES Permit No. NM0030155

Phase	Parameter	Water Quality Target (mg/L)	Waste Load Allocation (lb/day)
1st (Initial target)	Total Nitrogen	0.74 (a)	34.4 (a)
	Total Phosphorus	0.1105 (a)	5.14 (a)
2nd (Interim limit)	Total Nitrogen	TBD (b)	TBD (b)
	Total Phosphorus	TBD (b)	TBD (b)
nth (Water quality based)	Total Nitrogen	0.69 (c)	32.11 (d)
	Total Phosphorus	0.061 (c)	2.84 (d)

TBD = to be determined
(a) Phase 1 TP target based on the 85th percentile of June 2022–March 2026 quarterly DMR 30-day average effluent concentration data (16 quarters). Phase 1 TN target based on the 95th percentile of the same dataset; the 95th percentile (rather than 85th) was used for TN to prevent the WLA phases from being inverted (i.e., to ensure the Phase 1 TN WLA is less stringent than the nth-phase TN WLA). The Phase 1 TN and TP loading limits were calculated using the highest reported 30-day average flow (5.58 mgd), which is the basis for the permit's final effluent limits at Outfall 001. Many reported TP concentrations were at or near the analytical detection limit (typically < 0.10 mg/L), which is higher than the in-stream target of 0.061 mg/L, so the Phase 1 TP target value should be interpreted with this caveat.
(b) To be evaluated next permit cycle and TMDL revised if necessary. See Section 10.1.
(c) Targets based on in-stream nutrient targets discussed in Section 4.1.
(d) WLA calculated using Equation 4.6 and 5.58 MGD highest monthly average flow from June 2022 through March 2026

Stormwater discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the USEPA NPDES Construction General Permit (CGP) for construction sites of one or more acres, or smaller if part of a common plan of development, 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 ensure that waste load allocations and/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.

Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES Multi-Sector General Permit (MSGP). The MSGP also requires preparation of a SWPPP. Some of the industrial facilities and activities covered under the MSGP have technology based effluent limitations and/or benchmark monitoring for pollutants. The current MSGP includes state-specific requirements that the benchmark values be protective of State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. The discharges from these permits are typically transitory as the activities are temporary. Loads that are in compliance with the General Permits are therefore currently included as part of the Load Allocation (LA). While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

4.3.3 Load Allocation

Load Allocation is pollution from any nonpoint source(s) or natural background and is addressed through Best Management Practices (BMPs). To calculate the LA, the WLA and MOS are subtracted from the TMDL using **Equation 4.5** as shown on **Table 4.11**. The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors (see **Section 4.3.1** for details). The extensive data collection and analyses necessary to determine background plant nutrients loads are beyond the resources available for this study. It is assumed that a portion of the LA is made up of natural background loads. 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. Successful implementation of this TMDL will be determined based on achievement of the TN and TP targets under all flow conditions.

Table 4.11 Plant Nutrient Load Allocation calculations (units are in lbs/day)

Assessment Unit	Parameter	WLA	LA	MOS	TMDL
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	TN	0	0.93	0.10	1.03
	TP		0.09	0.01	0.10
Gallinas River (Pecos Arroyo to Las Vegas Diversion)	TN	0	1.53	0.17	1.70
	TP		0.22	0.02	0.25
Gallinas River (USGS Gage 08382000 to Pecos Arroyo)	TN	4.06	6.22	0.54	10.82
	TP	0.59	0.90	0.08	1.57
Gallinas River (Aguilar Creek to USGS Gage 08382000)	TN	0	2.16	0.24	2.40
	TP		0.19	0.02	0.21
Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)	TN	1.40	1.25	0.29	2.94
	TP	0.20	0.19	0.04	0.43
Pecos River (Canon de Manzanita to Alamitos Canyon)	TN	0.53	13.12	1.52	15.17
	TP	0.08	1.90	0.22	2.20
Pecos River (Santa Rosa Reservoir to Tecolote Creek)	TN	0	18.20	0.96	19.16
	TP		1.61	0.08	1.69
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	TN	32.11	165.19	10.38	207.68
	TP	2.84	14.60	0.92	18.36

4.3.4 Load Reduction

The extensive data collection and analysis necessary to determine background nutrient loads were beyond the resources available for this study. It is therefore assumed that a portion of the load allocation is made up of natural background loads.

Table 4.12 Calculation of load reductions for TN and TP (units are lbs/day)

TMDL Watershed	Parameter	Target Load[a]	Measured Load[b]	Load Reduction	Percent Reduction[c]
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	TN	0.93	0.72	0.00	0%
	TP	0.09	0.03	0.00	0%
Gallinas River (Pecos Arroyo to Las Vegas Diversion)	TN	1.53	1.39	0.00	0%
	TP	0.22	0.10	0.00	0%

TMDL Watershed	Parameter	Target Load[a]	Measured Load[b]	Load Reduction	Percent Reduction[c]
Gallinas River (USGS Gage 08382000 to Pecos Arroyo)	TN	10.28	297.65	287.37	97%
	TP	1.49	18.55	17.06	92%
Gallinas River (Aguilar Creek to USGS Gage 08382000)	TN	2.16	2.71	0.55	20%
	TP	0.19	0.24	0.05	20%
Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)	TN	2.65	5.11	2.47	48%
	TP	0.38	0.43	0.05	11%
Pecos River (Canon de Manzanita to Alamitos Canyon)	TN	13.65	7.94	0.00	0%
	TP	1.98	0.58	0.00	0%
Pecos River (Santa Rosa Reservoir to Tecolote Creek)	TN	18.20	21.94	3.74	17%
	TP	1.61	2.39	0.78	33%
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	TN	197.30	57.19	0.00	0%
	TP	17.44	6.62	0.00	0%

(a) Target Load = TMDL – MOS. 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.

*(b) The measured load is the magnitude of point and nonpoint sources. It is calculated using median measured concentration values at the TMDL critical flow. Values reported below the sample detection limit (SDL) were treated as zero in calculating the median, except where every sample for a parameter was below detection, in which case the SDL was used as a conservative value (**Appendix A**).*

(c) 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.

4.4 Identification and Description of Pollutant Sources

SWQB fieldwork includes an assessment of the probable sources of impairment in the AU drainage area, according to Standard Operating Procedure 4.1, Revision 2, Probable Source(s) Determination (https://www.env.nm.gov/surface-water-quality/sop/; **Appendix B**). Probable Source Sheets are filled out by SWQB monitoring staff during watershed surveys. The sheets are then reviewed by watershed protection staff familiar with the location, and the TMDL writer conducts a search of aerial imagery, GIS

files, and other available resources. The list of probable sources is not intended to single out any particular landowner or land management activity and generally includes several sources per pollutant. Pollutant sources that may contribute to each impairment were determined by field reconnaissance and evaluation (**Table 4.13**). Probable sources of nutrient impairment will be evaluated, refined, and changed as necessary through the Watershed Based Plans.

Table 4.13 Probable sources of excessive plant nutrients for Upper Pecos River basin TMDL Assessment Units.

Assessment Unit	Probable Sources
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	Forest fire (Hermit's Peak–Calf Canyon, 2022); Roads/bridges; On-site treatment systems; Rangeland grazing; Wildlife other than waterfowl
Gallinas River (Pecos Arroyo to Las Vegas Diversion)	Dams/diversion; Inappropriate waste disposal; Other recreational pollution sources; Roads/bridges; Rural residential area; Streambank modifications/destabilization; Urban high-density area; Urban runoff/storm sewers
Gallinas River (USGS Gage 08382000 to Pecos Arroyo)	Dams/diversion; Grazing in riparian zone; Loss of riparian habitat; Municipal point source; Rangeland grazing; Roads/bridges
Gallinas River (Aguilar Creek to USGS Gage 08382000)	Dams/diversion; Forest fire (Hermit's Peak–Calf Canyon, 2022); Grazing in riparian zone; Inappropriate waste disposal (junkyards); Loss of riparian habitat; Low water crossing; On-site treatment systems; Rangeland grazing; Roads/bridges; Streambank modifications/destabilization
Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)	Industrial point source discharge; Inappropriate waste disposal (junkyard); Loss of riparian habitat; Low water crossing; On-site treatment systems; Roads/bridges; Rural residential area; Wildlife other than waterfowl
Pecos River (Canon de Manzanita to Alamitos Canyon)	Forest fire (Tres Lagunas, 2013); Municipal point source; On-site treatment systems
Pecos River (Santa Rosa Reservoir to Tecolote Creek)	Dams/diversion; Forest fire (Tres Lagunas, 2013); Grazing in riparian zone; Inappropriate waste disposal; Loss of riparian habitat; On-site treatment systems; Rangeland grazing; Roads/bridges; Rural residential area; Streambank modification
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	Crop production; Dams/diversion; Loss of riparian habitat; Municipal point source; On-site treatment systems; Other recreational pollution sources; Rangeland grazing; Roads/bridges; Rural residential area; Urban high-density area

Glorieta Creek flows into the Pecos River upstream of the monitoring station where the DO impairment was documented for the **Pecos River (Canon de Manzanita to Alamitos Canyon)** AU. Glorieta Creek receives a substantial portion of its flow from effluent discharged by the Glorieta Adventure Camps WWTP (Permit NM0028088), and is listed as impaired for specific conductance (SC) and plant nutrients (however, the applicable SC standard is under review). Pollutant loading from this tributary, and from the Village of Pecos WWTP upstream, may contribute to the dissolved oxygen impairment in the Pecos River (see Section 4.1.1), although median in-stream TN and TP in this AU did not exceed the applicable thresholds.

It is apparent from the monitoring data (**Appendix A**) that concentrations of both TN and TP increase by one to two orders of magnitude over the 3-km distance between monitoring stations that brackets the Las Vegas WWTP outfall. While there are several additional probable sources of nutrients along the **Gallinas River (USGS Gage 08382000 to Pecos Arroyo)** and **Gallinas River (Aguilar Creek to USGS Gage 08382000)** AUs, it is possible that the nutrient impairment and elevated delta DO (8.8 mg/L; Appendix A) in **Gallinas River (Aguilar Creek to USGS Gage 08382000)** may be influenced by WWTP effluent that has not been sufficiently diluted over the 44 km distance to the monitoring station.

As described in **Section 4.2**, 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 near the stream because the hydrological pathways are shorter and have fewer obstacles than land uses located away from the riparian corridor. 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. The contributions from these natural sources are generally considered to represent background levels. Another nutrient source is atmospheric deposition, which adds nutrients directly to the waterbody through dryfall and precipitation. Atmospheric phosphorus and nitrogen can be found in both organic and inorganic particles, such as pollen and dust, as well as anthropogenic sources such as combustion and agriculture.

4.5 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 variation.” Conclusions expressed here should be regarded as preliminary, due to the small number of data points.

In El Porvenir Creek, which has a DO impairment but did not exceed nutrient thresholds, nutrient concentrations were greatest in May and June and below the detection limit in September 2019 and July 2020. This pattern is consistent with a natural flush of organic material from the upper watershed during snowmelt.

Plant nutrient concentrations in the **Gallinas River (Pecos Arroyo to Las Vegas Diversion)**, which has a DO impairment but did not exceed nutrient thresholds, did not show a consistent seasonal pattern in either year, and were below detection limit in some samples, particularly in the fall. Plant nutrient concentrations in the two Gallinas River AUs downstream of the city of Las Vegas, both of which exceeded nutrient thresholds, did not show any apparent seasonal pattern in either year, consistent with a point source of pollution. Concentrations of both TN and TP were far above the in-stream nutrient targets in all samples.

In Glorieta Creek, there was no apparent seasonal pattern to nutrient exceedances.

In the **Pecos River (Canon de Manzanita to Alamitos Canyon)**, which has a DO impairment but did not exceed nutrient thresholds, the concentrations were greatest in the spring, coinciding with runoff from the snowpack. Plant nutrient concentrations were below the detection limit in September and October. These low late-season concentrations are consistent with rapid uptake of available nutrients by attached algae and macrophytes (Section 4.1.1.)

In the **Pecos River (Santa Rosa Reservoir to Tecolote Creek)**, which did exceed nutrient thresholds, plant nutrient concentrations were extremely variable between sampling events, for no evident reason, and did not show any apparent seasonal pattern. Between the Santa Rosa and Sumner Reservoirs, where there is a DO impairment but no exceedance of nutrient thresholds, nutrient concentrations in the Pecos River were often undetectable and did not show any apparent seasonal pattern.

The critical condition used for calculating the TMDL is considered to be conservative and protective of the water quality standard under all flow conditions. Calculations made at the critical flow, 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.

4.6 Future Growth

Growth estimates by county are available from the University of New Mexico Geospatial and Population Studies (GPS) (https://gps.unm.edu/pop/population-projections.html). The estimates project growth to the year 2050. The Pecos Headwaters HUC extends over portions of six counties, Guadalupe, San Miguel, Santa Fe, Mora, Quay, and De Baca, however most of the HUC is within San Miguel and Guadalupe counties. GPS projects Guadalupe and San Miguel county populations to decline through 2050, as detailed in **Table 4.14**.

These projections account for the 2020 census results, also accessed through GPS (https://gps.unm.edu/pop/population-estimates.html). TMDL implementation planners should seek out the most current projections if the information is relevant to their project.

Table 4.14 Guadalupe and San Miguel county population estimates

County	2020 (Census)[B]	2025	2030	2035	2040	2045	2050[A]	% Change
Guadalupe	4,452	4,326	4,179	3,996	3,762	3,492	3,177	-28.64
San Miguel	27,201	26,064	24,902	23,435	21,577	19,470	17,036	-37.37

% Change: [(A – B) / B] × 100

5.0 SEDIMENTATION

Stream bottom substrate provides optimum habitat for many fish and aquatic insect communities when it does not include excessive fine sediment filling the interstitial spaces. Excessive fine sediment occurs when biologically-important habitat components such as spawning gravels and cobble surfaces are physically covered by fines (Chapman and McLeod, 1987). Substrate fining decreases intergravel oxygen and results in reduced or eliminated quality and quantity of habitat for fish, macroinvertebrates, and algae (Lisle 1989; Waters 1995). Chapman and Mcleod (1987) found that bed material size is related to habitat suitability for fish and macroinvertebrates and that excess fine sediment decreased both density and diversity of aquatic insects.

Sediment loads that exceed a stream's sediment transport capacity often trigger changes in stream morphology (Leopold et al., 1964). Streams that become overwhelmed with sediment often go through a period of accelerated channel widening and streambank erosion before returning to a stable form (Rosgen, 1994). These morphological changes can accelerate erosion, reduce habitat diversity (pools, riffles, etc.) and place additional stress on the designated aquatic life use.

5.1 Target Loading Capacity

The New Mexico WQS (20.6.4.13 NMAC) include a general narrative standard for "bottom deposits and suspended or settleable solids", which reads:

> *"Surface waters of the state shall be free of water contaminants including fine sediment particles (less than two millimeters in diameter), precipitates or organic or inorganic solids from other than natural causes that have settled to form layers on or fill the interstices of the natural or dominant substrate in quantities that damage or impair the normal growth, function or reproduction of aquatic life or significantly alter the physical or chemical properties of the bottom."*

The assessment approach used to determine these sedimentation impairments is described in detail in Appendix G of the SWQB Comprehensive Assessment and Listing Methodology (NMED/SWQB, 2025; https://www.env.nm.gov/surface-water-quality/calm/). Target values for this TMDL were based on the numeric thresholds identified in the CALM. The CALM establishes a procedure for determining impairment due to excessive sedimentation/siltation in perennial, wadable streams. Bedded sediments cannot be treated as introduced pollutants such as pesticides because they are not uniquely generated through human input or disturbance. Rather, bedded sediments are components of natural systems that are present even in pristine settings and to which stream organisms have evolved and adapted. Therefore, the detection of a sediment imbalance is more complicated than detecting an absolute concentration or percentage that represents a clear biological impact.

The SWQB and EPA Region 6 contracted with Tetra Tech, Inc., to develop sediment translators or thresholds. The contractor generally followed the steps provided in USEPA's Framework for developing suspended and bedded sediment water quality criteria (USEPA, 2006). This effort included the identification of sediment characteristics that are expected under the range of environmental settings in New Mexico, especially in undisturbed or best available reference streams. Examining the relationships between biological measures and sediment indicators helped to identify where disturbance had caused

sediment imbalance and biologically relevant habitat degradation. The analysis resulted in threshold recommendations for two bedded sediment indicators for New Mexico perennial streams (**Table 5.1**) – percent Sand & Fines (%SaFN) and log Relative Bed Stability calculated without bedrock (LRBS_NOR) -- for three different site classes, Mountains, Foothills, and Xeric. The site classes are defined by Level 3 and 4 ecoregions (Griffith et al., 2006) and distinguish sediment expectations across New Mexico. The report detailing this effort (Jessup et al., 2010) is available at https://www.env.nm.gov/surface-water-quality/sedimentation/.

Table 5.1. Bedded sediment indicators (from Jessup et al., 2010)

Sediment Indicator	Description
Percent Sand & Fines (%SaFN)	**The percentage of systematically selected streambed substrate particles that are ≤2.0 mm in diameter from reach-wide pebble count.**
Log Relative Bed Stability (LRBS)	**A measure of the relationship of the median particle size in a stream reach compared to the critical particle size calculated to be mobilized by standardized fluvial stresses in the reach.** Median particle size is determined using a reach-wide pebble count (Peck et al., 2006). Critical particle size is calculated from channel dimensions, flow characteristics, and channel roughness factors (Kaufmann et al., 2008). The measure is expressed as a logarithm of the ratio of geometric mean to critical particle size.
LRBS_NOR	**RBS without bedrock or hardpan (log10).** This measure regards only the potentially mobile streambed particles in determining the geometric mean particle size, and improved associations between the bedded sediment measure and biological responses in the TetraTech analyses (Jessup et al., 2010)

To determine if there is excessive sedimentation/siltation in the study stream reach, two levels of assessment are performed in sequential order. The first level considers the simpler indicator of biological impairment, and then refines the assessment with the second indicator of geomorphic impairment as needed when the first level threshold is exceeded. The % SaFN sediment indicator is used in the Level One assessment because it is easily measured and related strongly with biological metrics. If the %SaFN indicates excessive fine sediment in the stream bed, a Level Two survey is performed to collect data used to calculate the LRBS_NOR value.

In minimally disturbed streams, the measured geometric mean particle size should trend towards the expected particle size (i.e., the size the stream is capable of moving as bedload at bankfull flow). The LRBS_NOR indicator considers site-specific hydraulic potential for moving bed sediments, so that the observed amount of fine sediment is considered an impairment only when the streambed is more easily mobilized and transported than expected. It incorporates stream channel shape, slope, flow, and sediment supply. The LRBS_NOR measure is appropriate as a second-tier indicator because it is scaled to hydro-geomorphic factors of the individual sites, as well as to the broader site classes, thus allowing evaluation of the potential of the specific site in terms of retaining or flushing fine sediments.

Table 5.2 Sedimentation indicator thresholds based on biological responses and reference distributions (Jessup et al., 2010)

Site Class	% Sand and Fines	LRBS_NOR Units
Mountain	< 20	> -1.1
Foothill	< 37	> -1.3
Xeric	< 74	> -2.5

If the calculated LRBS_NOR is greater than the applicable site class threshold in **Table 5.2**, the AU is regarded as **Full Support** with respect to New Mexico's narrative sedimentation/siltation standard found at 20.6.4.13 NMAC. If the calculated LRBS_NOR is less than or equal to the applicable site class threshold, the AU is considered **Non Support**.

During the 2019-20 survey, impairment relative to the narrative criterion for sedimentation in 20.6.4.13 NMAC was documented in **Willow Creek subwatershed** (W_NM-2217_004), due to exceedances of the numeric sedimentation threshold (**Table 5.3**).

Table 5.3 Numeric thresholds applied to Willow Creek subwatershed (W_NM-2217_004)

Ecoregion/Site Class	% Sand and Fines Threshold	% Sand and Fines Observed	LRBS_NOR Threshold	Calculated LRBS_NOR
21f/Mountain	20	57.1	-1.1	-1.24

A load-based indicator is needed in order to generate a TMDL based on mass balance. Because a mass-based load cannot be derived directly from the bedded-sediment indicators (%SaFN and LRBS_NOR), Total Suspended Solids (TSS) is used as the load-based surrogate for this sedimentation/siltation TMDL. Jessup et al. (2010) suggest an interpretation of the indicator value distributions for sites which fully support their designated uses, using the 90th percentile value for Mountain and Foothills sites and the 75th percentile value for Xeric sites (**Table 5.4**). Therefore, the target Total Suspended Solids (TSS) value for the sedimentation TMDL AU will be 8.75 mg/L. Monitoring data for flow, TSS and turbidity (indicators of excessive sedimentation/siltation) are presented in **Appendix A**. Flow, TSS, and turbidity grab samples were collected at station 50Willow000.1 (Willow Creek below White Drain), the assessment unit pour point, which is located downstream of the Willow Creek fish barrier and outside the reconstructed channel. The bedded-sediment indicators (%SaFN and LRBS_NOR) were derived from a reach-wide pebble count and physical habitat survey conducted at 50Willow000.6, situated above the fish barrier approximately 0.5 km upstream of the pour point station (50Willow000.1). This habitat station was selected so that the survey transect would not fall within the constructed portion of the channel associated with the fish barrier and the 2002 Terrero Mine reclamation project.

Table 5.4 Suspended sediment indicator percentiles for fully supporting sites and all sites in three site classes

		Fully Supporting Sites			All Sites		
		Valid N	75th	90th	Valid N	25th	Median
Mountains	Turbidity (ntu)	68	4.88	9.50	217	1.25	3.10
	TSS (mg/L)	70	5.05	8.75	221	3.00	3.89
Foothills	Turbidity (ntu)	24	12.18	19.30	136	2.33	5.99
	TSS (mg/L)	24	9.88	16.12	138	3.71	6.71
Xeric	Turbidity (ntu)	83	68.50	191.76	289	5.60	16.00
	TSS (mg/L)	85	60.23	262.80	295	7.00	17.00

5.2 Flow

The TMDL is a value calculated at a defined critical flow condition as part of a planning process designed to achieve water quality standards. For these sedimentation TMDLs, the appropriate critical flow condition is at low flow to be protective when the assimilative capacity of a stream is at its lowest. According to the New Mexico Water Quality Standards, the low flow critical condition for numeric criteria (excluding human health-organism only criteria), set out in 20.6.4.97 through 20.6.4.900 NMAC and Subsection F of 20.6.4.13 NMAC, is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC). The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years.

Critical flow value used to calculate the sedimentation/siltation TMDL was obtained using a regression model. Because this stream is ungauged, an analysis method developed by Bell and Tillery (2023) was used to estimate the critical low flow. Bell and Tillery (2023) developed a set of regression equations for estimating 4Q3 in New Mexico based on basin characteristics and mean basin elevation, superseding the Waltemeyer (2002) equations used in prior TMDLs. The mean basin elevation of the **Willow Creek subwatershed** is above 8,000 ft, so the high-elevation regression equation (4Q3-1a) was used. The following high-elevation regression equation (**Equation 5.1**) is based on data from 44 stream gages in basins with mean elevation greater than 8,000 ft (Bell and Tillery, 2023):

Equation 5.1 $4Q3 = DA^{1.08} \times E^{12.20} \times e^{-115.37}$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
E = Mean basin elevation (ft)
e = Base of the natural logarithm (2.71828…)

The 4Q3 value calculated using the Bell and Tillery (2023) method is presented on **Table 5.5**. Parameters used in the calculation were determined using the StreamStats online GIS application developed by the USGS (https://streamstats.usgs.gov/ss/). The critical flow was converted from cubic feet per second (cfs) to million gallons per day (mgd) using a conversion factor of 0.646. The TMDL in Table 5.6 was calculated from the unrounded regression output rather than the rounded 4Q3 shown in Table 5.5, so a result computed from the rounded value may differ slightly in the last significant figure. The Willow Creek

subwatershed's drainage area (8.17 mi^2) falls below the 10.6 mi^2 minimum represented in the 4Q3-1a calibration dataset; because the subwatershed is ungaged and no Bell and Tillery (2023) equation covers this smaller drainage-area range, the 4Q3-1a estimate was retained as the best available value, with the understanding that estimates outside the calibrated range carry greater uncertainty. The TMDL itself is a value calculated at a defined critical condition 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. Management of the load to improve instream water quality is the goal of SWQB efforts.

Table 5.5 Calculation of Critical Flow for Willow Creek subwatershed

Average Elevation (ft)	Drainage Area (mi^2)	4Q3 (cfs)	4Q3 (mgd)
9599	8.17	0.29	0.188

5.3 TMDL Calculations

The TMDL is defined as the mass of pollutant that can be carried under critical flow conditions without violating the target concentration for that constituent. The TMDL is calculated based on simple dilution using critical flow, the numeric target, and a conversion factor to correct the TMDL units to lb/day, according to the formula:

Equation 5.2: *WQS (mg/L) x Critical flow (mgd) x Conversion Factor (8.34) = TMDL (lb/day)*

TMDLs are presented on **Table 5.6** for the critical low flow condition.

Table 5.6 Calculation of Sedimentation/Siltation TMDL for Willow Creek subwatershed

TSS Indicator Value (mg/l)	Critical Flow (mgd)	Conversion Factor	TMDL (lb/day as TSS)
8.75	0.188	8.34	13.7

The TMDL is a planning tool to be used to achieve water quality standards. Since flows vary throughout the year in these systems the target load will vary based on the changing flow. Management of the load to improve stream water quality and meet water quality criteria is the goal of SWQB efforts. The TMDL is further allocated to a MOS, WLA (permitted point sources), and LA (nonpoint sources), according to the formula: *WLA + LA + MOS = TMDL.*

5.3.1 Margin of Safety (MOS)

The CWA requires that each TMDL be calculated with a MOS. 33 U.S.C. § 1313(d)(1). 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, the MOS was developed using explicit allocations. Therefore, this MOS is the sum of the following two elements:

- Explicit Recognition of Potential Errors:
    - Uncertainty exists in the relationship between TSS and deposition of excess sediment. A conservative MOS for this element is **10%**.
    - There is error inherent in flow estimation. A conservative MOS for this element is **10%**.

Total MOS for this TMDL is **20%**.

5.3.2 Waste Load Allocation (WLA)

There are no active individual National Pollutant Discharge Elimination System (NPDES) permits that discharge to the sedimentation impaired AUs, therefore the WLA for these TMDLs is zero.

Sediment and associated contaminants are considered components of industrial storm water discharges covered under NPDES General Permits. Stormwater discharges from construction activities are transient, occurring mainly during the construction itself, and then only during storm events. Coverage under the NPDES Construction General Permit (CGP) for construction sites greater than one acre, or less than one acre but are part of a common plan of development which will exceed 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 2022 CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, and managerial and structural solids, erosion, and sediment control Best Management Practices (BMPs), and/or other controls. The SWPPP must include site-specific interim and permanent stabilization, managerial, and structural solids, erosion and sediment control BMPs and/or other controls that are designed to prevent to the maximum extent practicable an increase in the sediment yield and flow velocity from pre-construction, pre-development conditions to assure that applicable standards in 20.6.4 NMAC, including the antidegradation policy, and TMDL WLAs are met. This requirement applies to discharges both during construction and after construction operations have been completed. Currently in the 2022 CGP, EPA defines "sediment-related parameter" as a pollutant parameter that is closely related to sediment such as turbidity, total suspended solids (TSS), total suspended sediment, transparency, sedimentation, and siltation. For discharge covered under the CGP to a water that is impaired for a parameter other than a sediment-related parameter or nutrients, EPA will inform the operator if any additional controls are necessary to meet water quality standards.

Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES Multi-Sector General Permit (MSGP). The MSGP also requires preparation of a SWPPP. Based on the industrial sector, some of the industrial facilities and activities covered under the MSGP have technology based effluent limitations and/or benchmark monitoring for pollutants. Part 9.6.2 of the current MSGP includes New Mexico state-specific requirements that the benchmark values reflect State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. The discharges from these permits are typically transitory as the activities are temporary. Loads that are in compliance with the General Permits are therefore currently included as part of the Load Allocation (LA). While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

5.3.3 Load Allocation (LA)

To calculate the LA, the WLA and the MOS were subtracted from the target capacity (TMDL), as shown on **Table 5.7**. The MOS was developed using explicit recognition of potential errors (see Section 5.3.1 for details).

Table 5.7 TMDL Allocations for Total Suspended Solids to Meet WQS for Sedimentation/siltation for Willow Creek Subwatershed (units are in lb/day)

WLA	LA	20% MOS	TMDL
0	11.0	2.7	13.7

The extensive data collection and analyses necessary to determine background sediment loads were beyond the resources available for this study. It is therefore assumed that a portion of the load allocation is made up of natural background loads. The target load for TSS is the TMDL minus the MOS, in this case equal to the LA. Because the relationship of stream bottom sediment to instantaneous TSS loads is complex and includes a temporal element, a measured load cannot be calculated from available data, so TSS load reduction estimates are not presented for sedimentation/siltation impairments. One indicator of implementation progress could be achievement of the % SaFN threshold indicator (**Table 5.8**).

Table 5.8 Reduction of % Sand and Fines needed to fall below the % Sand and Fines threshold indicator value for sedimentation/siltation for Willow Creek Subwatershed.

Ecoregion/Site Class	% Sand and Fines Threshold	% Sand and Fines Observed	Load Reduction
21f/Mountain	20	57.1	65%

5.4 Identification and Description of Pollutant Sources

SWQB conducted an assessment of the probable sources of impairment in the AU drainage area, according to Standard Operating Procedure 4.1, Revision 2, Probable Source(s) Determination (https://www.env.nm.gov/surface-water-quality/sop/; see also **Appendix B**). Probable Source Sheets are filled out by SWQB monitoring staff during watershed surveys. The sheets are then reviewed by watershed protection staff familiar with the location, and the TMDL writer conducts a search of aerial imagery, GIS files, and other available resources. The list of probable sources is not intended to single out any particular landowner or land management activity and generally includes several sources per pollutant.

Table 5.9 displays probable pollutant sources that have the potential to contribute to sedimentation impairment within each AU in the TMDL study area. 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 of impairment will be further evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

Table 5.9 Probable sources of excessive sedimentation/siltation

Assessment Unit	Probable Sources
Willow Creek subwatershed	Mine Tailings; Off-road Vehicles; Wildlife Other Than Waterfowl

Although natural rates of sediment input vary among and within regions, human activities can alter these inputs. Excessive watershed erosion from these activities can transport large amounts of fine sediments into streams, leading to frequent bed mobility and poor instream habitat. Conversely, some human alterations like dredging, channelization or upstream impoundments, may lead to a lack of fine sediments in some parts of the channel, but an excess in other places. Clearing vegetation from banks and riparian areas may increase siltation and reduce large woody debris in streams. Logging or farming up to the stream banks, building roads across or along streams, dredging and straightening the stream channel, and building dams or other diversion structures in the stream channel may destabilize stream banks and change bottom substrate size and composition. Even in streams draining relatively pristine watersheds that are at equilibrium between sediment supply and transport, one might expect different characteristic values of Relative Bed Stability that are dependent upon the natural rates of erosion. In the absence of human activities, these natural erosion rates would depend upon climate, basin geology, geomorphology, channel position within the watershed, and related features such as glaciers and natural landslide frequency (Kaufmann et al., 2008).

The Willow Creek channel immediately east of NM Highway 63 was reconstructed in 2002, as a component of the Terrero Mine reclamation project. It is important to note that the Willow Creek physical habitat measurements, on which the impairment assessment is based, were performed at station 50Willow000.6 (above the fish barrier), upstream of the constructed portion of the channel and the highway. In addition, field observations and aerial imagery indicate that off-road vehicle use and an extensive network of unauthorized all-terrain vehicle (ATV) trails in and immediately adjacent to the Willow Creek streambed are a probable source of the excessive fine sediment, destabilizing streambanks and delivering sediment directly to the channel.

5.5 Consideration of Seasonal Variation

The sediment moving capacity of a stream is exponentially related to flow velocity and discharge. Therefore, most of the work of streams is accomplished during floods, when stream velocity and discharge (and therefore capacity) are many times their level during low flow conditions. This work is in the form of bed scouring (erosion), sediment transport (bed and suspended loads), and sediment deposition. It is likely that the excess fine sediment loading, and deposition occur during periods of higher flow, which in northern New Mexico are most likely to occur during spring snowmelt and summer monsoon storms.

TSS samples were collected throughout the sampling seasons of 2019 and 2020, capturing the spring, summer and fall seasons. In **Willow Creek subwatershed**, most turbidity and TSS results above the thresholds were collected in May and June of both years. Future effectiveness monitoring to evaluate progress toward the sedimentation target will be conducted within the assessed reach upstream of the 2002 channel reconstruction, and will include reach-wide pebble counts to track percent Sand and Fines (the implementation-progress indicator presented in **Table 5.8**) together with TSS sampling.

5.6 Future Growth

Growth estimates by county are available from the University of New Mexico Geospatial and Population Studies (GPS) (https://gps.unm.edu/pop/population-projections.html). The estimates project growth to the year 2050. The Pecos Headwaters HUC extends over portions of six counties, Guadalupe, San Miguel, Santa Fe, Mora, Quay, and De Baca, however most of the HUC is within San Miguel and Guadalupe counties. GPS projects Guadalupe and San Miguel county populations to decline through 2050, as detailed in **Table 5.10**.

These projections account for the 2020 census results, also accessed through GPS (https://gps.unm.edu/pop/population-estimates.html). TMDL implementation planners should seek out the most current projections if the information is relevant to their project.

Table 5.10 Guadalupe and San Miguel county population estimates

County	2020 (Census)[B]	2025	2030	2035	2040	2045	2050[A]	% Change
Guadalupe	4,452	4,326	4,179	3,996	3,762	3,492	3,177	-28.64
San Miguel	27,201	26,064	24,902	23,435	21,577	19,470	17,036	-37.37

% Change: [(A – B) / B] × 100

Estimates of future growth are not anticipated to lead to a significant increase in sedimentation that cannot be controlled with BMP implementation. BMPs should be utilized and improved upon while continuing to improve watershed conditions and adhering to SWPPP requirements related to construction and industrial activities covered under the general permit.

6.0 SPECIFIC CONDUCTANCE

Conductivity is measured by SWQB in microSiemens per centimeter (µS/cm). The conductivity of rivers in the United States generally ranges from 50 to 1500 µmhos/cm (an equivalent unit of measure). Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µS/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates (Behar, 1997). Conductivity is influenced by water temperature, increasing as temperatures rise. Specific conductance (SC) is conductivity corrected to 25°C.

The electrical conductivity of water is directly related to the concentration of dissolved solids in the water because total dissolved solids (TDS) concentrations are equal to the sum of positively charged ions (cations) and negatively charged ions (anions) in the water. These electrically charged dissolved particles make ordinary natural water a good conductor of electricity. Conversely, pure water has a high electrical resistance, and resistance is frequently used as a measure of its purity.

TDS reflects the total amount of all inorganic and organic substances – including minerals, salts and metals – that are dissolved within a volume of water. Higher concentrations of TDS may occur during and after precipitation events. In the United States, elevated TDS is often due to natural environmental features such as mineral springs, carbonate deposits, salt deposits and silt, the decomposition of leaves and plankton, and the weathering erosion of rocks. Other sources may include stormwater and agricultural runoff, mining operations, industrial wastewater and sewage.

6.1 Target Loading Capacity

The NM Water Quality Control Commission has adopted numeric water quality criteria for SC to protect the designated use of High Quality Coldwater Aquatic Life (HQCWAL). The HQCWAL use designation requires that a stream have water quality, streambed characteristics, and other attributes of habitat sufficient to protect and maintain HQCWAL. For this TMDL document, target values for SC are based on the reduction in TDS necessary to achieve numeric SC criteria. Indian Creek is within the 20.6.4.217 NMAC segment, for which a segment-specific criterion of 300 µS/cm or less applies (20.6.4.217(B) NMAC). Specific conductance was recorded continuously at station 50Indian000.1 at 15-minute intervals from July 9 to September 17, 2019 (6,731 measurements) and from May 27 to October 5, 2020 (12,588 measurements), excluding records rejected during data review. Of these, 71.5 percent of the 2019 measurements and 73.9 percent of the 2020 measurements exceeded the criterion. The continuous records are plotted against the criterion, with the grab samples overlaid, in Appendix A. These continuous specific conductance exceedances are the basis of the impairment, and the percent exceedance is reported here to document the extent of that impairment. The measured load, however, is calculated from grab-sample data using TDS as a surrogate for SC. TDS is used because it is the only measured parameter that can be expressed as a mass-based load; specific conductance is a field measurement of the water's ability to conduct electrical current and cannot itself be converted to a load. The TDS:SC ratio developed from paired grab samples (Appendix A) provides the link between the numeric SC criterion and the TDS-based load calculation.

The Indian Creek subwatershed (AU W_NM-2217_002) is a new assessment unit created in 2023. The AU has been created using a subwatershed-based approach, which means that the AU is visualized as a polygon showing the watershed instead of a singular linear waterway. This subwatershed-based approach is a pilot of this type of AU in New Mexico, but has been used as the sole approach or in combination with

linear AU's in other states throughout the U.S. Creating a single assessment conclusion for the watershed unit as a whole aligns with EPA's ATTAINS reporting requirements, and is also consistent with established methodologies in other states. Subwatershed AU's will be assessed in a similar manner as linear AUs, by using the station lowest in the AU (at or near the pourpoint) to capture activities within the AU as a whole. This AU is also an ONRW (Outstanding National Resource Water) as of September 2022.

6.2 Flow

40 C.F.R. § 130.7(c)(1) requires states to calculate a TMDL using critical conditions for stream flow. The TMDL is a value calculated at a defined critical flow condition as part of a planning process designed to achieve water quality standards. For this TMDL, the appropriate critical flow condition is at low flow to be protective when the assimilative capacity of a stream is at its lowest. The low flow, or 4Q3, is defined as the 4-day, 3-year low-flow frequency. The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years (Bell and Tillery, 2023).

SC in a stream can vary as a function of flow. As flow decreases, TDS can increase, thereby increasing the SC. It is often necessary to estimate critical flow for a portion of a watershed where there is no active flow gage. 4Q3 derivations for ungauged streams were based on analysis methods described by Bell and Tillery (2023), an analysis method developed by USGS in partnership with NMED. In the Bell & Tillery analysis, six regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico and stream basin characteristics (i.e., statewide and mountainous regions above 8,000 ft in elevation, or basins with less than 75 square mile drainage areas). The mean basin elevation of the **Indian Creek subwatershed** is above 8,000 ft, and this AU is not the San Juan River nor a tributary to the San Juan, so the 4Q3-1a statewide regression equation was used. The following regression equation is based on data from 44 gaging stations with non-zero discharge (Bell and Tillery, 2023):

Equation 6.1

$$4Q3 = DA^{1.08} \times E^{12.20} \times e^{-115.37}$$

Where:

4Q3 = four-day, three-year low-flow frequency (cfs)

DA = drainage area (mi^2)

E = mean basin elevation (ft)

e = mathematical constant, Euler's number

Variables for input to the Bell and Tillery equation were obtained using the USGS StreamStats web tool (https://streamstats.usgs.gov/ss/). The 4Q3 value was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) using the conversion factor 0.646. The Indian Creek subwatershed's drainage area (7.83 mi^2) falls below the 10.6 mi^2 minimum represented in the 4Q3-1a calibration dataset; because the subwatershed is ungaged and no Bell and Tillery (2023) equation covers this smaller drainage-area range, the 4Q3-1a estimate was retained as the best available value, with the understanding that estimates outside the calibrated range carry greater uncertainty.

Table 6.1 Calculation of 4Q3 for Indian Creek subwatershed

Assessment Unit	Average Elevation (ft.)	Drainage Area (mi^2)	4Q3 (cfs)	4Q3 (mgd)
Indian Creek Subwatershed	9,020	7.83	0.13	0.084

The TMDL itself is a value calculated at a defined critical condition, 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 and achieve WQS is the goal of SWQB efforts.

6.3 TMDL Calculations

To calculate a mass-based load, total dissolved solids (TDS) is used as a surrogate for SC. TDS to SC ratios range from 0.5 to 0.9 mg/L: µS/cm (American Public Health Association, 1998). Site-specific correlation should be derived if TDS values are available. TDS and SC data from the 2019-20 SWQB sampling season can be found in **Appendix A**. Data was collected from two stations in the AU. Data from station Indian-NM19-10030 was included in the site-specific TDS:SC ratio used to derive the TMDL target, because that ratio characterizes a basin-wide chemical relationship between TDS and specific conductance and the sample falls within the expected range for this relationship. The measured load, however, is assessed at the pour-point station (50Indian000.1), so the mean measured TDS concentration used in the measured-load calculation is based on the pour-point data and excludes the more dilute upstream sample from Indian-NM19-10030. The TDS:SC ratio average value was 0.659. The segment-specific WQS states that SC shall not exceed 300 µS/cm. The TDS concentration required to achieve State WQS is defined by **Equation 6.2.**

Equation 6.2: TDS (mg/L) $\cong$ SC (µS/cm) x (ratio)

Using the site-specific ratio and an SC value of 300 µS/cm, the TDS concentration required to achieve the WQS is:

300 µS/cm x 0.659 = 197.7 mg/L TDS

The TMDL for TDS is calculated based on the 4Q3 flow, the applicable WQS, and a conversion factor of 8.34, that is used to correct the TMDL units to pounds per day (lb/day).

Equation 6.3: *WQS (mg/L) x Critical flow (mgd) x Conversion Factor (8.34) = TMDL (lb/day)*

Table 6.2 Calculation of TMDL for TDS (as SC indicator) for Indian Creek subwatershed

4Q3 Flow (mgd)	TDS to meet SC Standard (mg/L)	Conversion Factor	TMDL (lb/day TDS)
0.084	197.7	8.34	138.48

The TMDL is further allocated to a MOS, WLA (permitted point sources), and LA (non-point sources), according to the formula: *WLA + LA + MOS = TMDL*.

6.3.1 Margin of Safety (MOS)

The CWA requires that each TMDL be calculated with a MOS. 33 U.S.C. § 1313(d)(1). 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 TDS (as SC surrogate) TMDL, the MOS was developed using a combination of conservative assumptions and explicit allocations. Therefore, this MOS is the sum of the following two elements:

- *Implicit Margin of Safety*
  Treating TDS as a conservative pollutant, meaning a pollutant that does not readily degrade in the environment, was used as a conservative assumption in developing these loading limits.

- *Explicit Margin of Safety*
  An explicit MOS of 10% was assigned to the SC impaired AU, to account for the inherent error in estimation of streamflow.

6.3.2 Waste Load Allocation

There are no active individual National Pollutant Discharge Elimination System (NPDES) permits that discharge to the specific conductance impaired AU, therefore the WLA for this TMDL is zero.

Sediment and associated contaminants are considered components of industrial storm water discharges covered under NPDES General Permits. Stormwater discharges from construction activities are transient, occurring mainly during the construction itself, and then only during storm events. Coverage under the NPDES Construction General Permit (CGP) for construction sites greater than one acre, or less than one acre but are part of a common plan of development which will exceed 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 2022 CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, and

managerial and structural solids, erosion, and sediment control Best Management Practices (BMPs), and/or other controls. The SWPPP must include site-specific interim and permanent stabilization, managerial, and structural solids, erosion and sediment control BMPs and/or other controls that are designed to prevent to the maximum extent practicable an increase in the sediment yield and flow velocity from pre-construction, pre-development conditions to assure that applicable standards in 20.6.4 NMAC, including the antidegradation policy, and TMDL WLAs are met. This requirement applies to discharges both during construction and after construction operations have been completed. Currently in the 2022 CGP, EPA defines "sediment-related parameter" as a pollutant parameter that is closely related to sediment such as turbidity, total suspended solids (TSS), total suspended sediment, transparency, specific conductivity, sedimentation, and siltation. For discharge covered under the CGP to a water that is impaired for a parameter other than a sediment-related parameter or nutrients, EPA will inform the operator if any additional controls are necessary to meet water quality standards.

Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES Multi-Sector General Permit (MSGP). The MSGP also requires preparation of a SWPPP. Based on the industrial sector, some of the industrial facilities and activities covered under the MSGP have technology based effluent limitations and/or benchmark monitoring for pollutants. Part 9.6.2 of the current MSGP includes New Mexico state-specific requirements that the benchmark values reflect State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. The discharges from these permits are typically transitory as the activities are temporary. Loads that comply with the General Permits are therefore currently included as part of the Load Allocation (LA). While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

6.3.3 Load Allocation

Load Allocation (LA) is pollution from any non-point source(s) or natural background and is addressed through Best Management Practices. Since there are no WLAs for this AU, the LA is equal to the TMDL value minus the MOS, as shown on **Table 6.3**. The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors (see **Section 6.3.1** for details).

The extensive data collection and analyses necessary to determine natural background TDS loads were beyond the resources available for this study. It is therefore assumed that a portion of the load allocation is made up of natural background levels.

Table 6.3 Load Allocation of TMDL for TDS (as SC Surrogate) for Indian Creek subwatershed

WLA (lb/day)	LA (lb/day)	MOS (lb/day)	TMDL (lb/day)
0	124.63	13.85	138.48

6.3.4 Load Reduction

Table 6.4 Load Reduction Estimate to meet WQS for TDS (as SC surrogate)

Assessment Unit	Target Load [(a)] (lb/day)	Measured Load [(b)] (lb/day)	Load Reduction [(c)]
Indian Creek subwatershed	124.63	133.31	6.5%

(a) Target Load = TMDL – MOS. 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.
*(b) The measured load is calculated using mean measured concentration values (**Appendix A**) at the critical flow, for comparison with the target load. The sample from Indian-NM19-10030 was excluded from this measured-concentration mean because the measured load is assessed at the pour-point station (50Indian000.1); the sample was included in the TDS:SC ratio used to derive the target load.*
(c) Load reduction is the percent by which 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.

6.4 Identification and Description of Pollutant Source(s)

SWQB conducted an assessment of the probable sources of impairment in the AU drainage area, according to Standard Operating Procedure 4.1, Revision 2, Probable Source(s) Determination (https://www.env.nm.gov/surface-water-quality/sop/; see also **Appendix B**). Probable Source Sheets are filled out by SWQB monitoring staff during watershed surveys. The sheets are then reviewed by watershed protection staff familiar with the location, and the TMDL writer conducts a search of aerial imagery, GIS files, and other available resources. The list of probable sources is not intended to single out any particular landowner or land management activity and generally includes several sources per pollutant.

Table 6.5 displays probable pollutant sources that have the potential to contribute to specific conductance impairment within the TMDL AU. 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 of impairment will be further evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

Table 6.5 Pollutant Source Summary

Assessment Unit	Probable Sources
Indian Creek subwatershed	Forest Fire (Tres Lagunas, 2013); Highway/Road/Bridge Runoff; Subsurface Mining; Wildlife Other than Waterfowl

Specific conductance exceedances were only documented at low flows (**Appendix A**). Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows. Streams that run through areas with granite bedrock tend to have lower conductivity because granite is composed of more inert materials that do not dissolve into ionic components when washed into the water. On the other hand, streams that run through areas with clay soils tend to have higher conductivity because of the presence of materials that ionize when washed into the water. Groundwater inflows can have the same effects depending on the bedrock they flow through. In addition, discharges to streams can change

the conductivity depending on their make-up. For example, a failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate.

Wildfire can affect the physical, chemical, and biological quality of streams, rivers, and lakes. After a fire, increased runoff provides the pathway for the transport of chemical-laden sediment to surface water, which may have substantial water quality impacts. Potential wildfire impacts to water quality are discussed on the SWQB website at https://www.env.nm.gov/surface-water-quality/wildfire-impacts-on-surface-water-quality/. The Tres Lagunas fire (2013) may have increased TDS in runoff to Indian Creek.

6.5 Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during high and low flow seasons to ensure coverage of any potential seasonal variation in the system. Exceedances were observed in summer and fall at the representative monitoring station in 2019 and 2020. As shown in Appendix A, exceedances in 2019 were distributed as numerous short-duration excursions across the criterion, whereas in 2020 specific conductance rose through the season and remained above the criterion almost continuously from late June onward. In both years the highest values occurred late in the season as flows receded, consistent with the low-flow critical condition on which this TMDL is calculated.

6.6 Future Growth

Growth estimates by county are available from the University of New Mexico Geospatial and Population Studies (GPS) (https://gps.unm.edu/pop/population-projections.html). The estimates project growth to the year 2050. The Pecos Headwaters HUC extends over portions of six counties — Guadalupe, San Miguel, Santa Fe, Mora, Quay, and De Baca — however most of the HUC is within San Miguel and Guadalupe counties. GPS projects Guadalupe and San Miguel county populations to decline through 2050, as detailed in **Table 6.6**. These projections account for the 2020 census results, also accessed through GPS (https://gps.unm.edu/pop/population-estimates.html). TMDL implementation planners should seek out the most current projections if the information is relevant to their project.

Table 6.6 Guadalupe and San Miguel county population estimates

County	2020 (Census)[B]	2025	2030	2035	2040	2045	2050[A]	% Change
Guadalupe	4,452	4,326	4,179	3,996	3,762	3,492	3,177	-28.64
San Miguel	27,201	26,064	24,902	23,435	21,577	19,470	17,036	-37.37

% Change: [(A – B) / B] × 100

Estimates of future growth are not anticipated to lead to a significant increase in specific conductance that cannot be controlled with BMP implementation. BMPs should be utilized and improved upon while continuing to improve watershed conditions and adhering to SWPPP requirements related to construction and industrial activities covered under the general permit.

6.7 Glorieta Creek Specific Conductance

Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP; AU NM-2214.A_081) is also listed on the Integrated Report as impaired for specific conductance. A TMDL for specific conductance is not developed for this AU in the current cycle. Glorieta Camps has communicated to EPA that the local source water is

naturally high in total dissolved solids, so both the WWTP influent and treated effluent, and the receiving stream itself, carry elevated specific conductance independent of the discharge. Because the impairment may reflect natural background conditions rather than an anthropogenic load reducible through a WLA, staff recommend that any future specific conductance TMDL for this AU be preceded by additional characterization, including paired specific conductance sampling above the impoundment, within the impoundment, at the WWTP outfall, and downstream while the creek is flowing, to support either a Factor 1 natural-source justification or a site-specific specific conductance standard under 20.6.4.10(G) NMAC. The current NPDES permit for Glorieta Adventure Camps WWTP (NM0028088) already includes an effluent limit for specific conductance (Susan Lucas-Kamat, personal communication, February 2026).

7.0 TEMPERATURE

Water temperature influences the metabolism, behavior, and mortality of fish and other aquatic organisms. Natural temperatures of a water body fluctuate daily and seasonally. These natural fluctuations do not eliminate indigenous populations, but may affect existing community structure and geographical distribution of species. Anthropogenic impacts such as thermal pollution, deforestation, flow modification and climate change can modify these natural temperature cycles, often leading to deleterious impacts on aquatic life communities. Such modifications may contribute to changes in geographic distribution of species and their ability to persist in the presence of additional stressors such as introduced species. One mechanism by which temperature affects fish is that warmer water has a lower capacity for dissolved oxygen. Water temperature within the stream substrate can influence the growth of insects and salmon eggs. In addition to direct effects, the toxicity of many chemical contaminants increases with temperature (Caissie, 2006).

7.1 Target Loading Capacity

Fish and other aquatic organisms have specific ranges of temperature tolerance and preference. Cold water fish such as salmonids (salmon and trout) are especially vulnerable to increased water temperatures. For that reason, coldwater criteria are typically designed primarily to support reproducing populations of salmonids. A coolwater Aquatic Life Use (ALU) was approved by the WQCC in October 2010, to support aquatic life whose physiologic tolerances are intermediate between those of warmwater and coldwater aquatic life (NMED/SWQB, 2009). Acute temperature criteria (such as New Mexico's T_{MAX}) are intended to protect aquatic life from lethal exposures, whereas chronic criteria (the 4T3 or 6T3) protect from sub-lethal exposures sufficient to cause long-term detrimental effects (Todd et al., 2008). The acute and chronic criteria are established to protect the most sensitive members of fish communities, based on laboratory studies of the upper thermal limits of individual species.

For this TMDL document, target values for temperature are based on the reduction in thermal loading necessary to achieve numeric criteria. Temperature criteria for ALUs in New Mexico are shown on **Table 7.1**. New Mexico's aquatic life temperature criteria are expressed as $T_{MAX,}$ 4T3 and 6T3. T_{MAX} is the maximum recorded temperature, 4T3 means the temperature not to be exceeded for four or more consecutive hours in a 24-hour period on more than three consecutive days, and 6T3 means the temperature not to be exceeded for six or more consecutive hours in a 24-hour period on more than three consecutive days.

Table 7.1 Aquatic Life Use Temperature (°C) Water Quality Criteria

Criterion	*High Quality Coldwater*	*Coldwater*	*Marginal Coldwater*	*Coolwater*	*Warmwater*	*Marginal Warmwater*
4T3	20	---	---	---	---	---
6T3	---	20	25	---	---	---
T_{MAX}	23	24	29	29	32.2	32.2

Assessment of the 2019-20 Upper Pecos watershed thermograph data determined that three AUs exceeded the T_{MAX} for their designated ALU, two of which also exceeded the applicable chronic criterion (4T3 or 6T3). For those AUs, the TMDL is calculated using the T_{MAX} criterion as a goal. Temperature data are presented in **Appendix A**.

Table 7.2 Aquatic Life Use designations of the temperature TMDL AUs

Assessment Unit	Designated ALU
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	High Quality Coldwater
Gallinas River (Aguilar Creek to USGS Gage 08382000)	Marginal Coldwater
Pecos River (Alamitos Canyon to Jack's Creek)	High Quality Coldwater

7.2 Flow

The TMDL is a value calculated at a defined critical flow condition as part of a planning process designed to achieve water quality standards. For this temperature TMDL, the appropriate critical flow condition is at low flow to be protective when the assimilative capacity of a stream is at its lowest. According to the New Mexico Water Quality Standards, the low flow critical condition for numeric criteria (excluding human health-organism only criteria), set out in 20.6.4.97 through 20.6.4.900 NMAC and Subsection F of 20.6.4.13 NMAC, is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC). The 4Q3 is the annual lowest four consecutive day flow that occurs with a frequency of at least once every three years.

Because **El Porvenir Creek (SFNF bnd to Hollinger Canyon)**, the **Gallinas River (Aguilar Creek to USGS Gage 08382000)**, and **Pecos River (Alamitos Canyon to Jack's Creek)** are ungaged for purposes of this TMDL, regression equations developed by Bell and Tillery (2023) were used to estimate the 4Q3 critical low flow. Bell and Tillery (2023) provide a set of regression equations applicable to different physiographic regions of New Mexico, with selection based on watershed elevation, drainage area, and other physical characteristics.

Although the **Pecos River (Alamitos Canyon to Jack's Creek)** AU contains USGS gage 08378500 (PECOS RIVER NEAR PECOS, NM), the gage is located near the top of the AU above several prominent tributaries and the Lisboa Springs Fish Hatchery (NM0030121). The Bell and Tillery (2023) regression estimate of 11.69 cfs for the contributing watershed at the downstream end of the AU is lower than the gage-based estimate of 16.15 cfs, which is consistent with the gage representing only a subset of the AU contributing area. The Bell and Tillery (2023) estimate was therefore selected as the critical flow for this AU.

The mean basin elevation for **El Porvenir Creek (SFNF bnd to Hollinger Canyon)** and the Pecos River (Alamitos Canyon to Jack's Creek) contributing watersheds is greater than 8,000 ft, so the Bell and Tillery (2023) Equation 4Q3-1a (Equation 7.1) was used to estimate the critical low flow for those AUs:

Equation 7.1 $$4Q3 = DA^{1.08} \times E^{12.20} \times e^{-115.37}$$

Where:

- 4Q3 = Four-day, three-year low-flow frequency (cfs)
- DA = Drainage area (mi^2)
- E = Mean basin elevation (ft)
- e = Euler's number (2.71828...)

The **Gallinas River (Aguilar Creek to USGS Gage 08382000)** AU has a drainage area greater than 200 mi² and a mean basin elevation below 8,000 ft, so the Bell and Tillery (2023) Equation 4Q3-4 (Equation 7.2) was used to estimate the critical low flow for that AU:

Equation 7.2 $4Q3 = DA^{1.24} \times P^{7.27} \times e^{-29.02}$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P = Mean annual basin-wide precipitation (in)
e = Euler's number (2.71828...)

The 4Q3 values calculated using the Bell and Tillery (2023) method are presented in **Table 7.3**. Parameters used in the calculation were obtained using the StreamStats online GIS application developed by the USGS (https://streamstats.usgs.gov/ss/). The TMDL is a value calculated at a defined critical condition 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. Management of the load to improve stream water quality is the goal of SWQB efforts.

Table 7.3 Variables used for Bell and Tillery (2023) regression estimation of critical flow

Assessment Unit	Mean Elevation (ft)	Drainage Area (mi^2)	Average Basin Slope (ft/ft)	Mean Annual Basin Precipitation (in)	4Q3 (cfs)
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	9,174	28.2	0.38	—	0.64
Gallinas River (Aguilar Creek to USGS Gage 08382000)	6,868	478	—	17.8	0.65
Pecos River (Alamitos Canyon to Jack's Creek)	9,647	236	0.32	29.75	11.69

Note: 4Q3 values are shown rounded to two decimal places. TMDL calculations in Table 7.4 were performed using the unrounded regression output, so results computed from the rounded values shown here may differ slightly in the last significant figure. Drainage areas shown are the StreamStats-delineated contributing areas at the point of calculation and may differ from the assessment unit watershed areas reported in the Executive Summary tables.

7.3 TMDL Calculations

The calculation of a TMDL is governed by the basic equation,

WQS criterion x flow x conversion factor = TMDL target capacity

For temperature TMDLs, the WQS criterion is a temperature specified either by the designated ALU or segment-specific criteria, and it can be either a maximum temperature or time-duration temperature such as the 4T3 or 6T3. The 4Q3 low-flow is generally used for the critical flow unless another flow statistic or multiple flow conditions are more appropriate for the situation. The conversion factor is a variable needed to correct the TMDL units to kJ/day. Substituting the appropriate unit conversion factors, the equation used for temperature is the following:

Equation 7.3: $WQS\ (^{o}C)\ x\ Flow\ (cfs)\ x\ (1.023\ x\ 10^{7}) = TMDL\ (kJ/day)$

Details of the derivation of the temperature TMDL equation are presented in **Appendix C**. **Table 7.4** shows the TMDL calculation values for each TMDL AU. For the Pecos River (Alamitos Canyon to Jack's Creek), the critical flow used in the TMDL calculation is the sum of the Bell and Tillery (2023) 4Q3 estimate (11.69 cfs) and the Lisboa Springs Fish Hatchery flow basis (0.94 cfs), for a total of 12.63 cfs.

Table 7.4 Temperature TMDL calculations

Assessment Unit Name	Target temperature (°C)	4Q3 critical flow (cfs)	Conversion factor	TMDL (kJ/day)
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	23	0.64	1.023×10^{7}	1.50×10^{8}
Gallinas River (Aguilar Creek to USGS Gage 08382000)	30*	0.65	1.023×10^{7}	1.98×10^{8}
Pecos River (Alamitos Canyon to Jack's Creek)	23	12.63	1.023×10^{7}	2.97×10^{9}

** Segment-specific criterion.*

The TMDL is further allocated to a Margin of Safety (MOS), Waste Load Allocation (WLA; permitted point sources), and Load Allocation (LA; nonpoint sources), according to the formula:

$$WLA + LA + MOS = TMDL$$

7.3.1 Margin of Safety (MOS)

The CWA requires that each TMDL be calculated with a MOS (33 U.S.C. § 1313(d)(1)), intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. 33 U.S.C. § 1313(d)(1). 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.

Because of the uncertainty in determining critical low flow, an **explicit MOS of 10%** is assigned to each TMDL because the critical flow for all three AUs was estimated using the Bell and Tillery (2023) regression equations rather than measured from gage data.

In recognition of the likelihood of future increases to air temperature and evaporative demand, an **additional explicit 10% MOS** is added for each AU for climate change.

7.3.2 Waste Load Allocation (WLA)

There are no active individual National Pollutant Discharge Elimination System (NPDES) individual permits that discharge to **El Porvenir Creek (SFNF bnd to Hollinger Canyon)** or **Gallinas River (Aguilar Creek to USGS Gage 08382000)**; therefore, the WLA for those AUs is zero. There are no Municipal Separate Storm Sewer System (MS4) permits in any of the temperature TMDL AUs. The NMDGF Lisboa Springs Fish Hatchery (NPDES permit NM0030121) discharges to the **Pecos River (Alamitos Canyon to Jack's Creek**; AU NM-2214.A_002) and is assigned a temperature WLA as described below. A reserve WLA is presented in Table 7.5.

Lisboa Springs Fish Hatchery (NM0030121, effective Aug. 1, 2024; expires Jul. 31, 2029) discharges to the Pecos River (Alamitos Canyon to Jack's Creek; New Mexico Water Quality Standards segment 20.6.4.217 NMAC) from Outfall 001. The permit does not specify a design flow; the permit's final effluent limits at Outfall 001 are based on the highest monthly average flow of 0.607 mgd (0.94 cfs). The receiving water is designated High Quality Coldwater Aquatic Life Use, with an applicable TMAX criterion of 23 °C, which is the basis for the temperature WLA.

The water quality-based temperature WLA was calculated using Equation 7.4, in which the WQS criterion is multiplied by the effluent flow basis and the same unit conversion factor used for the in-stream TMDL calculation:

Equation 7.4: $WQS\ (°C) \times Flow\ (cfs) \times 1.023 \times 10^7 = WLA\ (kJ/day)$

For the Lisboa Springs Fish Hatchery, applying the High Quality Coldwater TMAX criterion (23 °C) and the highest monthly average flow basis of 0.607 mgd (0.94 cfs) yields: $23 \times 0.94 \times 1.023 \times 10^7 = 2.21 \times 10^8$ kJ/day. The WLA is reflected in **Table 7.5**. This is a reserve WLA; see Implementation Section 10.1.1(E) for discussion of reserve WLA.

There may be storm water discharges from industrial, including construction, activities covered under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) or Multi-Sector General Permit (MSGP). Excess temperature loading may be a component of some storm water discharges covered under general NPDES permits. Stormwater discharges from industrial, including construction, activities are generally considered transient because they occur mainly during the construction itself and/or only during storm events.

Coverage under the EPA NPDES CGP for construction sites one acre or greater or smaller if part of a common plan which will exceed one acre of development requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of 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. Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current

NPDES MSGP. The MSGP also requires preparation of a SWPPP. Some of the industrial facilities and activities covered under the MSGP have technology based effluent limitation and/or benchmark monitoring for pollutants. The current MSGP includes state-specific requirements that the benchmark values reflect State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the Load Allocation (LA). While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements. State certification of federal permits ensure that applicable water quality standards, including the antidegradation policy, are met. Compliance with a CGP or MSGP SWPPP that meets the requirements of the general permits is generally assumed to be consistent with this TMDL.

7.3.3 Load Allocation (LA)

Load Allocation is pollution from any nonpoint source(s) or natural background and is addressed through Best Management Practices (BMPs). For **El Porvenir Creek (SFNF bnd to Hollinger Canyon)** and **Gallinas River (Aguilar Creek to USGS Gage 08382000)** the WLA is zero, so the LA is equal to the TMDL value minus the MOS. For Pecos River (Alamitos Canyon to Jack's Creek), the LA is equal to the TMDL value minus the MOS minus the WLA for the Lisboa Springs Fish Hatchery.

Table 7.5 Temperature TMDL load allocations. Units are kilojoules (kJ) per day.

Assessment Unit	MOS	Reserve WLA	LA	TMDL
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	3.00×10^7	0	1.20×10^8	1.50×10^8
Gallinas River (Aguilar Creek to USGS Gage 08382000)	3.96×10^7	0	1.58×10^8	1.98×10^8
Pecos River (Alamitos Canyon to Jack's Creek)	5.94×10^8	2.21×10^8	2.16×10^9	2.97×10^9

See Implementation Section 10.1.1(E) for discussion of reserve WLA.

7.4 Identification and Description of Pollutant Source(s)

SWQB conducted an assessment of the probable sources of impairment in the AU drainage area, according to Standard Operating Procedure 4.1, Revision 2, Probable Source(s) Determination (https://www.env.nm.gov/surface-water-quality/sop/; see also **Appendix B**). Probable Source Sheets are filled out by SWQB monitoring staff during watershed surveys. The sheets are then reviewed by watershed protection staff familiar with the location, and the TMDL writer conducts a search of aerial imagery, GIS files, and other available resources. The list of probable sources is not intended to single out

any particular landowner or land management activity and generally includes several sources per pollutant.

Table 7.6 displays probable pollutant sources that have the potential to contribute to temperature impairments. 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 of temperature impairments can be further evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

Table 7.6 Probable sources of excessive temperature for Upper Pecos basin TMDL Assessment Units.

Assessment Unit	Probable Sources
El Porvenir Creek (SFNF bnd to Hollinger Canyon)	Drought; Forest Fire (Hermit's Peak–Calf Canyon, 2022); Highway/Road/Bridge Runoff; Rangeland Grazing; Wildlife Other than Waterfowl
Gallinas River (Aguilar Creek to USGS Gage 08382000)	Dam or Impoundment; Drought; Forest Fire (Hermit's Peak–Calf Canyon, 2022); Grazing in Riparian Zone; Highway/Road/Bridge Runoff; Loss of Riparian Habitat; Low Water Crossing; Rangeland Grazing; Streambank Modifications/Destabilization
Pecos River (Alamitos Canyon to Jack's Creek)	Forest Fire (Jaroso, 2013; Tres Lagunas, 2013; Hermit's Peak–Calf Canyon, 2022); Forest Roads; Highway/Road/Bridge Runoff; Off-road Vehicles; Other recreation (angling, camping); Rural Residential Area; Wildlife other than Waterfowl

A variety of factors can impact stream temperature (**Figure 7.1**). Decreased effective shade levels may result from reduction of riparian vegetation. When canopy densities are reduced, thermal loading increases in response to the increase in incident solar radiation. Likewise, it is well documented that past hydromodification activities have led to channel incision and widening. Wider stream channels also increase the stream surface area exposed to sunlight, thereby increasing heat transfer. Riparian area and channel morphology disturbances may also be attributed to past or 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 influx, and (2) increasing stream surface area exposed to solar radiation.

Riparian vegetation, stream morphology, hydrology, climate, geographic location, and aspect all 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, elevated summertime stream temperatures attributable to anthropogenic causes may 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;

3. Reduced summertime base flows that result from instream impoundments and withdrawals and/or inadequate riparian vegetation; and,
4. Inflow from heated surfaces, such as road pavement, buildings, bare land, etc. and the flow of water over hardened channel bottoms and walls.

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 reaches, where the stream loses water through infiltration to the surrounding ground as it flows downstream, increased temperatures can result in increased streambed infiltration, which can result in lower base flow (Constantz et al., 1994).

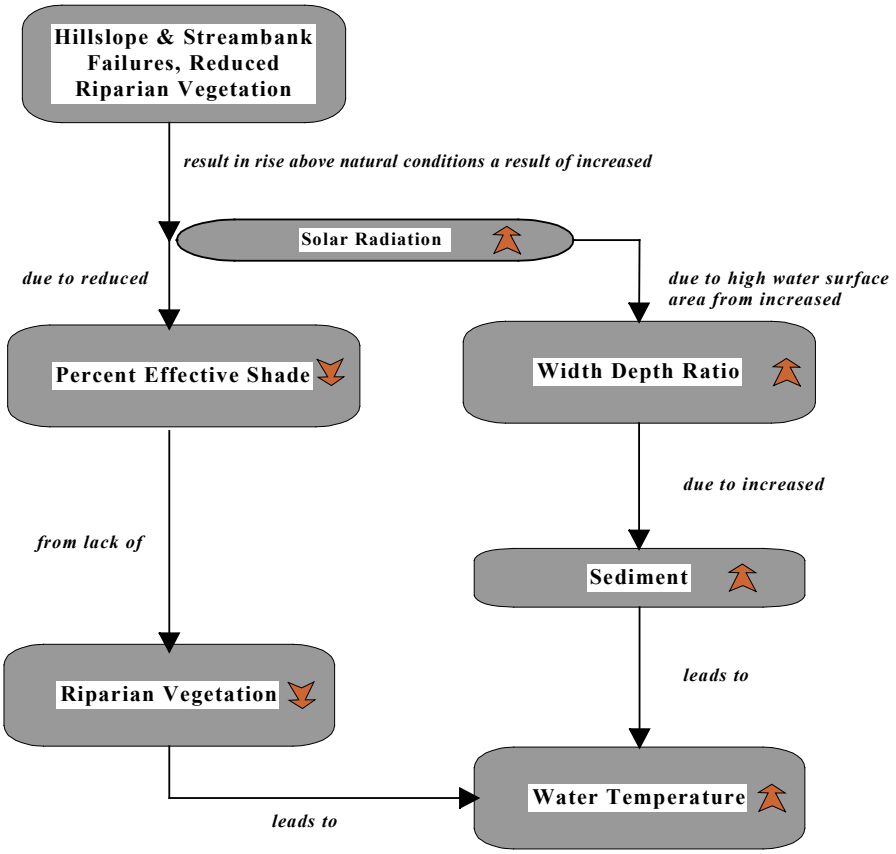


Figure 7.1 Factors Impacting Stream Temperature

Vegetation density increases will provide necessary shading, as well as encourage bank-building processes in severe hydrologic events (see **Section 10.3** of this report for modeling of shade increases to reduce water temperature). However, shade is only one avenue which may be pursued to decrease water temperature and ultimately meet WQS. Changes in geomorphological parameters might also prove useful. For example, unstable channels may be characterized by excess sedimentation. Many aquatic organisms respond to high temperature by seeking thermal refuge, moving into cooler tributaries or small

cold patches within the stream. Creation of thermal refuges, or enhanced connectivity, may mitigate the effects of increased water temperature (Caissie, 2006).

Wildfire can affect the physical, chemical, and biological quality of streams, rivers, and lakes. After a fire, increased runoff provides the pathway for the transport of chemical-laden sediment to surface water, which may have substantial water quality impacts. Forest fires can result in increased water temperature due to reduced infiltration and loss of shading vegetation. Potential wildfire impacts to water quality are discussed on the SWQB website at https://www.env.nm.gov/surface-water-quality/wildfire-impacts-on-surface-water-quality/.

Most watershed effects will naturally recover within 5 to 10 years after the fire, but some aspects of watershed structure and function, as well as areas of most severe fire intensity, may continue to recover for 15-20 years (Bixby et al., 2015). Therefore, runoff following forest fire has been added to the Probable Source list (**Table 7.6**) for **Gallinas River (Aguilar Creek to USGS Gage 08382000)**, which was impacted by the Viveash Fire in 2000, and the **Pecos River (Alamitos Canyon to Jack's Creek)**, which was impacted by the Viveash and Dalton Fires in 2000 and the Tres Lagunas and Jaroso Fires in 2013. All the temperature TMDL AUs were severely impacted by the Hermit's Peak-Calf Canyon Fire in 2022, after the water quality survey.

7.5 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 the winter and early spring months. Future climate change is expected to increase air temperatures and decrease streamflow, potentially leading to increases in maximum water temperature.

The warmest stream temperatures correspond to prolonged solar radiation exposure, warmer air temperature, and low flow conditions. Maximum temperatures were recorded in the TMDL AUs on July 11 and 12 of 2020.

7.6 Future Growth

SWQB acknowledges the projected impact of climate change on the state's water resources. Climate change will put additional stress on New Mexico's water resources and make attainment of water quality standards more difficult to achieve. In addition, shifting temperature and precipitation patterns affect vegetative composition and density and increase wildfire intensity and the propensity for wildfire in non-fire adapted ecosystems. In 2019, Governor Lujan Grisham signed Executive Order 2019-003 on Addressing Climate Change and Energy Waste Prevention. Executive Order 2019-003 directs all State agencies to evaluate the impacts of climate change on their programs and operations and integrate climate change mitigation and adaptation practices into their programs and operations.

In general, the strongest influence on in-stream water temperature is the ambient air temperature. Stakeholders should explore options to determine the most appropriate approach for each particular watershed or project, with the ultimate goal being that the stream meets the WQS. The SWQB encourages implementation practitioners to design projects to reduce water temperature well below the WQS, such that currently impaired AUs will be likely to meet WQS standards in the future with sufficient resiliency to warmer air temperatures and potentially lower flows.

Growth estimates by county are available from the University of New Mexico Geospatial and Population

Studies (GPS) (https://gps.unm.edu/pop/population-projections.html). The estimates project growth to the year 2050. The Pecos Headwaters HUC extends over portions of six counties: Guadalupe, San Miguel, Santa Fe, Mora, Quay, and De Baca, however most of the HUC is within San Miguel and Guadalupe counties. GPS projects Guadalupe and San Miguel County populations to decline through 2050 as detailed in **Table 7.7**.

These projections account for the 2020 census results, also accessed through GPS (https://gps.unm.edu/pop/population-estimates.html). TMDL implementation planners should seek out the most current projections if the information is relevant to their project.

Estimates of future growth are not anticipated to lead to a significant increase in temperature that cannot be controlled with BMP implementation. BMPs should be utilized and improved upon while continuing to improve watershed conditions and adhering to SWPPP requirements related to construction and industrial activities covered under the general permit.

Table 7.7 Guadalupe and San Miguel county population estimates

County	2020 (Census)[B]	2025	2030	2035	2040	2045	2050[A]	% Change
Guadalupe	4,452	4,326	4,179	3,996	3,762	3,492	3,177	-28.64
San Miguel	27,201	26,064	24,902	23,435	21,577	19,470	17,036	-37.37

% Change: [(A – B) / B] × 100

8.0 TURBIDITY

Turbidity is an expression of the optical property in water that causes incident light to be scattered and absorbed rather than transmitted in straight lines. It is a condition resulting from suspended solids in the water, including silts, clays, and plankton. Such particles absorb heat in the sunlight, thus increasing water temperature, which in turn lowers dissolved oxygen levels. It also prevents sunlight from reaching plants below the surface. This decreases the rate of photosynthesis, so less oxygen is produced by plants. Turbidity may harm fish and their larvae.

The impacts of suspended sediment and turbidity are well documented in the scientific literature. An EPA monitoring guideline report states that increased sediment load is often the most important adverse effect of human activities on streams (USEPA, 1991). An increase in suspended sediment concentration will reduce the penetration of light, decrease the ability of fish or fingerlings to capture prey, and reduce primary production (USEPA, 1991). As stated by Relyea et al. (2000), "increased turbidity by sediments can reduce stream primary production by reducing photosynthesis, physically abrading algae and other plants, and preventing attachment of autotrophs to substrate surfaces."

8.1 Target Loading Capacity

The New Mexico WQS has general criteria applicable to all waters of the state. The general narrative standard at 20.6.4.13(J) NMAC for turbidity reads:

> *"Turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function, or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural appearance of the water…"*

The assessment approach used to determine impairments of the narrative turbidity standard is described in detail in the Comprehensive Assessment and Listing Methodology (NMED/SWQB, 2025). Target values for this TMDL were based on the turbidity thresholds identified in the CALM. It relies upon the use of biotranslators to derive numeric thresholds from the narrative standard above. A biotranslator is a physical or chemical water quality parameter that has been isolated and affects the impairment of a quantifiable attribute of an indicator organism. In some cases, the quantifiable attribute may be the lethal dose or concentration of the parameter. In the case of turbidity, the attribute is typically based upon observed behavior and the Severity of Ill Effects ("SEV") index.

A SEV index of 3.5 was selected to develop thresholds for turbidity impairment in New Mexico. This SEV index value corresponds to the boundary between conditions that effect changes to feeding in aquatic organisms and conditions that have been found to reduce growth rate and habitat size. The relationship between turbidity, duration, and a SEV of 3.5 is given in Equation 8.1, where x is duration in hours and y is the turbidity in Nephelometric Turbidity Units (NTUs) for durations from 7 hours to 720 hours. Shorter-term turbidity excursions are unlikely to impair the growth, function, and reproduction of aquatic life as required by New Mexico's narrative turbidity water quality standard, while thresholds for durations longer than 720 consecutive hours result in turbidity values that are lower than supported by literature available

at the time of the assessment protocol development. The CALM provides a series of turbidity thresholds and durations which are listed in **Table 8.1**.

Equation 8.1

$$x = 37{,}382y^{-1.9887}$$

Where:
x = duration (hours)
y = turbidity (NTU)

Applicable for durations between 7 and 720 hours.

Table 8.1 Turbidity impairment thresholds and durations

Turbidity Threshold (NTU)	Allowable Duration (consecutive hours)	Allowable Duration (consecutive days)
23	72	3
20	96	4
18	120	5
16	144	6
15	168	7
11	336	14
7	720	30

NTU = Nephelometric Turbidity Units

The loading capacity, or TMDL, is the maximum amount of pollutant that a waterbody can receive, at a specific flow, while meeting its water quality objectives. The **Gallinas River (Aguilar Creek to USGS Gage 08382000)** [AU ID NM-2213_211], **Pecos River (Villanueva State Park to Cow Creek)** [AU ID NM-2213_01], and **Pecos River (Tecolote Creek to Villanueva State Park)** [AU ID NM-2213_00] were found to exceed the turbidity thresholds. The contiguous Pecos River AUs will be assigned one TMDL and will be referred to as **Pecos River (Tecolote Creek to Cow Creek)** for the remainder of this chapter. Several lines of evidence support assigning a single turbidity TMDL across these two contiguous AUs. Hydrologically, NM-2213_00 (19.46 mi) and NM-2213_01 (20.01 mi) form a single, uninterrupted riverine reach of the Pecos River totaling 39.47 miles, with no major tributaries or impoundments between them that would substantially alter sediment transport, loading characteristics, or assimilative capacity; the boundary at Villanueva State Park is an administrative rather than a hydrologic break. Both AUs lie within the same water quality standards segment (20.6.4.216 NMAC) and carry the same designated uses, including the marginal coldwater aquatic life use on which the turbidity thresholds in Table 8.1 are based, so the same numeric thresholds apply throughout the reach. Probable sources of turbidity are consistent along the corridor and include crop production, dams and impoundments, grazing in the riparian zone, highway, road, and bridge runoff, loss of riparian habitat, on-site treatment systems, rural residential area, and water diversion. No NPDES point sources discharge to either AU, so there are no permit-driven differences in loading and no wasteload allocation differences between the segments. All the turbidity-impaired AUs are designated for marginal coldwater aquatic life use. The most representative fish to use in determining the appropriate turbidity thresholds for coldwater aquatic life stream segments are salmonids, as that

group constitutes the majority of New Mexico's coldwater fish species, and a majority of studies on turbidity in fish have been conducted with them. The numeric thresholds in the CALM have also been supported with studies of turbidity effects on benthic macroinvertebrates.

The analytical basis for the TMDL is likewise shared between the two reaches. The site-specific TSS-turbidity regression used to convert the turbidity thresholds to mass-based loads (Appendix A) was developed by pooling all 16 paired grab samples with detected TSS results from monitoring stations located in both AUs: eight samples from Pecos abv Villanueva State Park (50PecosR697.0) in NM-2213_01 and eight samples from Pecos River above confluence with Tecolote Creek (50PecosR666.7) in NM-2213_00. A single regression relationship therefore underlies the calculated TSS thresholds in Table 8.3, and separate TMDLs would require applying that same pooled relationship twice rather than deriving an independent relationship for each reach. The critical flow is also common to both AUs: as described in Section 8.2, the 4Q3 of 7.97 cfs (5.15 mgd) carried forward from the 2013 Pecos River (Santa Rosa Reservoir to Tecolote Creek) TMDL is applied across the combined reach, consistent with the approach taken for the E. coli TMDL in Section 3.1. Assigning a single TMDL ensures a consistent target load, margin of safety, and implementation framework across a continuous impaired reach, and avoids assigning two different turbidity loads to waters that share the same criteria, probable sources, critical flow, and analytical basis.

Turbidity was measured using multiparameter sondes. During the sonde deployments, turbidity exceeded one or more thresholds on **Table 8.1**. Because a TMDL requires a mass-based numeric loading component which cannot be directly derived from turbidity, Total Suspended Solids (TSS) is used as a turbidity surrogate. TSS is a commonly used measurement of suspended material in surface water because it is acceptable for regulatory purposes and is an inexpensive laboratory procedure. Where there are no facilities with NPDES permits discharging into the impaired AU, it is assumed that TSS measurements in these ambient stream samples are representative of erosional activities, re-suspension of bedded sediments, or biosolids from livestock and wildlife.

A close relationship can typically be found between turbidity and TSS in a watershed or waterbody. Hence, suspended sediment levels may be inferred from turbidity studies; alternatively, turbidity levels may be inferred from studies that monitor suspended sediment concentrations. Extrapolation from these studies is possible when a site-specific relationship between concentrations of suspended sediments and turbidity is confirmed. Activities that generate varying amounts of suspended sediment will proportionally change or affect turbidity (USEPA, 1991). TSS grab samples and simultaneous turbidity results from the 2019-20 water quality survey are shown in **Appendix A**. The R^2 (coefficient of determination) value is a measure of how well a dataset fits the applied model; R^2 values approaching one represent better fits than R^2 values closer to zero. Based on the R^2 value, equations offering the best fit for the data were selected. The regression equations and statistics for the TMDL AUs are displayed in **Appendix A.**

8.2 Flow

The TMDL is a value calculated at a defined critical flow condition as part of a planning process designed to achieve water quality standards. For these turbidity TMDLs, the appropriate critical flow condition is at low flow to be protective when the assimilative capacity of a stream is at its lowest. According to the New Mexico Water Quality Standards, the low flow critical condition for numeric criteria (excluding human health-organism only criteria), set out in 20.6.4.97 through 20.6.4.900 NMAC and 20.6.4.13(F) NMAC, is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC). The 4Q3 is the annual lowest four consecutive day flow that occurs with a frequency of at least once every three years.

The critical flow value used to calculate the turbidity TMDL for AUs without available gage data was obtained using the regional regression equations developed by Bell and Tillery (2023). These equations estimate the 4Q3 low-flow frequency from basin characteristics and are implemented in the USGS StreamStats application. Bell and Tillery (2023) developed a series of 4Q3 equations stratified by mean basin elevation and drainage area; the applicable equation for each gaged-data-limited AU is selected from those characteristics.

The **Gallinas River (Aguilar Creek to USGS Gage 08382000)** watershed has a drainage area of 478 mi^2, which falls within the 200–1,000 mi^2 range for the equation below. The Bell and Tillery (2023) 4Q3 regression equation for this drainage-area class is:

Equation 8.2: $4Q3 = DA^{1.24} \times P^{7.27} \times e^{-29.02}$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = drainage area (mi^2)
P = mean annual basin precipitation (inches)

The 4Q3 for the combined **Pecos River (Tecolote Creek to Cow Creek)** reach was not estimated from the Bell and Tillery (2023) equations. Instead, the 4Q3 of 7.97 cfs (5.15 mgd) was carried forward from the 2013 **Pecos River (Santa Rosa Reservoir to Tecolote Creek)** TMDL (calculated using DFLOW) and applied to the combined reach, consistent with the Upper Pecos *E. coli* TMDL. As with the *E. coli* TMDL (Section 3.1), the 2013 critical flow of 7.97 cfs (5.15 mgd) is higher than the Bell and Tillery (2023) regression estimates for the reaches that make up the combined Pecos River (Tecolote Creek to Cow Creek) reach (3.35 cfs for Pecos River [Tecolote Creek to Villanueva State Park] and 5.38 cfs for Pecos River [Villanueva State Park to Cow Creek]), and it is higher than the 4Q3 calculated for Pecos River (Santa Rosa Reservoir to Tecolote Creek) from the current gage record (5.15 cfs, or 3.33 mgd; Table 4.3). The turbidity TMDLs presented in Section 8.3 are therefore less stringent than TMDLs calculated at Bell and Tillery critical flows would be. SWQB has used the 2013 critical flow to apply a single, internally consistent critical flow across the *E. coli* and turbidity TMDLs for this continuous reach of the Pecos River. This does not change the applicable target: the turbidity/duration thresholds in Table 8.3 are concentration- and duration-based and must be met under all flow conditions, and as noted in Section 8.3.3, the WLA and LA are estimates at a single critical flow condition that will change under differing hydrologic conditions. SWQB may re-evaluate the critical flow and the resulting loads for these AUs after the next Upper Pecos water quality survey and Integrated Report cycle.

The 4Q3 values are presented in **Table 8.2**. Variables for input to the Bell and Tillery (2023) equation were obtained using the USGS StreamStats web tool (https://streamstats.usgs.gov/ss/). The critical flow was converted from cubic feet per second (cfs) to million gallons per day (mgd) using a conversion factor of 0.646. The TMDL itself is a value calculated at a defined critical condition 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. Management of the load to improve stream water quality and achieve WQS is the goal of SWQB efforts.

Table 8.2 Calculation of 4Q3 critical flow for turbidity TMDLs

Assessment Unit	Average Elevation (ft)	Drainage Area (mi^2)	Average Basin Slope (ft/ft)	Mean Annual Precipitation (in)	4Q3
Pecos River (Tecolote Creek to Cow Creek)	—	—	—	—	7.97 cfs 5.15 mgd
Gallinas River (Aguilar Creek to USGS Gage 08382000)	6868	478	NA	17.8	0.65 cfs 0.417 mgd

8.3 TMDL Calculations

Because impairment of a waterbody depends on the duration of elevated turbidity, a separate TMDL has been determined for each NTU/duration threshold identified in the turbidity assessment protocol. These TMDLs were developed using the turbidity/duration thresholds identified in the SWQB turbidity assessment protocol (NMED/SWQB, 2025), the site-specific relationship between turbidity and TSS, the 4Q3 flow condition, and a unit conversion factor to correct the TMDL units into pounds per day (lb/day).

First, using the regression equations shown in **Appendix A**, TSS concentrations for each turbidity threshold were calculated (**Table 8.3**). Then, the 4Q3 critical low flow from **Table 8.2**, above, and the TSS threshold values, were substituted into **Equation 8.3** to determine the TMDL at each turbidity/duration threshold (**Table 8.3**). Note that each TMDL is for a particular turbidity/duration pairing. It should not be extrapolated to longer or shorter durations. For the combined Pecos River reach, the high coefficient of determination for the TSS–turbidity regression is influenced substantially by a single high-turbidity observation; within the range of turbidity thresholds evaluated here, the relationship is less tightly constrained, so the calculated TSS thresholds in this range should be regarded as approximate.

Equation 8.3: *WQS (mg/L) x Critical flow (mgd) x Conversion Factor (8.34) = TMDL (lb/day)*

Table 8.3 Calculated TSS thresholds and Turbidity-TSS/Duration TMDLs for Upper Pecos River basin

Assessment Unit	Turbidity (NTU)	TSS (mg/L)	TSS TMDL (lb/day)	Duration (consecutive days)
Gallinas River (Aguilar Creek to USGS Gage 08382000)	23	16.56	57.6	3
	20	14.69	51.1	4
	18	13.43	46.7	5
	16	12.18	42.4	6
	15	11.56	40.2	7
	11	9.05	31.5	14
	7	6.55	22.8	30

Assessment Unit	Turbidity (NTU)	TSS (mg/L)	TSS TMDL (lb/day)	Duration (consecutive days)
Pecos River (Tecolote Creek to Cow Creek)	23	24.19	1039	3
	20	21.95	943	4
	18	20.46	879	5
	16	18.97	815	6
	15	18.23	783	7
	11	15.24	655	14
	7	12.26	527	30

The TMDL is further allocated to a MOS, WLA (permitted point sources), and LA (non-point sources), according to the formula: *WLA + LA + MOS = TMDL*.

8.3.1 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source loading estimates, and the model analysis. The MOS can be expressed implicitly, explicitly, or a combination of the two. 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.

The MOS for these TMDLs was developed using a combination of conservative assumptions and allocating an explicit portion of the TMDL in recognition of potential errors. Therefore, this MOS is the sum of the following two elements:

Implicit Margin of Safety

- TSS is treated as a conservative parameter (no settling or loss from the water column is assumed).

Explicit Margin of Safety

- Uncertainty exists in the relationship between TSS and turbidity. A conservative MOS for this element is **5%**.

- There is inherent error in all flow calculations. A conservative MOS for this element for AUs which used the regression equation to determine critical flow is therefore **10%**.

Total explicit MOS for these TMDLs is **15%.**

8.3.2 Waste Load Allocation

There are no active individual NPDES point sources discharging to **Pecos River (Tecolote Creek to Cow Creek)**, or the **Gallinas River (Aguilar Creek to USGS Gage 08382000)**, therefore the WLA for these streams is zero.

Sediment and associated contaminants are considered components of industrial storm water discharges covered under NPDES General Permits. Stormwater discharges from construction activities are transient, occurring mainly during the construction itself, and then only during storm events. Coverage under the NPDES Construction General Permit (CGP) for construction sites greater than one acre, or less than one acre but are part of a common plan of development which will exceed 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 2022 CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, and managerial and structural solids, erosion, and sediment control Best Management Practices (BMPs), and/or other controls. The SWPPP must include site-specific interim and permanent stabilization, managerial, and structural solids, erosion and sediment control BMPs and/or other controls that are designed to prevent to the maximum extent practicable an increase in the sediment yield and flow velocity from pre-construction, pre-development conditions to assure that applicable standards in 20.6.4 NMAC, including the antidegradation policy, and TMDL WLAs are met. This requirement applies to discharges both during construction and after construction operations have been completed. Currently in the 2022 CGP, EPA defines "sediment-related parameter" as a pollutant parameter that is closely related to sediment such as turbidity, total suspended solids (TSS), total suspended sediment, transparency, sedimentation, and siltation. For discharge covered under the CGP to a water that is impaired for a parameter other than a sediment-related parameter or nutrients, EPA will inform the operator if any additional controls are necessary to meet water quality standards.

Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES Multi-Sector General Permit (MSGP). The MSGP also requires preparation of a SWPPP. Based on the industrial sector, some of the industrial facilities and activities covered under the MSGP have technology based effluent limitations and/or benchmark monitoring for pollutants. Part 9.6.2 of the current MSGP includes New Mexico state-specific requirements that the benchmark values reflect State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. The discharges from these permits are typically transitory as the activities are temporary. Loads that are in compliance with the General Permits are therefore currently included as part of the Load Allocation (LA). While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

8.3.3 Load Allocation

The Load Allocation (LA) accounts for pollution from any non-point source(s) or natural background and is addressed through Best Management Practices. Where there are no WLAs, the LA is equal to the TMDL value minus the MOS, as shown on **Table 8.4**. The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors (see **Section 8.3.1** for details). Where there are WLAs, the LA is equal to the TMDL minus the MOS and the WLA.

Table 8.4 TMDL TSS Allocations for Turbidity (all units in lb/day)

Assessment Unit	Load Allocation

	Duration (consecutive days)	WLA	MOS (15%)	LA	TMDL
Gallinas River (Aguilar Creek to USGS Gage 08382000)	3	0	8.64	49.0	57.6
	4	0	7.66	43.4	51.1
	5	0	7.01	39.7	46.7
	6	0	6.36	36.0	42.4
	7	0	6.03	34.2	40.2
	14	0	4.72	26.8	31.5
	30	0	3.42	19.4	22.8
Assessment Unit	**Load Allocation**				
	Duration (consecutive days)	**WLA**	**MOS (15%)**	**LA**	**TMDL**
Pecos River (Tecolote Creek to Cow Creek)	3	0	156	883	1039
	4	0	141	801	943
	5	0	132	747	879
	6	0	122	693	815
	7	0	117	665	783
	14	0	98	557	655
	30	0	79	448	527

8.4 Identification and Description of Pollutant Sources

SWQB conducted an assessment of the probable sources of impairment in the AU drainage area, according to Standard Operating Procedure 4.1, Revision 2, Probable Source(s) Determination (https://www.env.nm.gov/surface-water-quality/sop/; see also **Appendix B**). Probable Source Sheets are filled out by SWQB monitoring staff during watershed surveys. The sheets are then reviewed by watershed protection staff familiar with the location, and the TMDL writer conducts a search of aerial imagery, GIS files, and other available resources. The list of probable sources is not intended to single out any particular landowner or land management activity and generally includes several sources per pollutant.

Table 8.5 displays probable pollutant sources that have the potential to contribute to turbidity impairment in the TMDL AUs. 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 of impairment will be further evaluated, validated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

Table 8.5 Probable sources of excessive turbidity for Upper Pecos basin TMDL Assessment Units.

Assessment Unit	Probable Sources
Gallinas River (Aguilar Creek to USGS Gage 08382000)	Dam or Impoundment; Forest Fire (Hermit's Peak–Calf Canyon, 2022); Grazing in Riparian Zone; Highway/Road/Bridge Runoff; Inappropriate Waste Disposal (junkyards); Loss of Riparian Habitat; Low Water

	Crossing; Rangeland Grazing; Streambank Modifications/Destabilization
Pecos River (Tecolote Creek to Cow Creek)	Crop Production; Dam or Impoundment; Forest Fire (Tecolote, 2010; Hermit's Peak–Calf Canyon, 2022); Highway/Road/Bridge Runoff; Other Recreation (campground); Rural Residential Area; Water Diversion

Non-point sources of turbidity are usually attributed to soil erosion, excess nutrients, various wastes and pollutants, and the re-suspension of sediments up into the water column during high flow events. As reflected in SWQB data, turbidity values along the impaired reaches exceeded the applicable standard for the protection of designated uses. The components of a watershed continually change through natural ecological processes such as vegetation succession, erosion, and evolution of stream channels. Human activity often affects watershed function in ways that are inconsistent with the natural balance. These changes, often rapid and sometimes irreversible, occur when people cut forests, clear and cultivate land, remove riparian vegetation, alter the drainage of the land, channelize watercourses, withdraw water for irrigation, build towns and cities, and discharge pollutants into waterways. Disturbances may be historical or current in nature.

Wildfire can affect the physical, chemical, and biological quality of streams, rivers, and lakes. After a fire, increased runoff provides the pathway for the transport of chemical-laden sediment to surface water, which may have substantial water quality impacts. Forest fires can result in increased water temperature due to reduced infiltration and loss of shading vegetation. Potential wildfire impacts to water quality are discussed on the SWQB website at https://www.env.nm.gov/surface-water-quality/wildfire-impacts-on-surface-water-quality/. Most watershed effects will naturally recover within 5 to 10 years after the fire, but some aspects of watershed structure and function, as well as areas of most severe fire intensity, may continue to recover for 15-20 years (Bixby et al., 2015). Therefore, runoff following forest fire has been added to the Probable Source list (**Table 8.5**) for those TMDL AUs where fires occurred in the drainage area during the 20 years preceding the 2019-2020 water quality survey.

8.5 Consideration of Seasonal Variation

Federal regulations (40 C.F.R. § 130.7(c)(1)) require that TMDLs take into consideration seasonal variation in watershed conditions and pollutant loading. Higher turbidity values are typically associated with higher flows. However, as precipitation events are infrequent and transitory in nature, the 4Q3 is considered a more conservative estimate of the long-term stream condition. Since the critical flow condition is set to estimate low flow discharge, it is assumed that if critical conditions are met, coverage of any potential seasonal variation will also be met**.**

Based on monitoring data presented in **Appendix A**, turbidity did not exhibit any evident relationship with flow or seasonality in the **Gallinas River (Aguilar Creek to USGS Gage 08382000)**. The same was true at the two Pecos River stations in the TMDL AU. Most same-day sampling at the two stations during the summer months (June – September) showed lower flow as well as higher turbidity at the downstream station, possibly indicating that flow reduction is impacting the capacity of the river to assimilate suspended solids.

8.6 Future Growth

Growth estimates by county are available from the University of New Mexico Geospatial and Population Studies (GPS) (https://gps.unm.edu/pop/population-projections.html). The estimates project growth to the year 2050. The Pecos Headwaters HUC extends over portions of six counties, Guadalupe, San Miguel, Santa Fe, Mora, Quay, and De Baca, however most of the HUC is within San Miguel and Guadalupe counties. GPS projects Guadalupe and San Miguel county populations to decline through 2050, as detailed in **Table 8.6**.

These projections account for the 2020 census results, also accessed through GPS (https://gps.unm.edu/pop/population-estimates.html). TMDL implementation planners should seek out the most current projections if the information is relevant to their project.

Table 8.6 Guadalupe and San Miguel county population estimates

County	2020 (Census)[B]	2025	2030	2035	2040	2045	2050[A]	% Change
Guadalupe	4,452	4,326	4,179	3,996	3,762	3,492	3,177	-28.64
San Miguel	27,201	26,064	24,902	23,435	21,577	19,470	17,036	-37.37

% Change: [(A – B) / B] × 100

Estimates of future growth are not anticipated to lead to a significant increase in turbidity that cannot be controlled with BMP implementation. BMPs should be utilized and improved upon while continuing to improve watershed conditions and adhering to SWPPP requirements related to construction and industrial activities covered under the general permit.

9.0 MONITORING PLAN

Pursuant to CWA Section 106(e)(1), 33 U.S.C. Section 1256, the SWQB has established appropriate monitoring methods, systems and procedures to compile and analyze data on the quality of the surface waters of New Mexico. In accordance with the New Mexico Water Quality Act, NMSA 1978, Sections 74-6-1 to -17, 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's 10-year monitoring and assessment strategy (NMED/SWQB, 2016a) details both the extent of monitoring that can be accomplished with existing resources plus expanded monitoring strategies that could be implemented given additional resources. The SWQB utilizes a rotating basin approach to water quality monitoring. In this approach, ambient sampling is conducted during the non-winter months, generally from March through November, over a one- to two-year period, such that approximately one-fifth of the state's primarily perennial waters are monitored every one to two years. Each watershed has an established return frequency of approximately every eight to ten years. The next scheduled monitoring date for the Upper Pecos watershed is 2028.

The SWQB maintains current quality assurance and quality control plans to cover all monitoring activities. This document, called the Quality Assurance Project Plan, is updated regularly and approved by USEPA Region 6. 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 or TMDL alternatives; water bodies identified as needing ALU verification; the need to monitor unassessed perennial waters; and water bodies receiving point source discharge(s).

Once assessment monitoring is completed, those reaches showing impairment 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 Standard Operating Procedures.

Long-term monitoring for assessments will be accomplished through the establishment of sampling sites that are representative of the assessment unit, selected based on the data needs for each assessment unit and site accessibility, and which can be revisited approximately every eight years. Each assessment unit is typically represented by one monitoring station that receives four to eight site visits during the survey. 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.

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 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.

10.0 IMPLEMENTATION OF TMDLs

When approving TMDL documents, USEPA takes action on the TMDL, LA, WLA, and other components of the TMDL as needed (e.g., MOS and future growth). USEPA does not take action on the implementation section of the TMDL, and USEPA is not bound to implement any recommendations found in this section, in particular if they are found to be inconsistent with the CWA and NPDES regulations, guidance, or policy.

10.1 Point Sources

There are six individual NPDES permits that discharge to the assessment units addressed in this document (Table 1.2). The City of Las Vegas WTP (NM0030341) is not assigned a nutrient waste load allocation, for the reasons given in Section 4.3.2. The five permits assigned waste load allocations (or *reserve WLAs) are shown on **Table 10.1**. Calculation of Waste Load Allocations for the point sources are shown in Sections 4.3.2 and 7.3.2 of this document. Implementation of permit limits is discussed below.

Table 10.1 Individual NPDES permits

NPDES permit	Assessment Unit	Impairment
NM0028827 Las Vegas WWTP Expires 11/30/2027	Gallinas River (USGS Gage 08382000 to Pecos Arroyo)	Plant nutrients
NM0028088 Glorieta Adventure Camps WWTP Expires 9/30/2028	Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)	Plant nutrients
NM0029041 Village of Pecos WWTP Expires 5/31/2028	Pecos River (Canon de Manzanita to Alamitos Canyon)	Plant nutrients
NM0030155 NMDGF/Rock Lake Fish Hatchery Expires 11/30/2029	Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	Plant nutrients
NM0030121 NMDGF Lisboa Springs Fish Hatchery Expires 7/31/2029*	Pecos River (Alamitos Canyon to Jack's Creek)	Temperature

10.1.1 Individual NPDES Permit Implementation

The waste load allocations developed in this document are implemented through the individual NPDES permits listed in **Table 10.1**. Plant nutrient WLAs are implemented through a phased approach consistent with the derivation described in Section 4.3.2, and the temperature WLA applies to the Lisboa Springs Fish Hatchery as described in Section 7.3.2. Discharge Monitoring Report (DMR) data referenced below were obtained from the USEPA Enforcement and Compliance History Online (ECHO) database (https://echo.epa.gov/) on May 18, 2026.

10.1.1.A City of Las Vegas WWTP (NM0028827)

The City of Las Vegas WWTP (NM0028827; effective December 1, 2022, expires November 30, 2027) discharges from a single outfall to the Gallinas River (USGS Gage 08382000 to Pecos Arroyo; AU NM-2213_21) and is assigned a plant nutrient WLA. The current permit includes water quality-based final effluent limits for total nitrogen of 13.0 mg/L (145 lb/day) and total phosphorus of 2.14 mg/L (23.9 lb/day)

as 30-day averages. These limits are subject to a five-year compliance schedule, under which the permittee is currently required to report only and must attain the final limits no later than 60 months from the permit's effective date. Because the facility is already operating under a nutrient compliance schedule, the WLA established in this document will be incorporated at the next permit cycle. SWQB consulted the NMED Point Source Regulation Section during development of these allocations, and that section concurs that the nutrient WLAs should be implemented through the phased approach described in Section 4.3.2.

10.1.1.B Glorieta Adventure Camps WWTP (NM0028088)

The Glorieta Adventure Camps WWTP (NM0028088; expires September 30, 2028) discharges from a single outfall to Glorieta Creek (Perennial prt Pecos R to Glorieta Camps WWTP; AU NM-2214.A_081) and is assigned a plant nutrient WLA. The privately owned facility serves the conference center and Glorieta Village and has a design flow of 0.40 mgd. The current (2023) permit requires total nitrogen and total phosphorus monitoring but does not include numeric nutrient effluent limits, in part because of limited effluent data available at the time of issuance. The Phase 1 WLA (Section 4.3.2) was derived from the 85th percentile of reported effluent concentrations and is recommended for incorporation as effluent limits at the next permit cycle. Attainment of the in-stream nutrient targets on Glorieta Creek may warrant a Use Attainability Analysis, given the very low critical flow of the receiving water relative to the permitted design flow.

10.1.1.C Village of Pecos WWTP (NM0029041)

The Village of Pecos WWTP (NM0029041; effective June 1, 2023, expires May 31, 2028) discharges from a single outfall to the Pecos River (Canon de Manzanita to Alamitos Canyon; AU NM-2214.A_003) and is assigned a plant nutrient WLA. The current permit already contains Phase 1 nutrient effluent limits of 31.8 mg/L (19.6 lb/day) total nitrogen and 3.83 mg/L (2.36 lb/day) total phosphorus as 30-day averages, which take effect one day before the permit expiration date. Because the Phase 1 nutrient WLA is already incorporated as effluent limits, no additional permit action is recommended in the current cycle; subsequent phases will be evaluated at renewal.

10.1.1.D NMDGF Rock Lake State Fish Hatchery (NM0030155)

The New Mexico Department of Game and Fish (NMDGF) Rock Lake State Fish Hatchery (NM0030155; expires November 30, 2029) discharges from Outfall 001 to the Pecos River (Sumner Reservoir to Santa Rosa Reservoir; AU NM-2211.A_00) and is assigned a plant nutrient WLA. *E. coli* is not expected in hatchery effluent, and no *E. coli* WLA is assigned to this facility. The current permit requires total nitrogen and total phosphorus monitoring but does not include numeric nutrient effluent limits. Review of reported DMR data indicates that the facility only infrequently exceeds the proposed nutrient WLAs; the Phase 1 nutrient WLA (Section 4.3.2) is therefore recommended for incorporation as effluent limits at the next permit renewal.

10.1.1.E NMDGF Lisboa Springs Fish Hatchery (NM0030121)

The NMDGF Lisboa Springs Fish Hatchery (NM0030121; effective August 1, 2024, expires July 31, 2029) discharges from Outfall 001 to the Pecos River (Alamitos Canyon to Jack's Creek; AU NM-2214.A_002) and is the only facility assigned a temperature WLA in this document. The receiving reach is designated High Quality Coldwater Aquatic Life Use, with an applicable TMAX criterion of 23 °C. The temperature WLA of 2.21×10^8 kJ/day (Section 7.3.2, **Table 7.5**) was calculated from the applicable criterion and the highest monthly average effluent flow of 0.607 mgd (0.94 cfs) reported for the facility. Because this value was calculated directly from the applicable water quality criterion rather than from a documented

temperature exceedance attributable to the facility, it is assigned as a reserve WLA rather than incorporated as an immediate permit limit; see discussion below.

A reserve WLA is calculated the same as a typical WLA but is held in reserve in the event that a facility's discharge is shown to cause or contribute to the impairment of a receiving water. For the Lisboa Springs Fish Hatchery, the reserve WLA of 2.21×10^8 kJ/day reflects discharge at the water quality criterion rather than a documented temperature exceedance attributable to the facility, as noted above. It is recommended that future permit renewals include continued temperature monitoring and reporting to evaluate the discharge's effect on the receiving water. If monitoring data continue to show that the discharge does not cause or contribute to the temperature impairment, the WLA remains in reserve and no additional temperature effluent limits beyond current permit conditions would be required. If monitoring demonstrates that the discharge does cause or contribute to an exceedance of the applicable temperature criterion, the reserve WLA is recommended for incorporation into the permit as the facility's effluent limitation.

10.2 Nonpoint Sources

10.2.1 WBP and BMP Coordination

A Watershed Based Plan (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. Public awareness and involvement is crucial for the successful implementation of these plans and for achieving improved water quality. A long-range strategy is 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. A general list of BMPs to be considered as part of on-the-ground projects to address aluminum, *E. coli*, plant nutrients, sedimentation, specific conductance, temperature, and turbidity include, but are not limited to, riparian buffers, floodplain restoration, river restoration, wetland restoration, erosion control measures and soil health, a healthy wildfire regime that reduces the occurrence of catastrophic wildfires, grazing and recreation management, improved stormwater management from urban areas and roads, water conservation measures, on-site treatment system management, and agricultural BMPs. Additional information about the reduction of nonpoint source pollution can be found online at: https://www.epa.gov/polluted-runoff-nonpoint-source-pollution.

The Upper Pecos Watershed Association is an active watershed group and has already completed an EPA accepted WBP that focuses on temperature impairments for the Pecos River and its tributaries north of Interstate 25 (Upper Pecos Watershed Association, 2012 rev. 2019). The Hermit's Peak Watershed Alliance is an active watershed group in the Gallinas, Tecolote, Sapello and lower Mora Watersheds, and has already completed an EPA accepted WBP for the Gallinas River, the Sapello River, and the Rio Mora (Hermit's Peak Watershed Alliance, 2012). SWQB staff will continue to conduct outreach related to the CWA Section 319(h) funding program.

10.2.2 Clean Water Act Section 319(h) Funding

The SWQB-Watershed Protection Section awards CWA Section 319(h) funding from the EPA to assist in the implementation of BMPs to improve water quality on reaches with impaired water quality and a TMDL. An EPA accepted WBP or Alternative WBP is required for on-the-ground BMP projects to be eligible to receive CWA Section 319(h) funding. Under the USEPA's 2024 updated Section 319 guidelines, the

USEPA will allow implementing community demonstration projects concurrent with watershed-based planning activities in identified disadvantaged communities (DAC). The entire mainstem of the Upper Pecos River has been identified as a DAC by the USEPA and the Council on Environmental Quality. Funding is available to private, for-profit, and nonprofit entities, and local, state, federal, and tribal governmental entities. Proposals are submitted through a Request for Application (RFA) process. Selected projects require a non-federal match of 10% of the total project cost consisting of non-federal funds and/or in-kind services. Funding is generally available on an annual basis for both watershed-based planning and on-the-ground projects to improve surface water quality. Further information on funding from the CWA Section 319(h) can be found at the SWQB website: https://www.env.nm.gov/surface-water-quality/.

10.3 Temperature Modeling

Freshwater systems have interrelated biotic and abiotic parameters that drive the temperature of the waterbody. For a stream, these parameters can be generalized into simple categories that include: vegetation and land cover, channel morphology, and hydrology. Parameters such as channel width, meteorological measurements and microclimates, and solar irradiance, can exhibit considerable spatial variability. Together these parameters affect heat transfer and mass transfer processes to varying degrees. Due to the complexity of these systems, temperature modeling techniques are useful to facilitate the computation and prediction of the extent to which different parameters can affect a freshwater system. Temperature models can also identify the sensitivity of water temperature to individual parameters, to inform understanding of actions most likely to succeed in TMDL implementation. BMPs to be considered as part of on-the ground-projects to address temperature include establishment of additional woody riparian vegetation for shade and/or stream channel restoration work, particularly at road crossings.

The SSTEMP Model, Version 2.0.8, developed by the USGS Biological Resource Division (Bartholow, 2002) was used to predict stream temperatures of the impaired AUs 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 during a single day (Bartholow, 2002). Each AU was modeled on the date of the maximum recorded water temperature on the thermograph record which was used to assess impairment. The model is calibrated by comparing predicted temperature values with actual thermograph readings measured in the field. SSTEMP is useful to inform TMDL implementation practices for temperature impaired AUs. The model results presented in this section inform implementation planning and do not enter the temperature TMDL calculation in Section 7.3. As noted in Appendix D, the model hydrology inputs predate the Bell and Tillery (2023) update and will be re-derived when new data becomes available. The model analysis focuses mainly on changes in the riparian shade percentage and/or modification to channel dimensions. Total percent shade was chosen as a first-step analysis for TMDL implementation since it is easily translated into quantifiable management objectives.

SWQB collects physical habitat data using Standard Operating Procedure 5.0 (https://www.env.nm.gov/surface-water-quality/sop/). Sufficient physical habitat data was available to conduct SSTEMP modeling for the AUs **Gallinas River (Aguilar Creek to USGS Gage 08382000)** and **Pecos River (Alamitos Canyon to Jack's Creek)**. **El Porvenir Creek (SFNF bnd to Hollinger Canyon)** received a temperature TMDL (Section 7.0) but was not modeled with SSTEMP because sufficient physical habitat

data were not available; consequently, no shade or Width's A implementation targets are presented for that AU.

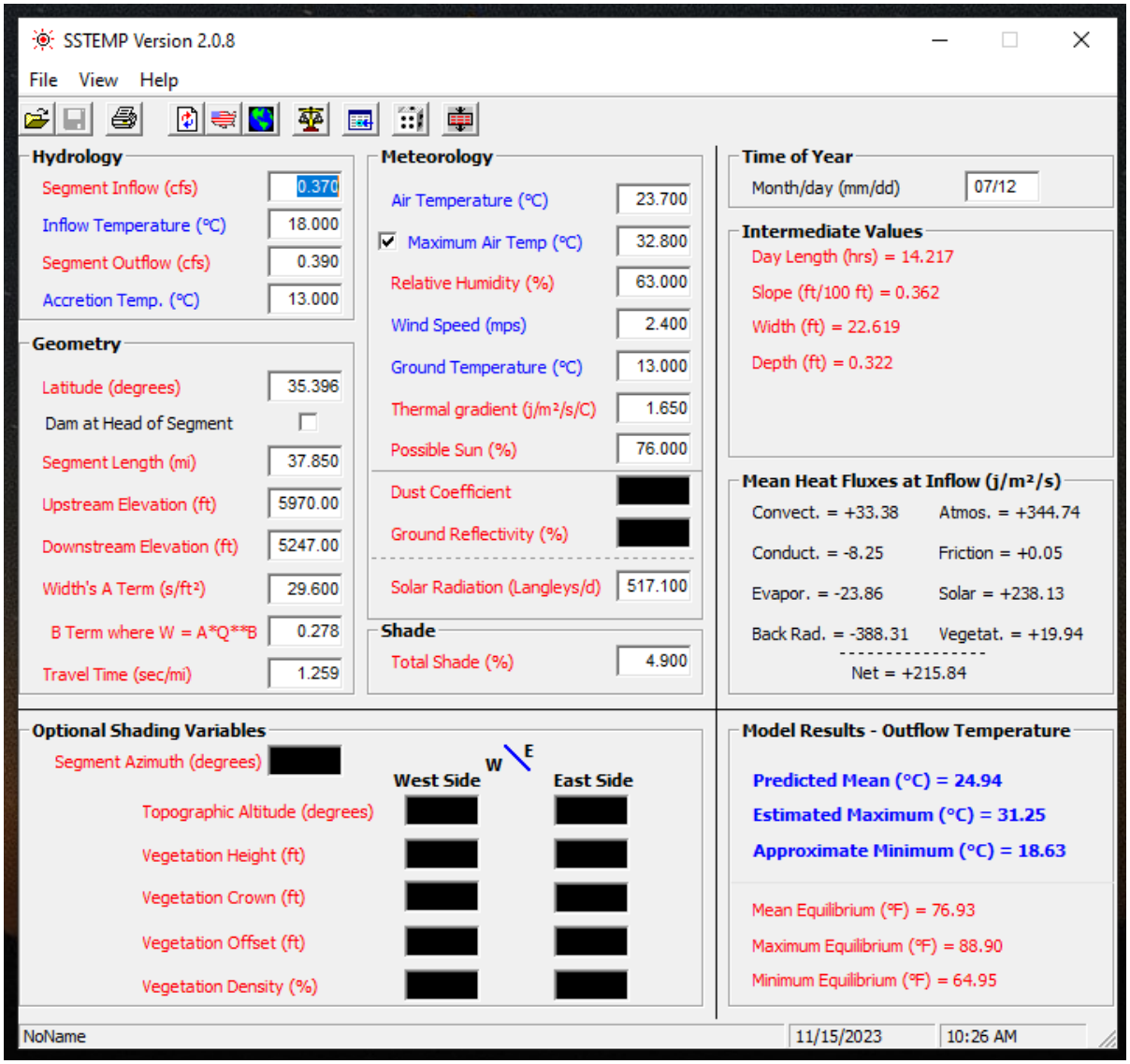


Figure 10.1 Example of SSTEMP output for Gallinas River (Aguilar Creek to USGS Gage 08382000)

A series of assumptions are associated with the SSTEMP model run conditions. Running the model outside of these assumptions may result in inaccuracies or model instability. The assumptions used in the development of SSTEMP that are most relevant to the present TMDLs are listed below. A complete list of assumptions and model deficiencies is presented in the SSTEMP user manual (Bartholow, 2002).

- Water in the system is instantaneously and thoroughly mixed at all times; there is no lateral temperature distribution across channel OR vertical gradients in pools.
- Stream geometry is characterized by mean conditions.
- Solar radiation and other meteorological and hydrological variables are 24-hour means.
- Distribution of lateral inflow is uniformly apportioned throughout the segment length
- Manning's n and travel time do not vary as functions of flow.

- Modeled/representative time periods must be long enough for water to flow the full length of the segment.
- SSTEMP is not able to model cumulative effects; for example, adding or deleting vegetation mathematically is not the same as in real life.

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 ($j/m^2/s$). The program will predict the minimum, mean, and maximum daily water temperature for the set of variables input into the model. The theoretical basis for the model is strongest for the mean daily temperature. The predicted maximum is largely an estimate and likely to vary widely with the maximum daily air temperature. The predicted minimum is computed by subtracting the difference between maximum and mean, from the mean; but the predicted minimum is always above 0 degrees Celsius (Bartholow, 2002).

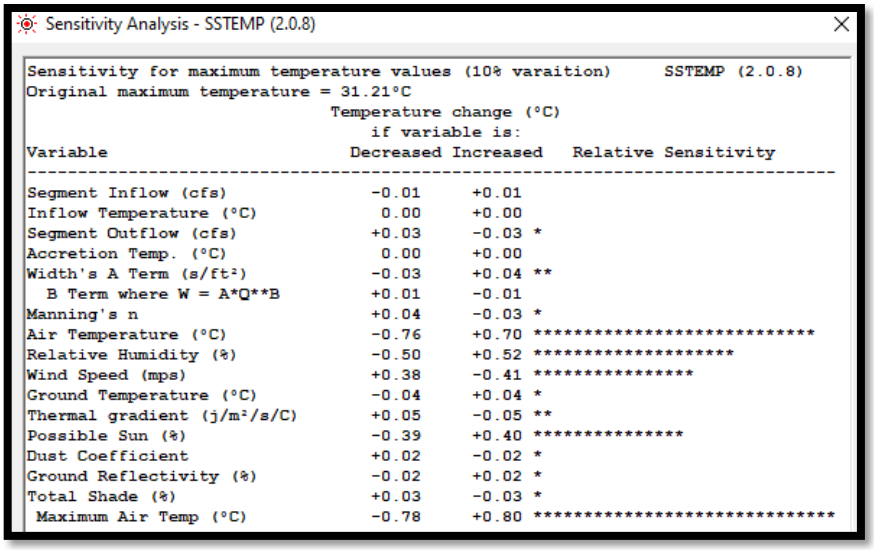
Sources for the SSTEMP input variables are shown in **Appendix D**. The SSTEMP predicted maximum temperature was calibrated against thermograph data. **Table D.1** show input values for the calibrated model. Percent total shade was then increased until the maximum 24-hour temperature decreased below the applicable temperature criterion. Width's A term (a measure of relative width-to-depth ratio) was then decreased, at the calibrated percent shade, until the criterion was reached. **Table 10.2** details model outputs for the TMDL AUs.

Table 10.2 SSTEMP model results for Upper Pecos River watershed temperature impaired AUs

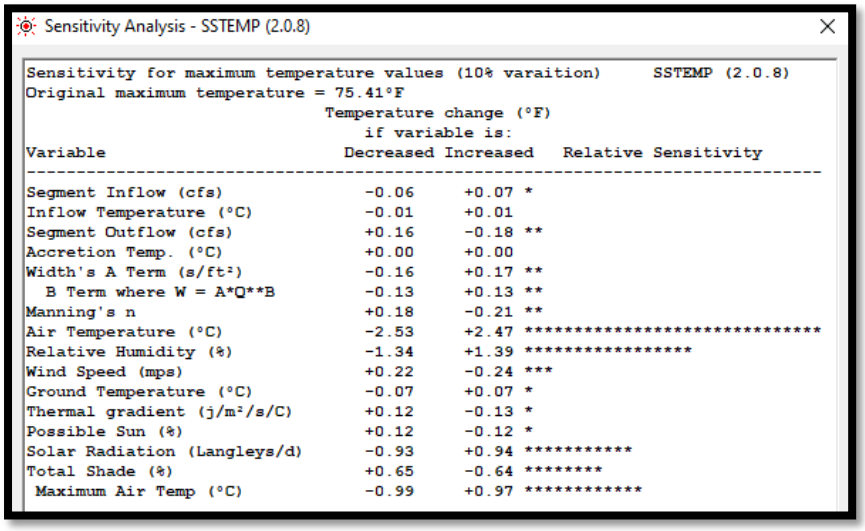
Assessment Unit	Estimated % Shade [a]	WQS % Shade [b]	Shade Increase [c]	Width's A	WQS Width's A [d]
Gallinas River (Aguilar Creek to USGS Gage 08382000)	4.9	20	308%	29.6	8.0
Pecos River (Alamitos Canyon to Jack's Creek)	44.5	59	33%	9.12	3.2

[a] *Estimates of AU vegetative canopy were measured during SWQB physical habitat monitoring events.*
[b] *% shade at which the SSTEMP predicted maximum temperature is held below the applicable WQS, all other variables being kept the same.*
[c] *% by which SSTEMP predicts that shade must be increased to hold maximum water temperature below the applicable WQS, all other variables being held the same.*
[d] *Width's A term at which the SSTEMP predicted maximum temperature is held below the applicable WQS, all other variables being held the same.*

The model indicates that large, and probably unrealistic, decreases in Width's A would be needed to result in support of the designated ALU in either river. While the modeled need for increase in shading of the Gallinas River is large (four times the existing shade), 20% does not seem unattainable.



A



B

Figure 10.2 SSTEMP sensitivity analyses for Gallinas River (Aguilar Creek to USGS Gage 08382000) (A) and Pecos River (Alamitos Canyon to Jack's Creek) (B)

SSTEMP may be used to compute, one at a time, the sensitivity to input values. This analysis varies most active input by 10% in both directions and displays a screen showing the resulting changes to estimated maximum temperature. The "Relative Sensitivity" schematic graph that accompanies the display gives an indication of which variables most strongly influence the results (Bartholow, 2002). Sensitivity analysis outputs are shown in **Figure 10.2**. Meteorological variables will always have the greatest impact on predicted maximum temperature. For the Gallinas River, the sensitivity analysis indicates that maximum water temperature is relatively insensitive to variables other than the meteorological conditions. However, varying the existing shade (4.9%) by 10% would not be sufficient to estimate the effects of a much greater relative increase in shade. For the Pecos River, the sensitivity analysis indicates a moderate sensitivity to shade.

The SSTEMP model does not consider any impacts of climate change. SWQB encourages implementation practitioners to design projects to decrease water temperatures beyond simply meeting the applicable

WQS, such that currently impaired AUs will be likely to meet WQS standards well into the future with some resiliency to climate change. Another example of designing for resiliency would be the creation of habitat refugia wherein water temperatures would be expected to remain cooler than the average for that water body.

10.4 Other Funding Opportunities and Restoration Efforts

Several other sources of funding exist 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 Section 319(h) projects using state revolving loan fund monies. The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Environmental Quality Incentive Program (EQIP) program can provide assistance to private landowners 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 US Bureau of Land Management (BLM) has several programs in place to provide assistance to improve unpaved roads and grazing allotments.

The SWQB annually makes available CWA Section 604(b) funds through a Request for Quotes (RFQ) process. The SWQB requests quotes from regional public comprehensive planning organizations to conduct water quality management planning as defined under Sections 205(j) and 303(e) of the CWA. The SWQB seeks proposals to conduct water quality management planning with a focus on projects that clearly address the State's water quality goals to preserve, protect and improve the water quality in New Mexico. The SWQB encourages proposals focused on TMDLs and UAAs or other water quality management planning activities that will directly address identified water quality impairments. The SWQB 604(b) RFQ is released annually in September.

The NMED River Stewardship Program (RSP) has the overall goal of addressing the root causes of poor water quality and stream habitat in New Mexico. Objectives include: restoring or maintaining hydrology of streams and rivers to better handle overbank flows and thus reduce flooding downstream; enhancing economic benefits of healthy river systems such as improved opportunities to hunt, fish, float or view wildlife; and providing state matching funds required for federal Clean Water Act grants the SWQB receives each year.

The RSP awarded over $10 Million across 28 projects in early 2025 and 2026. A competitive Request for Proposals was issued in the spring 2026, to award approximately $10 Million to new projects. These projects are funded through the Land of Enchantment Legacy fund and appropriations by the New Mexico Legislature. Awards are anticipated to be announced in early 2027. Additional funding sources for watershed protection and improvement projects are listed in Appendix C of the New Mexico Nonpoint Source Management Plan, available at https://www.env.nm.gov/surface-water-quality/nps-plan.

Information on additional watershed restoration funding resources is available on the SWQB website at https://www.env.nm.gov/surface-water-quality/watershed-protection-section/.

11.0 APPLICABLE REGULATIONS AND REASONABLE ASSURANCES

New Mexico's Water Quality Act, NMSA 1978, §§ 74-6-1 to -17 (Act), authorizes the WQCC to "adopt rules to prevent or abate water pollution in the state" and to require permits. The Act authorizes a constituent agency, such as NMED, 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 Act also states in Section 74-6-12(A):

> *The Water Quality Act 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 Standards for Interstate and Intrastate Surface Waters at 20.6.4.6(C) NMAC state:

> *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 CWA Section 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.*

33 U.S.C. § 1251(g)

New Mexico's CWA Section 319 Program has been developed in a coordinated manner with the State's CWA Section 303(d) process. All watersheds that are targeted in the annual § 319 request for proposal 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 the Act, 1978, Section 74-6-10, 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 an NPS. The NMED NPS water quality management program has historically strived for and will continue to promote voluntary compliance with NPS water pollution concerns by utilizing a voluntary, cooperative approach. The State provides technical support and grant money for implementation of BMPs and other NPS prevention mechanisms through Section 319 of the CWA. 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.

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 U.S. Forest Service and the BLM. 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.

12.0 PUBLIC PARTICIPATION

Public participation was solicited in development of this TMDL. Pursuant to 40 C.F.R. § 130.7(a), the public participation was conducted in accordance with Section XIV of the WQMP/CPP (NMED/SWQB, 2020), and as outlined in Section IV.C. of the WQMP/CPP. The draft TMDL was made available for a 30-day comment period beginning August 14, 2026, and ending on September 14, 2026. The draft document notice of availability included information on comment submittal and dates/times of the public meetings. It was advertised via email distribution lists and webpage postings. A virtual public meeting was held on September 3, 2026. A response to public comments is included in this TMDL document as **Appendix E**.

Once the TMDL is approved by the WQCC for submittal to EPA for final approval, the next step for public participation will be development of WBPs and watershed protection projects, including those that may be funded by CWA Section 319(h) grants managed by SWQB.

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APPENDIX A

WATER QUALITY DATA

Total recoverable aluminum data

Pecos River (Tecolote Creek to Villanueva State Park)
Monitoring stations: Pecos-NM19-10136
PECOS RIVER ABOVE CONFLUENCE WITH TECOLOTE CREEK - 50PecosR666.7

Station	Date	Hardness (mg/L)	A. std (mg/L)	C. std (mg/L)	TR Al (mg/L)	Flow (cfs)	pH
Pecos-NM19-10136	11/5/19	163	6.68	2.68	0.1	34.88	8.42
50PecosR666.7	3/20/19	114	4.09	1.64	0.24	199	8.38
50PecosR666.7	5/29/19	75	2.31	0.924	0.44	771	8.03
50PecosR666.7	8/8/19	101	3.47	1.39	**3.9**	131	8.24
50PecosR666.7	5/27/20	99	3.37	1.35	0.28	115	8.08
50PecosR666.7	6/24/20	87	2.83	1.13	**4.7**	14	7.76
50PecosR666.7	7/23/20	152	6.07	2.43	0.42	30	8.45

Mean hardness of the two WQS exceedance events (8/8/2019 and 6/24/2020) = 94 mg/L, used to calculate the chronic TR Al criterion in Table 2.3

E. coli data

MPN is the most probable number of colony forming units, and is equivalent to cfu in the New Mexico WQS.

Gallinas River (Aguilar Creek to USGS Gage 08382000)
Monitoring station: Gallinas River at La Liendre - 50Gallin057.8

WQS Acute standard: 410 mpn/100 ml

Station	Date	*E. coli* (mpn/100ml)	Flow (cfs)
50Gallin057.8	3/19/19	98.8	7.3
50Gallin057.8	5/22/19	10.9	6.2
50Gallin057.8	8/7/19	50.4	8.5
50Gallin057.8	9/18/19	32.7	1.9
50Gallin057.8	5/28/20	**>2419.6**	1.0
50Gallin057.8	6/25/20	133.4	1.0
50Gallin057.8	7/22/20	**665.3**	0.2
50Gallin057.8	10/7/20	55.6	0.1

Gallinas River (USGS Gage 08382000 to Pecos Arroyo)

Monitoring station: Gallinas River 0.25 miles below Las Vegas WWTF - 50Gallin101.8

WQS Acute standard: 410 mpn/100 ml

Station	Date	*E. coli* (mpn/100ml)	Flow (cfs)
50Gallin101.8	3/19/19	>2419.6	8
50Gallin101.8	5/22/19	61.98	6.3
50Gallin101.8	8/7/19	172.33	9.62
50Gallin101.8	9/18/19	172.47	3.149

Pecos River (Sumner Reservoir to Santa Rosa Reservoir)

Monitoring stations: PECOS RIVER BELOW SANTA ROSA DAM - 50PecosR575.0
Pecos R at Puerto de Luna - 50PecosR540.8

WQS Acute standard: 410 mpn/100 ml

Station	Date	*E. coli* (mpn/100ml)	Flow (cfs)
50PecosR540.8	3/20/19	7.5	92
50PecosR540.8	5/29/19	12.1	164
50PecosR540.8	8/6/19	**435.2**	73
50PecosR575.0	8/7/19	12.2	1
50PecosR540.8	9/19/19	37.3	238
50PecosR540.8	10/9/19	10.9	78
50PecosR540.8	5/27/20	4.1	74
50PecosR540.8	6/4/20	**461.1**	1270
50PecosR540.8	6/24/20	9.7	96
50PecosR540.8	7/23/20	186	99
50PecosR540.8	8/11/20	31.3	73

Pecos River (Villanueva State Park to Cow Creek)

Monitoring stations: Pecos-NM19-10043
Pecos abv Villanueva State Park - 50PecosR697.0

Station	Date	*E. coli* (mpn/100ml)	Flow (cfs)
Pecos-NM19-10043	10/17/19	19.9	32.0
50PecosR697.0	3/20/19	25.9	60.4
50PecosR697.0	5/29/19	43.5	753
50PecosR697.0	8/8/19	**461.1**	131
50PecosR697.0	9/19/19	290.9	36.9
50PecosR697.0	5/27/20	67.7	136
50PecosR697.0	6/24/20	88.3	50
50PecosR697.0	7/23/20	**727.0**	30

50PecosR697.0	10/6/20	178.5	9.57

Pecos River (Tecolote Creek to Villanueva State Park)
Monitoring stations: Pecos-NM19-10136
PECOS RIVER ABOVE CONFLUENCE WITH TECOLOTE CREEK - 50PecosR666.7

Station	Date	*E. coli* (mpn/100ml)	Flow (cfs)
Pecos-NM19-10136	11/5/19	1	34.88
50PecosR666.7	3/20/19	19.9	199
50PecosR666.7	5/29/19	20.1	771
50PecosR666.7	8/8/19	**2419.6**	131
50PecosR666.7	9/19/19	58.6	9.8
50PecosR666.7	5/27/20	14.1	115
50PecosR666.7	6/24/20	**2419.6**	14
50PecosR666.7	7/23/20	86	30
50PecosR666.7	10/6/20	25.3	6.8

Pecos River (Santa Rosa Reservoir to Tecolote Creek)
Monitoring stations: Pecos R @ NM 119 bridge nr Anton Chico - 50PecosR657.3
PECOS RIVER NEAR COLONIAS, NM - 50PecosR593.1

WQS Acute standard: 410 mpn/100 ml

Station	Date	*E. coli* (mpn/100ml)	Flow (cfs)
50PecosR657.3	3/20/19	10.9	243
50PecosR657.3	8/8/19	**>2419.6**	131
50PecosR657.3	5/27/20	11	115
50PecosR657.3	6/24/20	**2419.6**	14
50PecosR657.3	7/23/20	**>2419.6**	3.8
50PecosR657.3	10/6/20	240.0	0.4
50PecosR593.1	8/7/19	228.18	18.9
50PecosR593.1	10/9/19	325.54	7.9
50PecosR593.1	6/17/20	4.05	5.7

Tecolote Creek (I-25 to Blue Creek)
Monitoring stations: Tecolote-NM19-10068
TECOLOTE CREEK AT I-25 NEAR TECOLOTE - 50Tecolo041.2
WQS Acute standard: 235 mpn/100 ml (segment-specific standard)

Station	Date	*E. coli* (mpn/100ml)	Flow (cfs)
Tecolote-NM19-10068	10/1/19	**344.1**	0.1
50Tecolo041.2	3/19/19	9.7	44
50Tecolo041.2	5/22/19	10.7	18.8
50Tecolo041.2	8/7/19	81.6	1.8
50Tecolo041.2	9/18/19	93.2	0.1
50Tecolo041.2	5/28/20	75.4	1.0

50Tecolo041.2	6/25/20	**1986.3**	0.2
50Tecolo041.2	7/22/20	83.6	0.2
50Tecolo041.2	10/6/20	**517.2**	0.1

Plant nutrients data

El Porvenir Creek (SFNF bnd to Hollinger Canyon)
Monitoring station: El Porvenir Creek at Christian Camp, USGS 08380075 - 50ElPorv004.8

Applicable thresholds: TN (Steep) 0.30 mg/L, TP (Steep) 0.030 mg/L, delta DO 1.79 mg/L

Date	TN (mg/L)	TP (mg/L)	Flow (cfs)
5/22/19	0.79	<0.01	24.2
9/18/19	<0.25	<0.01	1.3
5/28/20	0.21	<0.01	2.5
6/25/20	0.39	<0.01	0.7
7/22/20	<0.25	<0.01	0.7
Max Delta DO = 1.65 mg/L, deployed 6/25/20 to 7/15/20 at 50ElPorv004.8 **Min DO = 5.46 mg/L, deployed 6/25/20 to 7/15/20 at 50ElPorv004.8 (DO listing based on multiple 4-hour excursions below the 6.0 mg/L criterion)**			

Median TN = 0.21 mg/L **Median TP** = <0.01 mg/L

Gallinas River (Pecos Arroyo to Las Vegas Diversion)
Monitoring station: Gallinas River at Grand Avenue - 50Gallin104.8

Applicable thresholds: TN (Moderate) 0.42 mg/L, TP (Flat-Moderate) 0.061 mg/L, delta DO 4.08 mg/L

Date	TN (mg/L)	TP (mg/L)	Flow (cfs)
3/19/19	0.66	0.013	10
5/22/19	1.74	0.011	3
8/7/19	0.28	0.038	5.9
9/18/19	<0.25	0.023	1.0
5/28/20	<0.25	0.029	2.1
6/25/20	0.69	0.075	0.01
7/22/20	0.41	0.035	0.3
10/7/20	<0.25	0.015	0.1
Max Delta DO = 4.95 mg/L, deployed 6/25/20 to 7/15/20 at 50Gallin104.*8* **Min DO = 1.01 mg/L, deployed 6/25/20 to 7/15/20 at 50Gallin104.8 (DO listing based on frequent 4-hour excursions below the 6.0 mg/L criterion)**			

Median TN = 0.345 mg/L **Median TP** = 0.026 mg/L

Gallinas River (USGS Gage 08382000 to Pecos Arroyo)
Monitoring station: Gallinas River 0.25 miles below Las Vegas WWTF - 50Gallin101.8

Applicable thresholds: TN (Moderate) (0.42), TP (Flat-Moderate) 0.061 mg/L, delta DO 4.08 mg/L

Date	TN (mg/L)	TP (mg/L)	Flow (cfs)
3/19/19	10.7	0.262	8
5/22/19	12.4	1.13	6.3
8/7/19	4.0	0.309	9.6
9/18/19	16.8	1.87	3.1
Max Delta DO = 5.74 mg/L, deployed 6/20/19 to 9/24/19 at 50Gallin101.8			

Median TN = **11.55** mg/L **Median TP** = **0.720** mg/L

Monitoring station: LAS VEGAS, NM WWTP OUTFALL PIPE (MAS) - NM0028827-A
For comparison purposes, data not assessed

Date	TN (mg/L)	TP (mg/L)
3/19/19	11.2	0.198
5/22/19	17.3	2.1
8/7/19	13.5	1.15
9/18/19	18.9	2.14

Median TN = **15.4** mg/L **Median TP** = **1.625** mg/L

Gallinas River (Aguilar Creek to USGS Gage 08382000)
Monitoring station: Gallinas River at La Liendre - 50Gallin057.8

Applicable thresholds: TN (Flat) 0.69 mg/L, TP (Flat-Moderate) 0.061 mg/L, delta DO 4.08 mg/L

Date	TN (mg/L)	TP (mg/L)	Flow (cfs)
3/19/19	1.15	0.072	7.3
5/22/19	0.91	0.033	6.2
8/7/19	0.59	0.130	8.5
9/18/19	0.33	0.052	1.9
5/28/20	1.22	0.108	1.0
6/25/20	0.64	0.066	1.0
7/22/20	1.12	0.115	0.2
10/7/20	0.30	0.065	0.1
Max Delta DO = 8.8 mg/L, deployed 6/25/20 to 7/15/20 at 50Gallin057.8			

Median TN = **0.78** **Median TP** = **0.069**

Glorieta Ck (Perennial prt Pecos R to Glorieta Camps WWTP)
Monitoring Station: Glorieta Creek @ NM 50 - 50Glorie011.4
Glorieta Creek above confluence with Pecos River - 50Glorie001.8

Applicable Thresholds: TN (Moderate) 0.42 mg/L, TP (Flat-Moderate) 0.061 m/L, delta DO 4.08 mg/L

Station	Date	TN (mg/L)	TP (mg/L)	Flow (cfs)
50Glorie011.4	6/18/20	.25	0.065	0.01

50Glorie001.8	3/18/19	.73	0.062	4.5
50Glorie001.8	5/21/19	1.65	0.016	1.2
50Glorie001.8	8/6/19	1.13	0.078	0.01
50Glorie001.8	9/17/19	NS	NS	dry
50Glorie001.8	5/20/20	.391	0.011	0.01
50Glorie001.8	7/21/20	NS	NS	dry
50Glorie001.8	10/5/20	NS	NS	dry

Median TN = **0.73** **Median TP** = **0.062**

Monitoring Stations: Glorieta Creek above Adventure Camps WWTP - 50Glorie014.0
Glorieta Adventure Camps WWTP - NM0028088

For comparison purposes, data not assessed.

Station	Date	TN (mg/L)	TP (mg/L)	Flow (cfs)
NM0028088	3/18/19	23.93	2.73	MDP
NM0028088	5/21/19	11.47	1.35	MDP
NM0028088	8/8/19	15.93	4.82	MDP
NM0028088	9/17/19	25.8	3.40	MDP

Median TN = **19.93 mg/L** **Median TP** = **3.07 mg/L**

Pecos River (Canon de Manzanita to Alamitos Canyon)
Monitoring stations: Pecos R blw Glorieta Cr - 50PecosR763.6

Applicable thresholds: TN (Moderate) 0.42 mg/L, TP (Flat-Moderate) 0.061 mg/L, delta DO 4.08 mg/L

Date	TN (mg/L)	TP (mg/L)	Flow (cfs)
3/18/19	0.90	0.033	126
5/21/19	3.41	0.017	401
8/6/19	0.24	0.029	89
9/17/19	< 0.25	< 0.01	45.7
5/20/20	0.11	0.015	196
6/17/20	0.20	0.013	65
7/21/20	0.24	0.023	28.5
10/5/20	< 0.25	0.012	19.1
Min DO = 5.50 mg/L, deployed 6/17/20 to 7/8/20 at 50PecosR770.0 **Min DO = 5.02 mg/L, deployed 6/24/20 to 7/21/20 at 50PecosR763.6** **DO listing based on frequent 4-hour excursions below the 6.0 mg/L criterion during the 2020 deployments; delta DO did not exceed the 4.08 mg/L threshold.**			

Median TN = 0.22 **Median TP** = 0.016

Monitoring station: Pecos, Village of/WWTP - NM0029041
For comparison purposes, data not assessed

Date	TN (mg/L)	TP (mg/L)

3/20/19	29.2	6.52
5/23/19	31.8	0.102
8/8/19	30.6	0.535
9/19/19	31.8	< 0.1

Median TN = **31.2** mg/L **Median TP** = **0.535** mg/L

Pecos River (Santa Rosa Reservoir to Tecolote Creek)

Monitoring stations: Pecos R @ NM 119 bridge nr Anton Chico - 50PecosR657.3
PECOS RIVER NEAR COLONIAS, NM - 50PecosR593.1

Applicable thresholds: TN (Flat) 0.69 mg/L, TP (Flat-Moderate) 0.061 mg/L, delta DO 4.08 mg/L

Station	Date	TN (mg/L)	TP (mg/L)	Flow (cfs)
50PecosR657.3	3/20/19	0.94	0.113	243
50PecosR657.3	8/8/19	10.08	2.11	131
50PecosR657.3	5/27/20	0.27	0.017	115
50PecosR657.3	6/24/20	2.20	0.297	14
50PecosR657.3	7/23/20	0.34	0.086	3.8
50PecosR657.3	10/6/20	0.11	0.018	0.4
50PecosR593.1	8/7/19	0.79	0.139	18.9
50PecosR593.1	10/9/19	0.87	0.015	7.9
50PecosR593.1	6/17/20	< 0.25	< 0.01	5.7
Max Delta DO = 1.46 mg/L, deployed 7/1/19 to 7/15/19 at 50PecosR657.3				
Max Delta DO = 6.85 mg/L, deployed 6/24/20 to 7/15/20 at 50PecosR657.3				

Median TN = **0.79** **Median TP** = **0.086**

Pecos River (Sumner Reservoir to Santa Rosa Reservoir)

Monitoring stations: PECOS RIVER BELOW SANTA ROSA DAM - 50PecosR575.0
Pecos R at Puerto de Luna - 50PecosR540.8

Applicable thresholds: TN (Flat) 0.69 mg/L, TP (Flat-Moderate) 0.061 mg/L, delta DO 4.08 mg/L

Station	Date	TN (mg/L)	TP (mg/L)	Flow (cfs)
50PecosR575.0	8/7/19	1.16	0.185	1
50PecosR540.8	3/20/19	0.50	0.023	91.9
50PecosR540.8	5/29/19	0.72	0.021	164
50PecosR540.8	8/6/19	< 0.25	0.016	72.6
50PecosR540.8	9/19/19	< 0.25	< 0.01	238
50PecosR540.8	10/9/19	< 0.25	< 0.01	77.7
50PecosR540.8	5/27/20	< 0.25	0.022	74.3
50PecosR540.8	6/24/20	0.37	0.025	96
50PecosR540.8	7/23/20	0.56	0.089	99.3
50PecosR540.8	8/11/20	< 0.25	0.016	72.6
Max Delta DO = 4.51 mg/L, deployed 6/12/19 to 9/19/19 at 50PecosR540.8				

Median TN = 0.19 **Median TP** = 0.022

Monitoring station: NMG&FD/Rock Lake Fish Hatchery - NM0030155
For comparison purposes, data not assessed

Date	TN (mg/L)	TP (mg/L)
3/20/19	0.41	< 0.1
5/29/19	2.47	< 0.1
8/7/19	0.23	0.025
9/19/19	0.44	< 0.1
5/27/20	0.24	< 0.1
6/24/20	0.24	< 0.1

Sedimentation/Siltation data

Willow Creek subwatershed
Monitoring stations:
WILLOW CR BLW WHITE DRAIN - 50Willow000.1
WILLOW CR ABV FISH BARRIER - 50Willow000.6 (physical habitat and pebble-count station from which the %SaFN and LRBS_NOR bedded-sediment indicators were derived; located above the fish barrier, approximately 0.5 km upstream of 50Willow000.1 and outside the reconstructed channel)

Target TSS threshold: 8.75 mg/L
Target Turbidity threshold: 9.50 NTU

Station	Date	TSS (mg/L)	Turbidity (NTU)	Flow (cfs)
50Willow000.1	3/18/19	7	6	5
50Willow000.1	5/21/19	**29**	**18.5**	8.1
50Willow000.1	8/6/19	7	4.4	2.9
50Willow000.1	9/17/19	3	0.1	1.5
50Willow000.1	5/21/20	**21**	**17.6**	4.1
50Willow000.1	6/18/20	**11**	**14.3**	2.0
50Willow000.1	7/21/20	5	5.3	3
50Willow000.1	10/5/20	3	0.8	0.4

Specific Conductance and TDS data

Indian Creek Subwatershed

Monitoring stations: Indian-NM19-10030
INDIAN CREEK 3M WEST OF HWY 63 BRDG - 50Indian000.1

Segment-specific SC criterion: 300 uS/cm

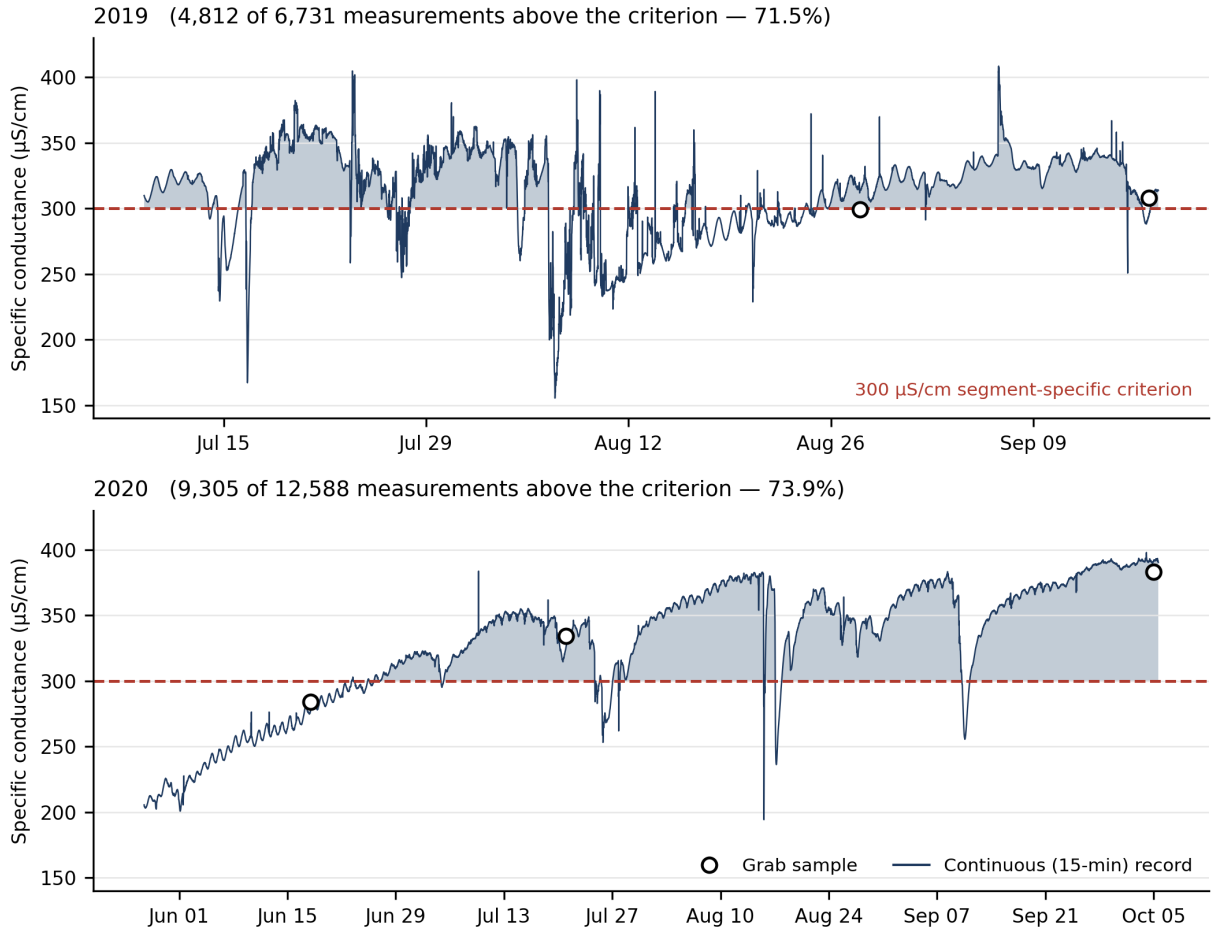
Monitoring Station	Date	SC (uS/cm)	TDS (mg/L)	TDS:SC ratio	Flow (cfs)
Indian-NM19-10030	9/5/19	122	94	0.770	0.39

50Indian000.1	8/28/19	299	194	0.649	0.63
50Indian000.1	9/17/19	**308**	200	0.649	0.3
50Indian000.1	5/21/20	179	120	0.670	0.1
50Indian000.1	6/18/20	284	166	0.585	0.05
50Indian000.1	7/21/20	**334**	218	0.653	0.2
50Indian000.1	10/5/20	**383**	244	0.637	0.05

Mean TDS:SC ratio (all stations, including Indian-NM19-10030; used to derive the TMDL target) = 0.659

Mean TDS at pour-point station 50Indian000.1 (excluding upstream Indian-NM19-10030; used for the measured load) = 190.3 mg/L

The TDS:SC ratio characterizes a basin-wide chemical relationship and pools all paired samples, whereas the measured load is assessed at the pour-point station; the more dilute upstream sample at Indian-NM19-10030 is therefore included in the ratio but not in the pour-point measured-concentration mean.



Continuous specific conductance recorded at station 50Indian000.1 during the 2019 and 2020 deployments, relative to the 300 µS/cm segment-specific criterion (dashed line). Shading marks

measurements above the criterion; open circles are grab samples collected at the same station during the deployment periods. Records rejected during data review are excluded.

Temperature data

AU Name – Thermograph Location	Designated ALU	Chronic Criterion (°C)	Measured Chronic (°C)	T_{MAX} Criterion (°C)	Date of Measured T_{MAX}	Measured T_{MAX} (°C)
El Porvenir Creek (SFNF bnd to Hollinger Canyon)- El Porvenir Creek at Christian Camp, USGS 08380075 - 50ElPorv004.8	High Quality Coldwater	(4T3) 20	**20.96**	23	7/11/20	**25.3**
Gallinas River (Aguilar Creek to USGS Gage 08382000) - Gallinas River at La Liendre - 50Gallin057.8	Marginal Coldwater	NA	NA	30*	7/12/20	**31.2**
Pecos River (Alamitos Canyon to Jack's Creek) – David Lemke Property	High Quality Coldwater	(4T3) 20	**21.53**	23	7/11/20	**24.1**
Gallinas River (USGS Gage 08382000 to Pecos Arroyo) - Gallinas River 0.25 miles below Las Vegas WWTF - 50Gallin101.8	Marginal Coldwater	(6T3) 25	21.52	30*	Did not exceed SSC Tmax	**23.66**

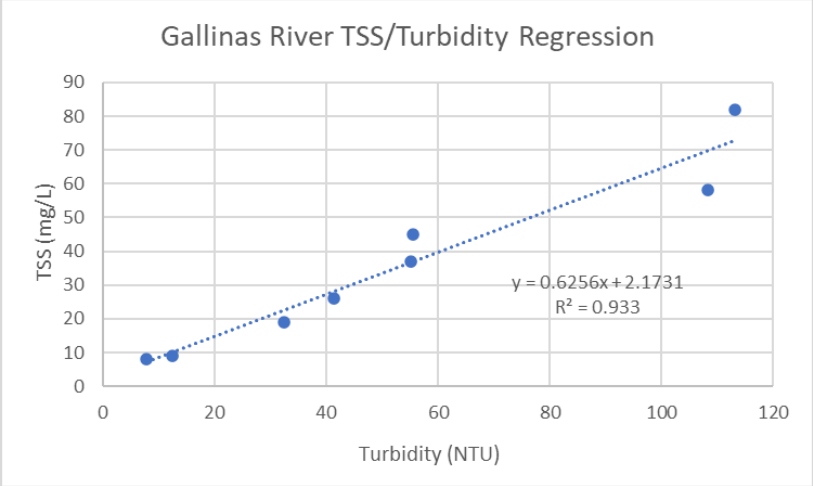
** segment-specific criterion (SSC)*

Turbidity Data

Gallinas River (Aguilar Creek to USGS Gage 08382000)

Monitoring station: Gallinas River at La Liendre - 50Gallin057.8

Station	Date	TSS (mg/L)	Turb (NTU)	Flow (cfs)
50Gallin057.8	3/19/19	9	12.4	7.3
50Gallin057.8	5/22/19	8	7.9	6.2
50Gallin057.8	8/7/19	58	108.3	8.5
50Gallin057.8	9/18/19	37	55.2	1.9
50Gallin057.8	5/28/20	82	113.1	1.0
50Gallin057.8	6/25/20	26	41.3	1.0
50Gallin057.8	7/22/20	19	32.4	0.2
50Gallin057.8	10/7/20	45	55.6	0.1



Regression fit to all 8 paired TSS/turbidity grab samples with TSS results from the Gallinas River (Aguilar Creek to USGS Gage 08382000).

Gallinas River (USGS Gage 08382000 to Pecos Arroyo)

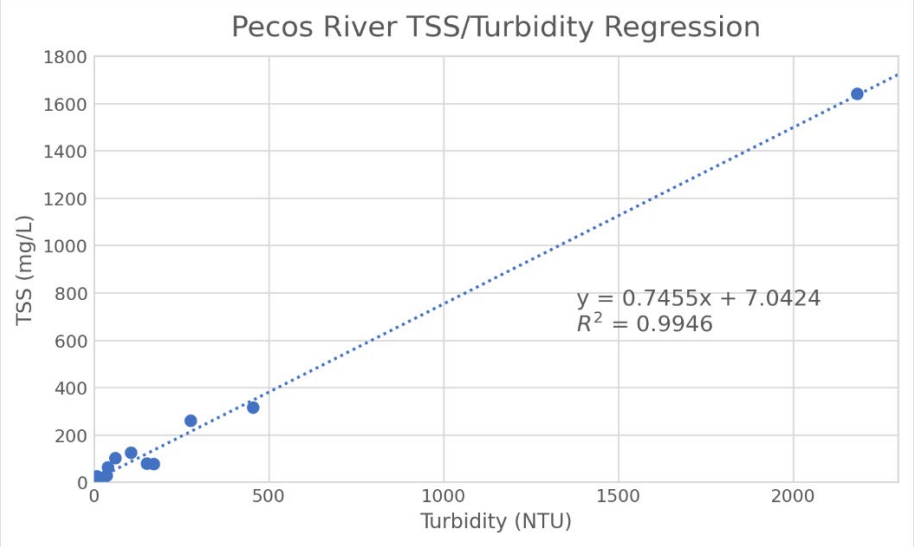
Monitoring station: Gallinas River 0.25 miles below Las Vegas WWTF - 50Gallin101.8

Station	Date	TSS (mg/L)	Turb (NTU)	Flow (cfs)
50Gallin101.8	3/19/19	5	4.9	8
50Gallin101.8	5/22/19	8	3	6.3
50Gallin101.8	8/7/19	14	12.4	9.62
50Gallin101.8	9/18/19	7	1.8	3.149

Pecos River (Tecolote Creek to Cow Creek)

Monitoring stations: Pecos-NM19-10043
Pecos abv Villanueva State Park - 50PecosR697.0
PECOS RIVER ABOVE CONFLUENCE WITH TECOLOTE CREEK - 50PecosR666.7

Station	Date	TSS (mg/L)	Turb (NTU)	Flow (cfs)
NM19-10043	10/17/19	< MRL	1.6	32.0
50PecosR697.0	3/20/19	124	106.7	60.4
50PecosR697.0	5/29/19	62	40.5	753
50PecosR697.0	8/8/19	259	277.5	131
50PecosR697.0	9/19/19	27	37.1	36.9
50PecosR697.0	5/27/20	24	9.3	136
50PecosR697.0	6/24/20	4	4.4	50
50PecosR697.0	7/23/20	13	14.2	30
50PecosR697.0	10/6/20	15	19.6	9.6
50PecosR666.7	3/20/19	78	152	199
50PecosR666.7	5/29/19	101	62	771
50PecosR666.7	8/8/19	1640	2183.4	131
50PecosR666.7	9/19/19	76	171.8	9.8
50PecosR666.7	5/27/20	13	10	115
50PecosR666.7	6/24/20	315	455.9	14
50PecosR666.7	7/23/20	18	18.9	30
50PecosR666.7	10/6/20	10	13.1	6.8



Regression fit to all 16 paired TSS/turbidity grab samples with TSS results from the combined **Pecos River (Tecolote Creek to Cow Creek)** reach. The 10/17/19 sample at Pecos-NM19-10043 is not included because TSS was reported below the minimum reporting level.

APPENDIX B

SOURCE DOCUMENTATION

The approach for identifying probable sources of impairment is documented in SWQB Standard Operating Procedure (SOP) 4.1, Probable Source(s) Determination (https://www.env.nm.gov/surface-water-quality/sop/). "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 (TMDLs), and Watershed-Based Plans (WBPs) is intended to include any and all activities that could be contributing to the identified cause of impairment, which are supported by evidence strong enough to establish presumption but not proof. Probable Source categories are selected from Appendix A of SOP 4.1, which was adapted from the EPA ATTAINS database.

USEPA, through guidance documents, strongly encourages states to include a list of Probable Sources for each listed impairment. According to the 1998 Section 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 landowner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each known impairment.

Any new impairment listing will be assigned a Probable Source of "Source Unknown." During sampling events, Monitoring Team staff select applicable Probable Sources from a drop-down menu on the Stream/River Field Data Form. Information gathered by the Monitoring Team is used to generate a draft Probable Source list in consequent TMDL planning documents. The TMDL writer then revises the list using aerial imagery, Geographic Information System data, and other available records. The list is also reviewed by Watershed Protection Section staff with knowledge of the AU and watershed. 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 Probable Source list in the approved TMDL will be used to update the subsequent Integrated List.

Data on Probable Sources gathered by Monitoring, Assessment, and Standards Section staff and Watershed Protection Section staff during water quality surveys and watershed restoration projects is housed in the NMED Surface Water Quality Information Database (SQUID). More specific information on Probable Sources of Impairment is provided in individual watershed planning documents (e.g., TMDLs, WBPs, etc.) as they are prepared to address individual impairments by AU.

Literature Cited:

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

APPENDIX C

CALCULATION OF TEMPERATURE TMDL

Calculation of Temperature TMDL

Problem Statement: Convert Temperature Criteria into a Daily Load

Background

The temperature of water is essential for proper metabolic regulation in the aquatic community. Water at a given temperature has a thermal mass that can be represented in units of energy (thermal energy). There are a variety of sources of temperature loading to a waterbody, including air temperature, solar radiation and point source discharge (if present). In addition, how the temperature loading to a stream is translated to the thermal mass of the stream is dependent on its hydrologic characteristics and condition of riparian area (i.e., shading).

The calculation of a TMDL target is governed by the basic equation,

Eq1. *WQS criterion * flow * conversion factor = TMDL target capacity*

For Temperature TMDLs, the WQS criterion is a temperature specified either by the designated Aquatic Life Use (ALU) or site-specific criteria and can be either a maximum temperature or time-duration temperature such as the 4T3 or 6T3.

Flow will generally use the 4Q3 low-flow for the critical flow unless another flow statistic or multiple flow conditions are more appropriate for the situation.

The conversion factor is a variable needed to 1) convert units used by SWQB for flow (in cfs) to cubic meters (m^3) and 2) convert change in water temperature (C) to a volumetric heat capacity ($kJ/(m^3*C)$).

Calculation of Thermal Energy

The thermal loading capacity of a volume is governed by the following equation,

Eq2. *thermal energy = specific heat capacity * mass * change in temperature*

Specific heat capacity is the amount of energy needed to raise the temperature of one kilogram of a substance by 1 degree Celsius.

Mass can be replaced by volume multiplied by density (mass = volume × density). Because the density of water is effectively constant over the ambient range of temperature and pressure, the volume of water passing through the reach in a day is proportional to the mass passing through in that period, and the volumetric flow rate may therefore be substituted for mass flux in Eq2.

Accepted Scientific Units for the variables above are:

thermal energy = kilojoule (kJ) (calories are less common and considered archaic)

specific heat capacity = kJ/(kg*C)

mass = kilograms (kg)

change in temperature = Celsius (C)

The specific heat capacity of water at 25°C = 4.182 kJ/(kg*C). This is the isobaric (under constant pressure) value for heat capacity at an absolute atmospheric pressure of 585 mmHg. Note: varying water temperature and absolute pressure to minimum and maximum ambient values has negligible effect on the resulting heat capacity.

Calculation of Conversion Factor

Flow (cfs) to (m^3/day)

Eq3. 1 cf/s * 86,400 s/day * 0.0283 m^3/cf = 2445.12 m^3/day

Heat Capacity to Volumetric Heat Capacity

Eq4. 4.182 kJ/(kg*C) * 1000 kg/m^3 = 4,182 kJ/(m^3*C)

Note: water density varies with temperature but only at a fraction of a percent.

Conversion Factor = 2445.12 m^3/day * 4,182 kJ/(m^3*C) = 1.023E+07 kJ/(day*C*cfs)

Note: Eq3 is evaluated for a flow of 1 cfs, so the conversion factor carries units of kJ per day per degree Celsius per cfs. Multiplying the conversion factor by the critical flow expressed in cfs, as in Eq5, therefore returns a loading capacity in kJ/day.

Form of TMDL Equation

Eq5. Δ [**°C**] x [**cfs]** x 1.023E+07 = TMDL (kJ/day)

Input variables in **bold**, Δ**°C** = (WQC - 0**°C)** and **cfs** = critical flow

The resulting value is the increase in kJ/day above 0° Celsius.

APPENDIX D

SSTEMP INPUT DATA

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. Meteorological inputs to SSTEMP Model include maximum air temperature, air temperature, relative humidity, windspeed, ground temperature, thermal gradient, possible sun, dust coefficient, ground reflectivity, and solar radiation. In the following sections, data sources for these parameters are discussed in detail for each Assessment Unit (AU) to be modeled using SSTEMP Model. Input values of the calibrated models are shown on **Table D.1**, following the discussion of data sources. Each AU was modeled on the date of the maximum recorded water temperature on the thermograph record which was used to assess impairment. The hydrologic inputs described below characterize conditions on that modeled date and are provided to calibrate and run the SSTEMP implementation model; they are distinct from the 4Q3 critical design flow used to derive the temperature TMDL loading capacity in Section 7.2.

D 2.0 HYDROLOGY

D 2.1 Segment Inflow and Outflow

This parameter is the streamflow at the top and bottom of the stream segment. 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 instead of the mean daily flow. These critical low flows were used to reflect the decreased assimilative capacity of the stream to absorb and disperse solar energy.

The 4Q3 inflow and outflow represent streamflow at the top and bottom of the modeled segment on the modeled date and are distinct from the single 4Q3 critical design flow used to derive the temperature TMDL loading capacity (Section 7.2). For the Gallinas River AU, the segment inflow was estimated from the record at USGS Gage 08382000 (Gallinas River near Lourdes, NM), the gage nearest SWQB station 50Gallin057.8 (Gallinas River at La Liendre), using the USGS Hydrologic Toolbox, and the segment outflow was estimated from available regression data; inflow and outflow for the Pecos River AU were likewise estimated from available regression data. The critical design flow for the temperature TMDL treats each AU as ungaged at the pour point and is estimated using the Bell and Tillery (2023) regression equations described in Section 7.2, so the gage at the upstream end of the Gallinas River AU was used here only to characterize the calibration-date flow rather than the design flow. The segment inflow and outflow values shown in Table D.1 were derived before the low-flow methodology in this document was updated to Bell and Tillery (2023), and the SSTEMP models were calibrated against them. They are therefore not directly comparable to the 4Q3 estimates reported in Section 7.2 and Table 7.3. These values do not enter the temperature TMDL calculation, which is derived from the applicable temperature criterion and the critical flow shown in Table 7.4; the SSTEMP results reported in Section 10.3 inform implementation planning only.

D 2.2 Inflow Temperature

This parameter represents the mean water temperature at the top of the segment on the modeled date.

To obtain inflow temperature for the **Gallinas River (Aguilar Creek to USGS Gage 08382000)**, thermograph mean temperature on the modeled date were obtained from a thermograph at the upstream end of the AU.

No thermograph data were available upstream of the Pecos River AU, so an alternative method was used to estimate inflow temperature. Mean air temperature for the modeled date was queried from the PRISM database (http://www.prism.oregonstate.edu/), and an assumption was made that the ratio between air temperature and water temperature is the same at the top and bottom of the reach.

D 2.3 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 temperatures for 2020, obtained from the PRISM database (http://www.prism.oregonstate.edu/), were used in the absence of measured data. PRISM was queried using a 4 km grid cell covering a central portion of each AU, with the interpolation function switched on.

D 3.0 GEOMETRY

D 3.1 Latitude

Latitude refers to the position of the stream segment on the earth's surface. Latitude was obtained from the SWQB Mapper, a GIS application, by taking the mean average between the highest and lowest values for the stream corridor for each AU.

D 3.2 Dam at Head of Segment

Neither of the TMDL AUs has a dam at the upstream end of the segment.

D 3.3 Segment Length

Segment length was obtained from the SWQB Surface Water Quality Database.

D 3.4 Upstream and Downstream Elevation

Elevations were obtained from Google Earth or the SWQB Surface Water Quality Database.

D 3.5 Width's A and Width's B Term

Field measurements of particle size distribution, water surface slope, and bankfull cross-section were collected following the SWQB Standard Operating Procedure for Physical Habitat Measurements (https://www.env.nm.gov/surface-water-quality/sop/). These field data were entered into the Windows-Based Stream Channel Cross-Section Analysis (WinXSPro 3.0) Program (USDA, 2005), to generate values for width and discharge at various stages up to bankfull. Width's B Term was calculated as the slope of the regression of the natural log of width and the natural log of flow. 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, 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)

Physical habitat monitoring on the Pecos River was conducted as part of a probabilistic water quality survey. As such, the exact monitoring locations were chosen at random, rather than having been selected as representative of the AU, and may not meet all the SOP requirements for site selection. The monitoring data used for SSTEMP were chosen out of three available records, based on staff judgement that Pecos-NM19-10046 was the most representative of the AU (personal communication, Chuck Dentino, Monitoring Team Supervisor at the time of this study, SWQB).

Data from a site near the top of the AU (50Gallin075.0) was used as input to WinXSPro for the **Gallinas River (Aguilar Creek to USGS Gage 08382000)**.

D 3.6 Manning's n or Travel Time

Site- and stage-specific geometry was modeled by the WinXSPro program described above. Manning's n is a measure of channel roughness which varies with depth of flow, increasing in value at shallower stages. WinXSPro uses Thorne and Zevenbergen's equation as the default Manning's n estimator, however the Manning's n coefficient calculated from physical habitat field monitoring data by the SWQB Surface Water Quality Database was selected.

D 4.0 METEOROLOGICAL PARAMETERS

D 4.1 Air Temperature

In the absence of measured air temperature at the thermograph stations, 24 hour mean temperature on the modelled date was obtained from the best available weather stations posted on the Western Regional Climate Center website (https://wrcc.dri.edu/wraws/nmF.html).

Air temperature for the Gallinas River AU was the temperature at the Remote Automatic Weather Station (RAWS) at Mills Canyon, NM, adjusted for the difference in elevation using the adiabatic lapse rate. Mills Canyon is approximately 60 miles distant from the modeled site but is at similar elevation and has a similar physiographic setting. Air temperature for the Pecos River AU was the temperature at the RAWS station at Pecos, NM, adjusted for the difference in elevation using the adiabatic lapse rate. The Pecos RAWS station is close to the modeled site but is at a much higher elevation.

D 4.2 Maximum Air Temperature

The maximum daily air temperature in SSTEMP overrides a calculated value only if the check box is checked. Since the WQS standard of concern is the T_{MAX}, which is particularly sensitive to the maximum air temperature (Bartholow, 2002), an empirical value was entered in this field. In the absence of measured air temperature at the thermograph stations, maximum temperature on the modelled date was obtained from the same weather stations used for mean daily air temperature, above, and adjusted for the difference in elevation using the adiabatic lapse rate.

D 4.3 Relative Humidity

Mean relative humidity on the modelled date was obtained from the same weather stations used for mean and maximum daily air temperature, above, and corrected for the difference in temperature at the RAWS station and adjusted temperature at the modeled sites.

For the Pecos River AU, relative humidity was changed from 78% to 68% to help calibrate the model.

D 4.4 Wind Speed

Mean wind speed on the modelled date was obtained from the same weather stations used for mean and maximum daily air temperature, above.

For the Gallinas River AU, wind speed was changed from 3.1 to 2.4 mps to help calibrate the model. For the Pecos River AU, wind speed was changed from 2.0 to 3.1 mps to help calibrate the model.

D 4.5 Ground Temperature

Same as Accretion Temperature, above.

D 4.6 Thermal Gradient

The software default value was used.

D 4.7 Possible Sun

This variable is an indirect and inverse measure of cloud cover. Percent possible sun was obtained from the Western Regional Climate Center (https://www.ncei.noaa.gov/pub/data/ccd-data/pctpos20.dat). The nearest location with monthly possible sun data is Albuquerque. Bartholow (2002) recommends using possible sun as a calibration parameter.

D 4.8 Dust Coefficient

The software default value was used.

D 4.9 Ground Reflectivity

The software default value was used.

D 4.10 Solar Radiation

Solar radiation values were obtained from the same weather stations used for relative humidity and mean and maximum daily air temperature, above, then multiplied by 0.9, as instructed in the SSTEMP manual.

D 5.0 SHADE

Vegetative canopy measurements taken during the physical habitat monitoring events were used.

Table D.1 SSTEMP input data values by Assessment Unit (calibrated model)

VARIABLE	Gallinas River (Aguilar Creek to USGS Gage 08382000)	Pecos River (Alamitos Canyon to Jack's Creek)
Segment Inflow (cfs)	0.37	10.27
Inflow Temperature (C)	18	14.7
Segment Outflow (cfs)	0.39	5.38
Accretion Temp (C)	13	7.8
Latitude (deg)	35.396	35.699
Dam?	No	No
Segment Length (mi)	37.85	21.83
Upstream Elevation (ft)	5970	8263
Downstream Elevation (ft)	5247	6897
Width's A Term (s/sqft)	29.6	9.12
B Term	0.278	0.389
Manning's n	1.259	0.077
Air Temperature (C)	23.7	22.4
Max Air Temp (C)	32.8	30.4
Relative Humidity	63	68*
Wind Speed (mps)	2.4*	3.1*
Ground Temp (C)	13	7.8
Thermal Gradient (j/sqm/s/C)	1.65	1.65
Possible Sun %	76	76
Dust Coefficient	5	5
Ground Reflectivity (%)	25	25

VARIABLE	Gallinas River (Aguilar Creek to USGS Gage 08382000)	Pecos River (Alamitos Canyon to Jack's Creek)
Solar Radiation (Langleys/day)	517.1	505.5
Total Shade (%)	4.9	44.5
Time of year	7/12/2020	7/11/2020

** variable was adjusted to calibrate the model*

D 6.0 REFERENCES

Bartholow, J.M. 2002. SSTEMP for Windows: The Stream Segment Temperature Model (Version 2.0). U.S. Geological Survey computer model and documentation. Available on the internet at https://www.sciencebase.gov/catalog/item/53ea4091e4b008eaa4f4c457. Revised August 2002.

Bell, M.T., and A.C. Tillery, 2023. Regression equations for estimating the 4-day, 3-year low-flow frequency and adjusted harmonic mean streamflow at ungaged sites for unregulated, perennial streams in New Mexico. U.S. Geological Survey Scientific Investigations Report 2023-5058, 31 p. https://doi.org/10.3133/sir20235058

New Mexico Environment Department/Surface Water Quality Bureau (NMED/SWQB). 2025. Standard Operating Procedure for Physical Habitat Measurements, Revision 8.

U.S. Department of Agriculture (USDA). 2005. WinXSPRO 3.0. A Channel Cross Section Analyzer. WEST Consultants Inc. San Diego, CA & Utah State University.

APPENDIX E

RESPONSE TO COMMENTS

The public draft of the Upper Pecos River TMDL was released on August 14, 2026. The public review period lasted for 30 days and closed on September 14, 2026. SWQB hosted a virtual public meeting on September 3, 2026, from 10:00–11:00 a.m. MDT. A public announcement of the public comment period and the public meeting was sent via GovDelivery to 3,864 subscribers of the SWQB Surface Water mailing list on August 14, 2026, in both English and Spanish. A separate email notice of the public comment period and the public meeting, with the public notice attached, was sent on August 10, 2026, to the five NPDES permittees assigned waste load allocations in this document (Table 10.1): the City of Las Vegas WWTP, the Glorieta Adventure Camps WWTP, the Village of Pecos WWTP, and the New Mexico Department of Game and Fish Rock Lake and Lisboa Springs fish hatcheries. The public meeting was attended by 20 participants: 14 SWQB staff members, two staff members of the New Mexico Department of Wildlife, and four members of the public and stakeholder organizations. Questions raised during the meeting concerning the use of this document in watershed based planning and the timing of NPDES permit implementation were addressed by SWQB staff.

One comment set was submitted during the public comment period, from Amigos Bravos. The comment set and SWQB responses are reproduced below.

Public comments received on the Upper Pecos River TMDL, and SWQB responses to those comments, are presented below.

Changes made to the TMDL based on public or additional staff comments include:

1. Section 8.1 Target Loading Capacity: additional detail and rationale were added explaining why the two contiguous Pecos River assessment units, NM-2213_00 (Tecolote Creek to Villanueva State Park) and NM-2213_01 (Villanueva State Park to Cow Creek), are combined and assigned a single turbidity TMDL. The added text describes the hydrologic continuity of the reach, the shared water quality standards segment and designated uses, the common probable sources, the absence of NPDES point sources, and the pooled TSS-turbidity regression and shared critical flow on which the TMDL is calculated, consistent with the rationale provided in Section 3.1 for the combined *E. coli* assessment unit.
2. Appendix A: corrected transcription errors in flow values in the *E. coli* data tables for Pecos River (Tecolote Creek to Villanueva State Park) and Pecos River (Villanueva State Park to Cow Creek) and in the plant nutrient data table for Pecos River (Sumner Reservoir to Santa Rosa Reservoir). These corrections do not affect exceedance counts, TMDLs, or allocations.
3. Appendix E Response to Comments: the comment set received from Amigos Bravos during the public comment period, and SWQB responses to each comment, were added.
4. Minor formatting, editorial, citation, and terminology errors were corrected throughout the document.

PLEASE NOTE: When feasible, original typed letters that were not received electronically were scanned and converted to MSWord. Likewise, when feasible, letters received electronically were also converted to MSWord. All text was converted to Times New Roman font with modified page margins for ease of collation. CAll original letters of comment are on file at the SWQB office in Santa Fe, NM.

AMIGOS BRAVOS
Because Water Matters

WATER IS LIFE.
It's Our Duty to Protect It.

September 14, 2026

Heidi Henderson
NMED SWQB
P.O. Box 5469,
Santa Fe, NM, 87502
voice: (505) 819-9986

Sent via the NMED Portal and Electronic Mail to heidi.henderson@env.nm.gov

RE: TMDLs for the Upper Pecos River

Dear Ms. Henderson,

Amigos Bravos is a statewide river conservation organization whose mission is to protect and restore the waters of New Mexico. Amigos Bravos works locally, statewide, and nationally to ensure that the waters of New Mexico are protected by the best policy and regulations possible. In this capacity Amigos Bravos works to make sure that New Mexico's water quality standards are protective enough to support the diverse human and non-human uses of our state's water resources. A TMDL is the first and often most critical step in cleaning up a waterbody as all other steps in the restoration process such as watershed planning and restoration projects pivot off the information provided in the TMDL. Therefore, advocating for comprehensive and accurate TMDLs is a critical component of our work to protect clean water and the cultures that depend upon it here in New Mexico. We would like to communicate the following comments regarding the draft TMDLs for the upper Pecos River.

Summary of Main Concerns:

- Potential increase in impairments and antidegradation of ONRW's in the upper Pecos River.
- Lack of ONRW specific implementation protocols to prevent degradation of these outstanding waters.
- Infrequent monitoring every 8-10 years is not comprehensive of New Mexico waters nor frequent enough to properly assess water quality.
- Lack of increased monitor in waterways adjacent to recent fire activity, especially if the waterways were monitored prior to the fire activity.
- Lack of ephemeral and intermittent streams included in TMDL analysis and reports.
- Need for developing TMDL's using low flows that consider climate change and continued drought conditions.

Impairments on Outstanding National Resource Waters (ONRW) Streams

We appreciate the language on page 30 and 37 that explains Outstanding National Resource Waters and Table 1.3 that explains which segments of the TMDL document are in ONRW's. This paragraph on page 38 is also particularly important:

"Several assessment units addressed in this TMDL were delineated at the sub watershed scale (for example, the Indian Creek sub watershed and Willow Creek sub watershed AUs) so that the assessment and TMDL boundaries align with the ONRW-protected waters. TMDLs developed for these and other ONRW-designated segments remain consistent with the antidegradation policy, because implementation restores and maintains water quality at or above the level necessary to protect existing uses and the exceptional quality for which the waters were designated."

We also appreciate that the NMED is beginning to use a sub watershed approach with the Indian Creek unit (AU W_NM-2217_002) created in 2023 and hope this approach starts to work well for wholistic watershed management (Page 38).

However, Amigos Bravos is still concerned that there are numerous new impairments in ONRW streams in the upper Pecos River, representing increased degradation since the time of ONRW designation in 2022. While we understand that the waters for this TMDL assessment were measured in 2019 and 2020, if the impairments have already been going on for 2-3 years before ONRW designation, they need to be closely monitored to assure that antidegradation violations are not occurring.

As Amigos Bravos has suggested in numerous comments on other regulatory processes (Forest Plans, Water Quality Management Plans), there needs to be specific ONRW implementation protocols developed to outline what steps will be taken to address these impairments. Amigos Bravos suggests the following steps if degradation of water quality is detected in an ONRW:

- Where water quality was better than the applicable designated uses and criteria, and there is sufficient water quality data to establish a baseline, TMDLs for the newly impaired ONRW should be calculated to attain water quality **at the time** of designation and not for the assigned designated uses and criteria for that segment.
- NMED will reach out to the appropriate land owner(s), land manager(s), and other interested parties, including the original ONRW petitioners, and will conduct a meeting or meetings with the purpose of drafting an action plan that details potential sources of the degradation and actions to take to address and/or remedy the degradation.
- NMED, in collaboration with the land managers and owners associated with the ONRW, will increase water quality sampling frequency to at least once annually in the ONRW until degradation is improved to the baseline water quality levels in existence at the time of ONRW designation.

SWQB Response:

Thank you for your comment. SWQB appreciates the recognition of the subwatershed delineation approach. These water quality assessments were based on data collected during the 2019-2020 survey, which precedes the September 2022 non-Wilderness ONRW designations. The listings therefore document conditions existing before the 2022 designation rather than degradation that occurred after it; however, waters within the Pecos Wilderness have carried ONRW status since January 2011. TMDL

targets are set to the applicable criteria for the designated uses of the segment, and SWQB cannot set a target more stringent than the standards adopted at 20.6.4 NMAC. Water quality at the time of designation is also not necessarily better than the criteria; where it is the same or worse, a target derived from it would not be protective.

Outreach to landowners, land managers, and original petitioners is consistent with the Watershed Based Planning process described in Section 10.2.1, which is built on landowner and stakeholder participation. SWQB notes that the lands surrounding the four ONRW AUs in the TMDL are predominantly managed by the U.S. Forest Service, so implementation authority for managing probable sources (through BMPs, etc.) rests with that agency. SWQB will continue to coordinate with the Santa Fe National Forest and interested parties, including Amigos Bravos, through watershed planning.

Finally, monitoring frequency is set through the SWQB's current Monitoring and Assessment Strategy (available at https://www.env.nm.gov/surface-water-quality/monitoring-assessment-and-standards-section/, currently under revision) and constrained by resource limitations which fluctuate yearly. SWQB cannot commit to a fixed sampling frequency in a TMDL document, however, ONRW status is one of the factors used to prioritize monitoring in the Monitoring and Assessment Strategy and during survey planning, which includes a public meeting and comment period on the sampling and analysis plan for each upcoming survey year. The next scheduled survey of this watershed is 2028 (2026-2028 Integrated Report, Figure 4). SWQB MASS also has an active goal to expand volunteer monitoring, with a particular focus on ONRWs, including for example, a potential collaboration with New Mexico Wild to enhance ONRW monitoring during the Bureau's 2027 Upper Rio Grande ambient survey. Outside data meeting quality assurance requirements may be submitted at any time.

1.4 Water Quality Monitoring Survey

The report states that on page 38 that "monitoring occurs during the non-winter months; focuses on physical, chemical, and biological conditions in perennial waters; and includes sampling for most pollutants that have numeric and/or narrative criteria in the WQS." Amigos Bravos feels that this selection of only perennial waters is not representative of the Upper Pecos River watershed, nor the State of New Mexico, as the vast majority of waters are intermittent or ephemeral. These streams are vital to the health of the watershed and to our communities for irrigation, recreation, and drinking water supply. Non-perennial streams also serve as tributaries for other waterways and their degradation will significantly impact the entire watershed. Finally, as climate change and drought conditions worsen, many of these perennial streams could become intermittent or ephemeral and lose their TMDL priority if these types of streams are not included in the analysis. Amigos Bravos would like to see ephemeral and intermittent streams included in TMDL analysis and reports.

SWQB Response:

Thank you for your comment. SWQB agrees that non-perennial waters are important and constitute most stream miles in New Mexico. The quoted sentence describes where assessment data can in practice be realistically obtained, not a decision to exclude these waters. Section 3.1 of the Antidegradation Policy Implementation Procedure states that lack of flow in ephemeral and intermittent waters makes characterizing baseline water quality difficult, and that these waters receive Tier 1 protection for all pollutants of concern, so they are not left unprotected. The definition of surface waters of New Mexico expressly includes both intermittent and ephemeral streams; Tier 1 applies categorically to all intermittent, ephemeral, and effluent-dependent waters and requires that water quality support existing and designated uses. Therefore, reduced flow does not remove a water from the program, nor are ephemeral or intermittent streams excluded from the assessment and TMDL development process. TMDLs and their implementation, through Watershed Based Plans or similar

mechanisms, are developed at the watershed scale, so intermittent and ephemeral streams feeding perennial waterbodies are captured in both the analysis and the resulting restoration work.

1.6 TMDL Uncertainties

The report states weaknesses in the TMDL analytical process include the limited availability of water quality data during the assessment process. Amigos Bravos applauds the NMED's recognition of the weakness and understands the organization is limited in resources and tasked with monitoring the entire State of New Mexico. However, we would add to this stated weakness the lack of data during the 8-10 years between monitoring assessments. As New Mexico continues to experience changes in its water landscape due to climate change stressors and urban growth, the degradation of waterways can occur rapidly. Amigos Bravos would like to see the NMED utilize partnerships with local organizations, schools, hunters/anglers, and other conservationists to continue the monitoring of TMDL waterways in between assessment periods, particularly ones that are on the verge of failing WQS and/or have experienced a degradation event such as fire or extreme flooding that could impact stream health. This will help alert the NMED to falling water quality standards and will also build ownership with community stakeholders to help maintain and improve their local waterways.

Amigos Bravos believes the water community in New Mexico is a potential strength for the TMDL analytical process and should be developed accordingly to help with the monitoring and implementation stages of the TMDL process.

SWQB Response:

Thank you for your comment. The interval between rotational surveys balances the need for sufficient sampling coverage for each waterbody in a watershed survey and obtaining sufficient data for assessment with the inability to sample more frequently. Competing priorities and resource limitations dictate trade-offs to shorten the monitoring rotation. SWQB plans to shorten the rotation to every six years in the Monitoring and Assessment Strategy revision (under development) by reverting to one year watershed surveys, targeting a max of n=4 for priority parameters, and reducing or removing sampling parameters that are not predominantly detected.

SWQB welcomes collaboration on community-based monitoring to build local stewardship in addition to producing data. SWQB also accepts data that meets the quality assurance requirements on a rolling basis and frequently obtains datasets from other agencies and outside data sources. Examples of these include CWA Section 319 project recipients reporting monitoring data, data pulled from the Water Quality Portal, permittees, USGS, and US EPA. Accordingly, the SWQB notes that the Bureau and Department are not solely internally reliant and assessments and TMDLs are often developed using a variety of data sources. As noted in the above Responses, SWQB plans to expand our volunteer monitoring program through dedicated grant-funded staff assignments to develop and strengthen partner relationships.

2.1 Target Loading Capacity

The report states "the SWQB Comprehensive Assessment and Listing Methodology says that for any one chemical/physical pollutant, there shall be no more than one exceedance of the acute criterion, and no more than one exceedance of the chronic criterion in three years." As the monitoring assessment period is only for two years, and then not again for 8-10 years, Amigos Bravos is unclear how a chronic criterion is

being assessed to occur less than once in a three-year period. It seems likely that a chronic condition could occur again outside of the assessment period and not be properly considered as a violation to the water quality standard.

SWQB Response:

Thank you for your comment. The assessment procedures are set out in the CALM. The exceedance thresholds are applied to the assessment dataset, and the three-year period referenced is the most recent three years within that dataset, counted on a rolling basis. "More than one exceedance" translates to two or more, so if least two exceedances of the chronic criterion are documented during a two-year survey (occurring during the rolling 3-year period), that supports a determination of non-support; the shorter survey period does not prevent a listing. SWQB also uses data from outside entities meeting the quality assurance requirements described above, which sometimes provide annual coverage between surveys or additional datapoints within a two or three-year period.

Impacts of Wildfires

Amigos Bravos was pleased to see the section on page 34 about the Calf Canyon/Hermits Peak Fire and that the SWQB was able to take some limited data on temperature post-fire. We also support the plan to stand up a multi-year monitoring initiative in the burn scar to evaluate post-fire conditions, identify priority areas for restoration projects, and verify trends in water quality as the watersheds recover. Considering that the fire was four years ago now, we encourage the SWQB to begin this initiative as soon as possible. This is another opportunity to build a collaboration platform with local organizations and agencies to assess potential rapid changes in stream water quality.

SWQB Response:

Thank you for your comment. The initiative described in Section 1.1 of the TMDL document is being developed with FEMA, USEPA, USGS, and the New Mexico Department of Homeland Security and Emergency Management, and its timing depends on the participating agencies, including those on the federal level, and on funding availability, rather than on SWQB alone. SWQB plans to return to the Upper Pecos watershed within the rotational monitoring survey timeline to collect data to inform assessments of the watershed in its new post-fire condition. SWQB continues to monitor and assess as resources allow and welcomes any outside data that meets our quality assurance requirements. SWQB is also aware of several local watershed groups active in the burned area, including the Upper Pecos Watershed Association and the Hermit's Peak Watershed Alliance. SWQB welcomes coordination with any organizations pursuing complementary restoration and planning efforts in the watershed.

Consideration of Seasonal Variation

This is a vital part of TMDL analysis, and we appreciate this section calling out effects on seasonal variation in all of the parameters analyzed. One more basic consideration for seasonal variation that we would like to see discussed is the fact that spring runoff is earlier in the season as climate change effects continue. How will this be worked into TMDL calculations?

SWQB Response:

Thank you for your comment. The critical condition for these TMDLs is the 4Q3 low flow, the lowest four consecutive day flow expected once in three years. Because 4Q3 is an annual low-flow statistic with a three-year recurrence interval, it captures the low-flow condition regardless of when in the year

it occurs, so a shift in the timing of spring runoff does not by itself invalidate the critical flow used. The 4Q3 statistic accounts for year-to-year variability in flow, so a shift in spring runoff timing is captured within that annual and inter-annual variation rather than treated as a separate seasonal input. Climate change is recognized in the Water Quality Standards at 20.6.4.6(D) NMAC, which provides that the standards serve to respond to its inherent threats and provide resiliency for continued protection of water quality.

Load Management

Amigos Bravos was encouraged by the report stating, "management of the load to improve stream water quality and meet water quality criteria at all times is the goal" (Page 44), and by the detail in section 2.2 (Flow). However, we would like further clarification on how the SWQB anticipates achieving this goal as additional demands are placed on our watersheds in continued extreme drought conditions. Has the SWQB explored minimal base flows or environmental flows to ensure water quality standards and aquatic ecosystem health are maintained? How will the SWQB balance these necessary flows with domestic and irrigation demand if drought conditions continue to worsen? Are there designations or protections, such as Outstanding National Resource Waters, that could help maintain base flows to protect water quality?

SWQB Response:

Thank you for your comment. The minimum flow incorporated into these TMDLs is the 4Q3 critical low flow; calculating the loading capacity at that condition is what keeps the allocation protective when flows are low. SWQB does not have authority to allocate water or establish minimum instream flows. Water rights administration rests with the Office of the State Engineer, particularly with regards to irrigation and domestic use. An ONRW designation is likewise a water quality protection rather than a flow protection; it constrains degradation but does not reserve a quantity of water.

SWQB does recognize hydrologic alteration as a form of pollution. Under Appendix J of the CALM, an AU impaired due to lack of adequate flow may be assigned to Integrated Report Category 4C and addressed through an Advance Restoration Plan or similar planning document. Where flow is a factor in the impairments addressed here it is also identified as a probable source; drought-related flow reduction and water diversion are both discussed in Section 4.4, and drought and water diversion are listed among the probable sources in Tables 3.6 and 7.6 and the Executive Summary tables.

Waste Load Allocation

In the description of Waste Load Allocations (WLA), the report states that it is not possible to calculate individual WLAs covered under general permits as these discharges are "typically transitory as the activities are temporary" (Page 77). Amigos Bravos would like to caution the SWQB in assuming these discharges are temporary in nature, and furthermore that the permittees are taking the necessary precautions to fulfill their management plans. As agencies throughout New Mexico are resource scarce, including enforcement personnel, violations and/or continued discharges are possible which would inhibit the Load Allocations and Margin of Safety to properly cover discharges to the system.

SWQB Response:

Thank you for your comment. A discharge not in compliance with its general permit is not an authorized load and is not accounted for in the Load Allocation(s); it is a compliance and enforcement matter rather than a TMDL allocation to be adjusted. SWQB encourages Amigos Bravos and the public to report suspected violations at https://www.env.nm.gov/general/report-an-environmental-issue-or-

incident/. We will forward your comment to the Point Source Regulation Section for review.

10.2.1 WBP and BMP Coordination (Page 124)

Amigos Bravos supports the SWQB's intent to utilize public awareness and involvement to achieve success in TMDL implementation, but we also want to be realistic about the time and resources needed to complete a watershed-based-plan. While the funding programs are a vital step in the right direction, additional resources, agency support, and the removal of required matching funds will be helpful to support the submission of these plans. Furthermore, the SWQB should understand the time required to not only develop the WBP but then to carry out project related discovery, development, and construction. Time is of the essence to protect our watersheds from further degradation and Amigos Bravos would like to see other avenues developed to support implementation of TMDL restoration projects.

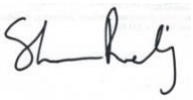
SWQB Response:

Thank you for your comment. The non-federal match associated with CWA Section 319(h) funding is a requirement of federal law and USEPA grant conditions, and NMED must provide it. SWQB does work with applicants on the forms match may take, including in-kind contributions and partner labor, which can materially reduce the cash burden on a local organization. NMED recently reduced CWA Section 319(h) match requirements to 10% for projects to reduce this burden on local organizations since the state-funded River Stewardship Program has been amply funded to help cover federal match requirements. Developing a Watershed Based Plan and carrying a project through construction is a multi-year undertaking that should be understood at the outset. Project timelines also reflect a deliberate approach to design and review intended to ensure the best use of public funds; rushing implementation projects tends to reduce their effectiveness and longevity.

The Nonpoint Source Management Program administers additional opportunities beyond Section 319, described at https://www.env.nm.gov/surface-water-quality/funding-opportunities/. We will forward your comment to the Nonpoint Source Management Program for review.

Thank you for the opportunity to provide input in and comment on the draft TMDL. We look forward to further discussion about the concerns that we have raised in our comments. Please do not hesitate to contact me at 575-758-3874 or sromeling@amigosbravos.org if further clarification or discussion on the above comments is merited or needed.

Sincerely,



Shannon Romeling
Projects and Foundations Coordinator Amigos Bravos

SWQB Response:

SWQB thanks Amigos Bravos for reviewing the draft document and submitting these comments. Several of the issues raised concern Bureau-wide methodology or other programs and will be forwarded to the Standards and Outreach Team, the Monitoring Team, the Watershed Protection Section (WPS) and the Point Source Regulation Section (PSRS), accordingly.