239043 – WASP Modeling Noble 2.1 MGD Scenario

WATER RESOURCES DIVISION
July 18, 2024

association of central oklahoma governments
4205 N. Lincoln Blvd. | Oklahoma City, OK 73105 | 405.234.2264 | Fax: 234.2200 | acogok.org

acog

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Association of Central Oklahoma Governments (ACOG) was asked by the city of Noble to assess the water quality impact on the Canadian River if the capacity of the wastewater plant increased to 2.1 MGD.

The regional WASP model by Guernsey (Guernsey, 2014) completed in October 2014 that was updated in 2019 was used in this effort in addition to local updates in 2023.

The Noble WWTP discharge is in a critical dissolved oxygen sag on the Canadian River. The location of this low oxygen condition is from the Norman discharge location at Kilometer 49.4 to the end of the model (Kilometer 0), or the thirty-one miles from Norman to Wayne, OK.

To achieve water quality standards at 2.1 MGD, the effluent quality will need to be changed from the present concentrations.

Modeling for spring conditions shows that the diurnal variation with an additional 2.1 MGD effluent at the Noble discharge location has two hours below the 6.0 mg/l standard. Modeling for summer conditions shows that the diurnal variation with an additional 2.1 MGD effluent at the Noble discharge location has five hours below the 5.0 mg/l standard. This attains the water quality requirements. Modeled winter conditions meet water quality standards.

Based on this modeling effort, the following changes to the effluent concentrations for the Noble WWTP are proposed in the following table:

Point Source	Parameter	Allowable Effluent Concentrations			Proposed Effluent Concentrations		
		Summer	Spring	Winter	Summer	Spring	Winter
Noble WWTP	CBOD5	25	25	25	12	25	25
	NH3N	12	12	12	4.1	4.1	4.1
	DO	5	2	2	5.5	5	2
	Daily Flow (MGD)	0.76	0.76	0.76	2.1	2.1	2.1

A. INTRODUCTION

The Association of Central Oklahoma Governments (ACOG) was asked by the city of Noble to assess the water quality impact on the Canadian River if the capacity of the wastewater plant increased to 2.1 MGD. The previous regional WASP model by Guernsey (Guernsey, 2014) completed in October 2014 was used in this effort.

The plant at the Noble site on the Canadian River currently uses the following effluent conditions as shown in Figure A-1.

Figure A-1 Noble 208 Plan

FACILITY 208:	NOBLE, NORTH	CITY/TOWN:	NOBLE
LEGAL LOCATION**:	S21 T08N R02W SE/NW/SE	COUNTY:	CLEVELAND
POD LOCATION:	S28 T08N R02W SE/SE/NE	SEGMENT:	520610
POD LATITUDE:	35° 08' 21" N	POD LONGITUDE:	97° 24' 26" W
OPDES #:	OK0031755	FACILITY ID #:	S- 20651
CURRENT TREATMENT PROCESS:	EXTENDED AERATION		
PRESENT AVG. DAILY FLOW (MGD):	0.38	2010 CENSUS POPULATION:	6,481
DESIGN AVG. DAILY FLOW (MGD):	0.76	YEAR 2035 PROJECTED POPULATION:	7,600
RECEIVING STREAM:	Canadian River (OK Waterbody ID: OK520610010010_05)	Stream Class:	Perennial
7-day 2-year low flow in MGD (7Q2)	ANNUAL 7Q2: 17.5 MGD	SPRING 7Q2: 154.5 MGD	
	SUMMER 7Q2: 17.5 MGD	WINTER 7Q2: 118.3 MGD	
DMA:	CITY OF NOBLE / NOBLE UTILITY AUTHORITY	DMA STATUS:	APPROVED
WASTELOAD ALLOCATION*:	Spring & Winter Limits (Nov- May): Secondary [30 mg/L BOD5 and 30 mg/l TSS] Summer Limits (Jun- Oct): 30 mg/L BODs, 30 mg/l TSS, and 5 mg/L DO		
Recommended Treatment Alternatives:			
A)	Upgrade		
		EPA Approval Date:	6/30/15
		Record Last Updated:	12/6/16

*Updated WLA based on WLA Study (October 2014) of the Canadian River from Union City to Wayne, Oklahoma.
**Updated based on permit (5/18/2009).
***7Q2 correction (12/6/2016)

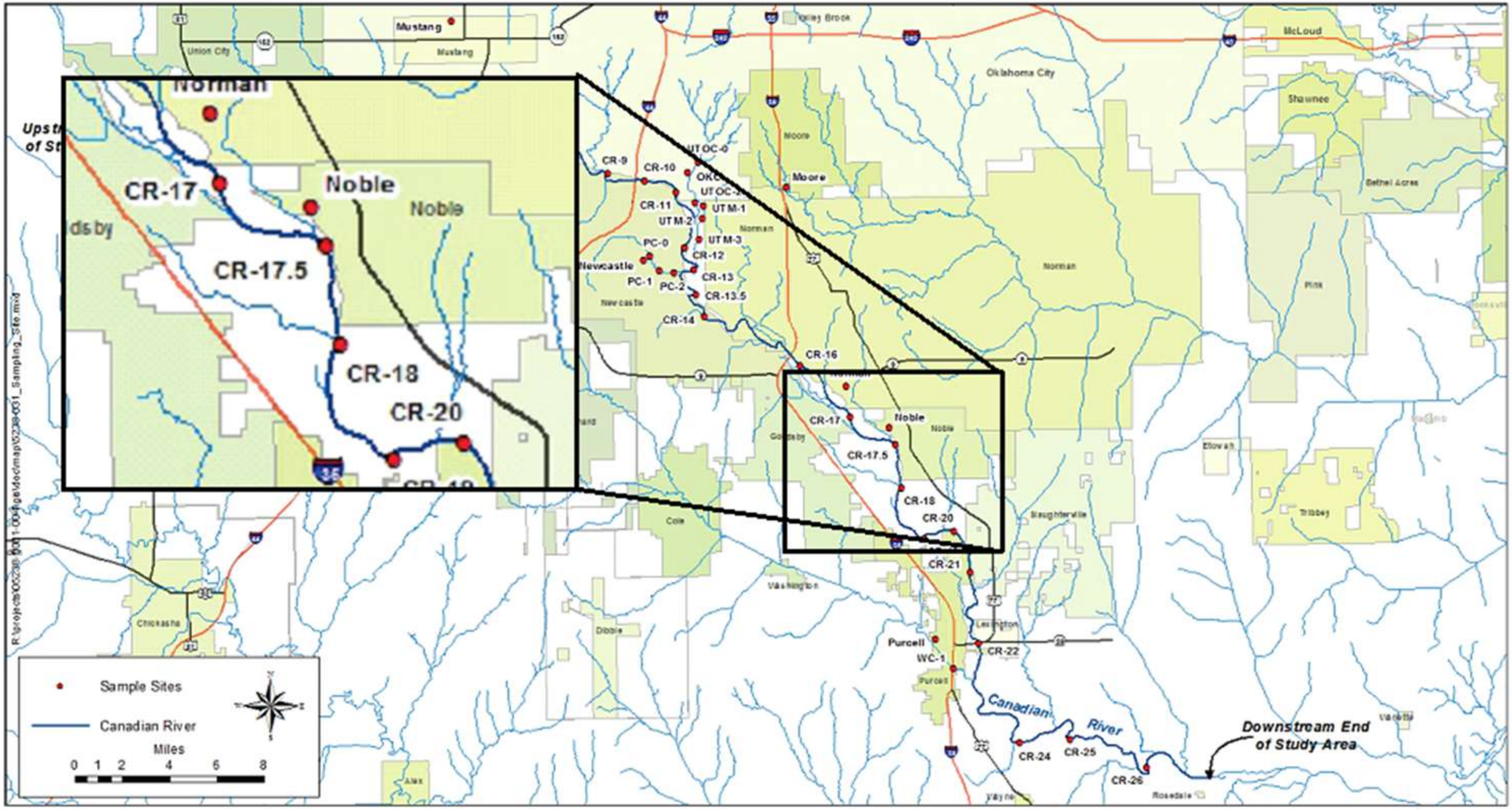
A1. GENERAL DESCRIPTION OF STUDY AREA

The original Garver project covered the Canadian River from the Highway 81 bridge near Minco to Wayne, OK (see Figure A-2). This report will focus on the Canadian River from the Noble discharge to the confluence of Bell Creek.

A1.1. Physiography/Ecoregions

The Canadian River is in the Interior Plains Physiographic Division, Rolling Plains. This area is characterized by slightly to moderately tilted, Permian age sedimentary rocks with Quaternary alluvium in the major river systems. In central Oklahoma, the river flows through two ecoregions including Cross Timbers and the Central Great Plains. Most of this WLA study area is in the Central Great Plains. The Central Great Plains was once grassland, with scattered low trees and shrubs. However much of this region is now cropland; the eastern boundary of this region marks the major winter wheat growing area of the United States.

Figure A-2 Canadian River Project Area (Guernsey, 2014)



A2. CLIMATE

The climate in central Oklahoma is temperate. Temperature and precipitation fluctuate widely on an annual basis compared with the average. The average annual temperature is 60.2 ºF. An average year has 77 days when the temperature is freezing or lower, but temperatures below zero degrees occur during about one third of the winters. Per climatological data (USDA, 1969), the coolest month for the Oklahoma City area is January with a mean temperature of 37.5 ºF. The warmest months are July and August. These months both have a mean temperature of 81.3 ºF.

Average annual rainfall is 32 inches per year, but the extremes range from 53.88 in 2015 to 17.84 inches in 1954. Wet months are usually May, June, and October. The driest months are December, January, and February. On average, about 33 percent of the annual precipitation is in spring, 29 percent in summer, 25 percent in fall, and 13 percent in winter.

A3. HYDROLOGY

The USGS has published stream flow data for the Canadian River at several flow gaging stations that are in or near the area of interest for this project. The flow gages with real time data were used to help determine when flows in the river were low enough to conduct the field studies for the regional project. The locations of the flow gages are shown in Figure A-3.

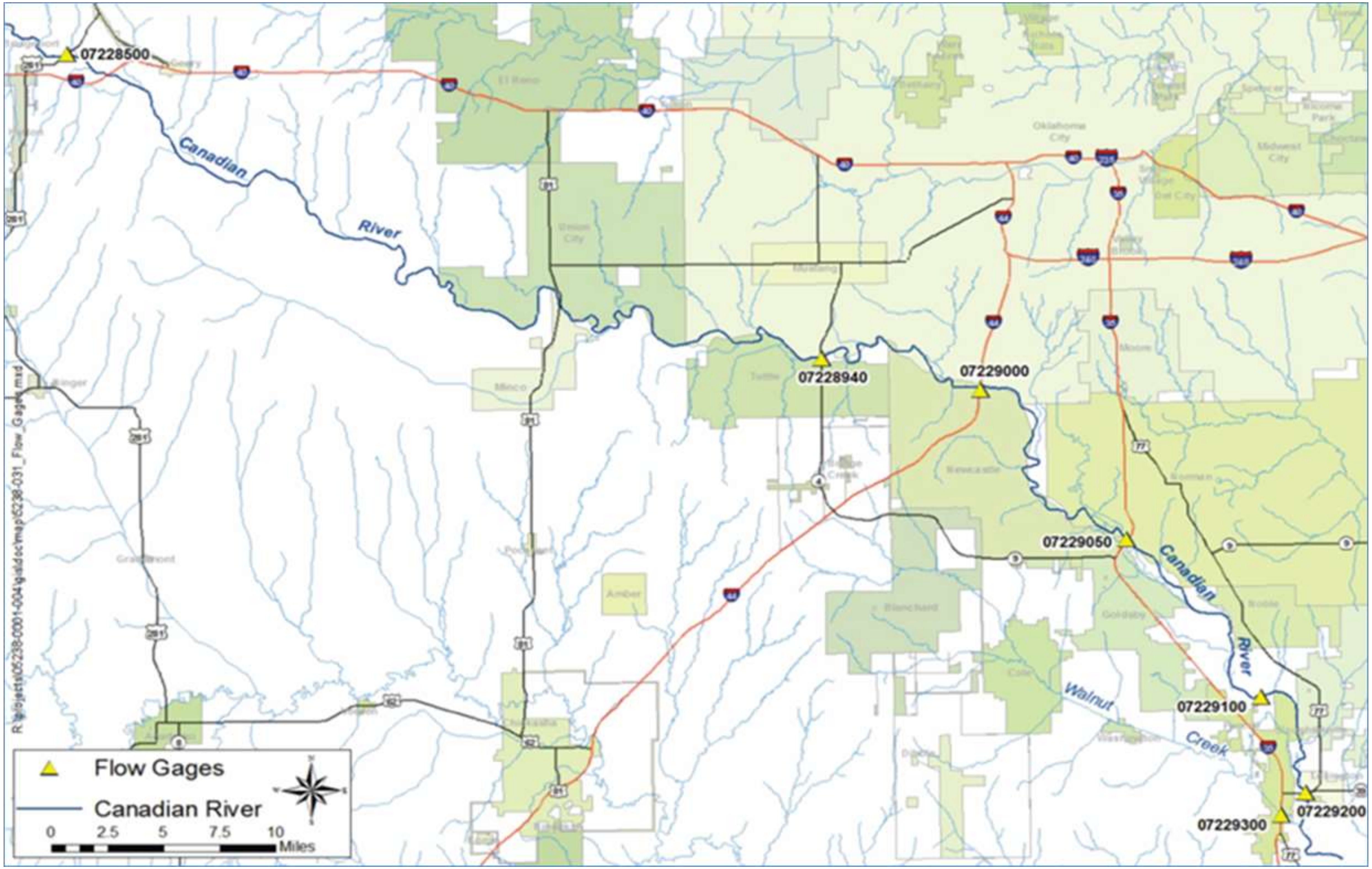
A4. GENERAL LAND USE

The Canadian River WLA study area contains the following communities and their representative populations:

- Union City (Canadian County) 1,404
- Noble (Grady County) 1,781
- Tuttle (Grady County) 5,842
- Mustang (Canadian County) 17,190
- Newcastle (McClain County) 7,010
- Oklahoma City (Cleveland County portion) 54,748
- Oklahoma City (Oklahoma County portion) 457, 589
- Moore (Cleveland County) 51,106
- Norman (Cleveland County) 106,707
- Noble (Cleveland County) 5,707
- Purcell (McClain County) 6,072
- Lexington (Cleveland County) 2,100

Land use within the WLA study area is characterized by a broad spectrum of uses. The western section of the original study area can be characterized as rural, with sporadic urbanization that is not necessarily adjacent to the river but is distant based on communities being located along tributaries of the Canadian River. Union City, Noble, Tuttle, Mustang, and Newcastle are all regional communities that are associated with the Oklahoma City metropolitan area.

Figure A-3 Flow Gauges Canadian River (after Guernsey, 2014)



Urbanization along the river significantly increases in the Newcastle area and becomes the predominant land use feature as the river turns to the south/southeast and flows adjacent to or through Oklahoma City, Moore, Norman, and Noble. There are portions of the river in this section that represent transitional mixed rural and urban uses, but in general, urbanization is the dominant feature.

A5. NONPOINT SOURCES

Nonpoint source (NPS) pollution comes from diffuse sources and is typically not defined by a single, isolated discharge location. NPS pollution is caused by rainfall or snowmelt moving over or through the ground. Natural and manmade pollutants are accumulated by the runoff and carried/deposited in lakes, rivers, and wetlands. Contaminants can include:

- Fertilizers, herbicides, and insecticides from agricultural practices
- Oil, grease, and toxic chemicals from urban sources
- Sediment from construction sites, crop, and forest lands, and eroding stream banks
- Salt from irrigation activities
- Bacteria and nutrients from livestock and faulty septic systems

NPSs make large contributions to degraded water quality throughout the United States. EPA reports that NPS pollution is the Nation’s largest source of water quality problems. In the Canadian River basin, and specifically within the study area, nonpoint sources are prevalent due to the varied land use activities. NPS pollution aligns very closely with land use and the types of land use in an area. Land uses in the study area include both rural and urban uses and the NPS pollution in the Canadian River Basin is consistent with the several types identified above.

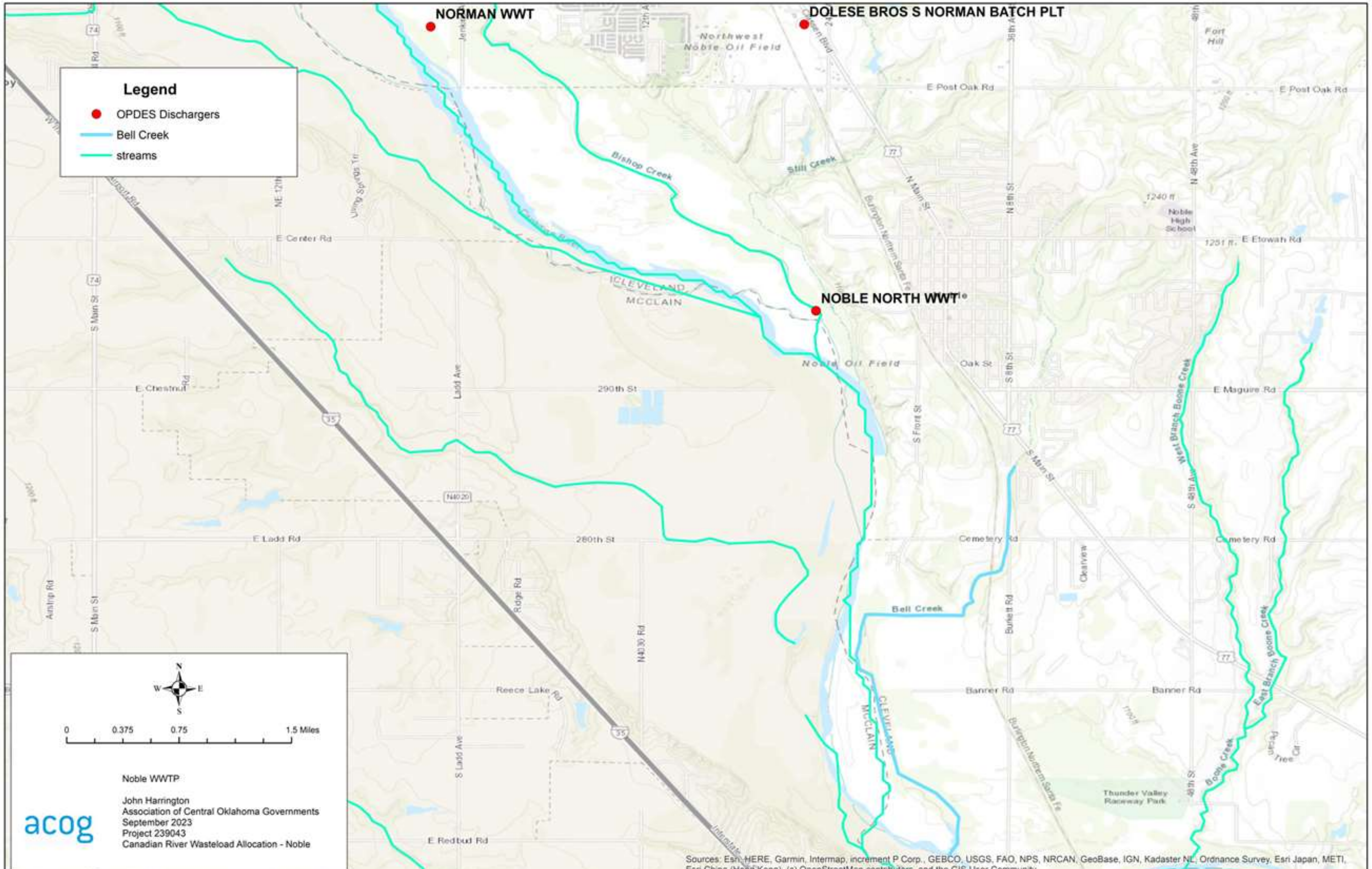
Within Oklahoma, the Oklahoma Conservation Commission (OCC) is the lead technical agency with authority over NPS pollution in Oklahoma. The OCC works with 88 conservation districts within Oklahoma to address NPS pollution through various programs.

A6. POINT SOURCES

Point sources are typically associated with a single discharge location (pipe, defined channel, etc.) of some type of waste effluent from municipal or industrial wastewater treatment facilities. The point source can include either treated or untreated waste. Within the study area, there are thirteen existing facilities with Oklahoma Pollutant Discharge Elimination System (OPDES) permits that discharge oxygen-demanding wastewater either directly into the Canadian River or into a tributary of the Canadian River, within several miles of the river. There is also one proposed facility (Tuttle’s Worley Creek facility) that would discharge oxygen-demanding wastewater into the Canadian River.

Figure A-2 and Figure A-4 identifies the current discharge locations as shown on the current ODEQ Map Viewer. Information for the map was also derived from OPDES permits and fact sheets, the ODEQ Water Quality Management Plan (WQMP), and questionnaires that were completed by permit holders during the Guernsey study (Guernsey, 2014).

Figure A-4 Point Sources Noble Area



A7. WATER QUALITY STANDARDS

Water quality standards, including designated uses, for water bodies in Oklahoma are established by the Oklahoma Department of Environmental Quality and published under Title 252 of the OAC. The designated uses for the Canadian River and other streams in the project area are listed in Table A-1.

The designated uses for "other streams" (the last row in the table) are the default designated uses that are specified in OAC 252:730-5-3. These default designated uses apply to the unnamed tributaries that receive discharges from the Oklahoma City (South Canadian) and Moore WWTPs. The last column in Table A-1 lists WWTP discharges that flow into each stream.

Table A-1 Designated Stream Uses (after Guernsey, 2014)

Stream	ID Number(s)	Designated Uses*	WWTP Discharges
Canadian River from the US Hwy. 81 bridge to its confluence with Buckhead Creek	520610010010, 520610020010, and 520610020150_00	AES, AG, WWAC, PBCR	Tuttle (proposed facility), Mustang, Norman, Noble, Lexington, Purcell
Tributary of Canadian River at SW 1/4, Sec. 3, T10N, R7W, IM	520610	AES, AG, HLAC, SBCR	Union City
Buggy Creek	520610020120	AES, AG, WWAC, PBCR, EWS	Minco
West Creek	520610020090	AES, AG, HLAC, SBCR	Tuttle (existing facility)
Store Creek	520610020080	AES, AG, WWAC, PBCR, PPWS	
Tributary of Pond Creek at NE 1/4, Sec. 14, T9N, R4W, IM (Tim's Creek)	520610010215	AES, AG, HLAC, SBCR	Newcastle
Pond Creek	520610010210	AES, AG, WWAC, PBCR, PPWS	
Other streams within the project area that are not listed above	--	AES, AG, WWAC, PBCR	Oklahoma City, Moore

NOTES: Abbreviations for designated uses are:
AES = aesthetics
AG = agriculture
WWAC = warm water aquatic community
HLAC = habitat limited aquatic community
PBCR = primary body contact recreation
SBCR = secondary body contact recreation
PPWS = public and private water supply
EWS = emergency water supply

The Noble WWTP is on the Canadian River next to the confluence of Bishop Creek (Figure A-4).

The water quality standards also specify numeric criteria for protecting designated uses. The designated uses that are of primary interest for this project are warm water aquatic community and habitat limited aquatic community. The water quality standards specify criteria for various parameters for protecting aquatic life, but the parameters of interest for this project are DO, ammonia nitrogen, and nutrients. The criteria for DO are presented in Table A-2.

Table A-2 Numeric Criteria for DO and Seasonal Temperatures

Season	Criteria for Minimum DO (mg/L)		Seasonal Temperature (°C)
	Habitat Limited Aquatic Community	Warm Water Aquatic Community	
Early Life Stages (4/01 – 6/15)	4.0	6.0 *	25
Summer Conditions (6/16 – 10/15)	3.0	5.0 *	32
Winter Conditions (10/16 – 3/31)	3.0	5.0	18

NOTE: *The following applies to the values marked with an asterisk: "Because of natural diurnal fluctuation, a 1.0 mg/L concentration deficit shall be allowed for not more than eight hours during any 24-hour period"

The water quality standards do not include numeric criteria for ammonia nitrogen, but 252:730-5-12(f)(6)(F) requires that permit limits for discharges of ammonia be set to prevent the discharge from causing acute toxicity at any location or chronic toxicity outside the mixing zone.

The water quality standards do not specify numeric criteria for nutrients that are applicable within the study area for this WLA, but the following narrative criterion applies to protection of aquatic life throughout Oklahoma and is specified in OAC 252:730-5-9(d) "Nutrients from point source discharges or other sources shall not cause excessive growth of periphyton, phytoplankton, or aquatic macrophyte communities which impairs any existing or designated beneficial use."

As specified in EPA's regulations at 40 Code of Federal Regulations (CFR) 130.7(b)(2), applicable water quality standards include anti-degradation requirements. Oklahoma's anti-degradation requirements are presented in OAC 252 Subchapter 3. None of the streams in Table 6 is specified as Outstanding Resource Waters, High Quality Waters, or Sensitive Water Supplies; therefore, the primary anti-degradation requirements for this project are:

- Application to beneficial uses: No water quality degradation which will interfere with the attainment or maintenance of an existing or designated beneficial use shall be allowed (252:730-3-2(d)).

- Application to improved waters: As the quality of any waters of the state improves, no degradation of such improved waters shall be allowed (252:730-3-2(e)).

B. WASP MODELING

B1. PREVIOUS MODELING

The original Guernsey report from 2014 includes detailed information concerning the field studies, WASP model setup, calibration, and validation. related to the setup and execution of the model if additional model development information is needed.

The WASP model was set up to simulate dissolved oxygen (DO), carbonaceous biochemical oxygen demand (CBOD5) from point sources, CBOD5 from ambient sources, organic nitrogen, ammonia nitrogen, nitrate nitrogen, organic phosphorus, ortho phosphorus, benthic algae, and two types of algae in the water column (represented in the input and output as chlorophyll a).

The model was calibrated for conditions during the first field study (August 8-13, 2010) and the model was validated by simulating conditions during the second field study (September 12-17, 2010). The WASP model was applied to the Canadian River from the US Highway 81 bridge near Union City to the confluence of Buckhead Creek near Rosedale. This corresponds to the same section of the Canadian River for which the aquatic life designated use was changed from habitat limited aquatic community to warm water aquatic community.

In the 2014 report, several projection scenarios were simulated and the dischargers collectively selected Scenario D. In Scenario D, the discharge from the City of Newcastle's wastewater treatment facility (WWTF) was relocated to the Canadian River near the mouth of Pond Creek (OK520610010010_10).

In 2018, ACOG developed a revision to Scenario D with the discharge from the Oklahoma City South Canadian WWTF moved to the Canadian River ("OK City proposed discharge location" on Figure 1). This modeling by ACOG has been approved by the Oklahoma Department of Environmental Quality (ODEQ). On October 4, 2018, ODEQ initiated a public comment period for incorporating the results of this modeling into the Water Quality Management Plan (WQMP).

An explicit margin of safety (MOS) of 5% was incorporated into the model as required by ODEQ for models that are both calibrated and verified. The MOS was applied to both the point source and nonpoint source oxygen demand by entering a value of 1.05263 (1.0 divided by 0.95) in the model as a "scale factor" for the sediment oxygen demand (SOD) and for all the inflow concentrations of ammonia nitrogen, point source CBOD5, and ambient CBOD5. The model internally multiplies the user-specified SOD values and inflow concentrations with these scale factors.

B2. SUBSEQUENT MODELING

Subsequent modeling in 2019-23 updated the Canadian River model to include Newcastle PWA's proposed discharge location which moved to the Canadian River near the end of Northeast 16th Street, which is approximately 2 miles upstream of the mouth of Pond Creek at Kilometer 71.2.

Other changes include moving the discharge from Oklahoma City directly to the Canadian River at Kilometer 77 and the Tuttle discharge directly to Kilometer 98.5. The city of Moore discharge is also at Kilometer 69.2, rather than the original tributary.

The Newcastle move did not change the quality of the effluent, however. The effluent standard for Newcastle is 12.0 NH4/18.0 CBOD5/2.0 DO for the entire year. The original report noted that this year-round standard "allows Newcastle to utilize a larger percentage of the river's assimilative capacity for summer" because Moore and Oklahoma City discharged into tributaries of the river (Guernsey, 2014).

However, now that Moore and Oklahoma have moved discharge points, one must return to this situation and address once again the fact that Newcastle will certainly be increasing their wasteload. The effluent quality will be the same as Oklahoma City and Moore.

Table B-2 through Table B-6 details the discharge amounts and effluent characteristics of the eleven dischargers in the Canadian River system from Union City to Wayne, OK that were used in the present WASP model.

B2.1. MODEL VERSION

There are several model versions of WASP available at present, including versions 7.3, 7.5 and 8.32. The model version utilized in this report is a version of WASP7.3 (shown in the splash screen), but which incidentally is labeled WASP 8 in the model build notes (see Table B-1). The build date is 12/26/2011. This is NOT the version on the EPA website. Additional modifications include an updated Multi-Algae.dll file to give more accurate dissolved oxygen calculations, which must replace the version that comes with the 12/26/2011 build.

Table B-1 WASP Model Build Notes

```
=================================================================
USEPA -- WASP Version 8.0                                Built on: 12/26/2011
Built on: 12/26/2011
 Eutro-Periphyton, Multi-Algae
=================================================================

   EPA would like to acknowledge the following groups for their
contribution to the enhancement of the Eutrophication Module

   Dr. James L. Martin -- Mississippi State University
           General Model Enhancements/SOD/Periphyton

  Dr. Dominic Di Toro -- Hydro Qual/Delaware University
      10 Years of Research in SOD/Nutrient Fluxes

   QEA LLC -- Montvale, NJ -- SOD Algorithms

   HydroQual -- Mahwah, NJ -- SOD/Periphyton Algorithms

   Dr. Steven C. Chapra -- Tufts University -- Periphyton Algorithms

=================================================================
```

Table B-2 WASP Model Effluent Inputs Union City to Tuttle

PLANT	Parameter	Note	Spring Effluent Standard	Spring WASP Model Units	Summer Effluent Standard	Summer WASP Model Units	Winter Effluent Standard	Winter WASP Model Units
Union City	CBOD5		25.0	57.5			25.0	57.5
Union City	DO		2.0	2.0			2.0	2.0
Union City	FLOW MGD	No Discharge for summer only	0.200	0.310	No Discharge	No Discharge	0.2	0.3
Union City	NH3N		15.4	15.4			15.4	15.4
Union City	TSS		90.0	90.0			90.0	90.0
Minco WWTP	CBOD5		12.0	27.6			25.0	57.5
Minco WWTP	DO		5.0	5.0			2.0	2.0
Minco WWTP	FLOW MGD	No Discharge for summer only	0.215	0.333	No Discharge	No Discharge	0.215	0.333
Minco WWTP	NH3N		3.7	3.7			15.4	
Minco WWTP	TSS		90.0	90.0			90.0	90.0
Tuttle (S Canadian Discharge)	CBOD5		25.0	57.5	8.0	18.4	25.0	57.5
Tuttle (S Canadian Discharge)	DO		2.0	2.0	6.5	6.5	2.0	2.0
Tuttle (S Canadian Discharge)	FLOW MGD		0.5	0.8	0.5	0.8	0.5	0.8
Tuttle (S Canadian Discharge)	NH3N		12.0	12.0	2.3	2.3	12.0	12.0
Tuttle (S Canadian Discharge)	TSS		90.0		90.0		90.0	

Table B-3 WASP Model Effluent Inputs Mustang to OG&E

PLANT	Parameter	Note	Spring Effluent Standard	Spring WASP Model Units	Summer Effluent Standard	Summer WASP Model Units	Winter Effluent Standard	Winter WASP Model Units
Mustang WWTP	CBOD5		9.0	20.7	7.0	16.1	13.5	31.1
Mustang WWTP	DO		5.0	5.0	6.5	6.5	5.0	5.0
Mustang WWTP	FLOW MGD		3.0	4.6	3.0	4.6	3.0	4.6
Mustang WWTP	NH3N		3.8	3.8	1.4	1.4	4.1	4.1
Mustang WWTP	TSS		10.0		10.0		22.0	
Oklahoma City WWTP Canadian River Direct Discharge	CBOD5		10.0	23.0	8.0	18.4	25.0	57.5
Oklahoma City WWTP Canadian River Direct Discharge	DO		7.0	7.0	7.5	7.5	5.0	5.0
Oklahoma City WWTP Canadian River Direct Discharge	FLOW MGD		8.7	13.4	8.7	13.4	8.7	13.4
Oklahoma City WWTP Canadian River Direct Discharge	NH3N		1.0	1.0	0.5	0.5	4.1	4.1
Oklahoma City WWTP Canadian River Direct Discharge	TSS		30.0	30.0	30.0	30.0	30.0	30.0
OG+E McClain Generating Station	CBOD5		25.0	57.5	9.0	20.7	25.0	57.5
OG+E McClain Generating Station	DO		2.0	2.0	4.0	4.0	2.0	2.0
OG+E McClain Generating Station	FLOW MGD		0.4	0.6	0.4	0.6	0.4	0.6
OG+E McClain Generating Station	NH3N		12.0	12.0	3.2	3.2	12.0	12.0
OG+E McClain Generating Station	TSS							

Table B-4 WASP Model Effluent Inputs Moore to Norma

PLANT	Parameter	Note	Spring Effluent Standard	Spring WASP Model Units	Summer Effluent Standard	Summer WASP Model Units	Winter Effluent Standard	Winter WASP Model Units
Moore WWTP	CBOD5		6.0	13.8	5.0	11.5	15.0	34.5
Moore WWTP	DO		7.4	7.4	6.5	6.5	7.4	7.4
Moore WWTP	FLOW MGD		9.0	13.9	9.0	13.9	9.0	13.9
Moore WWTP	NH3N		1.4	1.4	1.4	1.4	4.1	4.1
Moore WWTP	TSS		10.0		10.0		20.0	
Newcastle WWTP	CBOD5		18.0	41.4	18.0	41.4	18.0	41.4
Newcastle WWTP	DO		2.0	2.0	2.0	2.0	2.0	2.0
Newcastle WWTP	FLOW MGD		1.5	2.3	1.5	2.3	1.5	2.3
Newcastle WWTP	NH3N		12.0	12.0	12.0	12.0	12.0	12.0
Newcastle WWTP	TSS		30.0		30.0		30.0	
Norman WWTP	CBOD5		13.0	29.9	8.0	18.4	25.0	57.5
Norman WWTP	DO		5.0	5.0	6.5	5.0	5.0	5.0
Norman WWTP	FLOW MGD		16.0	24.8	16.0	24.8	16.0	24.8
Norman WWTP	NH3N		4.1	4.1	1.6	1.6	4.1	4.1
Norman WWTP	TSS		30.0		10.0		30.0	

Table B-5 WASP Model Effluent Inputs Noble to Lexington

PLANT	Parameter	Note	Spring Effluent Standard	Spring WASP Model Units	Summer Effluent Standard	Summer WASP Model Units	Winter Effluent Standard	Winter WASP Model Units
Noble WWTP	CBOD5		25.0	57.5	25.0	57.5	25.0	57.5
Noble WWTP	DO		2.0	2.0	5.0	5.0	2.0	2.0
Noble WWTP	FLOW MGD		0.8	1.2	0.8	1.2	0.8	1.2
Noble WWTP	NH3N		12.0	12.0	12.0	12.0	12.0	12.0
Noble WWTP	TSS		30.0		30.0		30.0	
Noble WWTP (Proposed)	CBOD5		25.0	57.5	12.0	27.6	25.0	57.5
Noble WWTP (Proposed)	DO		5.0	5.0	5.5	5.5	5.0	5.0
Noble WWTP (Proposed)	FLOW MGD		2.1	3.3	2.1	3.3	2.1	3.3
Noble WWTP (Proposed)	NH3N		4.1	4.1	4.1	4.1	4.1	4.1
Noble WWTP (Proposed)	TSS		30.0		30.0		30.0	
Lexington WWTP	CBOD5		25.0	57.5	25.0	57.5	25.0	57.5
Lexington WWTP	DO		2.0	2.0	2.0	2.0	2.0	2.0
Lexington WWTP	FLOW MGD		0.3	0.4	0.3	0.4	0.3	0.4
Lexington WWTP	NH3N		12.0	12.0	12.0	12.0	12.0	12.0
Lexington WWTP	TSS		30.0		30.0		30.0	

Table B-6 WASP Model Effluent Inputs Purcell

PLANT	Parameter	Note	Spring Effluent Standard	Spring WASP Model Units	Summer Effluent Standard	Summer WASP Model Units	Winter Effluent Standard	Winter WASP Model Units
Purcell WWTP	CBOD5		25.0	57.5	25.0	57.5	25.0	57.5
Purcell WWTP	DO		2.0	2.0	2.0	2.0	2.0	2.0
Purcell WWTP	FLOW MGD		0.8	1.2	0.8	1.2	0.8	1.2
Purcell WWTP	NH3N		15.4	15.4	7.2	7.2	15.4	15.4
Purcell WWTP	TSS		90.0		90.0		90.0	

B3. MODEL DISCUSSION

This model is based on the original 2014 model done for ACOG by Guernsey and updated with modifications that include discharges for Oklahoma City, Moore, Tuttle, and Newcastle. The baseline conditions for the Noble wasteload analysis used the updates to the Canadian River WASP model through 2023 as detailed in Table B-2 through Table B-6.

The critical water quality standards that need to be addressed is found in Table B-7. These are the numeric criteria for dissolved oxygen and seasonal temperatures. For the proposed expansion to the Noble WWTP modeled effluent quantity at 2.1 MGD.

B3.1. Spring Season (Early Life Stages)

Table B-7 Numeric Criteria for DO and Seasonal Temperatures

Season	Criteria for Minimum DO (mg/L)		Seasonal Temperature (°C)
	Habitat Limited Aquatic Community	Warm Water Aquatic Community	
Early Life Stages (4/01 – 6/15)	4.0	6.0 *	25
Summer Conditions (6/16 – 10/15)	3.0	5.0 *	32
Winter Conditions (10/16 – 3/31)	3.0	5.0	18

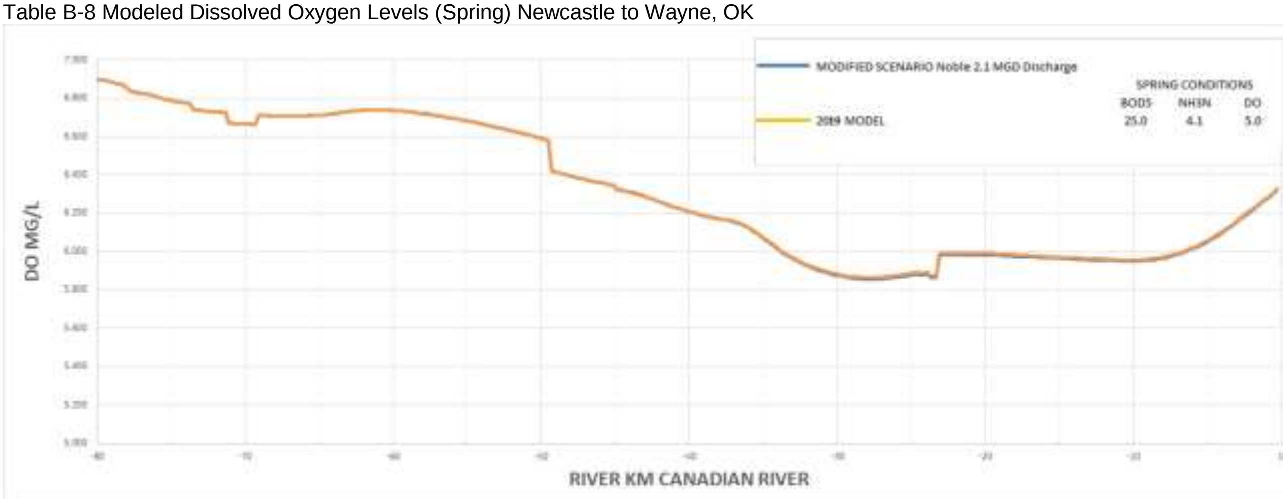
NOTE: *The following applies to the values marked with an asterisk: “Because of natural diurnal fluctuation, a 1.0 mg/L concentration deficit shall be allowed for not more than eight hours during any 24-hour period”

One of the areas of concern for the WASP Canadian River models is the dissolved oxygen levels from Kilometer 50 to the end of the model near Wayne, OK. This dissolved oxygen sag in the river starts with the Norman, OK discharge and extends to the end of the model at Wayne, OK, but becomes critical 10 km downstream from the Noble discharge point where the modeled dissolved oxygen drops below 6.0 mg/l.

Table B-8 shows that the increase in the Noble discharge has a very small effect on the dissolved oxygen sag. However, one must look at locations inside the dissolved oxygen sag in a temporal mode to determine if water quality standards have been violated. The model must indicate that the dissolved oxygen is not below 6.0 for a period of more than eight hours.

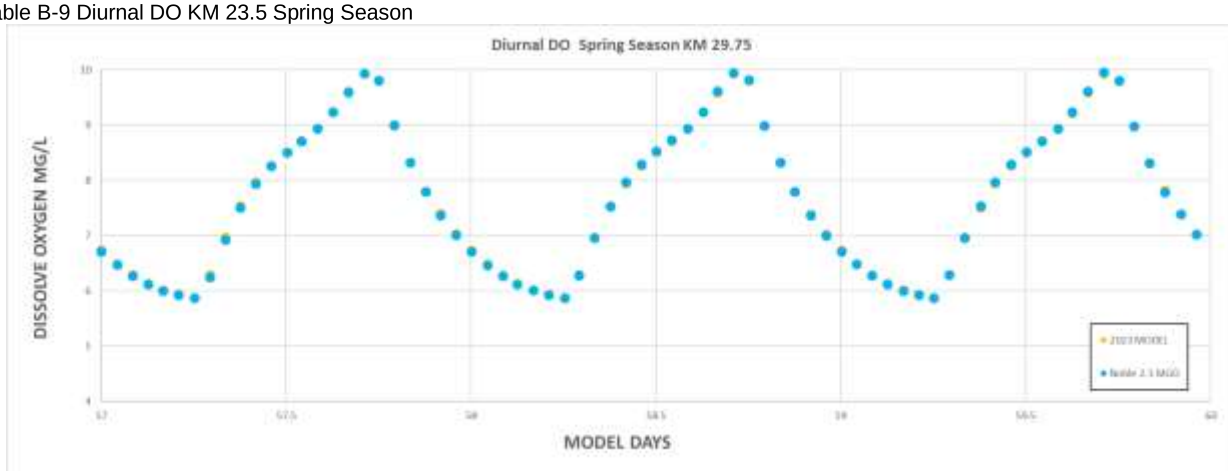
The model was run on an hourly basis for the last three days to calculate diurnal dissolved oxygen levels. In the dissolved oxygen sag, the most critical location was determined to be Kilometer 23.8. just upstream of the Purcell discharge at 23.5. Table B-9 shows the hourly variation for this location.

Table B-8 Modeled Dissolved Oxygen Levels (Spring) Newcastle to Wayne, OK



The diurnal variation at this location for the last three days of the 2023 model run shows that the diurnal variation dips below 6.0 mg/l for two hours each day, thus still attaining water quality standards. With an additional 2.1 MGD effluent at the Noble discharge location the model does not change – the dissolved oxygen sag persists for two hours below the 6.0 standard. This attains the water quality requirements as stated in Table B-7.

Table B-9 Diurnal DO KM 23.5 Spring Season



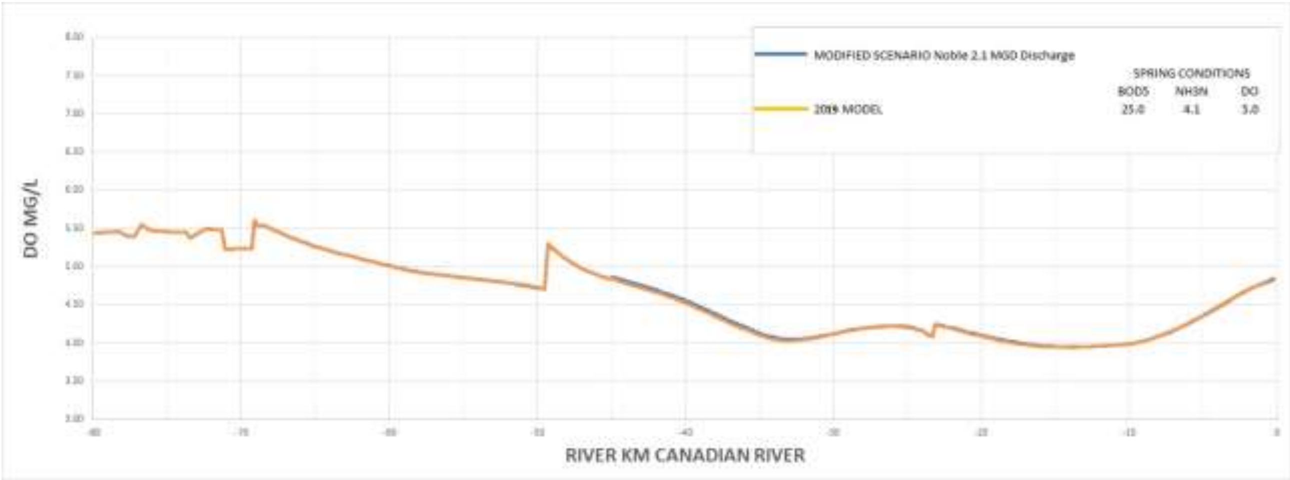
B3.2. Summer Conditions

Summer conditions show that the area of concern in the summer model is similar to the spring model (Table B-10). The city of Norman discharge briefly interrupts a large, dissolved oxygen sag from the Newcastle discharge to Wayne, OK.

As with the spring model, the model was run on an hourly basis for the last three days to calculate diurnal dissolved oxygen levels. In the dissolved oxygen sag, the most critical location was determined to be Kilometer 14.25 upstream of the Purcell discharge. Table B-11 shows the hourly variation for this location.

The diurnal variation at this location for the last three days of the model run shows that the diurnal

Table B-10 Modeled Dissolved Oxygen Levels (Summer) Newcastle to Wayne, OK



variation with an additional 2.1 MGD effluent at the Noble discharge location has five hours below the 5.0 mg/l standard, similar to the 2019 model (Table B-11).

Table B-11 Diurnal DO KM 14.5 Summer Season

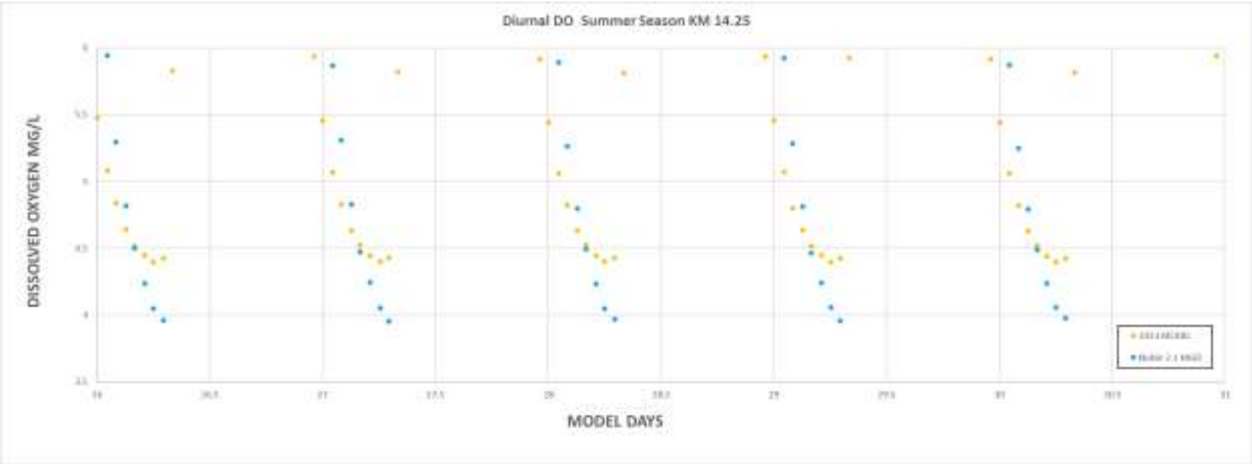
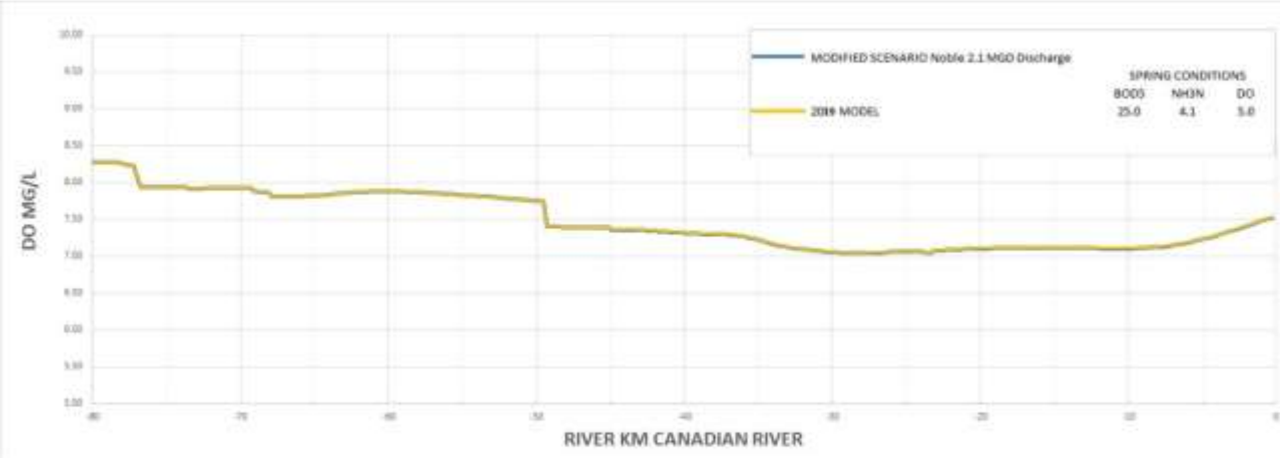


Table B-12 Modeled Dissolved Oxygen Levels (Winter) Newcastle to Wayne, OK



B3.3. Winter Conditions

The model for winter conditions indicates that the dissolved oxygen sag below Norman meets water quality criteria. Table B-12 illustrates this relationship.

B4. CONCLUSION

The Noble WWTP discharge is in a critical dissolved oxygen sag on the Canadian River. The location of this low oxygen condition is roughly from the Norman discharge location at Kilometer 49.4 to the end of the model (Kilometer 0), or the thirty-one miles from Norman to Wayne, OK.

Modeling for spring conditions shows that the diurnal variation with an additional 2.1 MGD effluent at the Noble discharge location has two hours below the 6.0 mg/l standard at the 25 CBOD5/4.1 NH4/5 DO effluent characteristics. This attains the water quality requirements. The modeled summer discharge at 12 CBOD5/4.1 NH4/5.5 DO is like the 2023 modeled hourly diurnal water quality variations in the dissolved oxygen sag at five hours below 5.0 mg/l. Modeled winter conditions meet water quality standards. Because of this modeling effort, the following changes to the effluent concentrations for the Noble WWTP are proposed in Table B-13.

Table B-13 Proposed Changes to Noble WWTP Effluent Concentrations

Point Source	Parameter	Allowable Effluent Concentrations			Proposed Effluent Concentrations		
		Summer	Spring	Winter	Summer	Spring	Winter
Noble WWTP	CBOD5	25	25	25	12	25	25
	NH3N	12	12	12	4.1	4.1	4.1
	DO	5	2	2	5.5	5	2
	Daily Flow (MGD)	0.76	0.76	0.76	2.1	2.1	2.1

B5. REFERENCES

ACOG, 2018. *184001 - WASP Modeling OKC. Final Report*.

Guernsey, 2014, *Wasteload Allocation Study Canadian River Union City to Wayne, Oklahoma*, presented to Association of Central Oklahoma Governments, 343p.

Guernsey, 2019, *Wasteload Allocation Report for the Newcastle PWA June 2019,* presented to ODEQ, 20p.

OK Mesonet, 2017, *Annual Precipitation History with 5-Year Tendencies,* Retrieved from http://climate.ok.gov/index.php/climate on 9/14/2017.

OK Mesonet, 2017, *Groundwater*, Retrieved from http://www.mesonet.org/index.php/weather/groundwater on 9/14/2017.

Oklahoma Administrative Code (OAC 252:730)

Table B-14 WASP Model Canadian River Spring Conditions

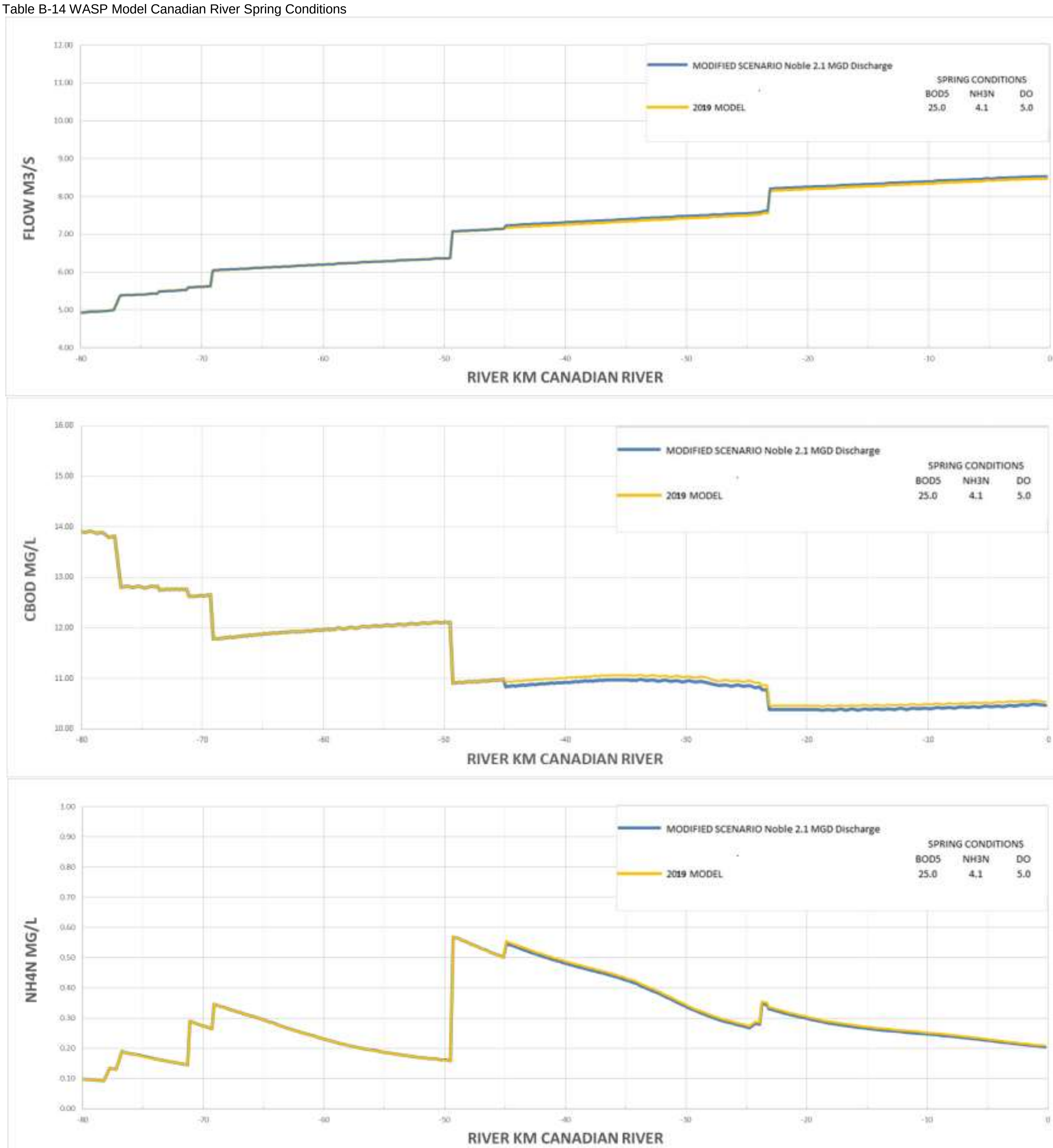


Table B-15 WASP Model Canadian River Summer Conditions

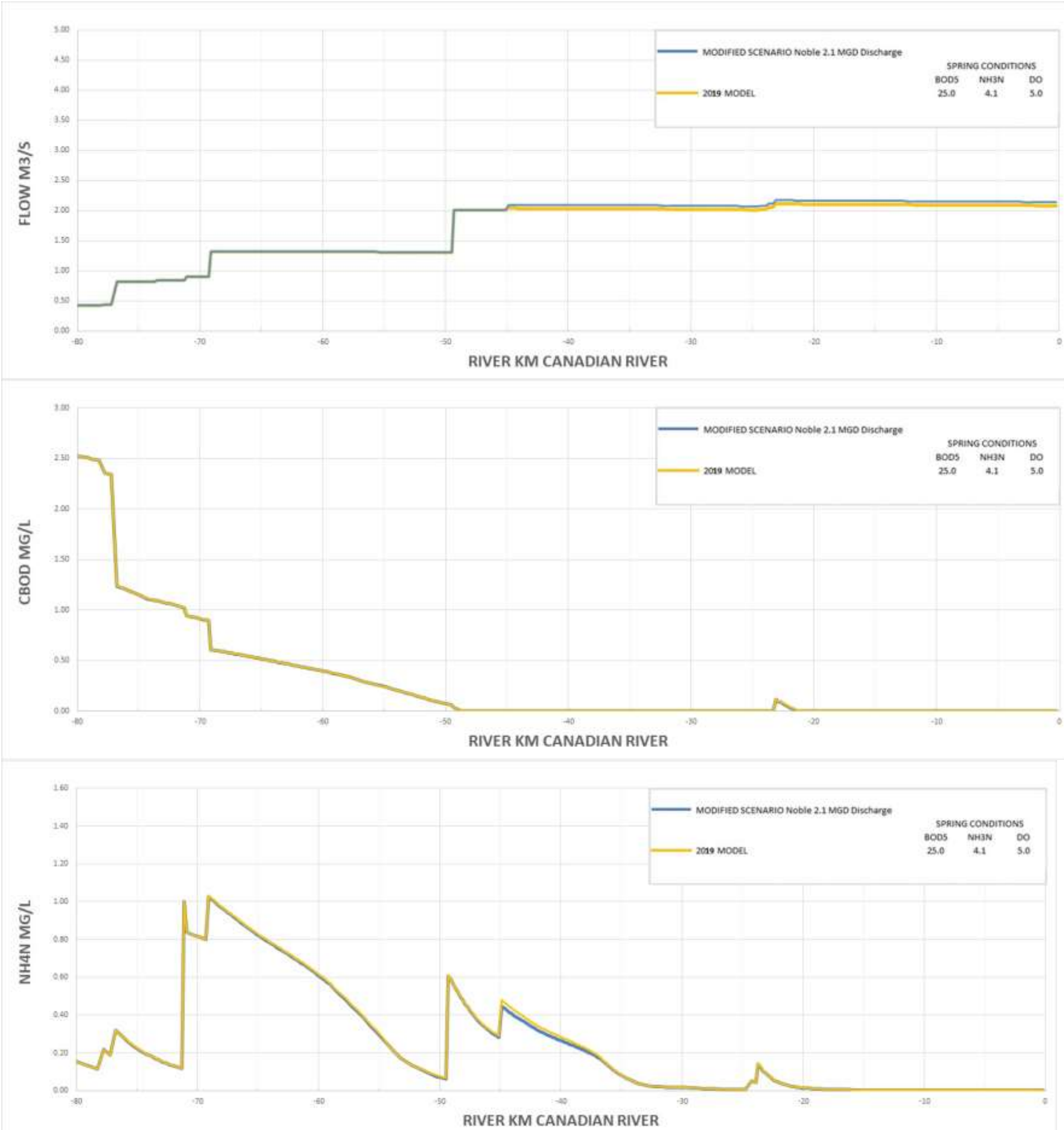


Table B-16 WASP Model Canadian River Winter Conditions