Water Quality Improvement Plan
for

Des Moines River – Five Segments

Polk, Warren and Marion Counties, Iowa

Total Maximum Daily Load
For Pathogen Indicators (*E. coli*)

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General Report Summary

What is the purpose of this report?

This Water Quality Improvement Plan has two purposes. First, it is a resource to be used by watershed planners, water quality action groups, individual citizens, and local and state government staff. It serves as a guide to help these groups understand and identify the cause of the Des Moines River water quality problems and to guide locally driven water quality improvement efforts. The problem addressed in this report is high bacteria concentration. Second, this report satisfies the Federal Clean Water Act obligation to establish a Total Maximum Daily Load (TMDL) for waterbodies on the 303(d) impaired waters list.

What's wrong with the Des Moines River?

The Des Moines River has bacteria concentrations that exceed the Water Quality Standards (WQS). This problem inhibits and reduces recreational use of the river in the impaired reaches.

What is causing the problem?

The Des Moines River is impaired for bacteria in five segments designated for primary contact recreation between the Saylorville and Red Rock Reservoirs. The bacteria problem, measured by *E. coli* concentration, is caused by overflowing sewers, undisinfected wastewater treatment plant discharges, runoff from developed urban areas, livestock manure, poorly functioning septic tank systems, and wildlife.

What can be done to improve the Des Moines River?

To improve the water quality of these five Des Moines River segments, bacteria loads delivered to the river must be reduced. A combination of the following management practices can be implemented to achieve these reductions:

- Eliminating sanitary and combined sewer overflows
- Disinfecting wastewater treatment plant discharges
- Controlling bacteria in urban runoff
- Limiting where and when manure is applied to agricultural lands and adoption of manure application strategies that reduce runoff
- Restricting cattle and other livestock from streams
- Inspecting, repairing, and maintaining septic tank systems to comply with state design standards

Who is responsible for a cleaner Des Moines River?

Everyone who lives, works, or plays in the watershed has a role in water quality improvement. Cities need to take responsibility for combined and sanitary sewer overflows, the disinfection of the discharges from their wastewater treatment facilities, and the control of urban stormwater discharges that have bacteria loads.

Unregulated nonpoint sources in the watershed need to incorporate voluntary management of livestock and manure applications to land to see positive results.

Much of the land draining to the river is in agricultural production, and financial assistance is often available from government agencies to individual landowners willing to adopt changes in livestock and manure management. Improving Des Moines River water quality will require the collaboration of citizens and agencies with an interest in protecting the river now and in the future.

Required Elements of the TMDL

This Water Quality Improvement Plan has been prepared in compliance with the current regulations for TMDL development that were promulgated in 1992 as 40 CFR Part 130.7 in compliance with the Clean Water Act. These regulations and consequent TMDL development are summarized below in Table 1.

Table 1 Required TMDL Elements

Name and geographic location of the impaired or threatened waterbodies for which the TMDLs are being established:	Des Moines River, five contiguous impaired segments, • IA 04-LDM-0040-segment 1 Red Rock Reservoir to South R. confluence • IA 04-LDM-0040-segment 2, South R. confluence to North R. confluence. • IA 04-LDM-0040-segment 3, North R. confluence to Raccoon R. confluence • IA 04-UDM-0010-segment 1, Raccoon R confluence to Center St. Dam • IA 04-UDM-0010-segment 2, Center St. Dam to I-80/35 bridge
Surface water classification and designated uses:	Class A1, primary contact recreation Class B (WW), warm water aquatic life Class C, drinking water source Class HH, human health, fish consumption
Impaired beneficial uses:	Class A1, primary contact recreation (March 15 to November 15)
TMDL priority level:	High Priority. The three impaired segments that comprise the LDM 0040 reach are listed in the EPA Consent Decree.
Identification of the pollutants and applicable Water Quality Standards (WQS):	Pathogen Indicator, *E. coli*. Primary contact recreational use (Class A1) is not supported due to violation of the *E. coli* Water Quality Standard criteria of 126 organisms/100 ml for the geometric mean and 235 organisms/100 ml for the single sample maximum.
Quantification of the pollutant loads that may be present in the waterbody and still allow attainment and maintenance of water quality standards:	The targets for all five of the Des Moines River segments are the Iowa WQS numeric limits for *E. coli,* a geometric mean of 126 *E. coli* organisms/100 ml or a single sample maximum of 235 *E. coli* organisms /100ml. The TMDLs for the five impaired segments have been calculated based on three monitoring sites used for the 2008 water quality assessment. The load capacities for these sites are in Tables 11 to 13.

Quantification of the amount or degree by which the current pollutant loads in the waterbody, including the pollutants from upstream sources that are being accounted for as background loading, deviate from the pollutant loads needed to attain and maintain water quality standards:	The *E. coli* load departure from capacity has been calculated for five flow recurrence intervals at each of the three assessment sites. Tables 17 to 19 list the existing loads and the departures from capacity.
Identification of pollution sources:	Point and nonpoint sources.
Wasteload allocations (WLA) for pollutants from point sources:	The wasteload allocations are in Tables 22 to 25. The four tables are for permitted wastewater treatment plants, municipal stormwater discharges, open feedlots, and a set aside for unsewered communities that will be permitted in the future, respectively.
Load allocations for pollutants from nonpoint sources (NPS):	The load allocations for the three assessment sites at the five flow recurrence intervals at both the geometric mean and single sample maximum criteria are in Tables 35 to 40.
Margin of safety (MOS):	The MOS are an explicit ten percent of the TMDL and are shown in Tables 35 to 40.
Consideration of seasonal variation:	These TMDLs were developed based on the Iowa WQS primary contact recreation season that runs from March 15 to November 15.
Allowance for reasonably foreseeable increases in pollutant loads:	An allowance for increased pathogen indicator loading was not included in this TMDL. All discharges into the impaired Des Moines River segments are expected to comply with the Iowa WQS. Any new permitted point source discharge would be required to meet the WQS limits. Any new nonpoint sources would be expected to meet the *E. coli* limits.
Implementation plan:	A general implementation plan is provided in Section 4 of this document to guide local citizens, government, and water quality groups. *E. coli* reduction will be accomplished through a combination of regulatory and non-regulatory activities. Point sources will be regulated through the National Pollutant Discharge Elimination System (NPDES) permitting process. Nonpoint source pollutants will be addressed using available programs, technical advice, information and education, and financial incentives.

1. Introduction

The Federal Clean Water Act requires states to assess their waterbodies every even numbered year and incorporate these assessments into the 305(b) Water Quality Assessment Report. Assessed lakes and streams that do not meet the Iowa Water Quality Standards (WQS)criteria are placed on the 303(d) Impaired Waters List. Subsequently, a Total Maximum Daily Load (TMDL) for each pollutant must be calculated and a Water Quality Improvement Plan written for each impaired water body.

A TMDL is a calculation of the daily maximum amount of a pollutant a waterbody can receive without exceeding the water quality standards. The total maximum daily load is allocated to permitted point sources (wasteload allocations), nonpoint sources (load allocations), and to a margin of safety that accounts for uncertainty in the calculations.

This TMDL report is for five segments of the Des Moines River between Saylorville and Red Rock Reservoirs in Polk, Warren, and Marion Counties. The five segments are on the 2008 impaired waters list for *E. coli*, a pathogen indicator.

There are two primary purposes of this report: 1) Satisfy federal TMDL requirements for impaired waters, and 2) Serve as a resource for guiding water quality improvement projects in the Des Moines River watershed that address bacteria problems. Local citizens, water quality groups, and government agencies will find it a useful account of the causes and solutions to the Des Moines River water quality concerns.

A TMDL report has some limitations:

- The 305(b) water quality assessment is made with available data that may not sufficiently describe water quality. Additional targeted monitoring is often expensive and requires time. Assumptions and simplifications on the nature, extent, and causes of impairment can cause uncertainty in calculated values.
- A TMDL may not deal easily with unregulated nonpoint sources of pollutants. It can be challenging to reduce pollutant loads if nonpoint sources are significant contributors.

This document can guide local water quality improvement projects that are coordinated and targeted to address pollutant sources within the entire watershed. Des Moines River water quality mirrors the land that drains to it and reflects how well that land is managed. Local landowners, tenants, and other stakeholders often have the greatest influence in determining water quality.

This report consists of a TMDL for each of five contiguous segments of the Des Moines River between the upper end of Red Rock Reservoir upstream to the I80/35 Bridge. These segments are listed in Table 2.

Table 2 Five Impaired Segments requiring TMDLs

Des Moines River Impaired Segment	Segment description	Segment length	Iowa Counties
IA 04-LDM-0040-segment 1 (DMTMDL-1)	Red Rock Reservoir to South R. confluence	16.6 miles	Marion, Polk and Warren Counties
IA 04-LDM-0040-segment 2 (DMTMDL-2)	South R. confluence to North R. confluence.	11.6 miles	Polk and Warren Counties
IA 04-LDM-0040-segment 3 (DMTMDL-3)	North R. confluence to Raccoon R. confluence	13.8 miles	Polk County
IA 04-UDM-0010-segment 1 (DMTMDL-4)	Raccoon R confluence to Center St. Dam	0.9 miles	Polk County
IA 04-UDM-0010-segment 2 (DMTMDL-5)	Center St. Dam to I-80/35 bridge	6.5 miles	Polk County

The DMTMDL-1 segment runs 16.6 miles from the upper end of Red Rock Reservoir to the South River confluence. This segment receives flow from 21 HUC 12 sub-watersheds and 10 wastewater treatment plants. The major tributaries draining to this segment are the South River, Camp Creek, and Walnut Creek.

The DMTMDL-2 segment runs 11.6 miles from the South River confluence to the North River confluence. This segment receives flow from 32 HUC 12 sub-watersheds and 19 wastewater treatment plants. The major tributaries draining to this segment are the Middle River, the North River, Butcher Creek, Spring Creek, and Mud Creek.

The DMTMDL-3 segment runs 13.8 miles from the North River confluence to the Raccoon River confluence. This segment receives flow from five HUC 12 sub-watersheds (excluding the Raccoon River watershed), and seven wastewater treatment plants. The major tributaries draining to this segment are the Raccoon River and Fourmile Creek.

The DMTMDL-4 segment runs 0.9 miles from the Raccoon River confluence to Center Street dam. This segment receives flow from a small part of one HUC 12 sub-watershed and no wastewater treatment plants. There are no major tributaries contributing to this segment.

The DMTMDL-5 segment runs 6.5 miles from the Center St. Dam to the I-80/35 bridge. This segment receives flow from 13 HUC 12 sub-watersheds and nine wastewater treatment plants. The tributaries draining into this segment are Beaver Creek, Saylorville Reservoir, Rock Creek and Saylor Creek.

2. Description and History of the Des Moines River – from Saylorville Dam to Red Rock Lake

The watershed area draining to the segments of the Des Moines River covered in this report is extensive, about 2,330 square miles excluding the Raccoon River system. A previous TMDL report was prepared for the Raccoon River system and will not be repeated here. (This EPA approved TMDL can be found on the IDNR website http://www.iowadnr.gov/water/watershed/tmdl/files/final/raccoon08tmdl.pdf.) Bacteria loads from the Raccoon River are introduced into the Des Moines River just upstream of their confluence at the Fleur Avenue USGS gage.

2.1. The Des Moines River

The Des Moines River originates in southwestern Minnesota from Lake Shetek and flows 525 miles to the Mississippi River. There are two major US Army Corps of Engineers dams on the river. These dams form Saylorville Reservoir on the upstream side and Red Rock Reservoir on the downstream side of the impaired segments covered in this report. Besides the Raccoon River, the important tributary streams in this report are Beaver Creek, Four Mile Creek, the North River, the Middle River, and the South River. This system is shown in Figure 1.

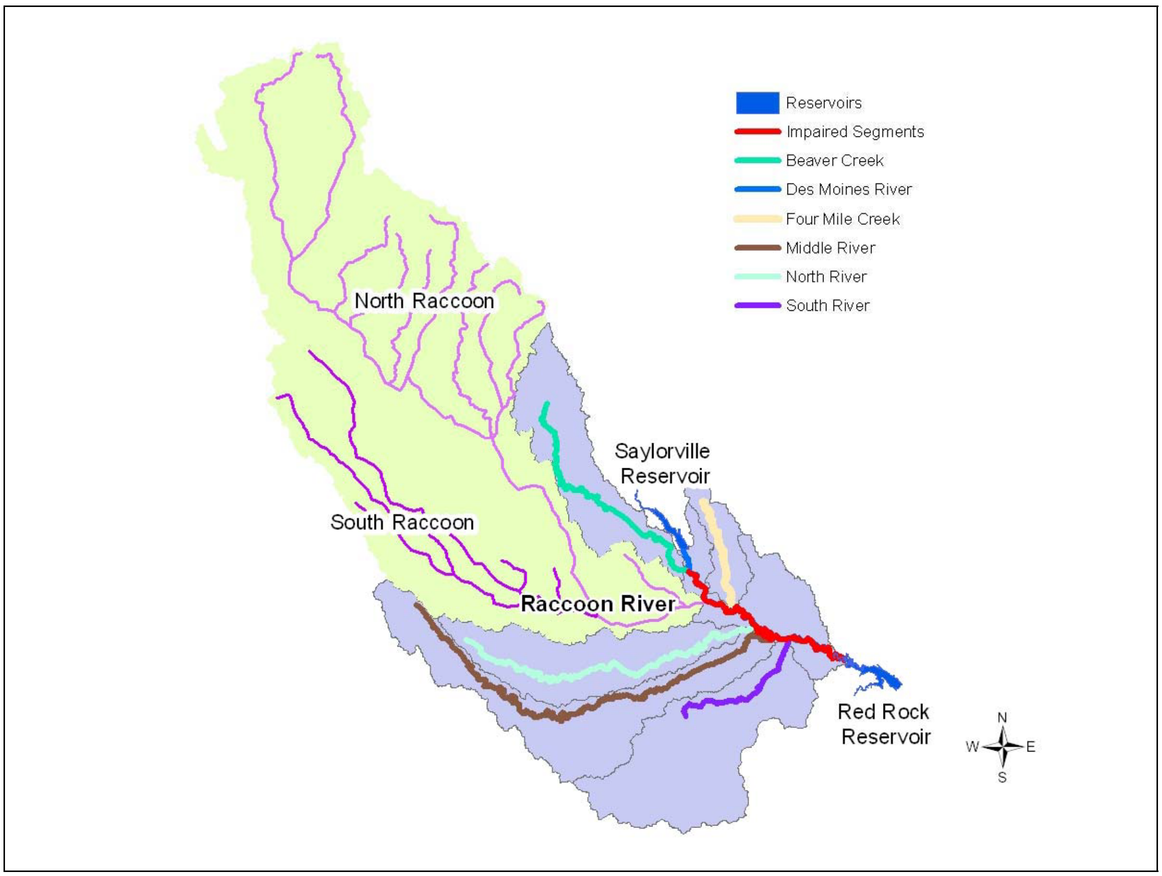

Figure 1 The Des Moines River between Saylorville and Red Rock Reservoirs and the major tributaries

Hydrology.
The impaired segments of the Des Moines River between the I-80/35 bridge (Beaver Creek confluence) and Red Rock Reservoir are 49.4 miles long and fall 200 feet along their course. In recent years there have been two major flood events, one in 1993 and one in 2008, in which the flow from Saylorville Reservoir went over the emergency spillway and flooded parts of the City of Des Moines. Information on the Des Moines River system and the tributaries relevant to this report are shown in Table 3.

Table 3 The Des Moines River

Waterbody Name:	Des Moines River, five assessment segments
Hydrologic Unit Code:	Des Moines River – 10170203
IDNR Waterbody ID:	IA 04-LDM-0040 segments 1, 2, and 3 IA 04-UDM-0010 segments 1, and 2
Location:	S34, T77N, R20W to S17, T79N, R24W
Water Quality Standards and Designated Uses:	See Appendix B
Major Tributaries:	Raccoon River, Beaver Creek, Four Mile Creek, North River, Middle River, South River, Saylorville Lake
Receiving Waterbody:	Mississippi River
Stream Segment Length:	49.4 miles
Sub-Watershed Areas:	
Beaver Creek[1]	358 square miles
Four Mile Creek[1]	62 square miles
North River[1]	349 square miles
Middle River[1]	489 square miles
South River[1]	460 square miles
Des Moines River, Lower[2]	250 square miles
Des Moines River, Middle[2]	177 square miles
Des Moines River, Upper[2]	133 square miles
Total	**2,278 square miles**
Raccoon River[3]	3,625 square miles

1. The sub-watersheds for Beaver and Four Mile Creeks and the North, Middle, and South Rivers are the area above the USGS gages for these streams.
2. These are the sub-watersheds adjacent to the impaired Des River segments.
3. The Raccoon River watershed sources are not evaluated for this report.

2.2. The Des Moines River Watershed

The watershed draining to the five impaired segments of the Des Moines River is quite large. For this report two sizeable parts of the watershed are not considered:

- The Des Moines River watershed above the Saylorville Reservoir Dam is not included because the Des Moines River segment between the dam and the I-80/35 Bridge is not impaired. The discharge from the reservoir meets the water quality standards for pathogen indicator bacteria because of the long detention time of the reservoir.
- The Raccoon River watershed above the Fleur Avenue USGS gage is not included because an earlier TMDL report was prepared for pathogen indicators from this watershed. The *E. coli* loads from the Raccoon River are included as loads to the

impaired Des Moines River segments downstream of the confluence of these two rivers.

Figure 2 shows the sub-watersheds evaluated for this report. They consist of the Beaver Creek, Four Mile Creek, North River, Middle River, and South River basins upstream of the USGS gages and three sub-watersheds adjacent to the impaired Des Moines River segments called the Lower, Middle and Upper Des Moines River subbasins.

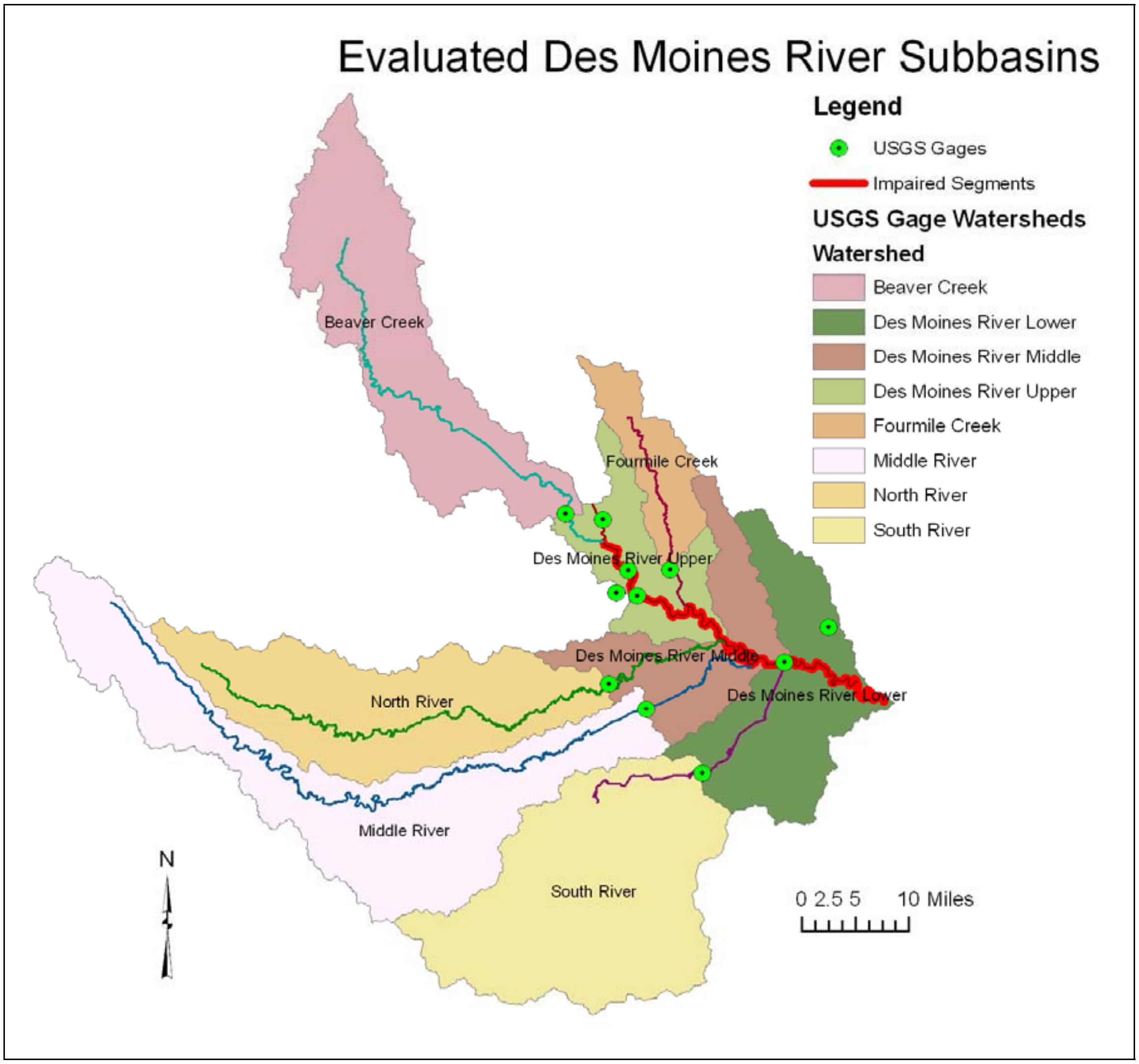

Figure 2 Evaluated sub-watersheds

Land Use.

The watershed evaluated for this report includes the most developed and populous region of Iowa. There are 57 cities in the study area watershed, comprising 6.7 percent of landuse by area as shown in Figure 3.

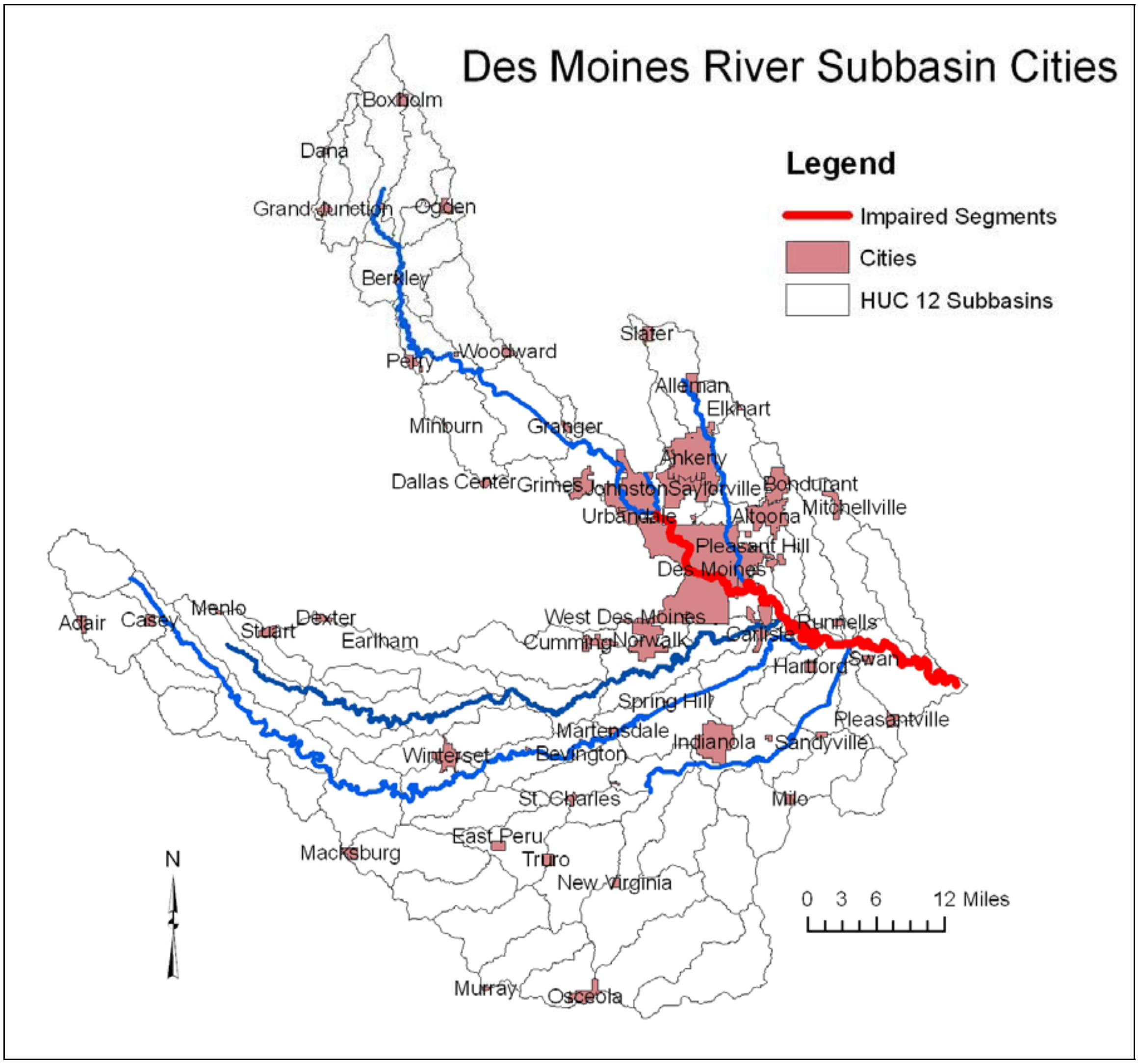

Figure 3 Des Moines River Subbasin Cities

There is also significant agricultural activity in the watershed with 58.6 percent of the land used for row crop farming or as pasture for livestock. Table 4 lists and Figure 4 shows the general landuse categories for each sub-watershed. The four general landuse categories have been derived from 2002 satellite imagery that included 19 land use categories as a GIS layer in the IDNR GIS library.

Table 4 Landuse in the defined subwatersheds

Watershed Name	Row Crop, Corn and Soybeans[1]	Grazed Pasture	Forest, Ungrazed Grass, CRP and Surface Water	Built Up Areas	Total
Beaver Creek	189,425	7,361	33,068	7,537	237,391
Des Moines River Lower	79,270	13,731	60,356	6,360	159,717
Fourmile Creek	37,558	2,278	11,740	7,026	58,602
Middle River	123,158	53,704	128,967	13,268	319,097
North River	118,075	25,442	69,912	10,192	223,621
South River	68,662	70,253	142,952	12,856	294,723
Des Moines River Upper	18,939	5,791	28,118	32,368	85,216
Des Moines River Middle	51,098	10,089	42,507	9,662	113,356
Basin Total	686,185	188,649	517,620	99,269	1,491,723
Percent of Total	**46.0%**	**12.6%**	**34.7%**	**6.7%**	**100.0%**

1. All area units are acres.

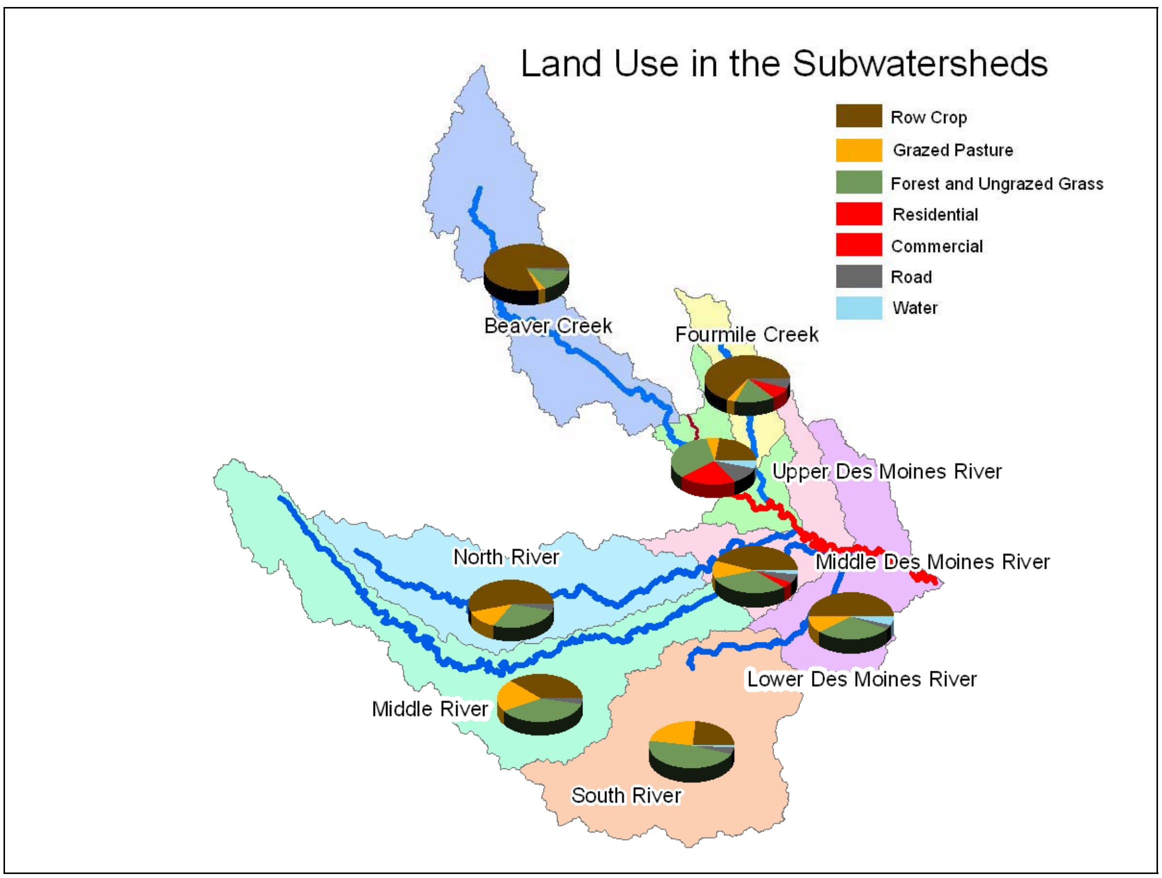

Figure 4 Land use by sub watershed

Landform, ecoregion and climate.

The watershed of the impaired segments is entirely in two landform regions as shown in Figure 5. The two landforms are also the primary landforms in the Raccoon River watershed that contributes to three of the five impaired segments. The two landform regions have been described as follows:

- **Des Moines Lobe** The last glacier to enter Iowa advanced in a series of surges beginning just 15,000 years ago and reached its southern limit, the site of modern-day Des Moines, 14,000 years ago. By 12,000 years ago, the ice sheet was gone, leaving behind a poorly drained landscape of pebbly deposits from the stagnant decaying ice, sand and gravel from swiftly flowing meltwater streams, as well as clay and peat from glacial lakes. Today, broadly curved bands of ridges and knobby hills set among irregular ponds and wetlands punctuate the otherwise subtle terrain of this freshly glaciated landscape.
- **Southern Iowa Drift Plain** This region is dominated by glacial deposits left by ice sheets that extended south into Missouri over 500,000 years ago. The deposits were carved by deepening episodes of stream erosion so that only a horizon line of hill summits marks the once-continuous glacial plain. Numerous rills, creeks, and rivers branch out across the landscape shaping the old glacial deposits into steeply rolling hills and valleys. A mantle of loess drapes the uplands and upper hill slopes. The terrain is well suited for water impoundments.

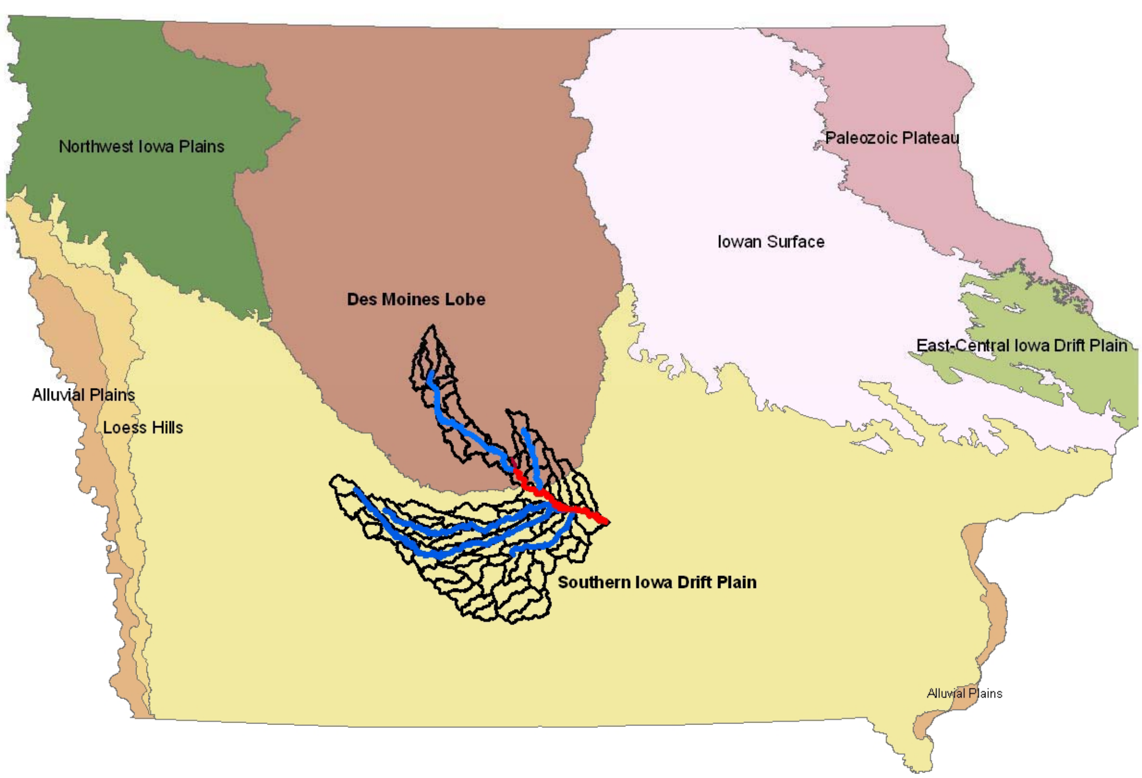

Figure 5 Location and landforms of the report watersheds

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. An ecoregion is identified through patterns and composition of both biological and physical characteristics, including geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The interactions and relative importance of each of these components varies between ecoregions, creating a unique ecosystem within each region.

The ecoregions of the watershed and their relationship to other ecoregions in the state are shown in Figures 6 and 7. Descriptions of the relevant ecoregions and transition zones are shown in Table 5.

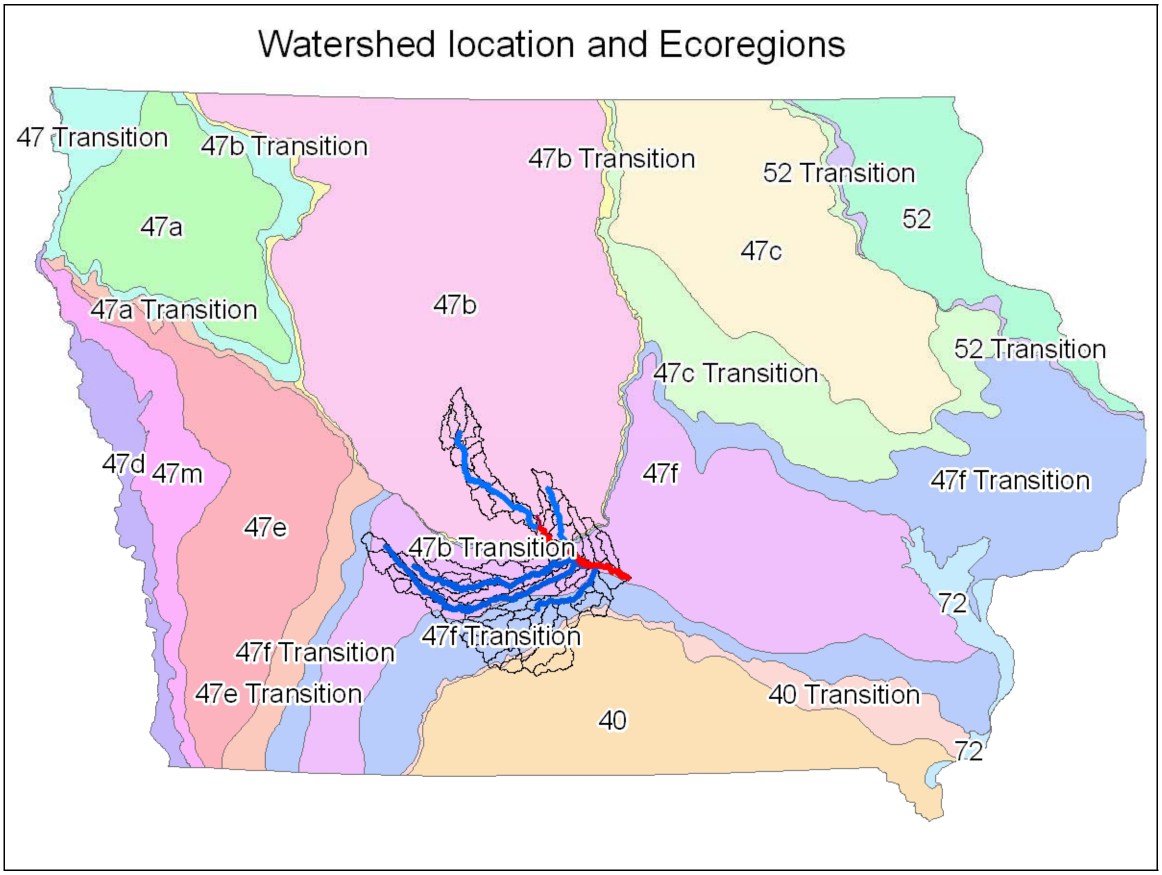

Figure 6 State and watershed ecoregions

Table 5 Ecoregion descriptions

Ecoregion	Description
47b	Western Corn Belt Plains - Des Moines Lobe - One of the youngest and flattest regions in Iowa, the Des Moines Lobe ecoregion is a distinctive area of Wisconsinan glacial stage landforms currently under extensive agriculture. In general, the land is level to gently rolling with some areas of the moraines having the most relief. The morainal ridges and hummocky knob and kettle topography contrast with the flat plains of ground moraines, former glacial lakes, and outwash deposits. A distinguishing characteristic from other parts of Ecoregion 47 is the lack of loess over the glacial drift. The stream network is poorly developed and widely spaced. The major rivers have carved valleys that are relatively deep and steep-sided. Almost all of the natural lakes of Iowa are found in the northern part of this region. Most of the region has been converted from wet prairie to agricultural use with substantial surface water drainage. Only a small fraction of the wetlands remain, and many natural lakes have been drained as a result of agricultural drainage projects.
47b transition	Transitional area between two adjacent ecoregions.
47f	Western Corn Belt Plains - Rolling Loess Prairie - Loess deposits on well drained plains and open low hills characterize the Rolling Loess Prairies ecoregion. Loess deposits tend to be thinner than those find in the Steeply Rolling Loess Prairies to the west, generally less than 25 feet in depth except along the Missouri River where deposits are thicker. Potential natural vegetation is a mosaic of mostly tall grass prairie and areas of oak-hickory forest. Although cropland agriculture is widespread, this region has more areas of woodland and pasture than the areas to the west.
47f transition	Transitional area between two adjacent ecoregions.
40	Central Irregular Plains – Loess flats and till plains - Deep to moderate loess deposits over glacial till and dark, shallow soils are characteristic of the Loess Flats and Till Plains ecoregion. Loess deposits generally increase to the south, especially near the Missouri River. Several streams have headwaters in this region, and the topography varies from flat to moderately hilly. Valley sides are not steep, with slopes generally less than 10%. The Chariton River area is a more dissected and hilly area within this region. It lacks glacial till in many places and has a greater drainage density and more woody vegetation in stream reaches than in other parts of the ecoregion. Natural wetlands occur along the Grand River and several other rivers in the region. Soils are inherently fertile, but use can be limited due to severe erosion. Land use includes areas of cropland; pasture in the valleys and on upland slopes, and bands of woodland. Corn and soybeans are the major crops.
40 transition	Transitional area between two adjacent ecoregions.

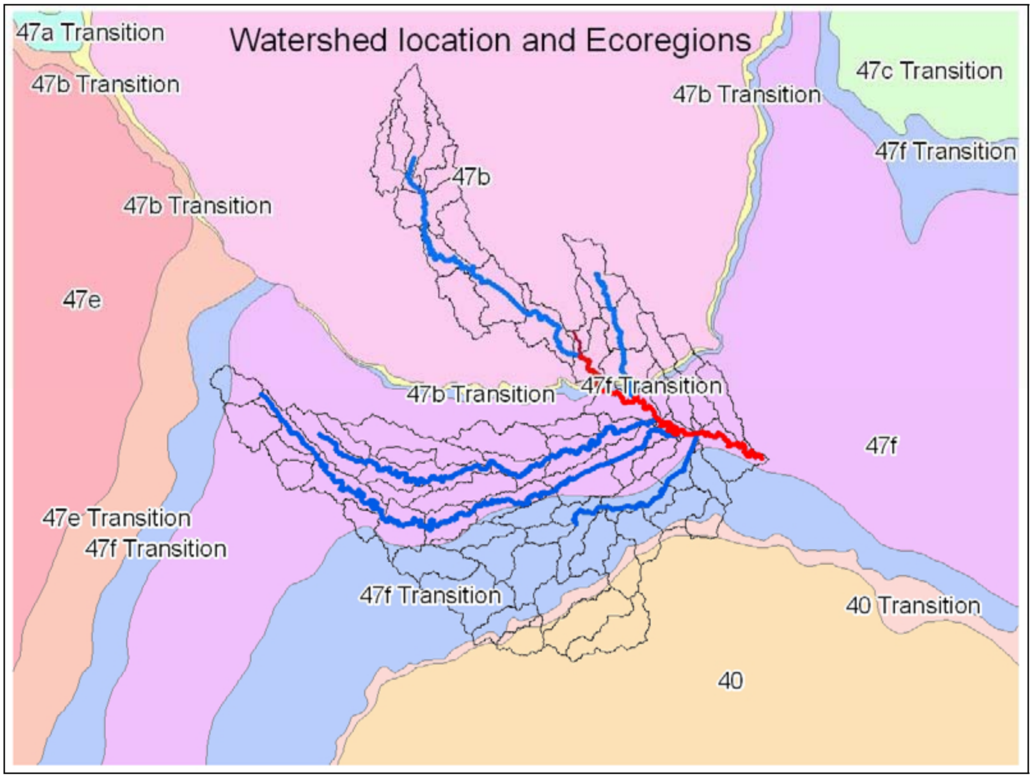

Figure 7 Watershed ecoregions

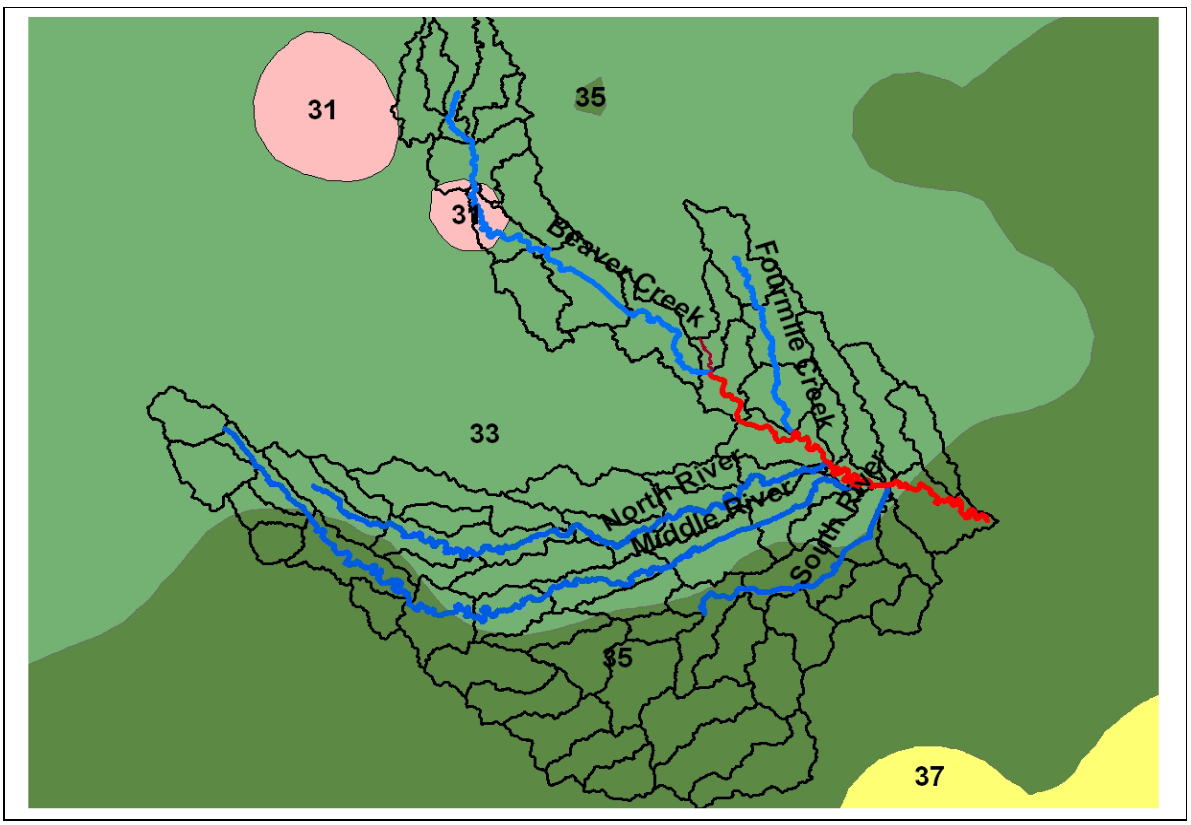

Figure 8 Project watershed average annual precipitation in inches

Increasing from northwest to southeast, the precipitation in the watershed ranges from an annual average of 31 to 36 inches as shown in Figure 8. Table 6 shows average annual climate data for the City of Des Moines as well as monthly averages.

Table 6 Average monthly climatological data for the City of Des Moines

Des Moines Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Temperature	19.4	24.7	37.3	50.9	62.3	71.8	76.6	73.9	65.1	53.5	39.0	24.4	49.9
Avg. Max Temperature	28.1	33.7	46.9	61.8	73.0	82.2	86.7	84.2	75.6	64.3	48.0	32.6	59.8
Avg. Min Temperature	10.7	15.6	27.6	40.0	51.5	61.2	66.5	63.6	54.5	42.7	29.9	16.1	40.0
Precipitation (inches)	1.0	1.1	2.3	3.4	3.7	4.5	3.8	4.2	3.5	2.6	1.8	1.3	33.1
Cloudy Days	16.0	15.0	17.0	15.0	15.0	11.0	9.0	10.0	11.0	12.0	16.0	17.0	164
Percent of Possible Sunshine	51.0	54.0	56.0	56.0	61.0	68.0	72.0	70.0	66.0	62.0	49.0	46.0	59.0

3. Des Moines River Total Maximum Daily Loads for Pathogen Indicators – Five Segments

Total Maximum Daily Loads (TMDL) are required by the Federal Clean Water Act for each of five segments of the Des Moines River between the Interstate 80/35 bridge just downstream of Beaver Creek and Red Rock Lake. This section quantifies the maximum daily pathogen indicator load that can be put into these segments without violating the state's water quality standards.

3.1. Problem Identification

The 2008 Iowa 305(b) Assessment Report lists all three segments of the Lower Des Moines River Reach (IA 04-LDM-0040) and two segments of the Upper Des Moines River Reach (IA 04-UDM-0010) as impaired for pathogen indicators, specifically *E. coli*. For the reach LDM-0040, segments 1 and 2 were assessed together and segment 3 was assessed separately. For reach UDM-0010 segments 1 and 2 were assessed as impaired and segment 3 as fully supporting. This TMDL report includes all five segments listed as impaired.

Applicable water quality standards.
The applicable designated uses and water quality standards for pathogen indicators are found in *Iowa Administrative Code 567, Chapter 61, Water Quality Standards.* Table 7 summarizes the water quality standards for pathogen indicators for the Class A1 use.

Table 7 *E. coli* Bacteria Criteria for Class A1 uses (organisms/100 ml of water)

Use	*Geometric Mean*	*Sample Maximum*
Class A1		
3/15 – 11/15	*126*	*235*
11/16 – 3/14	*Does not apply*	*Does not apply*

Problem statement.
For all five of the Des Moines River segments covered by this TMDL report, Class A1 uses are assessed as "not supported" based on results of monitoring for indicator bacteria (*E. coli*). According to IDNR assessment and impaired listing methodology, if monitoring shows that greater than ten percent of samples exceed the single sample maximum, a stream is partially supported for Class A1 use and is impaired. The complete 2008 305(b) Water Quality Assessments for the five impaired segments can be found in Appendix E of this report.

The basis for impairing the Lower Des Moines River (LDM-0040) segments 1 and 2 is the 2008 305(b) water quality report that the Class A1 uses are assessed (monitored) as "not supporting" due to levels of indicator bacteria (*E. coli*) that exceed state water quality standards. The assessment is the result of water quality monitoring conducted by Iowa State University (ISU) under contract with the U.S. Army Corps of Engineers

(USACE). Samples were collected upstream from Red Rock Reservoir (Station 7 at County Road S35 near Runnells) as part of the 2002 to 2004 Des Moines River Water Quality Study and 2002 to 2004 IDNR/UHL ambient monitoring downstream from Des Moines near Runnells. The monitoring results show that greater than ten percent of the samples exceed the single-sample maximum value, 46 percent from IDNR/UHL monitoring and 56 percent from ISU/USACE monitoring.

The basis for impairing the Lower Des Moines River (LDM-0040) segment 3 is the 2008 305(b) water quality report that the Class A1 (primary contact recreation) uses are assessed (monitored) as "not supporting" due to concentrations of *E. coli* that exceed state water quality standards. This assessment is based on 36 samples collected from 2004 to 2006 from at ISU/ACOE Station 6. The geometric mean of all these samples was 269 organisms/100 ml. In addition, 16 of 36 samples (44 percent) exceeded Iowa's single-sample maximum criterion of 235 orgs/100 ml.

The basis for impairing the Upper Des Moines River (UDM-0010) segments 1 and 2 is the 2008 305(b) water quality report indicating that Class A1 uses are assessed (monitored) as "not supported" due to concentrations of *E. coli* that exceed state water quality standards. This assessment results from monitoring by the Des Moines Water Works (DMWW) near the Second Avenue Bridge during 2004 and 2006. The running 30-day geometric mean often violated Iowa's geometric mean criterion of 126 orgs/100 ml. There were about 20 samples collected for the calculation of each 30 day geometric mean. In 2004, there were 26 violations of 58 calculated. In 2006, there were 95 violations of 217 calculated. Also, a significant fraction of samples, 25 percent in 2004 and 19 percent in 2006, exceeded Iowa's single-sample maximum criterion of 235 orgs/100 ml.

Data sources.
Pathogen indicator and flow data used in the development of this report were usually collected at different sites as depicted in Figure 9. Flow data were collected at eleven USGS gage stations and bacteria data were collected at five sites by two different agencies as described below.

Pathogen Indicator Data.
Two sources of pathogen indicator monitoring data were used to develop this report. These were:

- Iowa State University under contract to the US Army Corps of Engineers (USACE) monitors several sites in the study area for bacteria and three of these have been used in the development of this report.

- The Des Moines Water Works (DMWW) frequently monitors both the Des Moines and Raccoon Rivers for bacteria at their drinking water intakes.

The pathogen indicator data were collected at the sites listed in Table 8 and shown in Figure 9.

Table 8 Bacteria monitoring sites

Site name	Agency	USGS gage ID
Sycamore DMR[1]	ISU/USACE[2]	05481650
2nd Ave. DMR	DMWW[3]	05482000
Fleur Dr. RR[4]	DMWW	05484900
Route 46/Highway 65 DMR[5]	ISU/USACE	05485500
Runnels DMR	ISU/USACE	05487500

1. Des Moines River
2. Iowa State University under contract to the US Army Corps of Engineers
3. Des Moines Water Works
4. Raccoon River
5. The USGS gage associated with this monitoring site is five miles upstream.

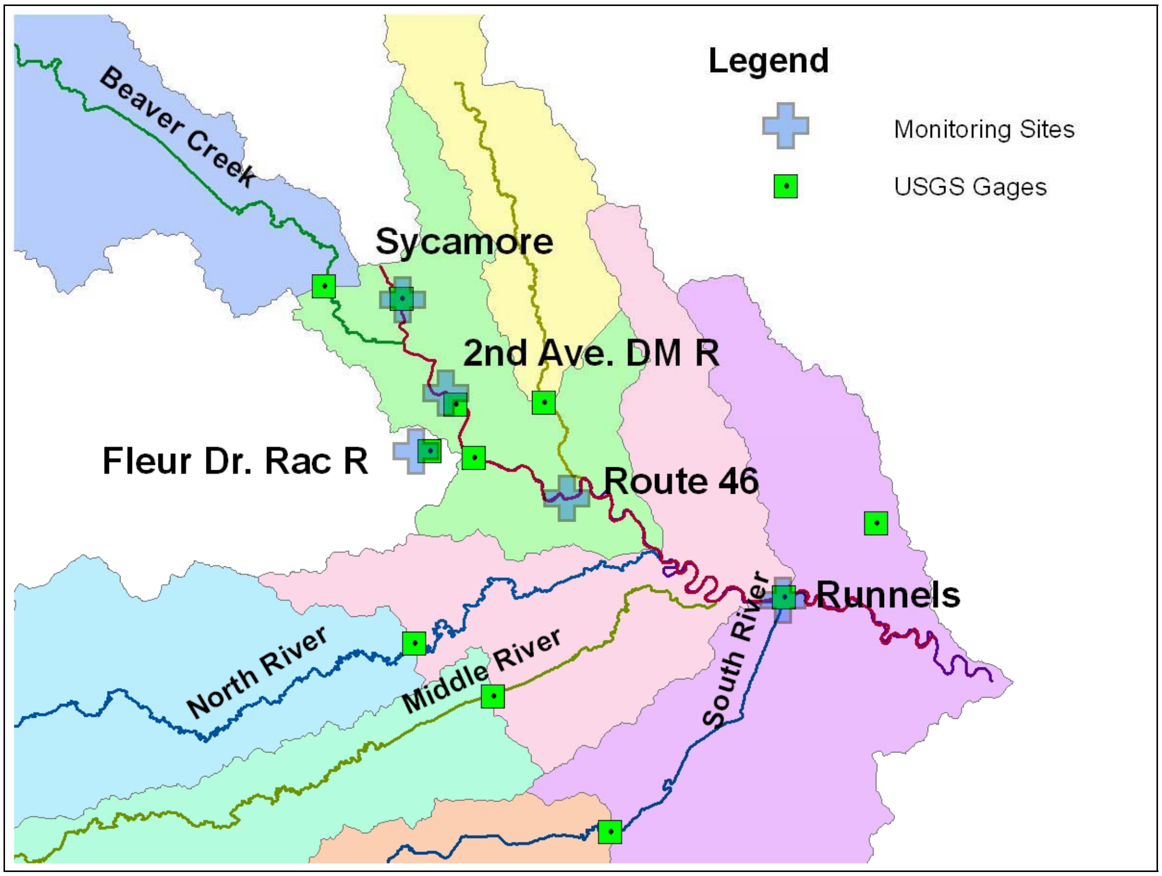

Figure 9 Monitoring sites for *E. coli* concentrations

Flow Data
Flow data was collected at eleven USGS gage stations. These gage stations are listed in Table 9 and shown in Figure 10.

Table 9 USGS gages in the study area

USGS gage ID	Location	Flow data period
05487500	Des Moines River near Runnells, IA	10/1/1961 - 9/30/2005
05481650	Des Moines River near Saylorville, IA	4/20/1960 - 9/30/2005
05481950	Beaver Creek near Grimes, IA	3/1/1915 - 9/30/2005
05482000	Des Moines River at 2nd Avenue, Des Moines, IA	7/1/1993 - 9/30/2005
05484900	Raccoon River at Fleur Drive, Des Moines, IA	4/1/1940 - 9/30/2005
05485500	Des Moines River below the Raccoon River at Des Moines, IA	10/1/1971 - 9/30/2005
05485640	Fourmile Creek at Des Moines, IA	2/28/1940 - 9/30/2005
05486000	North River near Norwalk, IA	3/1/1940 - 9/30/2005
05486490	Middle River near Indianola, IA	3/1/1940 - 9/30/2005
05487470	South River near Ackworth, IA	10/1/1994 - 9/30/2005
05487550	Walnut Creek near Vandalia, IA	10/1/1961 - 9/30/2005

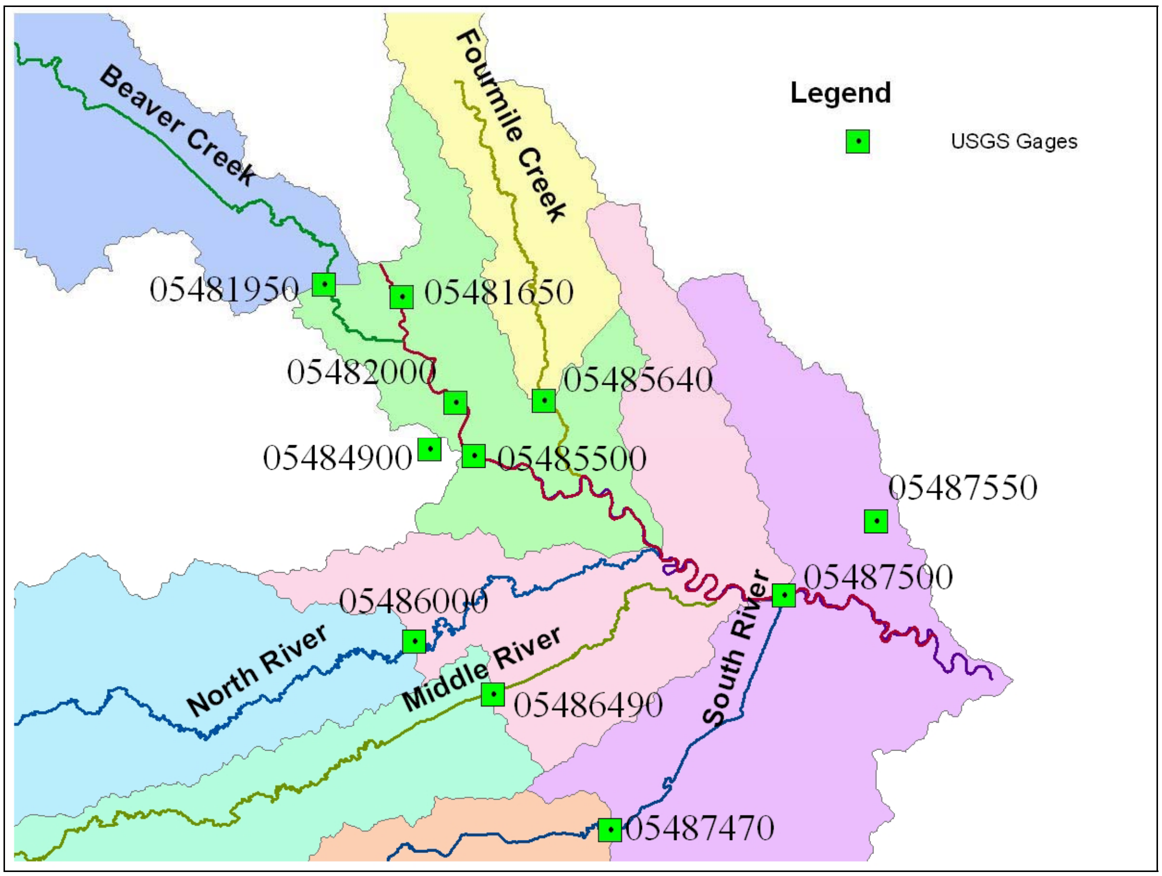

Figure 10 USGS gage site locations

Interpreting Des Moines River data.

Flow and load duration curves were used to establish the occurrence of water quality standards violations, to establish compliance targets, and to set pollutant allocations and margins of safety. Duration curves are derived from flow plotted as a percentage of their recurrence. *E. coli* loads are calculated from *E. coli* concentrations and flow volume. Load duration methods have been applied to Des Moines River data to establish the existing and target *E. coli* loads for five flow conditions (see Appendix D). The five flow intervals represent conditions that can be interpreted to reveal pollutant sources. These flow interval medians are the quartiles (25, 50, and 75 percent) of the flow recurrences and are often associated with flow and load duration analysis. The five flow conditions are described in Table 10.

Table 10 Five flow conditions used to establish existing and target loads

Flow condition	Description
Zero to ten percent recurrence interval, high flow	Runoff conditions predominate here and the flows and loads are the greatest primarily from nonpoint sources available for washoff.
Ten to forty percent recurrence interval, moist conditions	Runoff conditions are gradually decreasing in volume as is their contribution to bacteria loading.
Forty to sixty percent recurrence interval, mid-range	Impacts from runoff in this flow recurrence interval are still a an important fraction but flow from groundwater and interflow are a growing part of the total. Loads originate from minor occurrences of local runoff and from the continuous septic tank, cattle in the stream, and wastewater treatment plant flows.
Sixty to ninety percent recurrence interval, dry conditions	Runoff loads at this flow recurrence interval are a shrinking fraction of the total. Flow from groundwater and interflow are a growing part of the total. Loads originate from minor occurrences of local runoff and increasingly from failed septic tanks, cattle in the stream, and wastewater treatment plant effluent.
Ninety to one hundred percent recurrence interval, low flow	This is the low flow to no flow condition. Loads in this flow condition are nearly all from local continuous sources although the delivery of these continuous loads can be greatly reduced in the driest conditions.

The flow and load duration curves were developed using ten years of recreation season USGS gage flow data (from 1997 to 2007 for March 15 to November 15 of each year) for each of the three TMDL monitoring sites that established the impaired condition for the Des Moines River segments.

To construct the flow duration curves, the bacteria monitoring data and the Water Quality Standard (WQS) sample max (235 *E. coli* organisms/100 ml) were plotted with the flow duration percentile. The charts show the data that exceeds the WQS criteria at each of the five flow conditions. High flow violations indicate that the problem occurs during run-off conditions when nearly all bacteria are washing off from nonpoint sources. Criteria exceeded during low or base flow, when runoff is generally not occurring, indicate that continuous sources such as septic tanks, livestock in the stream, and wastewater treatment plants are the problem. Figures 11 through 13 show the flow duration curves for the three gage sites where the TMDLs for the five impaired segment were developed.

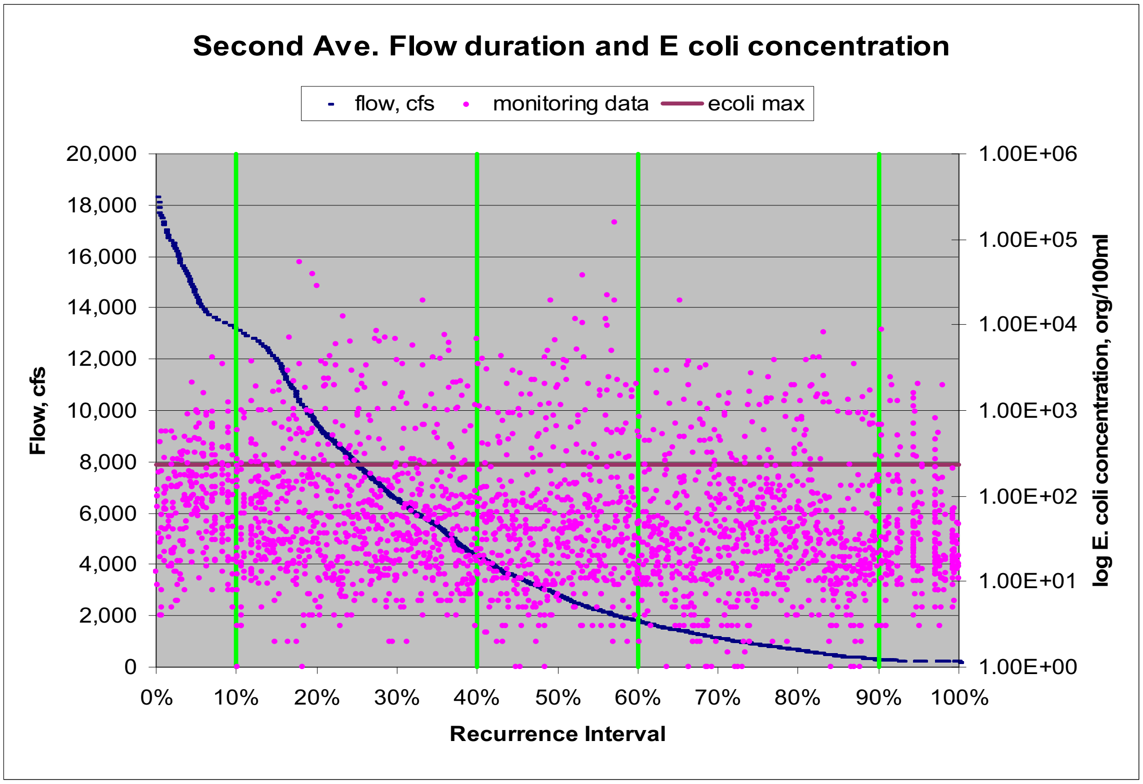

Figure 11 DMR Second Ave. flow duration curve

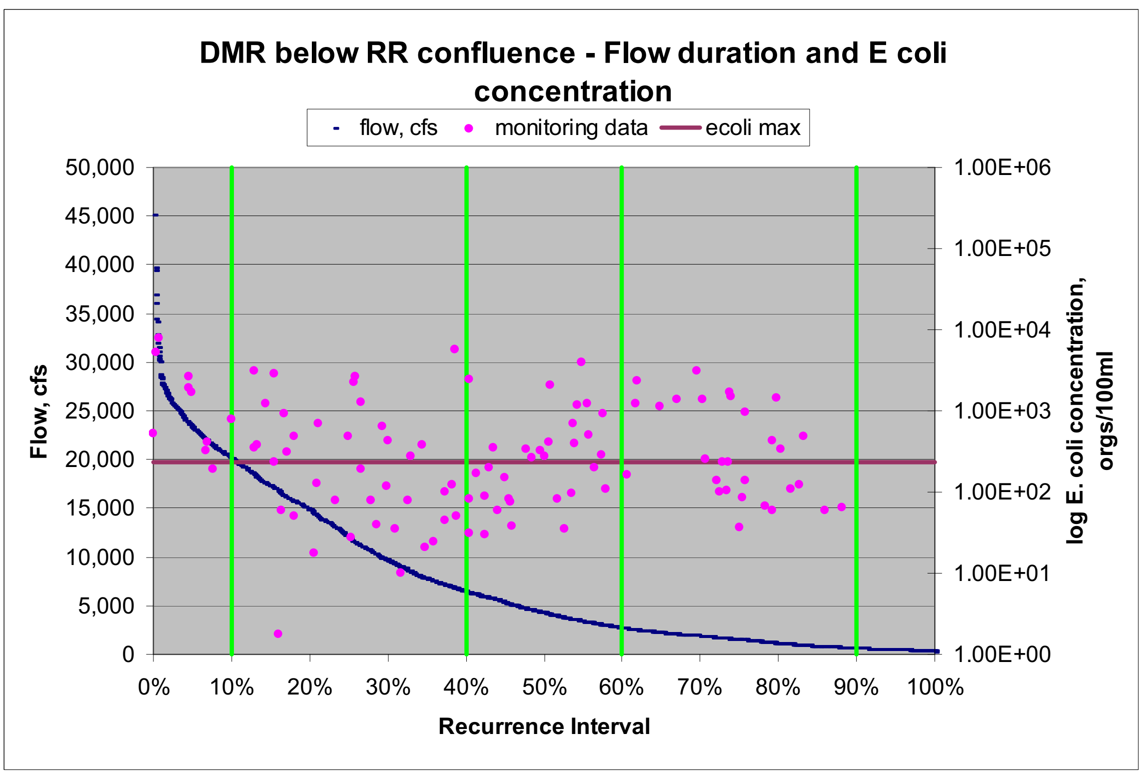

Figure 12 DMR gage site below Raccoon River flow duration curve

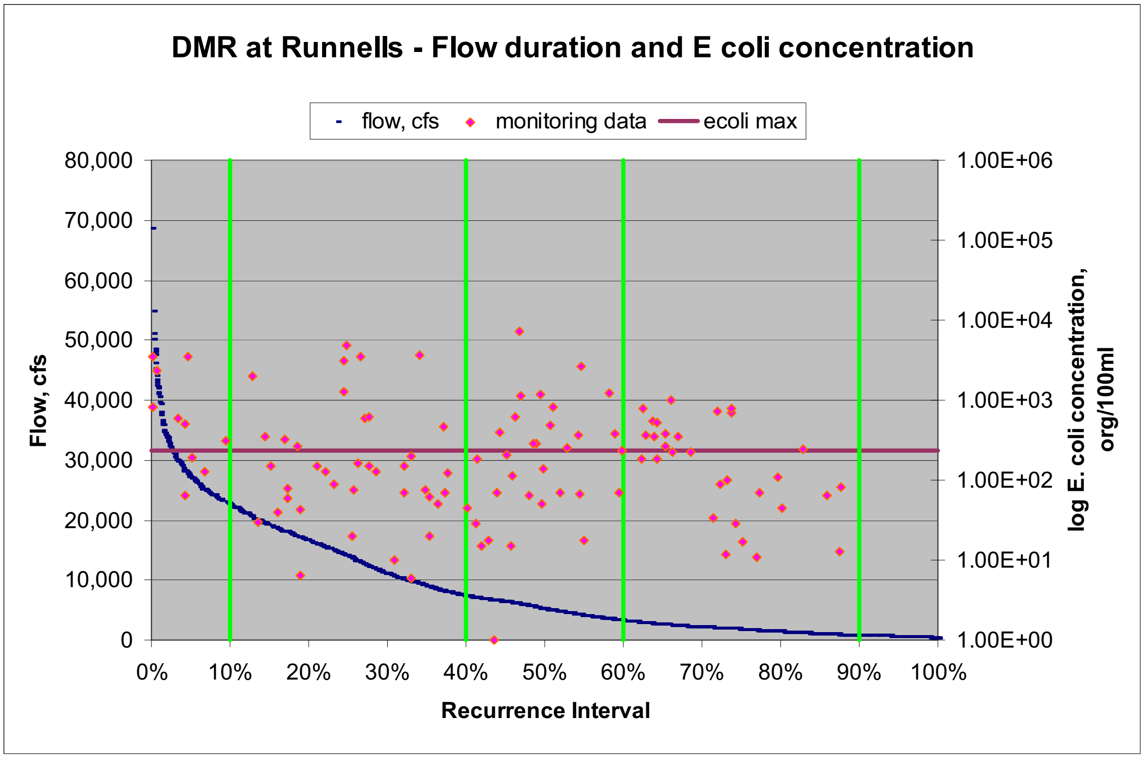

Figure 13 DMR gage site at Runnells flow duration curve

3.2. TMDL Target

The target for this TMDL is the water quality standard for Class A1, Primary Contact Recreational Use. The standard is a geometric mean of 126 *E. coli* organisms/100ml and a single sample maximum of 235 *E. coli* organisms/100ml. The load associated with this concentration is based on the average daily river flow. The criteria used to determine attainment of the water quality standards are explained in the 305(b) report assessment protocol in Appendix E.

In 2004, the Iowa Department of Natural Resources converted from fecal coliform to *E. coli* bacteria as the pathogen indicator for primary contact recreation assessment. Although *E. coli* may be a better indicator of human health issues for primary contact recreation assessment, it was not always used in the development of this report because much of the pollutant source reference material, particularly for the Bacteria Indicator Tool (BIT) spreadsheet calculations, uses fecal coliform as the pathogen indicator.

EPA's Bacteria Indicator Tool (USEPA, 2001) estimates watershed bacteria accumulation available for washoff when it rains. It is a spreadsheet model that estimates the bacteria contribution from multiple sources based on land use, livestock and wildlife populations, septic tanks, and built up area contributions. The BIT spreadsheet is currently only configured for and enabled for fecal coliform.

The fecal coliform/*E. coli* relationship used in this TMDL is based on the WQS geometric mean for fecal coliform that was used before the *E. coli* standard was adopted. The values, respectively, for these geometric means are 200 fecal coliform organisms/100 ml and 126 *E. coli* organisms/100 ml for a ratio of 1.59 - rounded to 1.6 for this document. Until November 2006, IDNR used this ratio to convert NPDES permits for wastewater treatment plants from *E. coli* to fecal coliform. BIT model fecal coliform output has been converted to *E. coli* using this ratio.

General description of the pollutant.
The point sources of *E. coli* for the five impaired Des Moines River segments are undisinfected wastewater treatment plant discharges, combined and sanitary sewer overflows, and stormwater runoff from cities with NPDES Municipal Stormwater Permits.

The nonpoint *E. coli* sources for the impaired segments are runoff from developed urban areas, grazing livestock, manure applied to fields, wildlife, and failed onsite septic tank systems. These nonpoint sources can be divided into two components. One is episodic and consists of livestock and wildlife fecal material periodically transported during precipitation events. The other is continuous discharges from leaking septic tank systems and manure from cattle in and near streams.

Selection of environmental conditions.
The recreation season as defined in the Iowa Water Quality Standards runs from March 15 through November 15. This is the season used in the development of the pathogen indicator TMDL for this document. Only flow and monitoring data for the recreation season have been used to develop the duration curves.

Water body pollutant loading capacity (TMDL).
The *E. coli* load capacities for the three assessment sites used to evaluate the impaired segments of the Des Moines River are the number of *E. coli* organisms that can be in the river and have it still comply with the water quality criteria. The flow and load duration curves were used to evaluate the five flow conditions for each of the three TMDL monitoring sites.

The load duration curves for the three sites are shown in Figures 14 to 16. The lower curve shows the maximum *E. coli* count for the geometric mean criteria and the upper curve shows the maximum *E. coli* count for a single sample at a continuum of flow recurrence percentage. The individual points are the observed (monitored) *E. coli* concentrations converted to loads based on daily flow for the day they were collected. Points above the load duration curves are violations of the WQS criteria and exceed the loading capacity. Table 11 shows the target loads based on the single sample maximum criteria for each flow condition at the Des Moines River Second Avenue gage site and Figure 14 shows the load duration curves and the site monitoring data.

Table 12 shows the target loads for each flow condition at the State Road 46/Highway 65 site below the confluence with the Raccoon River and Figure 15 shows the load duration curves and the site monitoring data.

Table 13 shows the target loads for each flow condition at the Runnells gage site and Figure 16 shows the load duration curves and the site monitoring data.

Table 11 DMR Second Ave. gage site – load capacity (TMDL) at five recurrence intervals

Flow condition, percent recurrence	Associated median flow, cfs	Estimated single sample maximum load capacity, *E. coli* org/day
High flows - runoff dominated, 0 to 10%	14,300	8.22E+13
Moist conditions, 10% to 40%	7,780	4.47E+13
Mid-range, 40% to 60%	2,770	1.59E+13
Dry conditions, mostly base flow, 60% to 90%	850	4.89E+12
Low (base) flow, 90% to 100%	214	1.23E+12

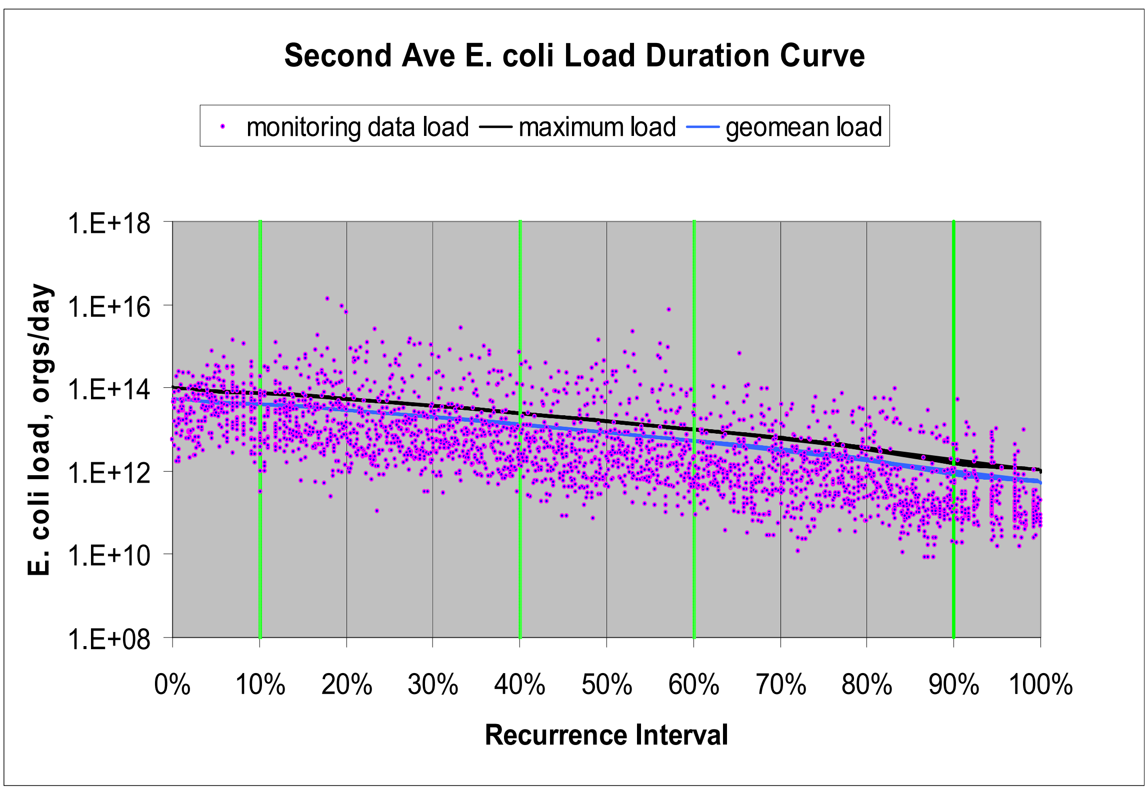

Figure 14 DMR Second Ave. load duration curve

Table 12 DMR gage site below Raccoon River – load capacity (TMDL) at five recurrence intervals

Flow condition, percent recurrence	Associated median flow, cfs	Estimated single sample maximum load capacity, *E. coli* org/day
High flows - runoff dominated, 0 to 10%	23,100	1.33E+14
Moist conditions, 10% to 40%	11,900	6.84E+13
Mid-range, 40% to 60%	4,180	2.40E+13
Dry conditions, mostly base flow, 60% to 90%	1,430	8.22E+12
Low (base) flow, 90% to 100%	435	2.50E+12

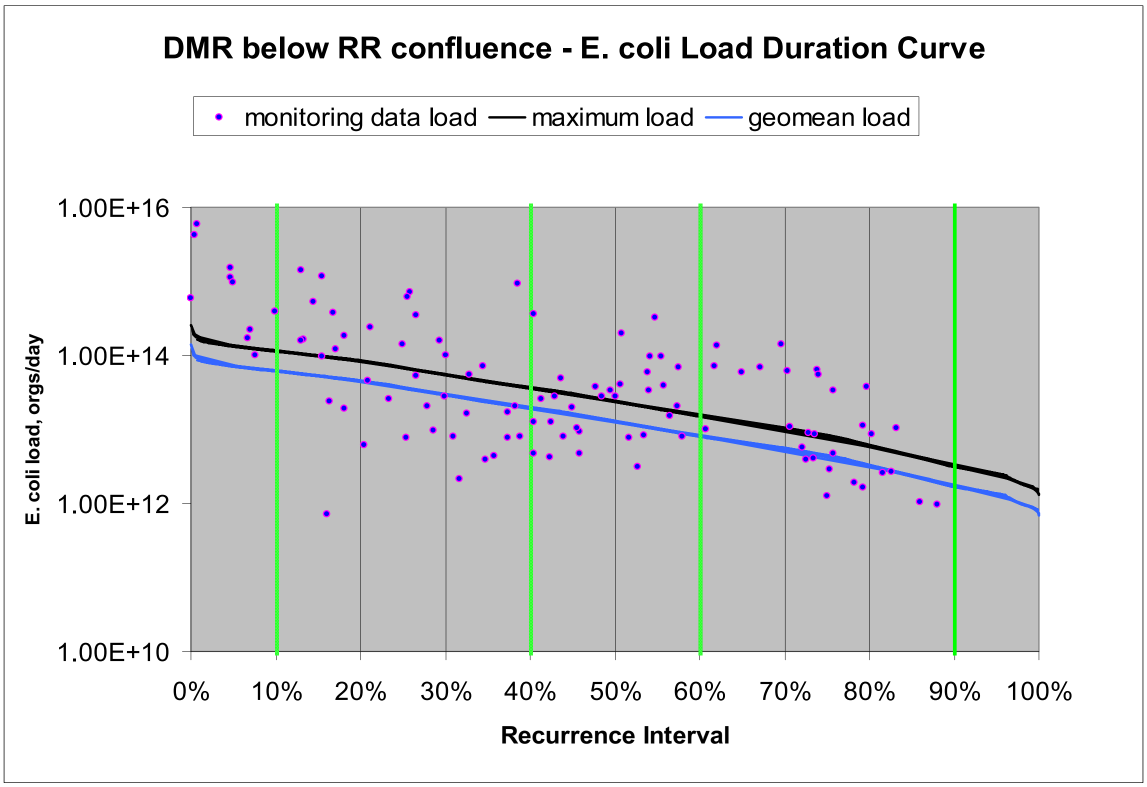

Figure 15 DMR gage site below Raccoon River load duration curve

Table 13 DMR gage site at Runnells – load capacity (TMDL) at five recurrence intervals

Flow condition, percent recurrence	Associated median flow, cfs	Estimated single sample maximum load capacity, *E. coli* org/day
High flows - runoff dominated, 0 to 10%	27,000	1.55E+14
Moist conditions, 10% to 40%	13,900	7.99E+13
Mid-range, 40% to 60%	5,090	2.93E+13
Dry conditions, mostly base flow, 60% to 90%	1,690	9.72E+12
Low (base) flow, 90% to 100%	550	3.16E+12

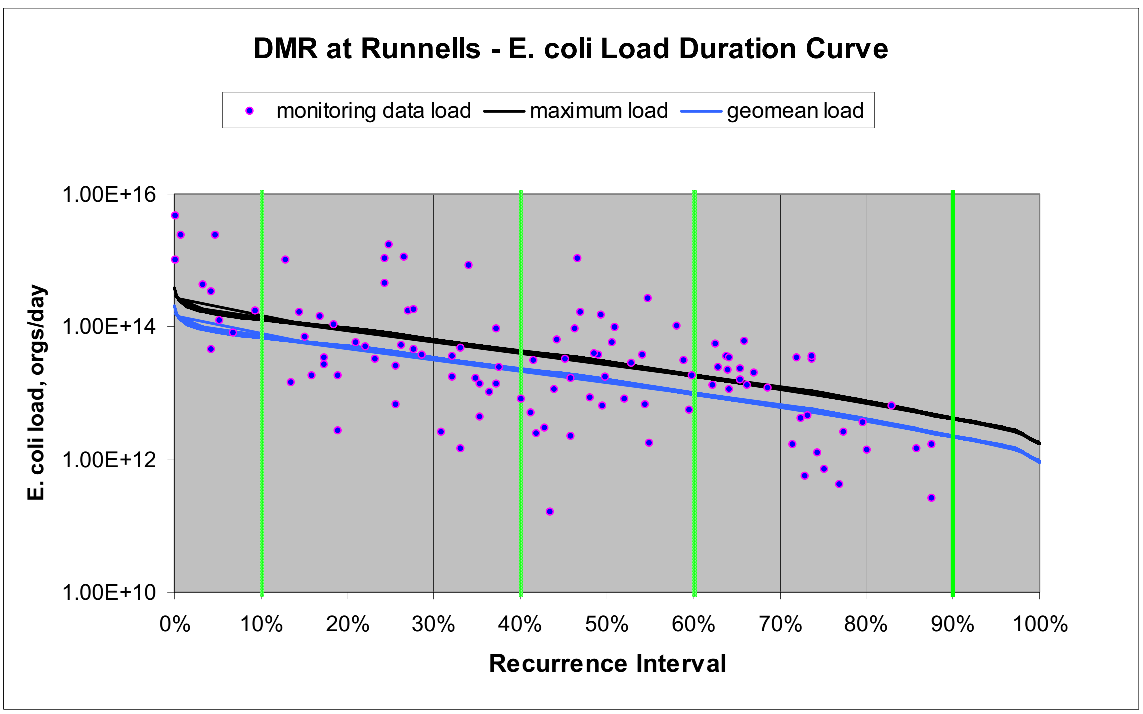

Figure 16 DMR Runnells gage site load duration curve

Decision criteria for water quality standards attainment.
Water Quality Standards will be attained in the five segments of the Des Moines River when the monitored *E. coli* concentrations meet the criteria of a geometric mean of 126 org/100 ml and a single sample maximum concentration of 235 org/100 ml.

3.3. Pollution Source Assessment

Bacteria sources include wastewater treatment plant and urban storm sewer discharges, failed septic tank systems, wildlife, grazing livestock, runoff from fields where manure has been applied, and feedlots. Nonpoint source bacteria problems often accompany heavy rainfall events. Point sources of bacteria, such as wastewater treatment plants, usually discharge continuously.

Existing load.
The existing loads are derived from the data measured at the three TMDL sites used in the water quality assessment 305(b) report. These data are the monitored points shown in the flow and load duration curves in the previous section. The monitored *E. coli* concentrations are multiplied by the average daily flow to get the monitored daily loads that are plotted with the load duration curves. The maximum allowable loads for a given flow equal the flow multiplied by the WQS limits for the geometric mean or single sample maximum. Monitored data that exceed the WQS criteria are above the WQS limit curves.

The maximum existing load occurs during events when maximum runoff and bacteria concentrations are highest. These high loads and flows cause bacteria concentrations to exceed the criteria. The other condition leading to criteria violations occurs during dry low flow periods when continuous loads from livestock in the stream, local wildlife, septic tanks, and wastewater treatment plants cause bacteria problems.

The assessment methodology used to evaluate pathogen indicator criteria assume that if 10 percent or more of samples exceed the *E. coli* criteria then the waterbody is not supporting recreational use. Therefore, the 90^{th} percentile of observed concentrations within each flow condition is multiplied by the median flow for each condition to estimate the existing loads.

This procedure has been used at the three TMDL gage sites to evaluate the five impaired segments. The Des Moines River Second Avenue gage site is used for the segments UDM 0010 01 and 02. The Des Moines River gage site below the Raccoon River confluence is used for segment LDM 0040 03. The Des Moines River gage site at Runnells is used for the segments LDM 0040 01 and 02. Table 14 shows the existing loads for each flow condition at the Des Moines River Second Avenue gage site. Table 15 shows the existing loads for each flow condition at the Des Moines River gage site below the Raccoon River gage site. Table 16 shows the existing loads for each flow condition at the Des Moines River gage site at Runnells.

Table 14 DMR Second Ave. gage site - Existing loads at the five recurrence intervals

Flow condition, percent recurrence	Associated median flow, cfs	Existing 90th percentile *E. coli* conc., org/100ml	Estimated flow interval existing *E. coli* org count/day
High flows - runoff dominated, 0 to 10%	14,300	467	1.63E+14
Moist conditions, 10% to 40%	7,780	824	1.57E+14
Mid-range, 40% to 60%	2,770	929	6.30E+13
Dry conditions, mostly base flow, 60% to 90%	850	497	1.03E+13
Low (base) flow, 90% to 100%	214	290	1.52E+12

Table 15 DMR gage site below Raccoon River - Existing loads at the five recurrence intervals

Flow condition, percent recurrence	Associated median flow, cfs	Existing 90th percentile *E. coli* conc., org/100ml	Estimated flow interval existing *E. coli* org count/day
High flows - runoff dominated, 0 to 10%	23,100	5,815	3.29E+15
Moist conditions, 10% to 40%	11,900	2,240	6.52E+14
Mid-range, 40% to 60%	4,180	1,196	1.22E+14
Dry conditions, mostly base flow, 60% to 90%	1,430	1,540	5.39E+13
Low (base) flow, 90% to 100%	435	no data	no data

Table 16 DMR gage site at Runnells - Existing loads at the five recurrence intervals

Flow condition, percent recurrence	Associated median flow, cfs	Existing 90th percentile *E. coli* conc., org/100ml	Estimated flow interval existing *E. coli* org count/day
High flows - runoff dominated, 0 to 10%	27,000	3474	2.29E+15
Moist conditions, 10% to 40%	13,900	2330	7.93E+14
Mid-range, 40% to 60%	5,090	1171	1.46E+14
Dry conditions, mostly base flow, 60% to 90%	1,690	726	3.00E+13
Low (base) flow, 90% to 100%	550	no data	no data

Departure from load capacity.

The departure from load capacity is the difference between the existing load and the load capacity. This varies for each of the five flow conditions. Tables 17 through 19 show this difference for the three monitored locations used to develop the TMDLs. The existing and target loads for the five flow conditions at each of the three TMDL sites are shown graphically in Appendix D in Figures D5 (Second Avenue site), D9 (site below the Raccoon River confluence), and D10 (Runnells site). There is also a chart, Figure D8 (Raccoon River at Fleur Drive), that shows existing and target loads for the Raccoon River near its confluence with the Des Moines River using load duration analysis.

At high flow, runoff loads are elevated since this is when watershed bacteria are washed off by storm events. In high flow runoff conditions, the concentrations are often higher than when runoff is not occurring. This high runoff bacteria concentration combined with high flow results in very high bacteria counts.

Table 17 DMR Second Ave. gage site - Departure from load capacity

Design flow condition, percent recurrence	Existing *E. coli* org count/day	Load capacity[1], org counts/day	Departure from capacity, org counts/day
High flows - runoff dominated, 0 to 10%	1.63E+14	8.22E+13	8.11E+13
Moist conditions, 10% to 40%	1.57E+14	4.47E+13	1.12E+14
Mid-range, 40% to 60%	6.30E+13	1.59E+13	4.70E+13
Dry conditions, mostly base flow, 60% to 90%	1.03E+13	4.89E+12	5.45E+12
Low (base) flow, 90% to 100%	1.52E+12	1.23E+12	2.88E+11

1. This is calculated using the single sample maximum of 235 organisms/100 ml.

Table 18 DMR gage site below Raccoon River - Departure from load capacity

Design flow condition, percent recurrence	Existing *E. coli* org count/day	Load capacity[1], org counts/day	Departure from capacity, org counts/day
High flows - runoff dominated, 0 to 10%	3.29E+15	1.33E+14	3.15E+15
Moist conditions, 10% to 40%	6.52E+14	6.84E+13	5.84E+14
Mid-range, 40% to 60%	1.22E+14	2.40E+13	9.83E+13
Dry conditions, mostly base flow, 60% to 90%	5.39E+13	8.22E+12	4.57E+13
Low (base) flow, 90% to 100%	no data	2.50E+12	no data

1. This is calculated using the single sample maximum of 235 organisms/100 ml.

Table 19 Des Moines River gage site at Runnells - Departure from load capacity

Design flow condition, percent recurrence	Existing *E. coli* org count/day	Load capacity[1], org counts/day	Departure from capacity, org counts/day
High flows - runoff dominated, 0 to 10%	2.29E+15	1.55E+14	2.14E+15
Moist conditions, 10% to 40%	7.93E+14	7.99E+13	7.13E+14
Mid-range, 40% to 60%	1.46E+14	2.93E+13	1.17E+14
Dry conditions, mostly base flow, 60% to 90%	3.00E+13	9.72E+12	2.03E+13
Low (base) flow, 90% to 100%	no data	3.16E+12	no data

1. This is calculated using the single sample maximum of 235 organisms/100 ml.

Identification of pollutant sources.
There are two categories of pollutant sources evaluated for TMDL development. One of these categories is permitted point sources and includes municipal wastewater treatment facilities and stormwater NPDES permits. The second category is nonpoint sources that include all discharges that are not regulated. Nonpoint sources are often of a diffuse nature such as runoff from agricultural areas.

Point Sources
The point sources in the Des Moines River impaired segments include municipal wastewater treatment plants (WWTP) with National Pollutant Discharge Elimination System (NPDES) permits and municipal stormwater discharges with Municipal Separate Storm Sewer System (MS4) NPDES permits.

The 45 permitted wastewater treatment plants in the watershed that currently have NPDES permits are listed in Table 20 and locations are shown in Figure 14. Waste stabilization lagoons are controlled discharge processes that usually discharge twice a year when receiving stream flows are high. All other facilities discharge continuously.

Table 20 NPDES permitted wastewater treatment plants in the watershed

City Name	EPA NPDES ID	Iowa DNR NPDES ID	Receiving Stream	Treatment type	Design population equivalents
Adair WWTP	IA0035416	0105001	Middle River	Trickling Filter	898
Adair-Casey School WWTP	IA0067156	3900501	Middle River	Trickling Filter	210
Ankeny WWTP	IA0038628	7709001	Fourmile Creek	Activated Sludge	64856
Bondurant WWTP	IA0023396	7717001	Mud Creek	Aerated Lagoon	3850

City Name	EPA NPDES ID	Iowa DNR NPDES ID	Receiving Stream	Treatment type	Design population equivalents
Boxholm WWTP	IA0058491	0825001	Beaver Creek	Stabilization Lagoon	329
Camp Dodge	IA0063215	7700901	Beaver Creek	Aerated Lagoon	2216
Carlisle WWTP	IA0024554	9113001	North River	Aerated Lagoon	5090
Casey WWTP	IA0027197	3914001	Middle River	Activated Sludge	713
Country Living Mob. Home Park WWTP	IA0068004	7700605	Fourmile Creek	Stabilization Lagoon	211
Cumming WWTP	IA0071935	9123001	North River	Septic Tank/Sand Filter	204
Des Moines WWTP	IA0044130	7727001	Des Moines River	Activated Sludge	1,170,958
DNR Lake Aquabi State Park WWTP	IA0066001	9100900	South River	Stabilization Lagoon	101
Easter Seal Soc. of IA (Camp Sunnyside)	IA0071226	7700408	Des Moines River	Stabilization Lagoon	222
Grand Junction WWTP	IA0041891	3730001	Beaver Creek	Stabilization Lagoon	987
Granger WWTP	IA0041912	2537001	Beaver Creek	Aerated Lagoon	1072
Grimes WWTP	IA0035939	7736001	Beaver Creek	Activated Sludge	10,623
Hartford WWTP	IA0066761	9128001	Des Moines River	Aerated Lagoon	1317
Indianola WWTP	IA0027669	9133001	Middle River	Activated Sludge	11557
Iowa Assoc. of Municipal Util. WWTP	IA0075531	7700502	Fourmile Creek	Septic Tank to Wetlands Cells	17
IDOT Rest Area #01 I-80 Adair WWTP	IA0068756	0100903	Middle River	Stabilization Lagoon	287
IDOT Rest Area #02 I-80 Adair WWTP	IA0068764	0100902	Middle River	Stabilization Lagoon	287
IDOT Rest Area #17 & #18 I-35 Ankeny WWTP	IA0068870	7700915	Fourmile Creek	Stabilization Lagoon	287
Lift LLC WWTP	IA0068403	2000300	South River	Stabilization Lagoon	50
Martensdale WWTP	IA0031836	9147001	Middle River	Stabilization Lagoon	509
Menlo STP	IA0071374	3956001	North River	Stabilization Lagoon	485
Milo WWTP	IA0030511	9155001	South River	Aerated Lagoon	1078

City Name	EPA NPDES ID	Iowa DNR NPDES ID	Receiving Stream	Treatment type	Design population equivalents
Mitchellville WWTP	IA0021997	7751001	Camp Creek	Activated Sludge (SBR)	6006
New Virginia San. Dist. WWTP	IA0058891	9159901	South River	Stabilization Lagoon	898
N. Polk School Dist. WWTP	IA0063321	7705500	Fourmile Creek	Activated Sludge	204
Norwalk WWTP	IA0033243	9164001	North River	Activated Sludge	11533
Ogden WWTP	IA0041904	0858001	Beaver Creek	Trickling Filter	2347
Patterson WWTP	IA0062961	6151001	Middle River	Stabilization Lagoon	407
Pleasantville WWTP	IA0035921	6377001	South River	Aerated Lagoon	2353
Runnells WWTP	IA0063355	7774001	Des Moines River	Activated Sludge	719
Saylorville - Bob Shetler WWTP	IA0065528	7700406	Des Moines River	Stabilization Lagoon	96
Slater WWTP	IA0033740	8580001	Fourmile Creek	Aerated Lagoon	2323
St. Charles WWTP	IA0039896	6161001	South River	Aerated Lagoon	713
St. Marys WWTP	IA0072451	9176001	Middle River	Stabilization Lagoon	162
Sunnybrook Mobile Home Park WWTP	IA0068071	7714601	Camp Creek	Aerated Lagoon	61
Thomas Mitchell Park WWTP	IA0066966	7700911	Camp Creek	Stabilization Lagoon	60
Truro WWTP	IA0040991	6167001	South River	Stabilization Lagoon	898
Walnut Cr. Nat. Wildlife Ref. WWTP	IA0074829	5000402	Walnut Creek	Septic Tank to Wetland	162
Wilshire Mobile Home Court WWTP	IA0067903	9100601	North River	Stabilization Lagoon	126
Winterset WWTP	IA0034291	6171001	Middle River	Trickling Filter	3473
Woodward WWTP	IA0057517	2576001	Beaver Creek	Stabilization Lagoon	1246

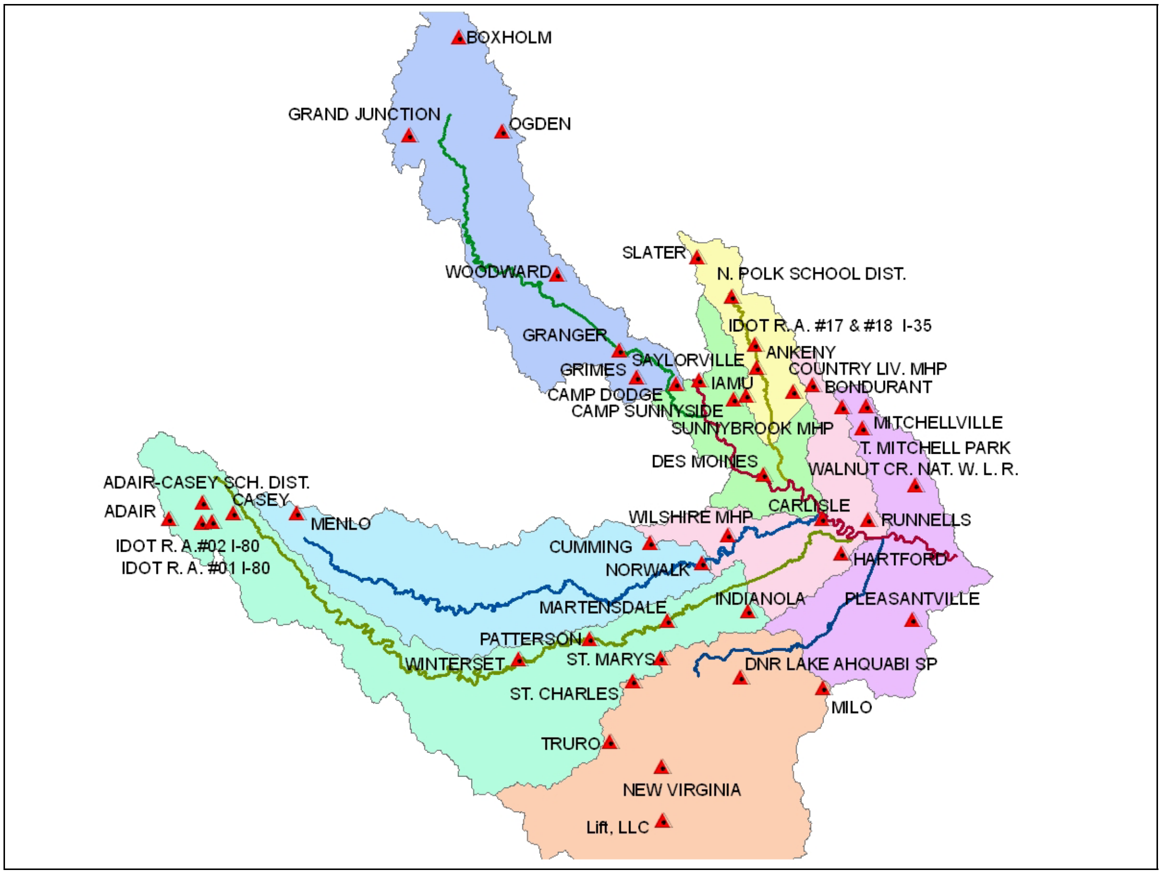

Figure 17 NPDES permitted WWTP location map

Table 21 lists the cities with MS4 stormwater permits that currently limit bacteria indicator discharges through the implementation of best management practices (BMP).

Table 21 Municipal NPDES MS4 Stormwater Permit cities in the watershed

City Name	EPA NPDES ID	Iowa DNR NPDES ID	Receiving waterbody	Population	Area covered under MS4, Sq. Mi.
Altoona	IA0078603	7707002	Fourmile Creek and Des Moines River	13,301	7.1
Ankeny	IA0078611	7709008	Fourmile Creek and Des Moines River	36,161	16.8
Bondurant	IA0078786	7717002	Mud Creek	1,846	4.8
Des Moines	IA0075540	7727007	Des Moines River	209,124	77.2
Grimes	IA0078883	7736002	Beaver Creek	5,098	9.0
Johnston	IA0078212	7740002	Beaver Creek and Des Moines River	8,649	15.5
Norwalk	IA0078913	9164002	North River	8,502	6.56
Pleasant Hill	IA0078751	7767002	Fourmile Creek and Des Moines River	6,961	7.9
Urbandale	IA0078620	7780002	Des Moines River	35,904	20.7
West Des Moines	IA0078778	7785002	North River	54,726	26.8

Nonpoint Sources.
The nonpoint sources of pathogen indicators include contributors that do not have localized points of release into a stream. In the watershed these sources are:

- Grazing animals
- Cattle contributions directly deposited in a stream
- Land application of manure
- Built-up and urban area runoff
- Wildlife
- Faulty septic tank systems

These nonpoint *E. coli* sources have been evaluated and bacteria loads estimated using the EPA Bacteria Indicator Tool (BIT). The BIT spreadsheet model is detailed in Appendix D as are its assumptions and procedures.

The nonpoint source *E. coli* loads have been estimated for each of the three TMDL gage sites. Bar charts showing the distribution for the land use and source categories can be found in Appendix D. Below are pie charts that show major source percentages for each TMDL site at each of the five flow recurrence conditions.

Second Avenue monitoring site.
The Second Avenue TMDL site receives loads from three major sources:

- Beaver Creek subbasin as measured and sampled at the Beaver Creek gage,
- Direct drainage from nearby small tributaries and the areas adjacent to the Des Moines River segment upstream from the Second Avenue site, estimated as the difference between total Second Avenue loads and the loads from Beaver Creek and Saylorville dam discharge, and
- Saylorville dam discharge as measured and sampled at Sycamore.

The Beaver Creek subbasin is the largest bacteria contributor during high flow conditions as shown in Figure 18. There are two components of the Beaver Creek bacteria load:

- continuous loads from failed septic tanks and livestock in streams and,
- runoff carrying bacteria available for washoff when it rains.

Continuous loads are fairly constant in volume and concentration. Runoff loads have high bacteria concentrations and usually occur with elevated streamflow.

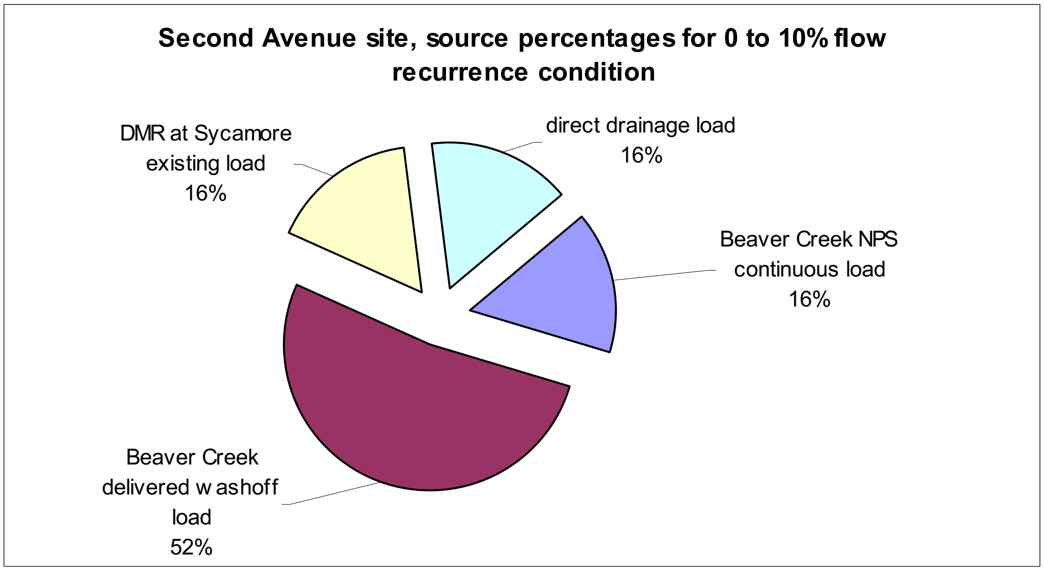

Figure 18 Nonpoint source load distribution at the Second Avenue TMDL site for the 0 to 10% flow recurrence condition

The direct drainage component is the flow and load from parts of the watershed not included in the Beaver Creek flow and load. It has been calculated as the difference between the load at the Des Moines River (DMR) Second Avenue site and the combined Beaver Creek and Sycamore DMR loads at the five flow conditions. Direct drainage becomes more important in moist conditions and median flow since it is generally closer to the monitoring site. This direct drainage impact can be seen in Figures 19 through 21.

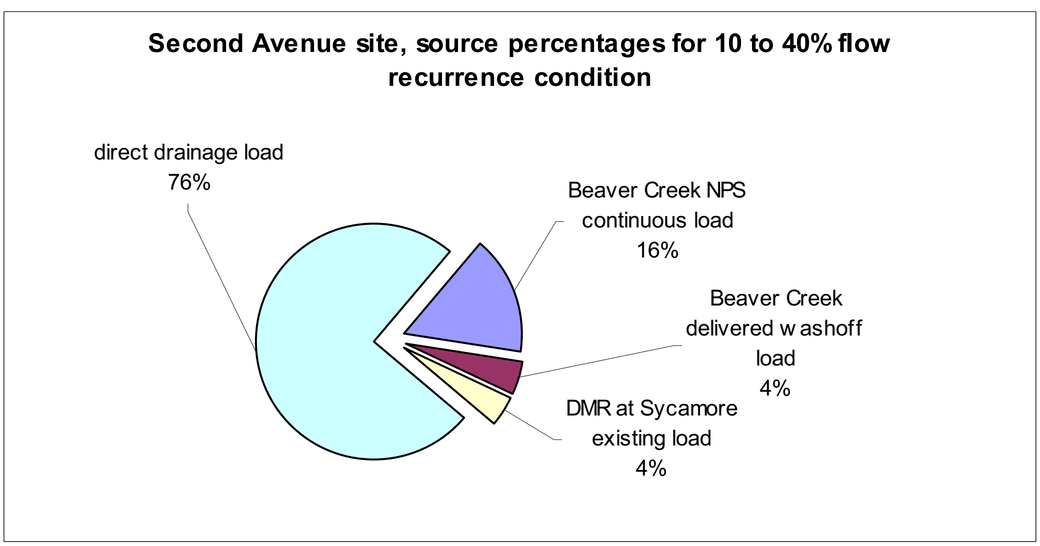

Figure 19 Nonpoint source load distribution at the Second Avenue TMDL site for the 10 to 40% flow recurrence condition

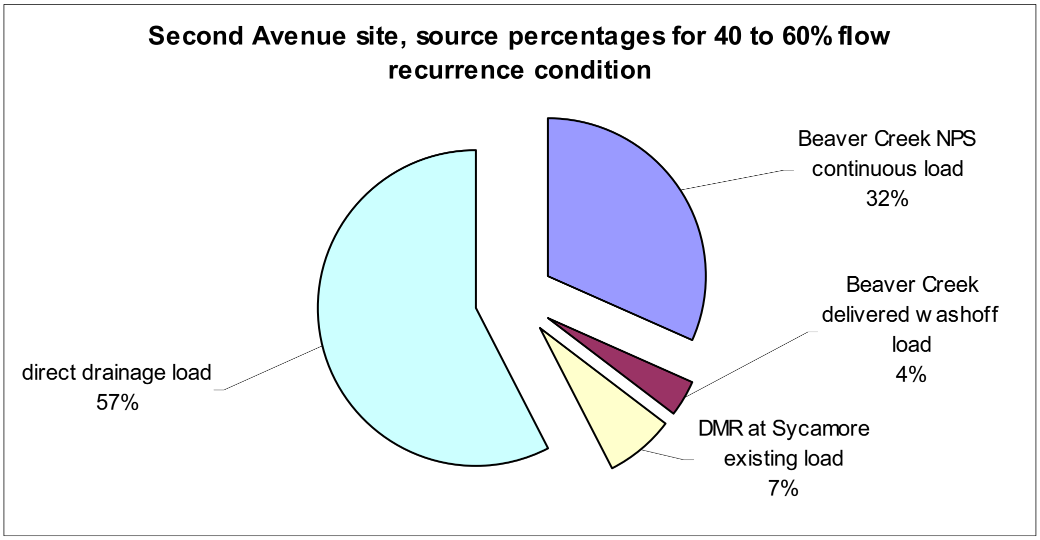

Figure 20 Nonpoint source load distribution at the Second Avenue TMDL site for the 40 to 60% flow recurrence condition

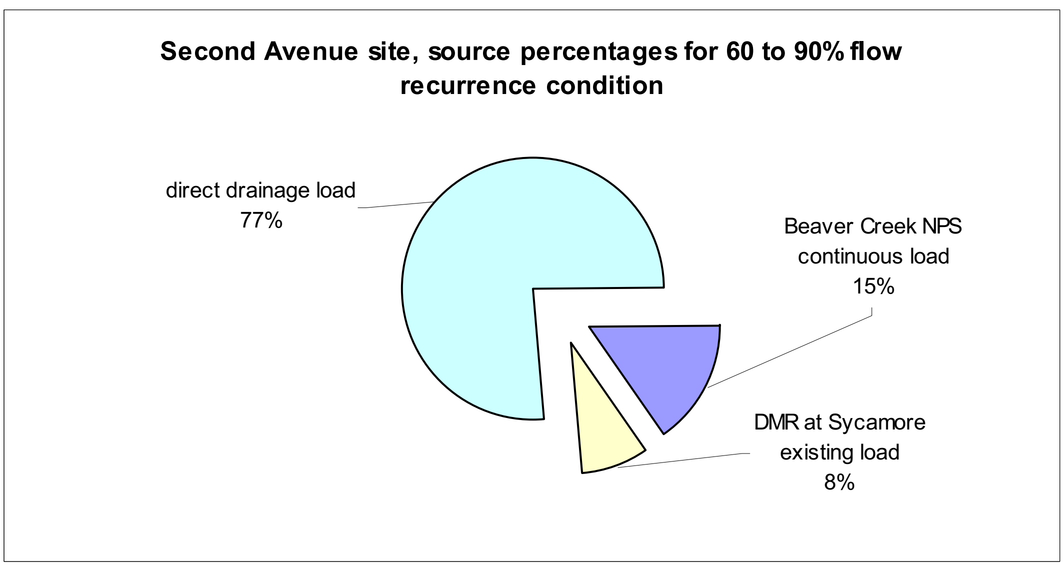

Figure 21 Nonpoint source load distribution at the Second Avenue TMDL site for the 60 to 90% flow recurrence condition

The Des Moines River at Sycamore is the discharge from the Saylorville dam and it almost always has *E. coli* concentrations well below the criteria. Because of this low *E. coli* concentration and significant flow, it dilutes loads from the other two sources as overall flows decrease. The Saylorville dam discharge is controlled by the US Army Corps of Engineers and is not necessarily related to precipitation events. During dry conditions and low flow it is an increasingly influential flow and load fraction.

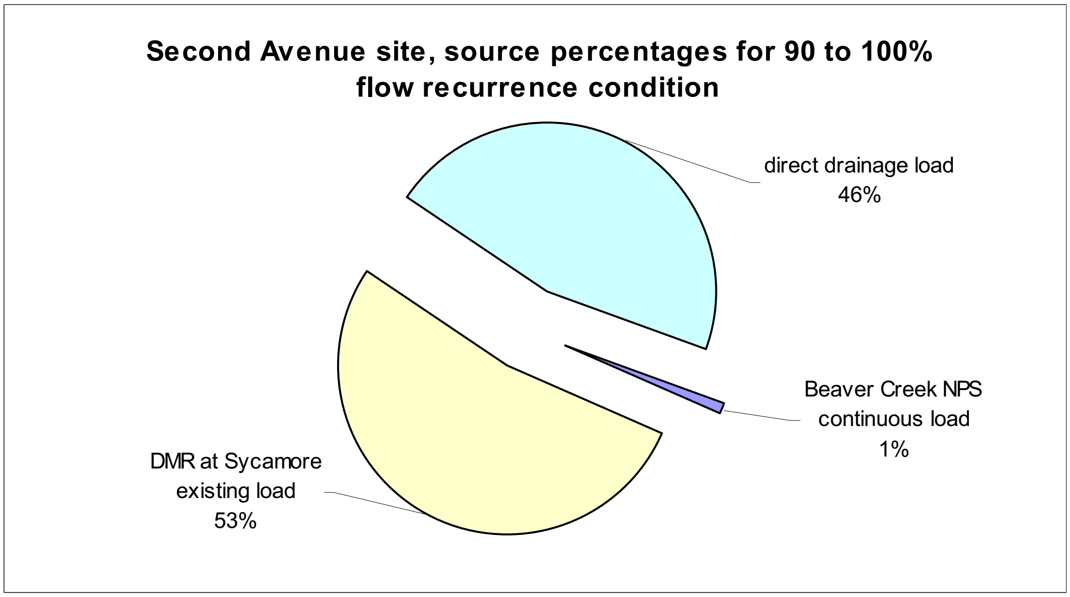

Figure 22 Nonpoint source load distribution at the Second Avenue TMDL site for the 90 to 100% flow recurrence condition

Site below the Raccoon River confluence (State Road 46/Highway 65).
The State Road 46/Highway 65 TMDL site below the confluence with the Raccoon River receives loads from three major sources:

- Upstream Des Moines River flows and loads as measured at Second Avenue,
- Direct drainage from the DMR Upper subbasin including areas adjacent to the Des Moines River segment upstream from the State Road 46/Highway 65, and
- Raccoon River flows and loads as measured at the Fleur Drive gage.

The relative nonpoint source loads for the site below the confluence with the Raccoon River are shown in Figures 23 through 27. As can be seen from these pie charts, the Raccoon River loads, from a watershed that is 3,625 square miles, is most of the load at four of five flow conditions. At high flows it is estimated to be 93 percent of the load. The upstream Second Avenue Des Moines River loads are also significant.

The direct drainage load from the DMR Upper subbasin (133 square miles) has a minor impact at high flows and in moist conditions, however, at low flows it is 19 percent of the total load. This includes runoff from the City of Des Moines and combined sewer overflow from some of the city's stormwater collection network.

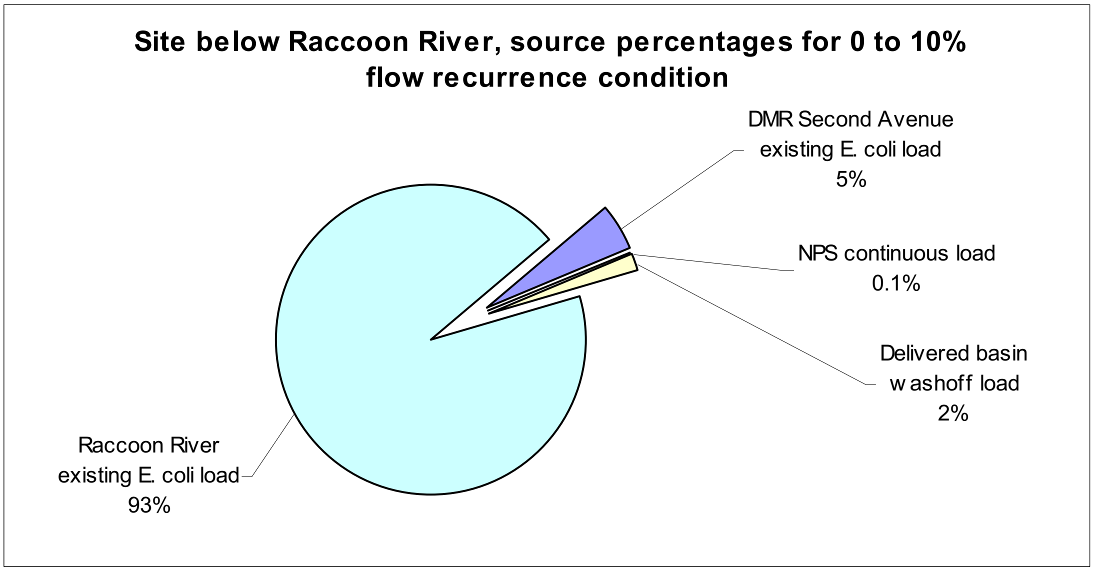

Figure 23 Nonpoint source load distribution at the TMDL site below the Raccoon River for the 0 to 10% flow recurrence condition

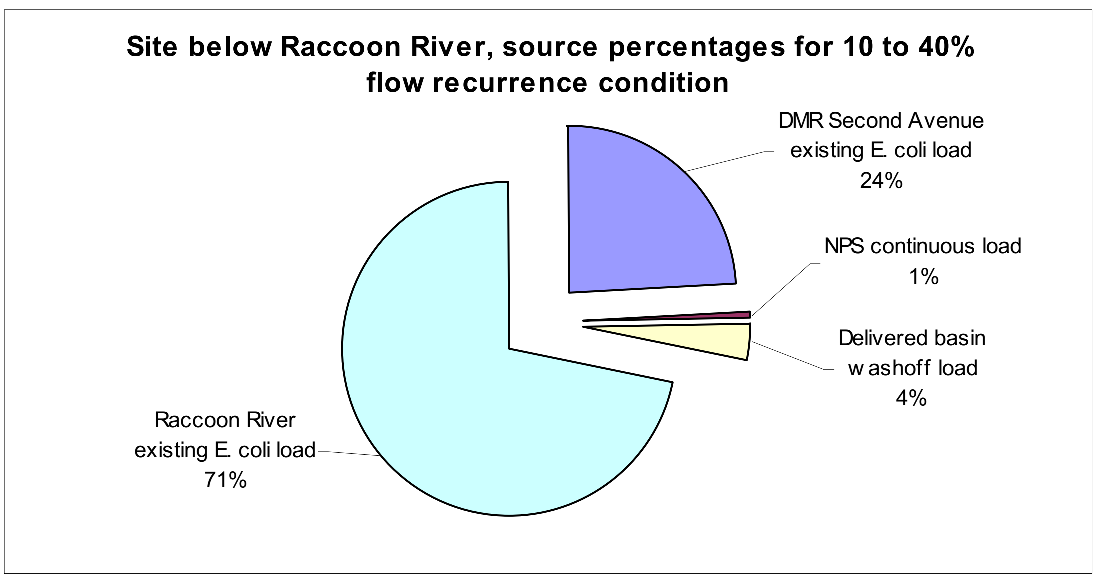

Figure 24 Nonpoint source load distribution at the TMDL site below the Raccoon River for the 10 to 40% flow recurrence condition

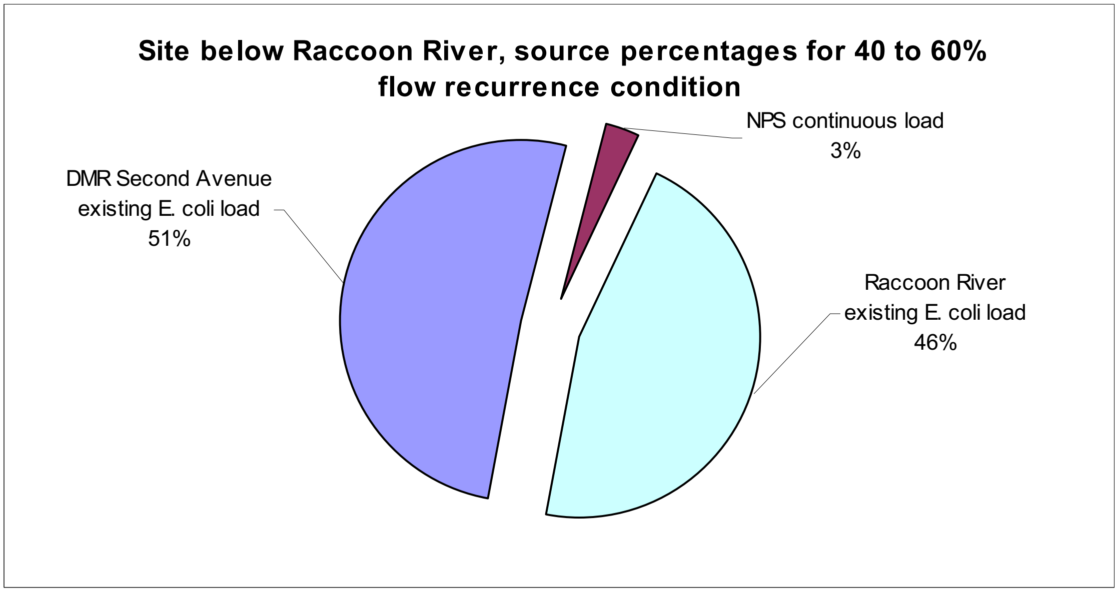

Figure 25 Nonpoint source load distribution at the TMDL site below the Raccoon River for the 40 to 60% flow recurrence condition

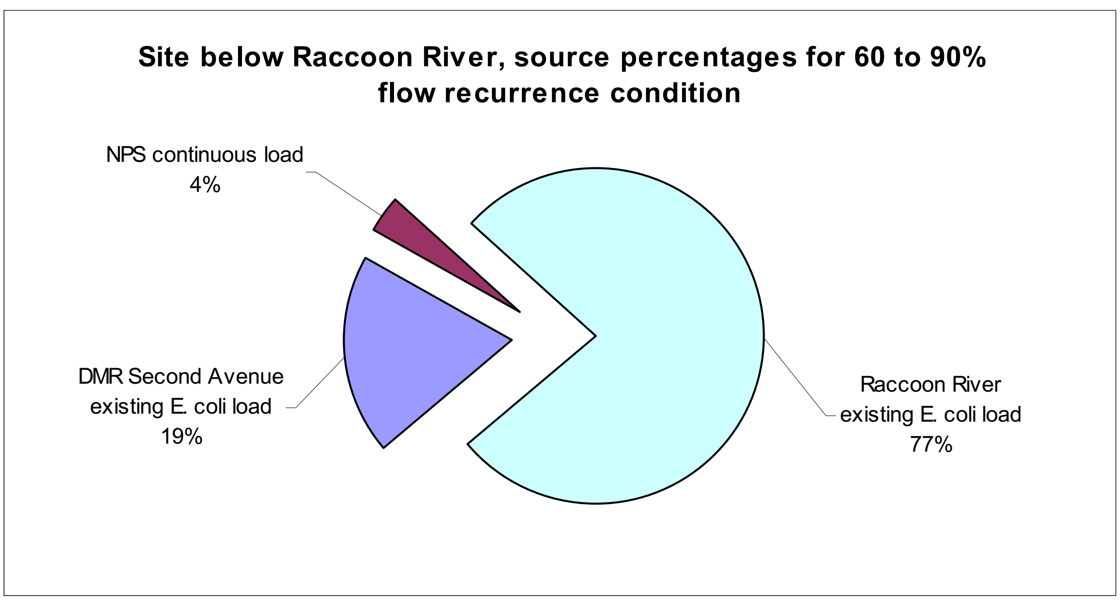

Figure 26 Nonpoint source load distribution at the TMDL site below the Raccoon River for the 60 to 90% flow recurrence condition

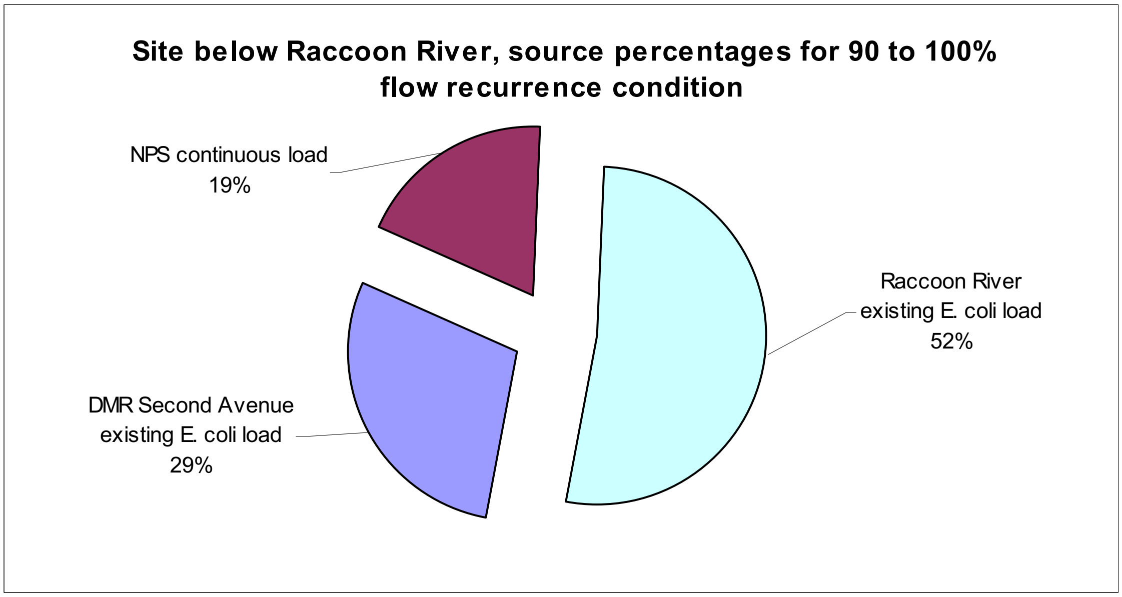

Figure 27 Nonpoint source load distribution at the TMDL site below the Raccoon River for the 90 to 100% flow recurrence condition

Site at Runnells
The Runnells TMDL site receives loads from six major sources:

- Upstream Des Moines River flows and loads as measured at State Road 46/Highway 65 below the Raccoon River confluence,
- Drainage from the Fourmile Creek subbasin as estimated from the BIT model,
- Drainage from the North River subbasin as estimated from the BIT model,
- Drainage from the Middle River subbasin as estimated from the BIT model,
- Drainage from the South River subbasin as estimated from the BIT model, and
- Drainage from the Des Moines River Middle subbasin as estimated from the BIT model.

The nonpoint source subbasin load fraction for the six sources at the Runnells site is shown in Figure 28. These relative fractions have the same apportionment for each of the five flow conditions. This is because there is only one sampling site, Runnells, and the estimated existing load is a single value for each flow condition. The load distribution for each of the subbasins by the four land use categories and the two continuous source categories can be found in Appendix D, Figures D13 through D17.

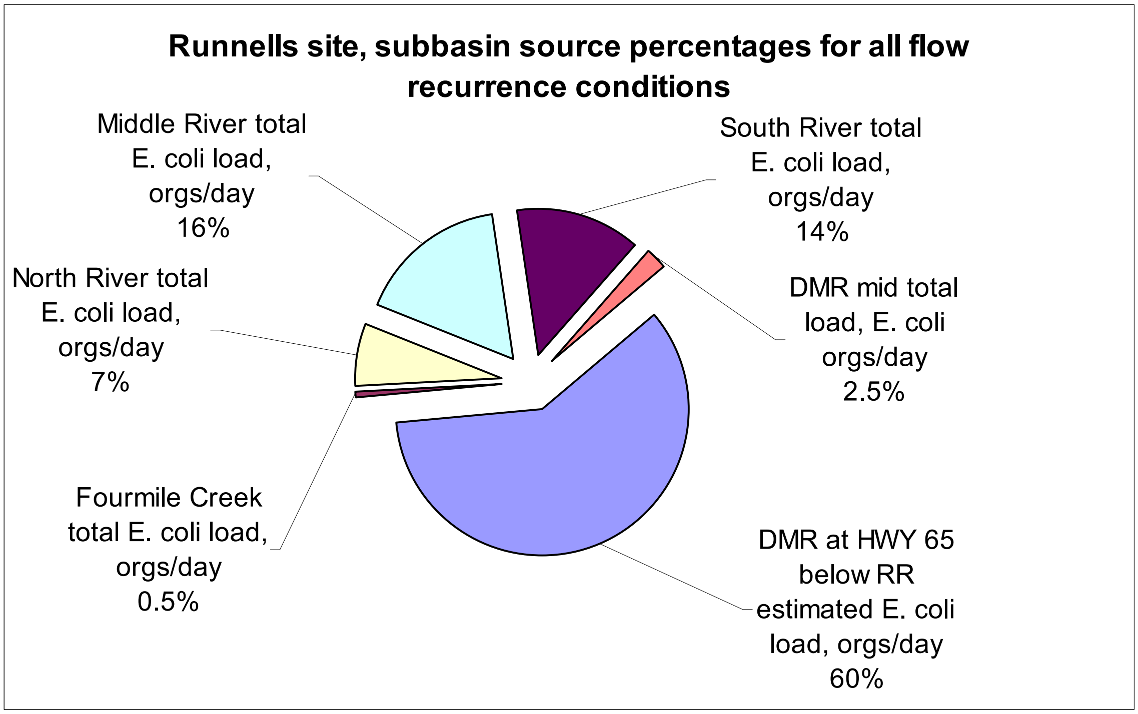

Figure 28 Source load fractions for the upstream Des Moines River and the nonpoint sources for the subbasins draining to the Runnells site.

The subbasin loads have been combined into two categories, washoff loads delivered by rain events and continuous NPS loads from failed septics and cattle in the stream. The fraction of the load from the upstream Des Moines River as measured at State Road 46/Highway 65 is assumed to be 60 percent for all flow conditions. The nonpoint source loads for the Runnells TMDL site are shown in Figures 29 through 33.

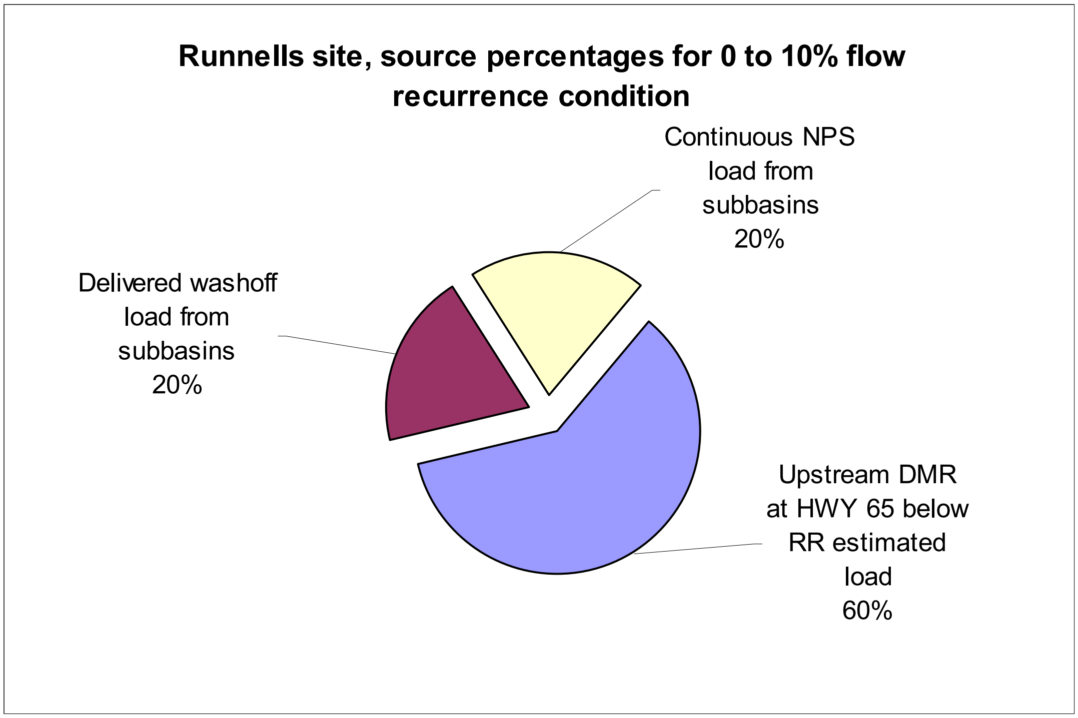

Figure 29 Nonpoint source load distribution at the Runnells TMDL site for the 0 to 10% flow recurrence condition

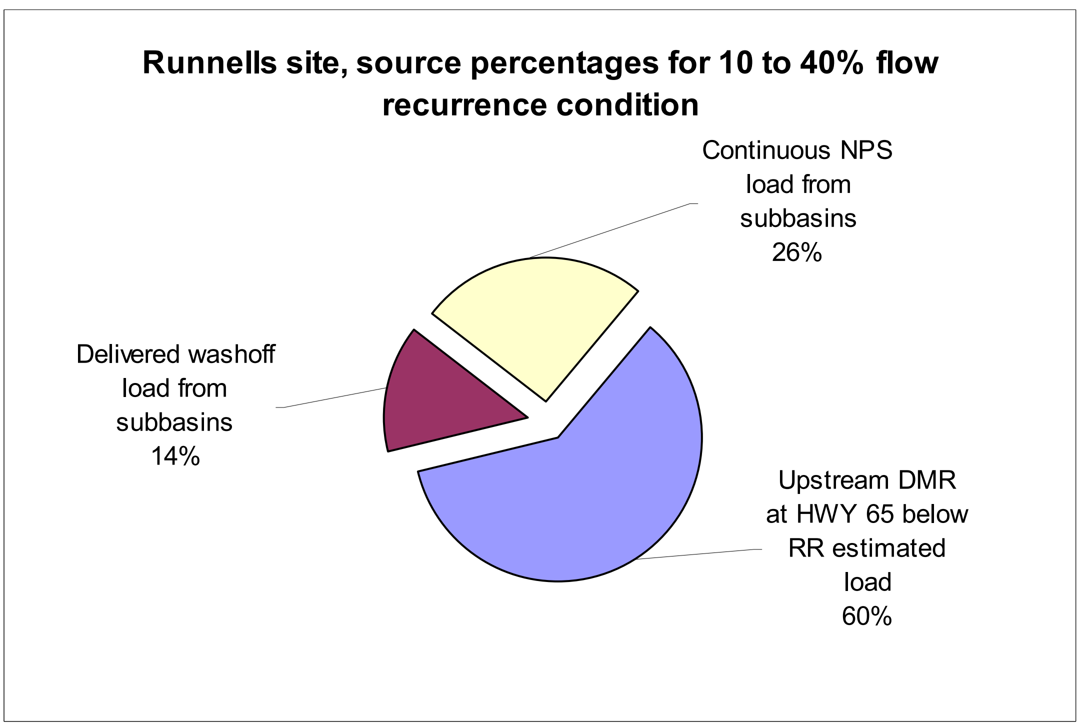

Figure 30 Nonpoint source load distribution at the Runnells TMDL site for the 10 to 40% flow recurrence condition

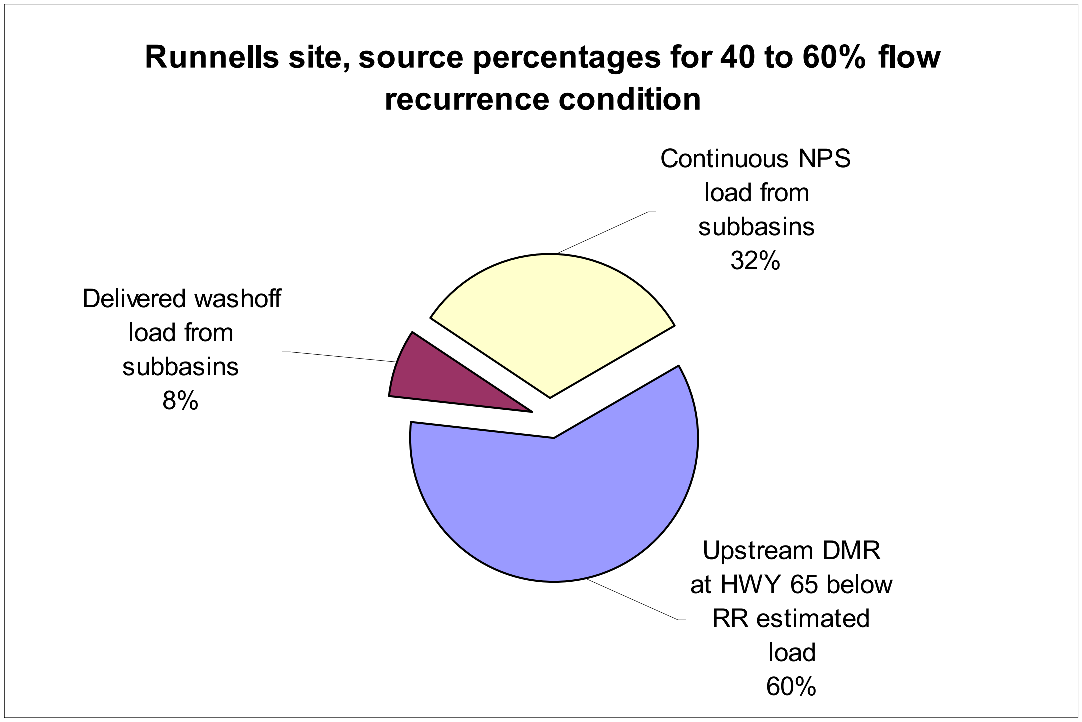

Figure 31 Nonpoint source load distribution at the Runnells TMDL site for the 40 to 60% flow recurrence condition

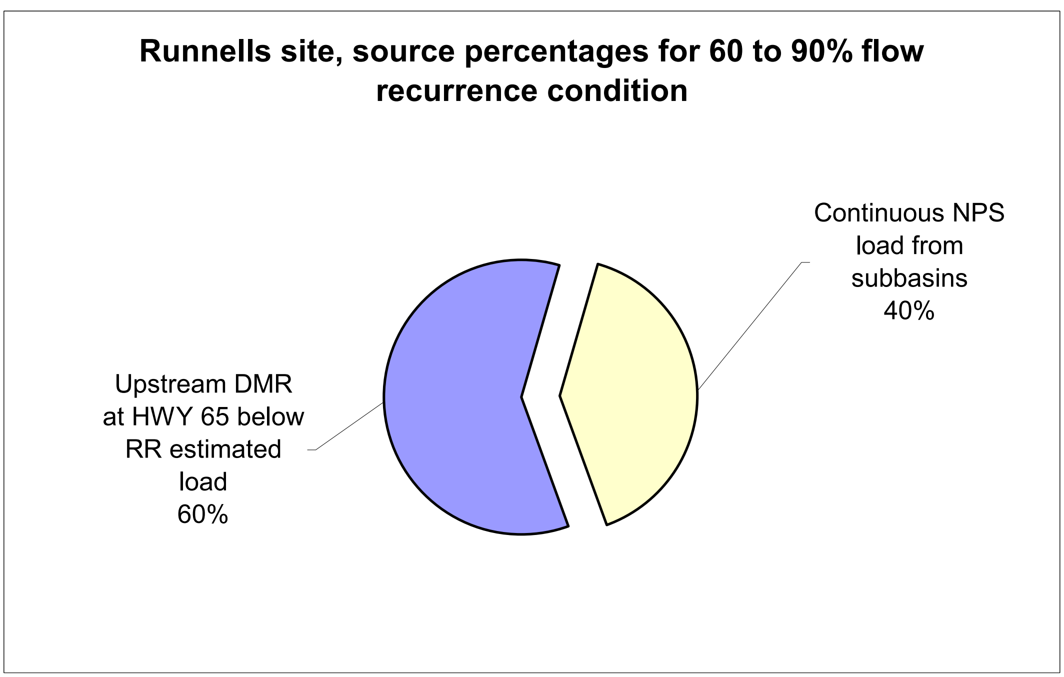

Figure 32 Nonpoint source load distribution at the Runnells TMDL site for the 60 to 90% flow recurrence condition

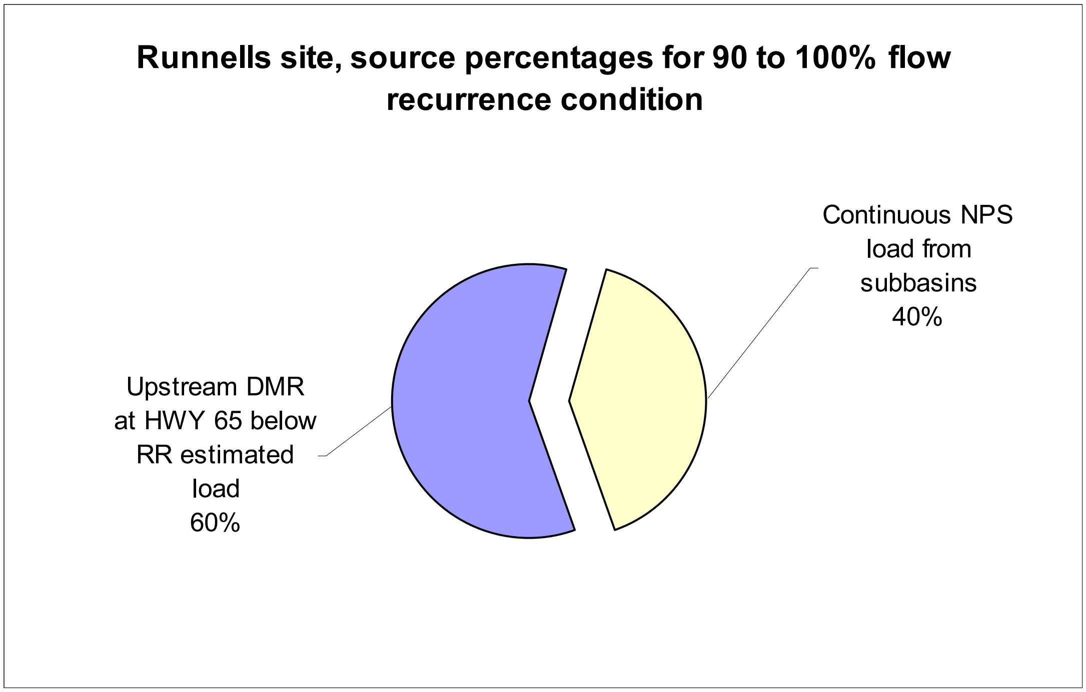

Figure 33 Nonpoint source load distribution at the Runnells TMDL site for the 90 to 100% flow recurrence condition

Allowance for increases in pollutant loads.
An allowance for increased pathogen indicator loading was not included in this TMDL. All discharges into the impaired Des Moines River segments are expected to comply with the Iowa Water Quality Standards. Any new permitted point source discharge would be required to meet the WQS limits. Any new nonpoint sources would be expected to meet the *E. coli* limits.

3.4. Pollutant Allocation

Wasteload allocations.
The wasteload allocations for the forty-five wastewater treatment facilities discharging to the Des Moines River or its tributaries are in Table 22. It is currently assumed that all of the wastewater treatment plants in the watershed discharge to a Class A1 stream. The wasteload allocations for direct discharges are the same as the *E. coli* water quality standards, a geometric mean of 126-organisms/100 ml and a single sample maximum of 235-organisms/100 ml. These concentration criteria have been multiplied by the 30 day average wet weather (AWW) and the maximum day wet weather (MWW) wastewater treatment plant design flows, respectively, to obtain the wasteload allocations for each facility.

Table 22 Permitted Wastewater Treatment Plant discharge Wasteload Allocations

NPDES PERMITTED MUNICIPAL/SEMI-PUBLIC TREATMENT FACILITIES			*E. coli* Wasteload Allocations for the two criteria concentrations and loads			
City Name	AWW Design Flow, MGD[1]	MWW Design Flow, MGD[2]	Geometric Mean[3]	Single Sample Max.[3]	Geometric Mean[4]	Single Sample Max.[4]
Adair WWTP	0.2000	0.300	126	235	9.55E+08	2.67E+09
Adair-Casey School WWTP	0.0175	0.026	126	235	8.36E+07	2.33E+08
Ankeny WWTP	8.0000	12.100	126	235	3.82E+10	1.08E+11
Bondurant WWTP	0.5150	1.035	126	235	2.46E+09	9.22E+09
Boxholm WWTP[5]	0.0330	na	126	235	1.58E+09	2.94E+09
Camp Dodge	0.3960	0.792	126	235	1.89E+09	7.05E+09
Carlisle WWTP	1.4800	5.750	126	235	7.07E+09	5.12E+10
Casey WWTP	0.0750	0.105	126	235	3.58E+08	9.35E+08
Country Living Mobile Home Park WWTP[5]	0.0146	na	126	235	6.97E+08	1.30E+09
Cumming WWTP	0.0200	0.027	126	235	9.55E+07	2.44E+08
Des Moines WWTP	134.0000	200.000	126	235	6.40E+11	1.78E+12
DNR Lake Aquabi State Park WWTP[5]	0.0036	na	126	235	1.72E+08	3.21E+08
Easter Seal Soc. of IA (Camp Sunnyside) [5]	0.0085	na	126	235	4.06E+08	7.57E+08
Grand Junction WWTP[5]	0.0152	na	126	235	7.26E+08	1.35E+09
Granger WWTP	0.3110	0.427	126	235	1.48E+09	3.80E+09
Grimes WWTP	2.1300	2.910	126	235	1.02E+10	2.59E+10
Hartford WWTP	0.2600	0.325	126	235	1.24E+09	2.89E+09
Indianola WWTP	2.5000	4.320	126	235	1.19E+10	3.85E+10
Iowa Assoc. of Municipal Util. WWTP	0.0018	0.003	126	235	8.59E+06	2.49E+07
IDOT Rest Area #01 I-80 Adair WWTP[5]	0.0120	na	126	235	5.73E+08	1.07E+09
IDOT Rest Area #02 I-80 Adair WWTP[5]	0.0120	na	126	235	5.73E+08	1.07E+09
IDOT Rest Area #17 & #18 I-35 Ankeny WWTP[5]	0.0120	na	126	235	5.73E+08	1.07E+09
Lift, LLC WWTP[5]	0.0050	na	126	235	2.39E+08	4.45E+08
Martensdale WWTP[5]	0.0800	na	126	235	3.82E+09	7.12E+09
Menlo STP[5]	0.0455	na	126	235	2.17E+09	4.05E+09
Milo WWTP	0.1900	0.350	126	235	9.07E+08	3.12E+09
Mitchellville WWTP	1.6900	4.830	126	235	8.07E+09	4.30E+10

City Name	AWW Design Flow, MGD[1]	MWW Design Flow, MGD[2]	Geometric Mean[3]	Single Sample Max.[3]	Geometric Mean[4]	Single Sample Max.[4]
New Virginia San. Dist. WWTP[5]	0.198	na	126	235	9.45E+09	1.76E+10
N. Polk School Dist. WWTP	0.0140	0.033	126	235	6.68E+07	2.94E+08
Norwalk WWTP	2.3300	3.530	126	235	1.11E+10	3.14E+10
Ogden WWTP	0.7080	0.723	126	235	3.38E+09	6.44E+09
Patterson WWTP[5]	0.0400	na	126	235	1.91E+09	3.56E+09
Pleasantville WWTP	0.4550	1.250	126	235	2.17E+09	1.11E+10
Runnells WWTP	0.0700	0.110	126	235	3.34E+08	9.80E+08
Saylorville - Bob Shetler WWTP[5]	0.0029	na	126	235	1.38E+08	2.58E+08
Slater WWTP	0.9200	1.600	126	235	4.39E+09	8.19E+09
St. Charles WWTP	0.0700	0.175	126	235	3.34E+08	6.23E+08
St. Marys WWTP[5]	0.0120	na	126	235	5.73E+08	1.07E+09
Sunnybrook Mobile Home Park WWTP	0.0400	0.150	126	235	1.91E+08	1.34E+09
Thomas Mitchell Park WWTP[5]	0.0031	na	126	235	1.48E+08	2.76E+08
Truro WWTP[5]	0.1110	na	126	235	5.30E+09	9.88E+09
Walnut Creek Nat. Wildlife Refuge WWTP	0.0130	0.026	126	235	6.21E+07	2.32E+08
Wilshire Mobile Home Ct WWTP[5]	0.0123	na	126	235	5.87E+08	1.10E+09
Winterset WWTP	1.7500	2.500	126	235	8.36E+09	2.23E+10
Woodward WWTP[5]	0.1220	na	126	235	5.83E+09	1.09E+10

1. AWW is the 30 day average wet weather design flow for a continuously discharging wastewater treatment plant and the 180 day average wet weather design flow from a controlled discharge waste stabilization lagoon.
2. MWW is the maximum daily wet weather design flow for a continuously discharging wastewater treatment plant.
3. These are the water quality standard *E. coli* concentration WLAs for the 30 day geometric mean and single sample maximum.
4. Number of *E. coli* organisms (load) allowed at the design discharge flows.
5. These controlled discharge waste stabilization lagoons usually discharge twice a year for a relatively short time. They are permitted to discharge at a rate that is ten times the 180 day AWW flow. The daily E. coli load WLAs for these facilities are the WQS concentrations multiplied by ten times the 180 day AWW.

Built-up or urban land use is 6.7 percent of the watershed of the impaired segments. Residential, roadway, and commercial land uses may be included in the nonpoint bacteria sources or as point sources under municipal stormwater NPDES permits. There are ten MS4 discharge permits in the watershed as shown in Table 23. Stormwater runoff from these cities flows into the impaired Des Moines River segments or their tributaries.

The wasteload allocation targets for the MS4 permits are the same as those for the NPDES wastewater treatment plants, the water quality standard values of 126 organisms/100 ml for a 30 day geometric mean and 235 organisms/100 ml for the single sample maximum. The State of Iowa permits the cities listed in Table 23 assuming the implementation of best management practices (BMPs) described in their existing MS4 permits will control bacteria contributions. The water quality based wasteload allocations in this TMDL are numeric *E. coli* discharge concentrations from the WQS applied to the flow at the municipal stormwater outfalls in the MS4 permitted cities.

Table 23 Municipal NPDES MS4 Stormwater Permits and Wasteload Allocations

City Name	EPA NPDES ID	Runoff flow[1], m^3/day	30-day Geom. Mean[2], orgs/100 ml	Single Sample Max.[2], orgs/100 ml	Geom. Mean[3], orgs/day	Sample Max.[3], orgs/day
Altoona	IA0078603	1,479,250	126	235	1.86E+12	3.48E+12
Ankeny	IA0078611	625,146	126	235	7.88E+11	1.47E+12
Bondurant	IA0078786	324,316	126	235	4.09E+11	7.62E+11
Des Moines	IA0075540	6,350,788	126	235	8.00E+12	1.49E+13
Grimes	IA0078883	852,528	126	235	1.07E+12	2.00E+12
Johnston	IA0078212	1,208,073	126	235	1.52E+12	2.84E+12
Norwalk	IA0078913	470,861	126	235	5.93E+11	1.11E+12
Pleasant Hill	IA0078751	571,984	126	235	7.21E+11	1.34E+12
Urbandale	IA0078620	1,900,906	126	235	2.40E+12	4.47E+12
West Des Moines	IA0078778	2,283,077	126	235	2.88E+12	5.37E+12

1. Runoff estimated using the Rational equation (Q=CIA) applied to six land use categories (residential, commercial/industrial, roads/transport, cropland, grassland/park, forest) in the MS4 cities and a 2 year return 24 hour precipitation event (3 inches).
2. Wasteload allocations for the MS4 permits are the *E. coli* water quality standard limits of the 30 day geometric mean of 126 orgs/100 ml and the single sample maximum of 235 orgs/100 ml.
3. The total *E. coli* organisms is calculated from the estimated runoff from a two year return 24 hour precipitation event for each city. The two year precipitation event for the Des Moines Metro Area is 2.91 inches and this was rounded to 3 inches for the calculation.

There are two permitted open feedlots in the impaired Des Moines River segments watershed. The wasteload allocations for these are in Table 24.

Table 24 NPDES Permitted Open Feedlot Operation Wasteload Allocation

Facility Name	Facility ID	NPDES permit #	EPA #	Township and range	Sec	1/4 Sec	WLA[1]
Brenton Brothers, Inc.	58687	2500001	IA0038911	T80N, R25W	19	NW 1/4	No discharge
Holz Brothers, Inc.	56814	N/A	IA0080837	T83N, R29W	15	NE	No discharge

1. No discharge resulting from precipitation events less than or equal to the 25 year, 24 hour precipitation event.

A wasteload allocation set aside has been included in this TMDL to account for unsewered communities that may eventually become sewered and have an NPDES permitted discharge from a wastewater treatment plant. This set aside includes the unsewered communities in the Raccoon River Basin as well as the part of the Des Moines

River Basin covered by this TMDL. The wasteload allocation set asides for both geometric mean and single sample maximum are shown in Table 25.

Table 25 Unsewered community wasteload allocation set asides

Basin	Des Moines River	Raccoon River
Number of unsewered communities	26	34
Unsewered Community Population	1350	2276
Estimated flow at 100 gpcpd [1]	135000	227600
Estimated flow, l/day	511031	861560
***E. coli* count at 126 orgs/100 ml** [2]	6.44E+08	1.09E+09
***E. coli* count at 235 orgs/100 ml** [2]	1.20E+09	2.02E+09

1. One hundred gallons per capita per day is the per capita design flow required for facility planning of new wastewater treatment plants by the Iowa Design Standards.
2. These are the *E. coli* organism count set aside for unsewered communities when they require an NPDES permit after new WWTP construction.

Wasteload allocation summations by TMDL site.
The summations for the WLAs for each of the TMDL sites are shown in Tables 26 to 34. The site wastewater treatment plant and set aside WLA summations are shown in Tables 26, 29, and 32. The site geometric mean WLA summations including the MS4 WLAs are in Tables 27, 30, and 33. The site single sample maximum WLA summations including the MS4 WLAs are in Tables 28, 31, and 34. These summations are used in the load allocation and TMDL calculation tables.

Table 26 WWTP and set aside WLAs for the watershed of the Second Ave monitoring site TMDL

City Name	Geometric Mean, orgs/day	Sample Max., orgs/day
Boxholm WWTP	1.58E+09	2.94E+09
Camp Dodge	1.89E+09	7.05E+09
Easter Seal Soc. of IA (Camp Sunnyside)	4.06E+08	7.57E+08
Grand Junction WWTP	7.26E+08	1.35E+09
Granger WWTP	1.48E+09	3.80E+09
Grimes WWTP	1.02E+10	2.59E+10
Iowa Assoc. of Municipal Util. WWTP	8.59E+06	2.49E+07
Ogden WWTP	3.38E+09	6.44E+09
Saylorville - Bob Shetler WWTP	1.38E+08	2.58E+08
Sunnybrook Mobile Home Park WWTP	1.91E+08	1.34E+09
Woodward WWTP	5.83E+09	1.09E+10
WWTP summation	**2.58E+10**	**6.07E+10**
Unsewered set aside	**1.46E+08**	**2.72E+08**
Total	**2.59E+10**	**6.10E+10**

Table 27 Sum of all geometric mean WLAs for the Second Ave monitoring site TMDL

Flow condition, percent recurrence	Median flow, cfs	MS4 WLA *E. coli*, orgs/day	WWTP WLA *E. coli*, orgs/day	Sum of all WLA, *E. coli*, orgs/day
High flows, 0 to 10%	14,300	4.99E+12	2.59E+10	5.02E+12
Moist cond., 10 to 40%	7,780	2.72E+12	2.59E+10	2.74E+12
Mid-range, 40 to 60%	2,770	9.67E+11	2.59E+10	9.93E+11
Dry cond., 60 to 90%	850	NA	2.59E+10	2.59E+10
Low flow, 90 to 100%	214	NA	2.59E+10	2.59E+10

Table 28 Sum of all maximum single sample WLAs for the Second Ave monitoring site TMDL

Flow condition, percent recurrence	Median flow, cfs	MS4 WLA *E. coli*, orgs/day	WWTP WLA *E. coli*, orgs/day	Sum of all WLA, *E. coli*, orgs/day
High flows, 0 to 10%	14,300	9.31E+12	6.10E+10	9.37E+12
Moist cond., 10 to 40%	7,780	5.06E+12	6.10E+10	5.13E+12
Mid-range, 40 to 60%	2,770	1.80E+12	6.10E+10	1.86E+12
Dry cond., 60 to 90%	850	NA	6.10E+10	6.10E+10
Low flow, 90 to 100%	214	NA	6.10E+10	6.10E+10

Table 29 WWTP and set aside WLAs for the watershed of the TMDL monitoring site below the Raccoon River confluence

City Name	Geometric Mean, orgs/day	Sample Max., orgs/day
Des Moines WWTP	6.40E+11	1.19E+12
WWTP summation	**6.40E+11**	**1.19E+12**
Unsewered set aside	**1.09E+09**	**2.02E+09**
Total	**6.41E+11**	**1.20E+12**

Table 30 Sum of all geometric mean WLAs for the TMDL monitoring site below the Raccoon River confluence

Flow condition, percent recurrence	Median flow, cfs	MS4 WLA *E. coli*, orgs/day	WWTP WLA *E. coli*, orgs/day	Sum of all WLA, *E. coli*, orgs/day
High flows, 0 to 10%	23,100	1.16E+13	6.41E+11	1.22E+13
Moist cond., 10 to 40%	11,900	5.98E+12	6.41E+11	6.62E+12
Mid-range, 40 to 60%	4,180	2.10E+12	6.41E+11	2.74E+12
Dry cond., 60 to 90%	1,430	NA	6.41E+11	6.41E+11
Low flow, 90 to 100%	435	NA	6.41E+11	6.41E+11

Table 31 Sum of all maximum single sample WLAs for the TMDL monitoring site below the Raccoon River confluence

Flow condition, percent recurrence	Median flow, cfs	MS4 WLA *E. coli*, orgs/day	WWTP WLA *E. coli*, orgs/day	Sum of all WLA, *E. coli*, orgs/day
High flows, 0 to 10%	23,100	2.16E+13	1.20E+12	2.28E+13
Moist cond., 10 to 40%	11,900	1.11E+13	1.20E+12	1.23E+13
Mid-range, 40 to 60%	4,180	3.91E+12	1.20E+12	5.11E+12
Dry cond., 60 to 90%	1,430	NA	1.20E+12	1.20E+12
Low flow, 90 to 100%	435	NA	1.20E+12	1.20E+12

Table 32 WWTP and set aside WLAs for the watershed of the Runnells monitoring site TMDL

City Name	Geom. Mean	Sample Max.
Adair WWTP	9.55E+08	2.67E+09
Adair-Casey School WWTP	8.36E+07	2.33E+08
Ankeny WWTP	3.82E+10	1.08E+11
Bondurant WWTP	2.46E+09	9.22E+09
Carlisle WWTP	7.07E+09	5.12E+10
Casey WWTP	3.58E+08	9.35E+08
Country Living Mobile Home Park WWTP	6.97E+08	1.30E+09
Cumming WWTP	9.55E+07	2.44E+08
DNR Lake Aquabi State Park WWTP	1.72E+08	3.21E+08
Hartford WWTP	1.24E+09	2.89E+09
Indianola WWTP	1.19E+10	3.85E+10
IDOT Rest Area #01 I-80 Adair WWTP	5.73E+08	1.07E+09
IDOT Rest Area #02 I-80 Adair WWTP	5.73E+08	1.07E+09
IDOT Rest Area #17 & #18 I-35 Ankeny WWTP	5.73E+08	1.07E+09
Lift LLC	2.39E+08	4.45E+08
Martensdale WWTP	3.82E+09	7.12E+09
Menlo STP	2.17E+09	4.05E+09
Milo WWTP	9.07E+08	3.12E+09
Mitchellville WWTP	8.07E+09	4.30E+10
New Virginia San. Dist. WWTP	9.45E+09	1.76E+10
N. Polk School Dist. WWTP	6.68E+07	2.94E+08
Norwalk WWTP	1.11E+10	3.14E+10
Patterson WWTP	1.91E+09	3.56E+09
Pleasantville WWTP	2.17E+09	1.11E+10
Runnells WWTP	3.34E+08	9.80E+08
Slater WWTP	4.39E+09	1.42E+10
St. Charles WWTP	3.34E+08	1.56E+09
St. Marys WWTP	5.73E+08	1.07E+09
Thomas Mitchell Park WWTP	1.48E+08	2.76E+08
Truro WWTP	5.30E+09	9.88E+09
Walnut Creek Nat. Wildlife Refuge WWTP	6.21E+07	2.32E+08
Wilshire Mobile Home Court WWTP	5.87E+08	1.10E+09
Winterset WWTP	8.36E+09	2.23E+10
WWTP summation	**1.25E+11**	**3.92E+11**
Unsewered set aside	**4.98E+08**	**9.29E+08**
Total	**1.26E+11**	**3.93E+11**

Table 33 Sum of all geometric mean WLAs for the Runnells Ave monitoring site TMDL

Flow condition, percent recurrence	Median flow, cfs	MS4 WLA *E. coli*, orgs/day	WWTP WLA *E. coli*, orgs/day	Sum of all WLA, *E. coli*, orgs/day
High flows, 0 to 10%	27,000	3.65E+12	1.01E+11	3.75E+12
Moist cond., 10 to 40%	13,900	1.88E+12	1.01E+11	1.98E+12
Mid-range, 40 to 60%	5,090	6.89E+11	1.01E+11	7.90E+11
Dry cond., 60 to 90%	1,690	NA	1.01E+11	1.01E+11
Low flow, 90 to 100%	550	NA	1.01E+11	1.01E+11

Table 34 Sum of all maximum single sample WLAs for the Runnells monitoring site TMDL

Flow condition, percent recurrence	Median flow, cfs	MS4 WLA *E. coli*, orgs/day	WWTP WLA *E. coli*, orgs/day	Sum of all WLA, *E. coli*, orgs/day
High flows, 0 to 10%	27,000	6.81E+12	1.88E+11	7.00E+12
Moist cond., 10 to 40%	13,900	3.51E+12	1.88E+11	3.70E+12
Mid-range, 40 to 60%	5,090	1.28E+12	1.88E+11	1.47E+12
Dry cond., 60 to 90%	1,690	NA	1.88E+11	1.89E+11
Low flow, 90 to 100%	550	NA	1.88E+11	1.89E+11

Load allocation.
The load allocations for this *E. coli* TMDL are the load capacity less an explicit 10 percent margin of safety (MOS) less the total WLA for the flow condition for the geometric mean or single sample maximum. There is a separate load allocation set for each of the target recurrence intervals for each of the three monitored sites for which load duration curves were developed. The load allocations are shown in Tables 35 through 40.

Table 35 DMR Second Ave. gage site geometric mean *E. coli* load allocations for UDM 0010 segments 1 and 2

Flow condition, percent recurrence	Geomean target (TMDL) *E. Coli*, orgs/day	Geomean 10% MOS *E. Coli*, orgs/day	Total WLA Geomean *E. coli*, orgs/day	LA Geomean *E. coli*, orgs/day
High flows, 0 to 10%	4.41E+13	4.41E+12	5.02E+12	3.47E+13
Moist cond., 10 to 40%	2.40E+13	2.40E+12	2.74E+12	1.88E+13
Mid-range, 40 to 60%	8.54E+12	8.54E+11	9.93E+11	6.69E+12
Dry cond., 60 to 90%	2.62E+12	2.62E+11	2.59E+10	2.33E+12
Low flow, 90 to 100%	6.60E+11	6.60E+10	2.59E+10	5.68E+11

1. Based on geometric mean standard of 126 *E. coli* organisms/100 ml

Table 36 DMR Second Ave. gage site maximum single sample *E. coli* load allocations for UDM 0010 segments 1 and 2

Flow condition, percent recurrence	Max. single sample target (TMDL) *E. Coli*, orgs/day	Max. single sample 10% MOS *E. Coli*, orgs/day	Total WLA max single sample *E. coli*, orgs/day	LA max single sample *E. coli*, orgs/day
High flows, 0 to 10%	8.22E+13	8.22E+12	9.37E+12	6.46E+13
Moist cond., 10 to 40%	4.47E+13	4.47E+12	5.13E+12	3.51E+13
Mid-range, 40 to 60%	1.59E+13	1.59E+12	1.86E+12	1.25E+13
Dry cond., 60 to 90%	4.89E+12	4.89E+11	6.10E+10	4.34E+12
Low flow, 90 to 100%	1.23E+12	1.23E+11	6.10E+10	1.05E+12

1. Based on single sample maximum standard of 235 *E. coli* organisms/100 ml

Table 37 DMR gage site below Raccoon River geometric mean *E. coli* load allocations for LDM 0040 segment 3

Flow condition, percent recurrence	Geomean target (TMDL) *E. Coli*, orgs/day	Geomean 10% MOS *E. Coli*, orgs/day	Total WLA Geomean *E. coli*, orgs/day	LA Geomean *E. coli*, orgs/day
High flows, 0 to 10%	7.12E+13	7.12E+12	1.22E+13	5.19E+13
Moist cond., 10 to 40%	3.67E+13	3.67E+12	6.62E+12	2.64E+13
Mid-range, 40 to 60%	1.29E+13	1.29E+12	2.74E+12	8.86E+12
Dry cond., 60 to 90%	4.41E+12	4.41E+11	6.41E+11	3.33E+12
Low flow, 90 to 100%	1.34E+12	1.34E+11	6.41E+11	5.66E+11

1. Based on geometric mean standard of 126 *E. coli* organisms/100 ml

Table 38 DMR gage site below Raccoon River maximum single sample *E. coli* load allocations for LDM 0040 segment 3

Flow condition, percent recurrence	Max. single sample target (TMDL) *E. Coli*, orgs/day	Max. single sample 10% MOS *E. Coli*, orgs/day	Total WLA max single sample *E. coli*, orgs/day	LA max single sample *E. coli*, orgs/day
High flows, 0 to 10%	1.33E+14	1.33E+13	2.34E+13	9.61E+13
Moist cond., 10 to 40%	6.84E+13	6.84E+12	1.29E+13	4.87E+13
Mid-range, 40 to 60%	2.40E+13	2.40E+12	5.70E+12	1.59E+13
Dry cond., 60 to 90%	8.22E+12	8.22E+11	1.78E+12	5.62E+12
Low flow, 90 to 100%	2.50E+12	2.50E+11	1.78E+12	4.68E+11

1. Based on single sample maximum standard of 235 *E. coli* organisms/100 ml

Table 39 Des Moines River gage site at Runnells geometric mean *E. coli* load allocations for LDM 0040 segments 1 and 2

Flow condition, percent recurrence	Geomean target (TMDL) *E. Coli*, orgs/day	Geomean 10% MOS *E. Coli*, orgs/day	Total WLA Geomean *E. coli*, orgs/day	LA Geomean *E. coli*, orgs/day
High flows, 0 to 10%	8.32E+13	8.32E+12	3.78E+12	7.11E+13
Moist cond., 10 to 40%	4.29E+13	4.29E+12	2.01E+12	3.66E+13
Mid-range, 40 to 60%	1.57E+13	1.57E+12	8.14E+11	1.33E+13
Dry cond., 60 to 90%	5.21E+12	5.21E+11	1.26E+11	4.56E+12
Low flow, 90 to 100%	1.70E+12	1.70E+11	1.26E+11	1.40E+12

1. Based on geometric mean standard of 126 *E. coli* organisms/100 ml

Table 40 Des Moines River gage site at Runnells maximum single sample *E. coli* load allocations for LDM 0040 segments 1 and 2

Flow condition, percent recurrence	Max. single sample target (TMDL) *E. Coli*, orgs/day	Max. single sample 10% MOS *E. Coli*, orgs/day	Total WLA max single sample *E. coli*, orgs/day	LA max single sample *E. coli*, orgs/day
High flows, 0 to 10%	1.55E+14	1.55E+13	7.21E+12	1.33E+14
Moist cond., 10 to 40%	7.99E+13	7.99E+12	3.90E+12	6.80E+13
Mid-range, 40 to 60%	2.93E+13	2.93E+12	1.68E+12	2.47E+13
Dry cond., 60 to 90%	9.72E+12	9.72E+11	3.93E+11	8.35E+12
Low flow, 90 to 100%	3.16E+12	3.16E+11	3.93E+11	2.45E+12

1. Based on single sample maximum standard of 235 *E. coli* organisms/100 ml

Margin of safety.
The margin of safety for *E. coli* is an explicit 10 percent of the load capacity at each of the design recurrence intervals as shown in Tables 35 through 40.

3.5. Reasonable Assurance

EPA guidance (EPA 440/4-91-001) and policy (EPA Memorandum 8/8/97) calls for reasonable assurance that TMDLs can be implemented. Reasonable assurance indicates confidence that the goals outlined in the TMDL can be achieved, whether in the form of wasteload allocations or load allocations. For the Des Moines River, various regulations and programs exist that can be utilized to implement TMDLs.

Reasonable assurance is a demonstration that the wasteload and load allocations will be realized through regulation or implementation of non-regulatory actions. For waterbodies such as the segments of the Des Moines River impaired by both point and nonpoint sources, wasteload allocations assume anticipated reductions of E. coli from nonpoint sources will occur (40CFR 130.2g).

For point sources, including stormwater discharges covered by MS4 stormwater permits and combined sewer overflows (CSOs), Code of Federal Regulations Title 40 (40 CFR) 122.44(d)(1)(vii)(B) requires effluent limitations for an NPDES permit to be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA including those in TMDLs. Furthermore, EPA has authority to object to issuance of a NPDES permit that is inconsistent with the WLAs established for that point source. These wasteload allocations are implemented through the Iowa NPDES permitting procedure following state rules in Iowa Administrative Code (IAC) 567-64. Special conditions for the control of the City of Des Moines CSOs are included in the NPDES permit issued to the Des Moines Water Metropolitan Reclamation Authority Facility.

The federal storm water permitting regulations require municipalities to obtain permit coverage for all storm water discharges from separate storm sewer systems (MS4s). Due to the variability of storm events and discharges from storm sewer system discharges, it is difficult to establish numeric limits on stormwater discharges that accurately address projected loadings. As a result, EPA regulations and guidance recommend expressing NPDES permit limits for MS4s as BMPs, and only using numeric limits in unique instances. The stormwater wasteload allocations for E coli for the MS4 cities in these TMDLs are numerically based and are the water quality criteria concentrations.

In these TMDLs, WLAs were developed for each municipality holding a stormwater permit. Distribution of bacteria load was estimated by applying unit area runoff to land use data within municipal boundaries. As additional data are collected by the municipal storm water programs regarding drainage areas of each storm sewer system in the basin, these WLAs can become more detailed.

For nonpoint sources, funding assistance from programs such as the Clean Water Act Section 319 grants are available These programs address nonpoint source load allocations by providing funds to implement best management practices (BMP) for nonpoint source pollutants. Measures that benefit nonpoint source control efforts include development of the Iowa Nonpoint Source Management Program document, watershed group activities for river restoration, expanded stormwater permitting, and implementation of other bacteria TMDLs for impaired tributaries such as the Raccoon River.

Reasonable assurance for nonpoint sources will be accomplished through methods and projects that reduce the impacts of livestock, manure applications to fields, failed septic tank systems, and unpermitted runoff from built-up areas as described in *Section 4.*

3.6. TMDL Summary

The following equation represents the total maximum daily load (TMDL) and its components for the five impaired segments of the Des Moines River covered in this report:

Total Maximum Daily Load = Σ Load Allocations + Σ Wasteload Allocations +MOS

A Total Maximum Daily Load calculation has been made for each of the design flow conditions at each of the three monitoring sites and these are shown in Tables 41 through 46 and Figures 34 through 39.

Table 41 TMDL calculations for geometric mean *E. coli* for UDM 0010 segments 1 and 2 flow conditions

Flow condition, percent recurrence	Σ LA, organisms/day	Σ WLA, organisms/day	MOS, organisms/day	TMDL, organisms/day
High flows, 0 to 10%	5.02E+12	3.47E+13	4.41E+12	4.41E+13
Moist cond., 10 to 40%	2.74E+12	1.88E+13	2.40E+12	2.40E+13
Mid-range, 40 to 60%	9.93E+11	6.69E+12	8.54E+11	8.54E+12
Dry cond., 60 to 90%	2.59E+10	2.33E+12	2.62E+11	2.62E+12
Low flow, 90 to 100%	2.59E+10	5.68E+11	6.60E+10	6.60E+11

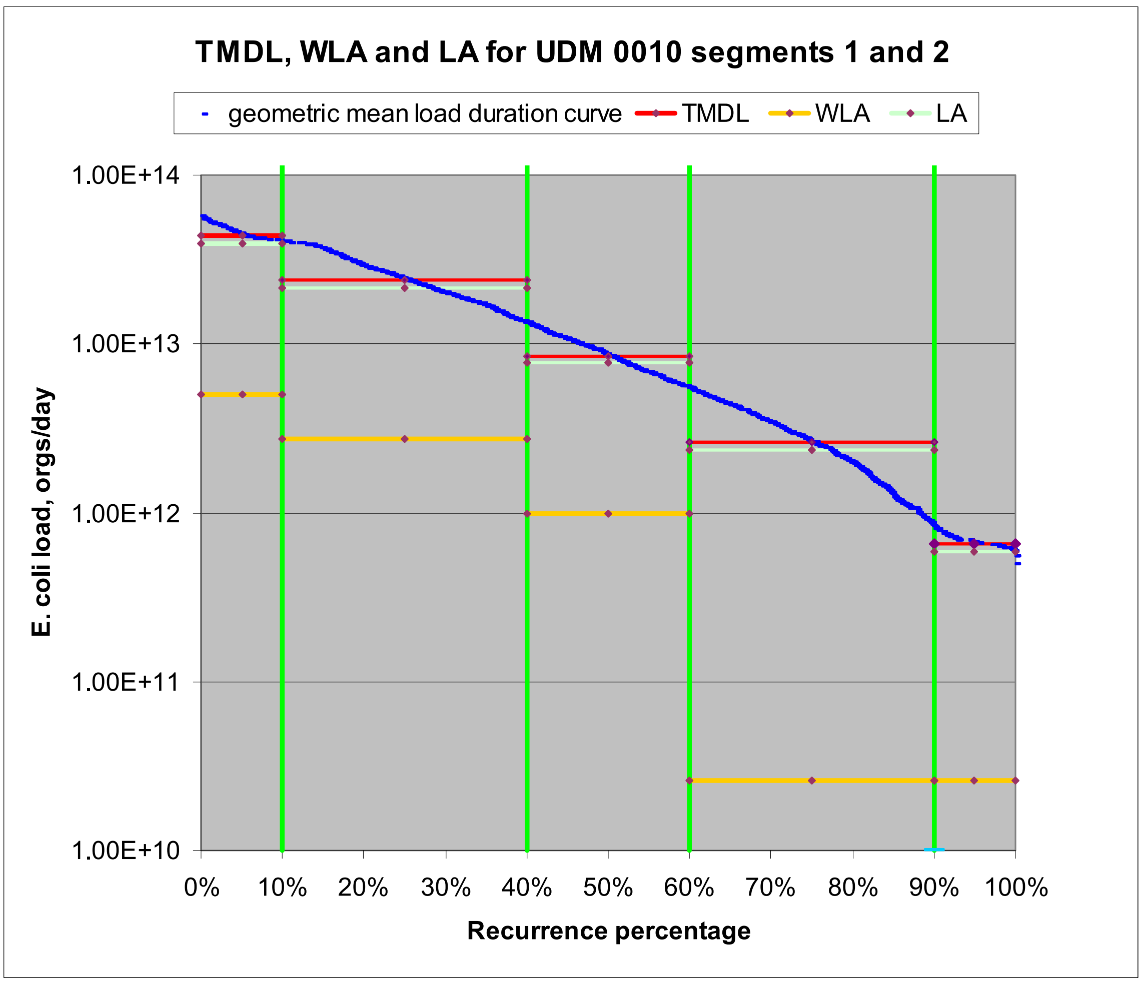

Figure 34 TMDL at the geometric mean WQS of 126 orgs/100 ml for the five flow conditions

Table 42 TMDL calculations for maximum single sample *E. coli* for UDM 0010 segments 1 and 2 flow conditions

Flow condition, percent recurrence	Σ LA, organisms/day	Σ WLA, organisms/day	MOS, organisms/day	TMDL, organisms/day
High flows, 0 to 10%	6.46E+13	9.37E+12	8.22E+12	8.22E+13
Moist cond., 10 to 40%	3.51E+13	5.13E+12	4.47E+12	4.47E+13
Mid-range, 40 to 60%	1.25E+13	1.86E+12	1.59E+12	1.59E+13
Dry cond., 60 to 90%	4.34E+12	6.10E+10	4.89E+11	4.89E+12
Low flow, 90 to 100%	1.05E+12	6.10E+10	1.23E+11	1.23E+12

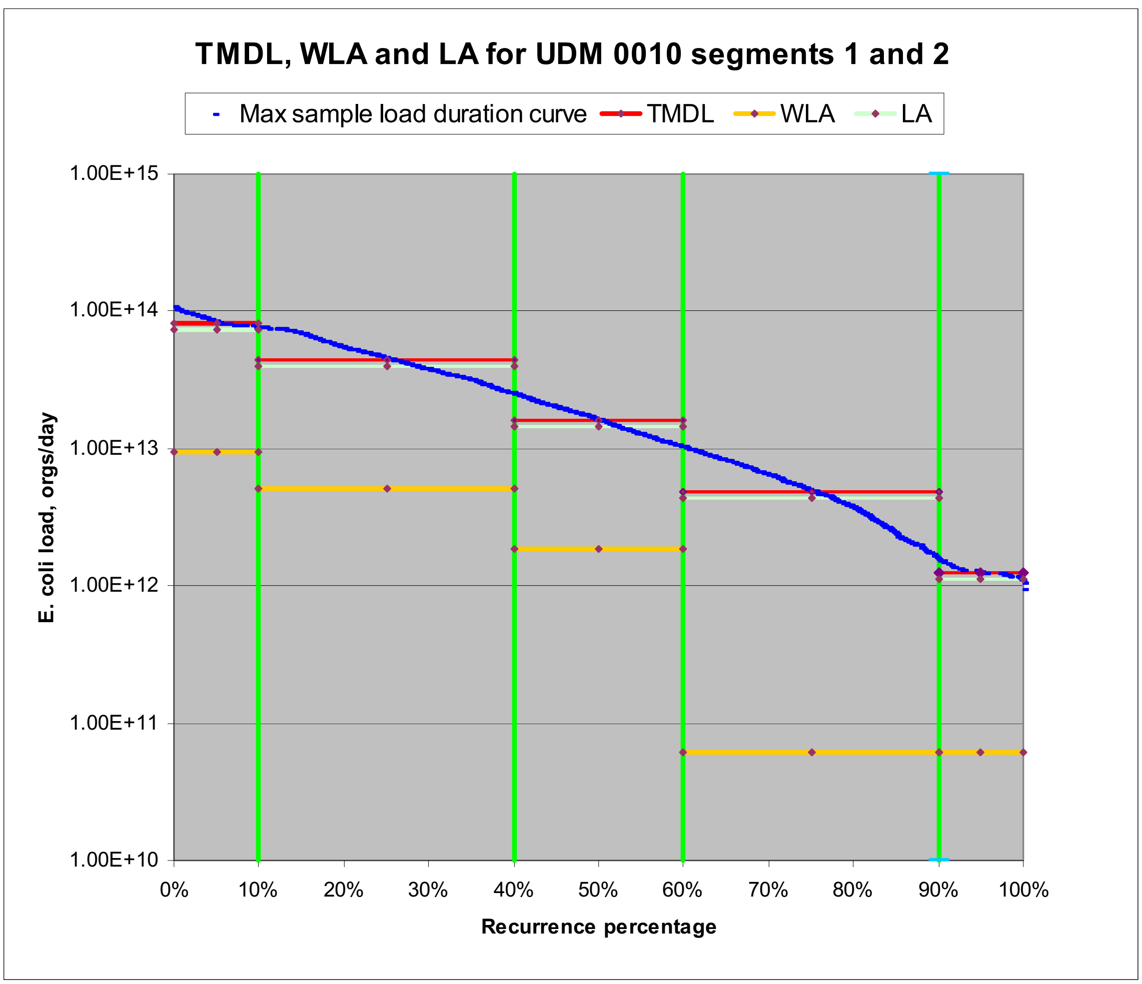

Figure 35 TMDL at the maximum single sample WQS of 235 orgs/100 ml for the five flow conditions

Table 43 TMDL calculations for geometric mean *E. coli* for LDM 0040 segment 3 flow conditions

Flow condition, percent recurrence	Σ LA, organisms/day	Σ WLA, organisms/day	MOS, organisms/day	TMDL, organisms/day
High flows, 0 to 10%	5.19E+13	1.22E+13	7.12E+12	7.12E+13
Moist cond., 10 to 40%	2.64E+13	6.62E+12	3.67E+12	3.67E+13
Mid-range, 40 to 60%	8.86E+12	2.74E+12	1.29E+12	1.29E+13
Dry cond., 60 to 90%	3.33E+12	6.41E+11	4.41E+11	4.41E+12
Low flow, 90 to 100%	5.66E+11	6.41E+11	1.34E+11	1.34E+12

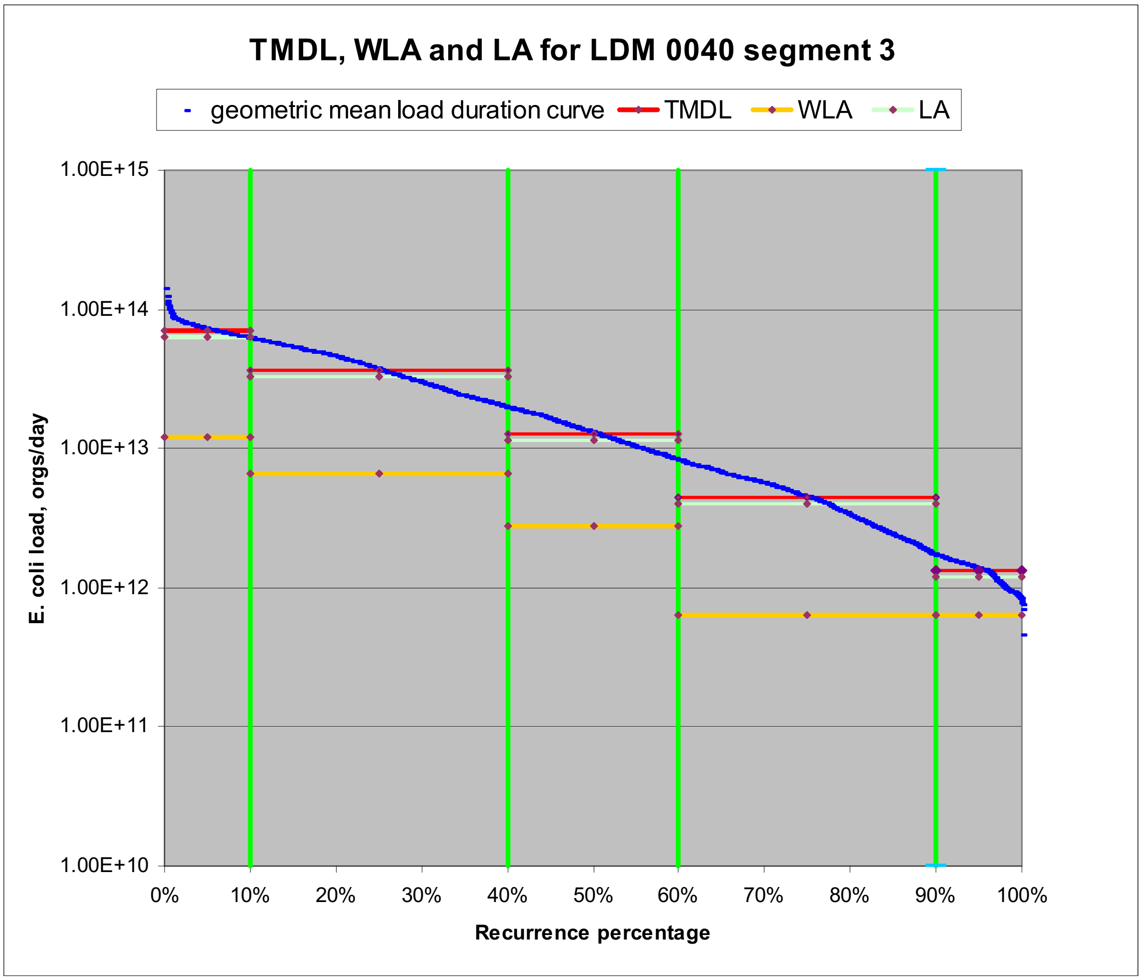

Figure 36 TMDL at the geometric mean WQS of 126 orgs/100 ml for the five flow conditions

Table 44 TMDL calculations for maximum single sample *E. coli* for LDM 0040 segment 3 design flow conditions

Flow condition, percent recurrence	Σ LA, organisms/day	Σ WLA, organisms/day	MOS, organisms/day	TMDL, organisms/day
High flows, 0 to 10%	9.61E+13	2.34E+13	1.33E+13	1.33E+14
Moist cond., 10 to 40%	4.87E+13	1.29E+13	6.84E+12	6.84E+13
Mid-range, 40 to 60%	1.59E+13	5.70E+12	2.40E+12	2.40E+13
Dry cond., 60 to 90%	5.62E+12	1.78E+12	8.22E+11	8.22E+12
Low flow, 90 to 100%	4.68E+11	1.78E+12	2.50E+11	2.50E+12

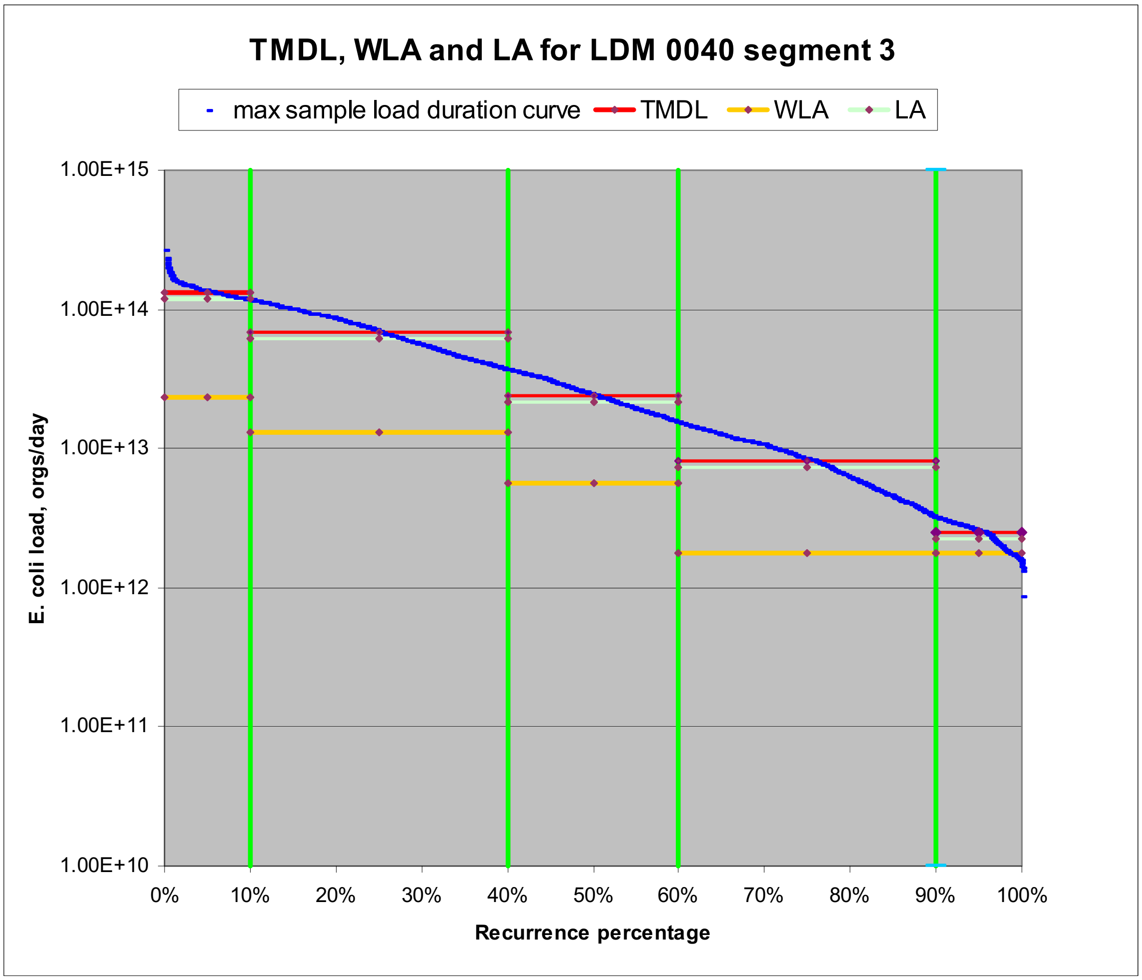

Figure 37 TMDL at the maximum single sample WQS of 235 orgs/100 ml for the five flow conditions

Table 45 TMDL calculations for geometric mean *E. coli* for LDM 0040 segments 1 and 2 flow conditions

Flow condition, percent recurrence	Σ LA, organisms/day	Σ WLA, organisms/day	MOS, organisms/day	TMDL, organisms/day
High flows, 0 to 10%	7.11E+13	3.78E+12	8.32E+12	8.32E+13
Moist cond., 10 to 40%	3.66E+13	2.01E+12	4.29E+12	4.29E+13
Mid-range, 40 to 60%	1.33E+13	8.14E+11	1.57E+12	1.57E+13
Dry cond., 60 to 90%	4.56E+12	1.26E+11	5.21E+11	5.21E+12
Low flow, 90 to 100%	1.40E+12	1.26E+11	1.70E+11	1.70E+12

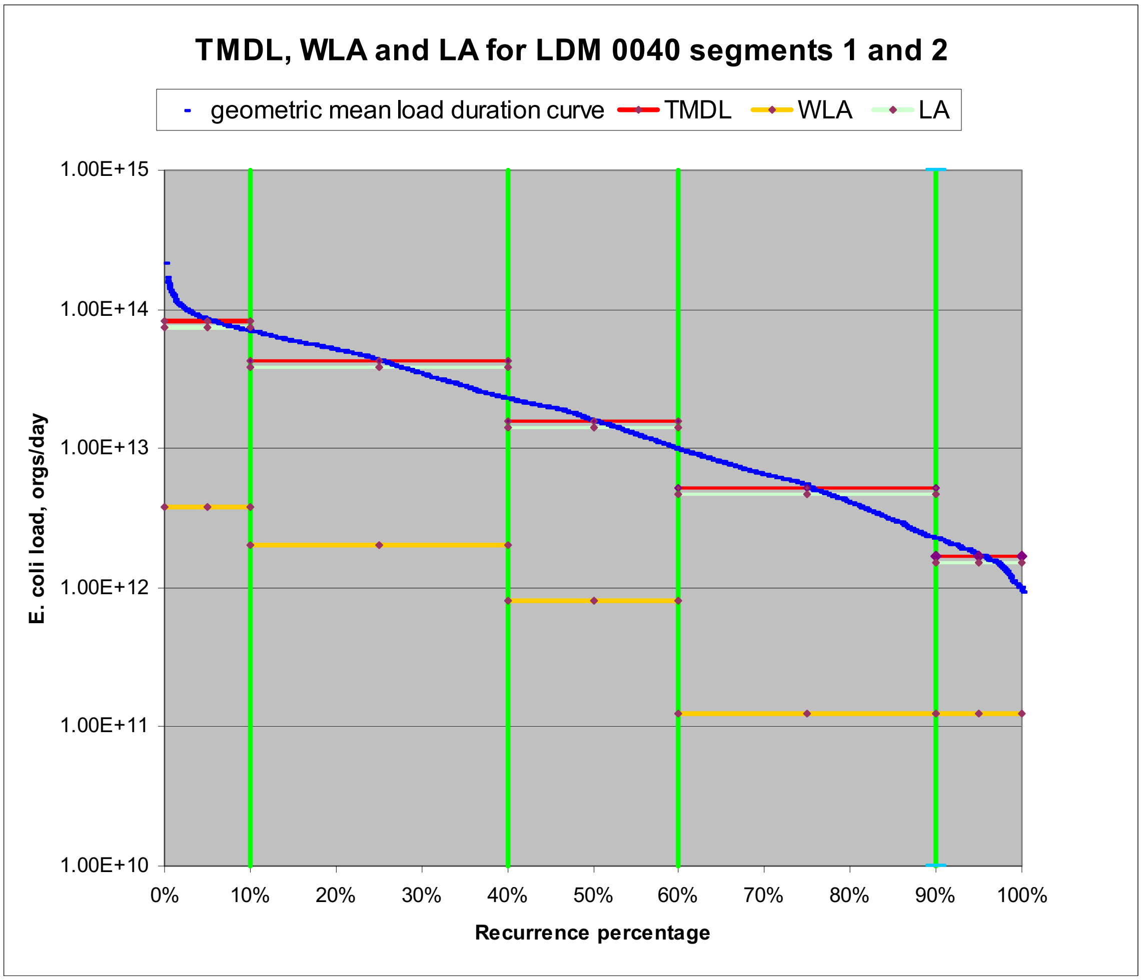

Figure 38 TMDL at the geometric mean WQS of 126 orgs/100 ml for the five flow conditions

Table 46 TMDL calculations for maximum single sample *E. coli* for LDM 0040 segments 1 and 2 design flow conditions

Flow condition, percent recurrence	Σ LA, organisms/day	Σ WLA, organisms/day	MOS, organisms/day	TMDL, organisms/day
High flows, 0 to 10%	1.33E+14	7.21E+12	1.55E+13	1.55E+14
Moist cond., 10 to 40%	6.80E+13	3.90E+12	7.99E+12	7.99E+13
Mid-range, 40 to 60%	2.47E+13	1.68E+12	2.93E+12	2.93E+13
Dry cond., 60 to 90%	8.35E+12	3.93E+11	9.72E+11	9.72E+12
Low flow, 90 to 100%	2.45E+12	3.93E+11	3.16E+11	3.16E+12

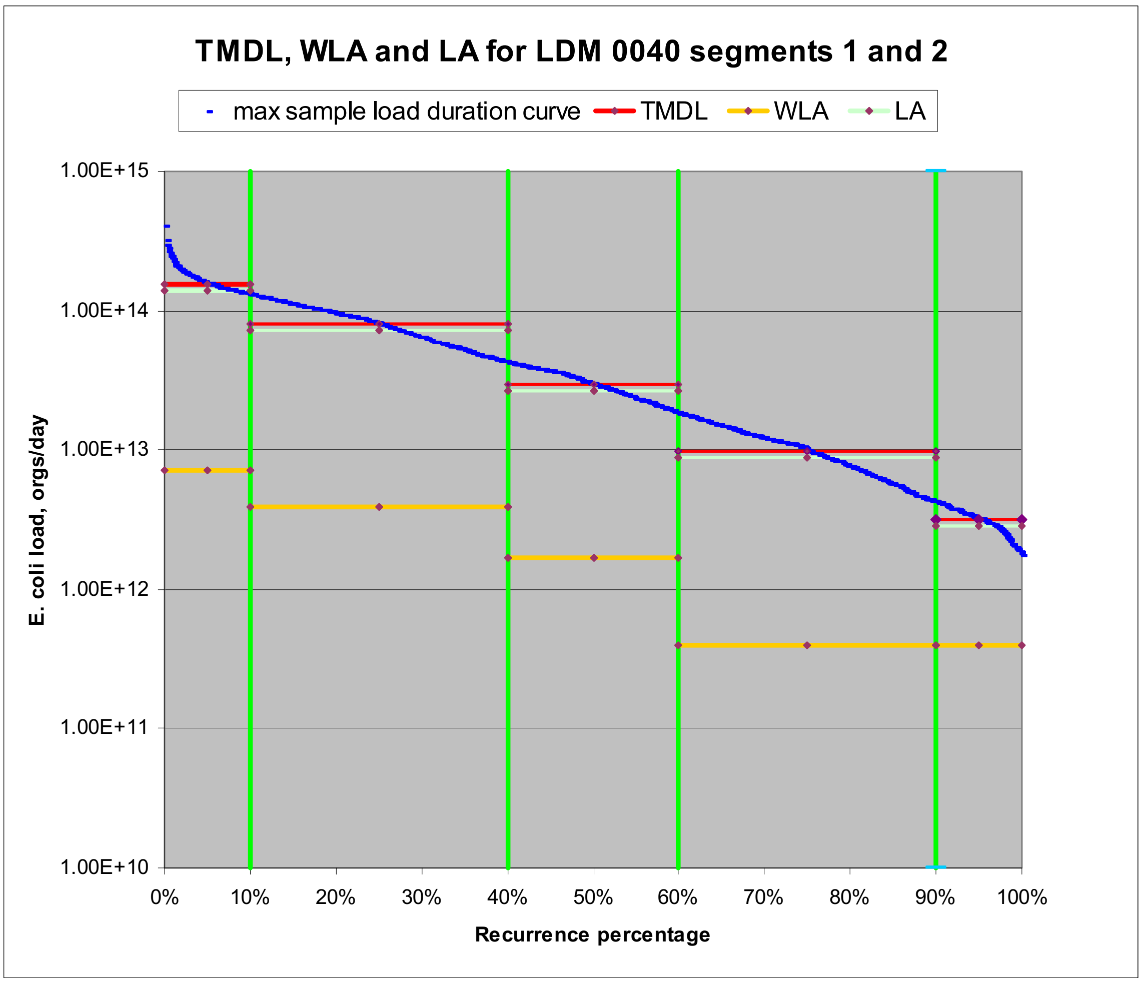

Figure 39 TMDL at the maximum single sample WQS of 235 orgs/100 ml for the five flow conditions

4. Implementation Plan

An implementation plan is not a required component of a TMDL document but it is a useful and logical extension of TMDL development. It provides IDNR staff, partners, and other watershed stakeholders with a general idea of how a specific strategy and work plan can be developed. This strategy should guide stakeholders and the IDNR in the development of a detailed and priority-based plan that implements best management practices, improves Des Moines River water quality, and moves towards meeting the TMDL water quality goals.

This water quality improvement plan sets targets for *E. coli* in the five impaired segments of the Des Moines River between two of Iowa's largest reservoirs. Watershed stakeholders, including municipalities and agricultural interests, will need to participate in the implementation of bacteria controls and water quality evaluation to accomplish water quality improvement goals. It will take an ongoing effort to develop best management practices in the watershed through projects funded by a variety of city, county, state and federal water quality improvement programs.

As a start it would be useful to create a local watershed advisory committee to help identify high priority areas where resources can be concentrated for the greatest effect. Since the watersheds for these segments of the Des Moines River are so large, it would be advisable to have a separate committee for each of the eight subbasins. This would also make it possible to organize and direct monitoring efforts at a specific stream.

A good start would be to focus on the five subbasins that already have USGS gages. Water quality sampling at these gages would make it possible to evaluate trends in the watershed loading to the five streams. These streams are Beaver Creek, Fourmile Creek, North River, Middle River, and the South River. In addition, this information helps prioritize best management practices based on effectiveness.

An example of this is the locally supported efforts in the Beaver Creek watershed to monitor water quality. Efforts such as this can help identify the most significant pollutant sources and assist in planning for water quality improvement activities.

4.1. Implementation Approach and Timeline

Since the impairment problem occurs at most flow conditions, solutions will need to be implemented for nonpoint sources with event driven transport, nonpoint sources that are continuous such as cattle in streams and failed septic tank systems, and point sources that discharge effluent with *E. coli* concentrations exceeding the WQS criteria.

Stakeholders will need to participate in the implementation of pollutant controls and to continue evaluating water quality. Initially this will require:

- A more detailed and systematic assessment of potential nonpoint pollutant sources that shows the source location, magnitude, and relative impact based on proximity to streams and runoff controls in place. This will involve persons out in the watershed evaluating and inventorying bacteria sources.
- An ongoing evaluation of data collected for the MS4 stormwater permit sampling requirements for the ten cities in the watershed that have MS4 permits. This work is increasingly important as large parts of the watershed are developed and urban runoff becomes a larger fraction of the pollutant load.
- Continued ongoing water quality monitoring and improve existing efforts as described in *Section 5*.
- More detailed monitoring at USGS gages to support detailed hydrologic and water quality models. Improved modeling would provide a clearer understanding of activities and practices contributing to bacteria problems.
- An understanding of the relationship of Saylorville dam releases to flows and loads from Beaver Creek and other tributaries and the impacts this has on *E. coli* concentrations.
- Application of watershed and water quality models to provide information on which best management practices will have the most impact and where they can be most effectively employed.

A large fraction of existing load to the impaired segments of the Des Moines River originates from nonpoint sources within the watershed. These sources include septic systems, livestock, and wildlife. Reductions in these loads will require changes in the way manure and other waste is managed and these changes will take time to implement.

If goals are to be achieved then a schedule with milestones must be set. Below is one example of specific objectives and a timetable that suggests how Des Moines River water quality might be improved.

1. Identify, assess, and rank the potential nonpoint sources within one half mile of the major tributaries to the Des Moines River. Select best management practices for each source. Complete this by the end of 2012.
2. Begin implementation of the best management practices by priority ranking for the nonpoint sources identified in step 1. Reduce the identified nonpoint source pathogen loading by 25 percent by 2017.
3. Measure *E. coli* in all major storm sewer outfalls to the Des Moines River and its tributaries to establish the urban impact and revise MS4 permits conditions to ensure targeted pathogen reductions. This could involve inspecting and repairing leaky or cross-connected sanitary sewers and eliminating sanitary sewer overflow. Complete by the end of 2014.
4. Continue the process of identifying, assessing and ranking nonpoint sources and selecting BMPs outward from the streams in half-mile increments every three to five years until the entire watershed has been covered.

4.2. Best Management Practices

Some best management practices for reducing pathogen indicators are:

- Limiting livestock access to waterways in pastures and providing alternate watering sources.
- Controlling manure runoff. Manure application should utilize incorporation or subsurface application of manure while controlling soil erosion. Incorporation physically separates fecal material from surface runoff. Buffer strips should be installed and maintained along the streams and tributaries to slow and divert runoff.
- Control of combined sewer overflow. The City of Des Moines is working with the state to fix this problem. Combined sewer overflow can be a significant *E. coli* contributor downstream from its discharge location at high flows.
- Identifying, repairing, or replacing improperly connected and malfunctioning septic tank systems with on-site systems that meet state design standards.
- Discharges from all wastewater treatment facilities should be sampled for pathogen indicators and disinfected if they do not meet water quality standard *E. coli* criteria.
- Immediate removal of pet feces from the ground in urbanized areas where storm sewers have a direct connection to streams.
- Control of bacteria from urban runoff through storm sewers. Disinfection may be needed.

Table 47 is a list of best management practices that can be applied to the different categories of bacteria sources and an estimate of the impact the BMP would have if implemented.

Table 47 Best Management Practices and associated efficiency[1]

Best Management Practice	Efficiency	Notes
Agricultural BMPs		
Grass riparian Buffer	40%	Bacteria efficiency assumed equal to sediment reduction efficiency.
Forested riparian buffer	40%	Bacteria efficiency assumed equal to sediment reduction efficiency.
Cover crop	20%	Bacteria efficiency assumed equal to sediment reduction efficiency.
Manure injection	90%	Reduces manure in runoff
Manure storage facility, beef and dairy	75%	Bacteria reduction occurs over time due to die-off
Poultry litter storage facility	75%	Bacteria reduction occurs over time due to die-off
Livestock exclusion fencing	100%	Eliminates or reduces cattle in stream bacteria.
Improved pasture management	50%	Reduces runoff to streams
Wetland development and enhancement	30%	Includes creation and restoration
Stream bank protection and stabilization	40%	
Detention ponds/basins	25%	Reduces runoff to streams
Built-up/urban area BMPs		
Pet waste education program	75%	
Street sweeping	22%	Bacteria efficiency assumed equal to sediment reduction efficiency
Rain garden, Bio-retention basin	40%	Filters and delays runoff to stream
Infiltration basin/Infiltration trench	50%	Filters and delays runoff to stream
Elimination of sanitary sewer overflow	100%	
Stream bank protection and stabilization	40%	
Disinfection of storm sewer discharge	100%	
On-site septic tank systems		
Septic system pump-out	5%	Should be routine maintenance
Connect to public sewer	100%	Requires sewer availability
Septic system repair	100%	
Replacement of failed septic systems	100%	

1. Guidance Manual for TMDL Implementation Plans. Virginia Department of Environmental Quality. 2003

5. Future Monitoring

Water quality monitoring is a critical element in assessing the current status of water resources and the historical trends. Furthermore, monitoring is necessary to track the effectiveness of water quality improvements made in the watershed and document the status of the waterbody in terms of achieving total maximum daily loads.

As noted in the implementation plan, follow-up to this report requires stakeholder driven solutions and more effective management practices. Continuing monitoring plays an important role in determining what practices result in load reductions and the attainment of water quality standards. Continued monitoring will:

- Assess the future beneficial use status;
- Determine if water quality is improving, getting worse, or staying the same;
- Evaluate the effectiveness of implemented best management practices.

Phasing TMDLs is an iterative approach to managing water quality used when the origin, nature and sources of water quality impairments are not completely understood. Initially, the stream load capacity, existing pollutant load in excess of this capacity, and the source load allocations are estimated based on resources and information available. Follow up activities require monitoring that can provide information on water quality changes taking place.

Some of the monitoring projects that provided the data used to create this report are expected to be ongoing. Monitoring of Des Moines River bacteria are expected to continue at the ISU/USACE sites identified in this report. It is also expected that the Des Moines Water Works will continue the frequent monitoring of bacteria concentrations at their drinking water intakes. Data collected at all of these sites will continue to be used by the IDNR for its biannual water quality assessments (305(b) report) of the Des Moines River.

5.1. Monitoring Plan

Due to resource limitations, the existing monitoring in the watershed covered in this report does not provide all of the data that would enhance modeling and evaluation of Des Moines River water quality for these five segments. Some beneficial additions to the monitoring design include the following:

- Sampling at all of the USGS gages would greatly improve the data sets used to indentify pollutant sources. This is the most significant monitoring shortcoming in the watershed. Seven of the eleven gages do not have any ongoing sampling including Beaver Creek, Fourmile Creek, North River, Middle River, South River, and Walnut Creek.
- More frequent sampling at gage sites during a wider range of flow conditions, especially at high flows during the rising part of the hydrograph. This would provide a more accurate picture of nonpoint source bacteria loads.

- Analyze samples for both *E. coli* and fecal coliform. This does two things; it provides some assurance that a single value was not due to analytical work or a particular sample, and provides data that can be compared to historical data and source references and research reported as fecal coliform.
- Select hydrologic and water quality models to use in future evaluations of the Des Moines River and focus on the data needs of those models. An example of such a model is the Water Quality Analysis Simulation Program (WASP).
- Install autosamplers and continuous flow meters on some of the smaller but still important streams such as Mud and Camp Creeks near their confluences with the Des Moines River. Grab sampling does not provide sufficient data for estimating the loads for mass balances.
- Install autosamplers with stage measurement on the Des Moines River at sites that will help define the urban runoff loads in the adjacent areas. These sites could be located so that they coordinate with MS4 and CSO compliance monitoring.

5.2. Monitoring to Support Watershed Improvement Projects

Perform an annual trend analysis on the load estimates to provide information on the effectiveness of implemented BMPs. This could be part of an ongoing data analysis program that includes a statistical design for the number of samples required to achieve desired confidence in the results.

Monitoring for evaluation of BMP effectiveness should be targeted and designed to address loads from specific sources at different flow conditions where the mechanisms of delivery affect the load delivered. Precipitation driven runoff should be measured during and immediately after it rains so that runoff loads can be estimated.

6. Public Participation

Public involvement is important in the TMDL process since it is the landowners, tenants, municipalities and citizens who directly manage the land and live in the watershed that determine the water quality in the Des Moines River. IDNR has put together a plan to inform the public and stakeholders and receive input and comments on the Lower Des Moines River watershed water quality improvement plan.

6.1. Public Meetings

Three initial public information meetings were held at three locations in the watershed. The dates and locations of these three public information meetings were:

Urbandale - Public Library,
Date: September 15, 2008
This meeting was well attended with stakeholders from municipalities, environmental groups, businesses, and citizens. IDNR staff explained that the TMDL would affect wasteload allocations for wastewater treatment facilities and municipal stormwater permit holders. There was a discussion of how the numeric standard might be implemented for municipal stormwater permit holders. Stakeholders were referred to IDNR stormwater permitting staff and IDNR Field Office 5. IDNR staff also explained that the impact from the TMDL on wastewater treatment facilities would be the same as the impact of the revised approach to water quality standards for bacteria. That is, nearly all streams are now classified for recreational use and the *E. coli* water quality standards will apply to wastewater effluent at the end of the pipe. Some stakeholders expressed concern that nonpoint sources were not going to be required to reduce their contributions.

Winterset – Farmers & Merchant State Bank Community Room
Date: September 15, 2008
There were no attendees at this meeting.

Indianola - Simpson College
Date: September 17, 2008
There were two attendees at this meeting representing rock quarries. IDNR staff answered general questions about the TMDL program and its relationship to quarries.

The draft TMDL was put on thirty day public notice and posted to the IDNR TMDL website on September 17, 2009. The public comment period ended on October 16, 2009. Three public information meetings were held at three locations in the watershed after the draft TMDL was put on public notice. The dates and locations of these three public information meetings were:

Urbandale - Public Library,
Date: October 8, 2009
This meeting was attended by three people. Presentations on the draft Water Quality Plan and the TMDL program were made by IDNR staff and questions were answered.

Winterset – Farmers & Merchant State Bank Community Room
Date: October 6, 2009
There were no attendees at this meeting.

Indianola - Simpson College
Date: October 8, 2009
There were no attendees at this meeting.

6.2. Written Comments

Two written comments were received during the public comment period. These comments and the IDNR responses to these comments can be found in Appendix G.

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8. Appendices

Appendix A --- Glossary of Terms and Acronyms

303(d) list:	Refers to section 303(d) of the Federal Clean Water Act, which requires a listing of all public surface water bodies (creeks, rivers, wetlands, and lakes) that do not support their general and/or designated uses. Also called the state's "Impaired Waters List."
305(b) assessment:	Refers to section 305(b) of the Federal Clean Water Act, it is a assessment of the state's water bodies ability to support their general and designated uses. Those found to be not supporting their uses are placed on the 303(d) list.
319:	Refers to Section 319 of the Federal Clean Water Act, the Nonpoint Source Management Program. States receive EPA grants to provide technical & financial assistance, education, and monitoring for local nonpoint source water quality improvement projects.
AFO:	Animal Feeding Operation. A livestock operation, either open or confined, where animals are kept in small areas (unlike pastures) allowing manure and feed to become concentrated.
Base flow:	The of stream flow from ground water.
BMP:	Best Management Practice. A general term for any structural or upland soil or water conservation practice. Examples are terraces, grass waterways, sediment retention ponds, and reduced tillage systems.
CAFO:	Confinement Animal Feeding Operation. An animal feeding operation in which livestock are confined and totally covered by a roof.
Designated use(s):	Refer to the type of economic, social, or ecologic activities that a specific water body is intended to support. See Appendix B for a description of general and designated uses.
DNR (or IDNR):	Iowa Department of Natural Resources.
Ecoregion:	A system used to classify geographic areas based on similar physical characteristics such as soils and geologic material, terrain, and drainage features.
EPA (or USEPA):	United States Environmental Protection Agency.
FSA:	Farm Service Agency (United States Department of Agriculture). Federal agency responsible for implementing farm policy, commodity, and conservation programs.
General use(s):	Refer to narrative water quality criteria that all public water bodies must meet to satisfy public needs and expectations. See Appendix B for a description of general and designated uses.
GIS:	Geographic Information System(s). A collection of map-based data and tools for creating, managing, and analyzing spatial information.

LA:	Load Allocation. The waterbody pollutant load that comes from *nonpoint sources* in a watershed.
Load:	The total amount (mass) of a particular pollutant in a waterbody.
MOS:	Margin of Safety. In a total maximum daily load (TMDL) report, it is a set-aside amount of a pollutant load to allow for any uncertainties in the data or modeling.
Nonpoint source pollutants:	Contaminants that originate from diffuse sources not covered by NPDES permits.
NPDES:	National Pollution Discharge Elimination System. A federal system of regulatory discharge controls that sets pollutant limits in permits for point source discharges to waters of the United States.
NRCS:	Natural Resources Conservation Service (United States Department of Agriculture). Federal agency that provides technical assistance for the conservation and enhancement of natural resources.
Phytoplankton:	Collective term for all suspended photosynthetic organisms that are the base of the aquatic food chain. Includes algae and cyano-bacteria.
Point source pollution:	NPDES permits regulate point sources. Point source discharges are usually from a location of flow concentration such as an outfall pipe.
PPB:	Parts per billion. A measure of concentration that is the equivalent of micrograms per liter (µg/l).
PPM:	Parts per million. A measure of concentration that is the equivalent of milligrams per liter (mg/l).
Riparian:	The area near water associated with streambanks and lakeshores and the physical, chemical, and biological characteristics that cause them to be different from dry upland sites.
Sediment delivery ratio (SDR):	The fraction of total eroded soil that is actually delivered to the stream or lake.
Seston:	All suspended particulate matter (organic and inorganic) in the water column.
Sheet & rill erosion	Water eroded soil loss that occurs diffusely over large flatter landscapes before the runoff concentrates.
Storm flow (or stormwater):	The fraction of stream flow that is direct surface runoff from precipitation.
SWCD:	Soil and Water Conservation District. Agency that provides local assistance for soil conservation and water quality project implementation, with support from the Iowa Department of Agriculture and Land Stewardship.
TMDL:	Total Maximum Daily Load. The maximum allowable amount of a pollutant that can be in a waterbody and still comply with the Iowa Water Quality Standards and support designated uses.
TSS:	Total Suspended Solids. The quantitative measure of seston, all materials, organic and inorganic, which are held in the water

	column. It is defined by the lab filtration procedures used to measure it.
Turbidity:	A measure of the scattering and absorption of light in water caused by suspended particles.
UHL:	University Hygienic Laboratory (University of Iowa). Collects field samples and does lab analysis of water for assessment of water quality.
USGS:	United States Geologic Survey. Federal agency responsible for flow gauging stations on Iowa streams.
Watershed:	The land surface that drains to a particular body of water or outlet.
WLA:	Waste Load Allocation. The allowable pollutant load that an NPDES permitted point source may discharge and not violate water quality standards.
WQS:	Water Quality Standards. Defined in Chapter 61 of Environmental Protection Commission [567] of the Iowa Administrative Code, they are the criteria by for water quality in Iowa.
WWTP:	Waste Water Treatment Plant. A facility that treats municipal and/or industrial wastewater so that the effluent complies with NPDES permit limits.

Scientific Notation: Scientific notation is the way that scientists easily handle very large numbers or very small numbers. For example, instead of writing 45,000,000,000 we write 4.5E+10. So, how does this work?

We can think of 4.5E+10 as the product of two numbers: 4.5 (the digit term) and E+10 (the exponential term).

Here are some examples of scientific notation.

10,000 = 1E+4	24,327 = 2.4327E+4
1,000 = 1E+3	7,354 = 7.354E+3
100 = 1E+2	482 = 4.82E+2
1/100 = 0.01 = 1E-2	0.053 = 5.3E-2
1/1,000 = 0.001 = 1E-3	0.0078 = 7.8E-3
1/10,000 = 0.0001 = 1E-4	0.00044 = 4.4E-4

As you can see, the exponent is the number of places the decimal point must be shifted to give the number in long form. A **positive** exponent shows that the decimal point is shifted that number of places to the right. A **negative** exponent shows that the decimal point is shifted that number of places to the left.

Appendix B --- General and Designated Uses of Iowa's Waters

Introduction

Iowa's Water Quality Standards (Environmental Protection Commission [567], Chapter 61 of the Iowa Administrative Code) provide the narrative and numerical criteria used to assess water bodies for support of their aquatic life, recreational, and drinking water uses. There are different criteria for different waterbodies depending on their designated uses. All waterbodies must support the general use criteria.

General Use Segments

A general use water body does not have perennial flow or permanent pools of water in most years, i.e. ephemeral or intermittent waterways. General use water bodies are defined in IAC 567-61.3(1) and 61.3(2). General use waters are protected for livestock and wildlife watering, aquatic life, non-contact recreation, crop irrigation, and industrial, agricultural, domestic and other incidental water withdrawal uses.

Designated Use Segments

Designated use water bodies maintain year-round flow or pools of water sufficient to support a viable aquatic community. In addition to being protected for general use, perennial waters are protected for three specific uses, primary contact recreation (Class A), aquatic life (Class B), and drinking water supply (Class C). Within these categories there are thirteen designated use classes as shown in Table B1. Water bodies can have more than one designated use. The designated uses are found in IAC 567-61.3(1).

Table B1. Designated use classes for Iowa water bodies.

Class prefix	Class	Designated use	Comments
A	A1	Primary contact recreation	Supports swimming, water skiing, etc.
	A2	Secondary contact recreation	Limited/incidental contact occurs, such as boating
	A3	Children's contact recreation	Urban/residential waters that are attractive to children
B	B(CW1)	Cold water aquatic life – Type 2	Able to support coldwater fish (e.g. trout) populations
	B(CW2)	Cold water aquatic life – Type 2	Typically unable to support consistent trout populations
	B(WW-1)	Warm water aquatic life – Type 1	Suitable for game and nongame fish populations
	B(WW-2)	Warm water aquatic life – Type 2	Smaller streams where game fish populations are limited by physical conditions & flow
	B(WW-3)	Warm water aquatic life – Type 3	Streams that only hold small perennial pools which extremely limit aquatic life
	B(LW)	Warm water aquatic life – Lakes and Wetlands	Artificial and natural impoundments with "lake-like" conditions
C	C	Drinking water supply	Used for raw potable water
Other	HQ	High quality water	Waters with exceptional water quality
	HQR	High quality resource	Waters with unique or outstanding features
	HH	Human health	Fish are routinely harvested for human consumption

Appendix C --- Water Quality Data

The bacteria monitoring data collected at two of the monitoring sites , the site below the Raccoon River confluence (State Road 46/Highway 65) and the site at Runnells, are in Tables C1 and C2. For the the third site at Second Avenue in Des Moines data was collected daily by the Des Moines Water Works and it is impractical to include it in this appendix since it consists of ten years of data in 2,750 rows. This data can be obtained by contacting IDNR or DMWW. All daily flow data can be obtained for each gage at the USGS website http://waterdata.usgs.gov/ia/nwis/rt.

Table C1 USACE site 6 below the Raccoon River confluence, State Road 46/Hwy 65, fecal coliform and *E. coli* data from 1997 to 2007

Date	Fecal Coliform, value[1]	*E. coli* estimate or value[2]	Flow at gage, cfs	Date	Fecal Coliform, value[1]	*E. coli* estimate or value[2]	Flow at gage, cfs
6/2/1997	60	35	9120	6/24/2003	600	353	5610
6/9/1997	140	82	6250	7/8/2003	1200	800	20000
6/16/1997	130	76	5000	7/15/2003	330	320	21900
7/8/1997	210	124	6760	7/22/2003	90	80	10400
7/15/1997	150	88	5790	8/5/2003	3600	2300	2420
7/22/1997	540	318	4260	8/12/2003	3200	980	1400
8/5/1997	140	82	3860	8/19/2003	3000	1450	1070
8/12/1997	1900	1118	2150	5/25/2004	12500	7900	30000
8/28/1997	570	335	1030	6/1/2004	2700	2600	23500
6/2/1998	530	312	16000	6/15/2004	1300	1230	17400
6/9/1998	1200	706	13900	6/29/2004	150	130	14000
6/16/1998	900	529	45000	7/6/2004	3000	2600	11300
7/7/1998	9000	5294	32400	7/13/2004	1400	1300	11000
7/14/1998	3	2	16600	7/26/2004	40	24	7410
7/21/1998	460	271	8360	8/2/2004	2500	2040	3980
8/4/1998	50	29	5800	8/30/2004	340	230	1600
8/11/1998	740	435	9470	9/13/2004	230	60	716
8/18/1998	570	335	4550	5/16/2005	2000	1700	23100
6/1/1999	820	482	15600	5/23/2005	60	50	15600
6/8/1999	1600	941	16100	6/6/2005	47	39	10100
6/29/1999	3300	1941	23500	6/13/2005	3400	3100	18300
7/6/1999	700	412	21700	6/27/2005	390	350	18300
7/13/1999	330	194	11000	7/11/2005	100	83	5070
7/27/1999	200	118	9550	7/18/2005	4000	4000	3320
8/3/1999	76	45	7060	7/25/2005	120	110	2920
8/24/1999	1980	1165	3440	8/1/2005	310	200	3070
8/31/1999	143	84	1410	8/15/2005	340	140	1650
6/6/2000	490	288	2950	8/23/2005	100	60	1110
6/13/2000	460	271	4150	9/6/2005	80	63	623
6/27/2000	1600	941	2940	9/20/2005	140	110	957
7/11/2000	640	376	7770	5/15/2006	31	27	11500
7/18/2000	290	171	6070	5/22/2006	24	21	7690
7/25/2000	60	35	3650	6/5/2006	42	38	4970
8/1/2000	400	235	1510	6/12/2006	150	97	3520
8/15/2000	210	124	882	6/26/2006	320	260	4420
8/24/2000	180	106	1550	7/10/2006	160	160	2530
6/5/2001	640	376	18000	7/17/2006	320	250	1760
6/12/2001	4800	2824	16900	7/24/2006	140	140	1390

Date	Fecal Coliform, value[1]	*E. coli* estimate or value[2]	Flow at gage, cfs	Date	Fecal Coliform, value[1]	*E. coli* estimate or value[2]	Flow at gage, cfs
6/26/2001	30	18	14300	8/7/2006	140	100	1620
7/10/2001	27	10	8850	8/14/2006	1700	1700	1500
7/17/2001	40	50	6640	8/22/2006	510	490	867
7/24/2001	160	60	5500	9/5/2006	650	420	1110
8/7/2001	830	400	3470	9/19/2006	2600	2400	6220
8/14/2001	180	36	1430	5/14/2007	220	190	21300
8/21/2001	410	67	1180	5/21/2007	60	60	16300
6/11/2002	14500	5600	6700	6/4/2007	250	230	16900
6/18/2002	800	200	5730	6/11/2007	80	80	8490
6/25/2002	2800	1200	3230	6/25/2007	2400	2200	11400
7/2/2002	3600	1400	1970	7/9/2007	40	31	6190
7/16/2002	500	1400	1780	7/16/2007	1200	1200	2430
8/6/2002	860	700	3500	7/23/2007	4600	3100	1830
8/13/2002	700	412	3990	8/6/2007	600	500	3210
8/20/2002	2	150	5280	8/13/2007	3900	1500	1490
6/11/2003	590	490	11900	8/21/2007	1300	650	9770
6/17/2003	110	100	7050	9/4/2007	140	80	12900

1. Units for fecal coliform and *E. coli* concentration are organisms/100 ml.
2. The first *E. coli* data was available on 7/10/2001. Fecal coliform data has been translated to *E. coli* from 1997 to 2001 using a ratio of 1.7 EC to FC (400 FC org/235 EC org). *E. coli* numbers in magenta are estimates based on this translation. .

Table C2 USACE site 7 at Runnells, fecal coliform and *E. coli* data from 1997 to 2007

Date	Fecal Coliform, value[1]	*E. coli* estimate or value[2]	Flow at gage, cfs	Date	Fecal Coliform, value[1]	*E. coli* estimate or value[2]	Flow at gage, cfs
6/2/1997	340	200	9560	6/24/2003	550	210	6270
6/9/1997	30	18	6700	7/8/2003	780	350	19200
6/16/1997	84	49	5160	7/15/2003	190	190	26800
7/8/1997	77	45	7300	7/22/2003	170	150	12100
7/15/1997	190	112	6150	8/5/2003	980	540	2670
7/22/1997	490	288	5310	8/12/2003	570	220	2180
8/5/1997	120	71	4650	8/19/2003	270	110	1320
8/12/1997	1730	1018	2450	5/25/2004	4000	2353	40900
8/28/1997	120	71	1500	6/1/2004	3700	3500	27200
6/2/1998	440	259	17100	6/15/2004	2070	2000	20200
6/9/1998	130	76	13400	6/29/2004	160	150	15900
6/16/1998	5900	3471	54700	7/6/2004	600	580	12400
7/7/1998	1400	824	50000	7/13/2004	5100	4900	14000
7/14/1998	50	29	20000	7/26/2004	80	69	8030
7/21/1998	130	76	9000	8/2/2004	310	250	4490
8/4/1998	120	71	6500	8/30/2004	640	520	2620
8/11/1998	250	147	10000	9/13/2004	140	83	804
8/18/1998	490	288	5500	5/16/2005	1500	580	29600
6/1/1999	250	147	19000	5/23/2005	100	77	17900
6/8/1999	550	324	18000	6/6/2005	140	130	11700
6/29/1999	840	494	28000	6/13/2005	230	130	15400
7/6/1999	520	306	23000	6/27/2005	660	620	12100

Date	Fecal Coliform, value[1]	*E. coli* estimate or value[2]	Flow at gage, cfs	Date	Fecal Coliform, value[1]	*E. coli* estimate or value[2]	Flow at gage, cfs
7/13/1999	280	165	13000	7/11/2005	100	51	8270
7/27/1999	120	71	10000	7/18/2005	1100	810	4890
8/3/1999	210	124	8000	7/25/2005	110	70	3210
8/24/1999	1900	1118	5890	8/1/2005	360	230	3170
8/31/1999	49	29	1800	8/15/2005	300	180	2620
6/6/2000	590	347	2650	8/23/2005	27	11	1540
6/13/2000	2000	1176	5210	9/6/2005	20	13	805
6/27/2000	6000	3529	12800	9/20/2005	67	64	938
7/11/2000	1040	612	6070	5/15/2006	22	20	13500
7/18/2000	25	15	6850	5/22/2006	20	20	8790
7/25/2000	30	18	4000	6/5/2006	15	15	6160
8/1/2000	20	12	1900	6/12/2006	80	67	4120
8/15/2000	410	241	1100	6/26/2006	560	480	4930
8/24/2000	310	182	2850	7/10/2006	100	100	1890
6/5/2001	110	65	28000	7/17/2006	280	260	2510
6/12/2001	73	43	17000	7/24/2006	51	44	1300
6/26/2001	11	6	17000	8/7/2006	880	360	2790
7/10/2001	10	10	10500	8/14/2006	1200	1200	3440
7/17/2001	24	29	7000	8/22/2006	720	720	1950
7/24/2001	190	63	5600	9/5/2006	1040	800	1850
8/7/2001	790	140	5120	9/19/2006	3800	3700	9280
8/14/2001	130	17	1700	5/14/2007	150	130	24900
8/21/2001	80	34	1980	5/21/2007	60	60	17900
6/11/2002	4300	7300	5960	6/4/2007	40	40	18400
6/18/2002	700	460	8060	6/11/2007	6	6	9650
6/25/2002	1200	370	4200	6/25/2007	1300	1300	14100
7/2/2002	620	220	2420	7/9/2007	1	1	6570
7/16/2002	860	380	2500	7/16/2007	440	380	3330
8/6/2002	1060	700	1850	7/23/2007	90	90	1920
8/13/2002	4500	2647	4080	8/6/2007	570	350	2330
8/20/2002	160	180	6950	8/13/2007	1000	780	2830
6/11/2003	4400	3100	14100	8/21/2007	2600	400	6420
6/17/2003	69	62	8810	9/4/2007	150	90	14800

1. Units for fecal coliform and *E. coli* concentration are organisms/100 ml.
2. The first *E. coli* data was available on 7/10/2001. Fecal coliform data has been translated to *E. coli* from 1997 to 2001 using a ratio of 1.7 EC to FC (400 FC org/235 EC org). *E. coli* numbers in magenta are estimates based on this translation. .

Appendix D --- Procedures and Assumptions

This appendix presents the procedures and assumptions used to develop the Des Moines River bacteria TMDL. It also includes a guide to the spreadsheets and models that were used.

The primary tools used to develop this report were flow and load duration curves and the EPA Bacteria Indicator Tool (BIT) spreadsheet model. Below are descriptions of these tools and how they were used followed by discussion and descriptions of the three monitoring sites and how the duration curves and the BIT were implemented to calculate the load allocations, wasteload allocations, margins of safety, and the total maximum daily loads for each flow condition and target.

Flow and Load Duration Curves

The daily flow data from the USGS gages is used to generate the flow and load duration curves found in this document. The flow and concentration data from the data worksheet is plotted against the TMDL target load on the load duration curve. Multiplying the daily flow values times the target concentrations of 126 or 235 *E. coli* org/100 ml converted to a daily load and plotting it as a percent load recurrence generates the curve representing the target load.

The flow and load duration curves have been divided into five flow conditions that are represented as the percent recurrence of a flow and are described in Table 10 in Section 3 of the main report. These flow regions are shown in Table D1. :

Table D1 Flow conditions for recurrence intervals

Recurrence Interval	Flow condition
0-10%	High flows - runoff dominated
10-40%	Moist conditions
40-60%	Mid-range flow
60-90%	Dry conditions - mostly base flow
90-100%	Low (base) flow

In general, monitored bacteria concentrations exceeding the criteria at high flows are from the washoff of nonpoint sources and criteria exceeded at low flows are from continuous discharges sources such as wastewater treatment plants. Between these two extreme flow conditions, there is a continuum of sources from moist conditions when bacteria are delivered by runoff from rainfall, to dry low flow conditions when bacteria are delivered by continuously discharging sources.

The medians of the five flow conditions occur at recurrences of 95%, 75%, 50%, 25%, and 5%. The median *E. coli* count for each flow condition is calculated at the two criteria concentrations (126 and 235 orgs/100 ml) for each interval median flow. This calculation becomes the target for the flow condition interval. The TMDL targets are listed in Tables 11 to 13 and shown graphically in Figures 18 to 23.

The existing loads are estimated by taking the 90th percentile of all of the monitored *E. coli* values in a flow condition. This is because EPA assessment criteria state that if 10 percent or more of a sample set exceed the water quality standards, then a waterbody does not meet designated uses.

Duration Analysis of the Three TMDL Monitoring Sites

There were three monitoring sites on the Des Moines River used for the 2008 water quality assessments that determined that the five segments covered in this document were impaired for bacteria. These sites were:

- near the Second Avenue USGS gage in Des Moines,
- downstream of the USGS gage just below the confluence with the Raccoon River, and
- at the USGS gage at Runnells.

Load duration curves constructed from the flow and *E. coli* data for these three sites were used to derive the TMDL values.

Second Avenue monitoring site
The Second Avenue monitoring site is the Des Moines Water Works intake at Prospect Park just upstream from the USGS gage at Second Avenue. The flows from this site are primarily from the Saylorville dam discharge and Beaver Creek. There are gages and monitoring data both on Beaver Creek and the Sycamore site below the dam. Under an ongoing contract with the USACE, ISU collected *E. coli* data at the Sycamore River Access monitoring site. IDNR collected *E. coli* data at the Beaver Creek gage site from 1999 to 2005.

The Sycamore monitoring site is upstream from Beaver Creek and consists primarily of the discharge from Saylorville dam. This discharge does not exceed the *E. coli* criteria as interpreted for water quality assessment purposes. There are only two exceedances of the criteria over the ten year period evaluated for this study as shown in the flow and load duration curves of Figures D1 and D2. There are not any monitoring data available for the low flow conditions because the lowest flows occur later in the season when sampling is no longer taking place.

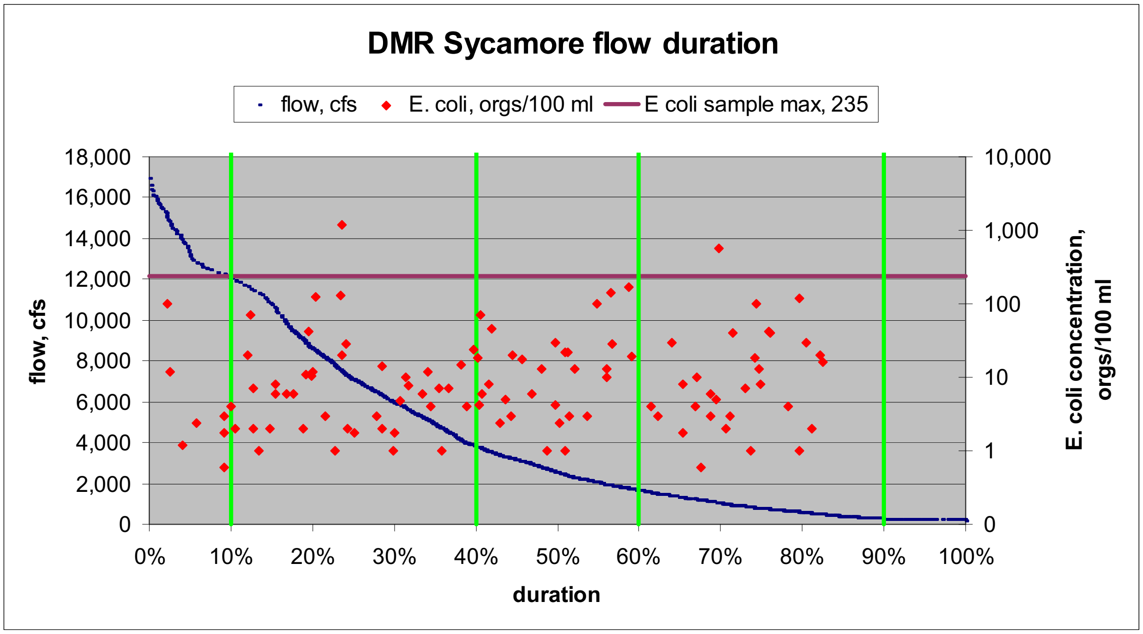

Figure D1 Sycamore flow duration curve

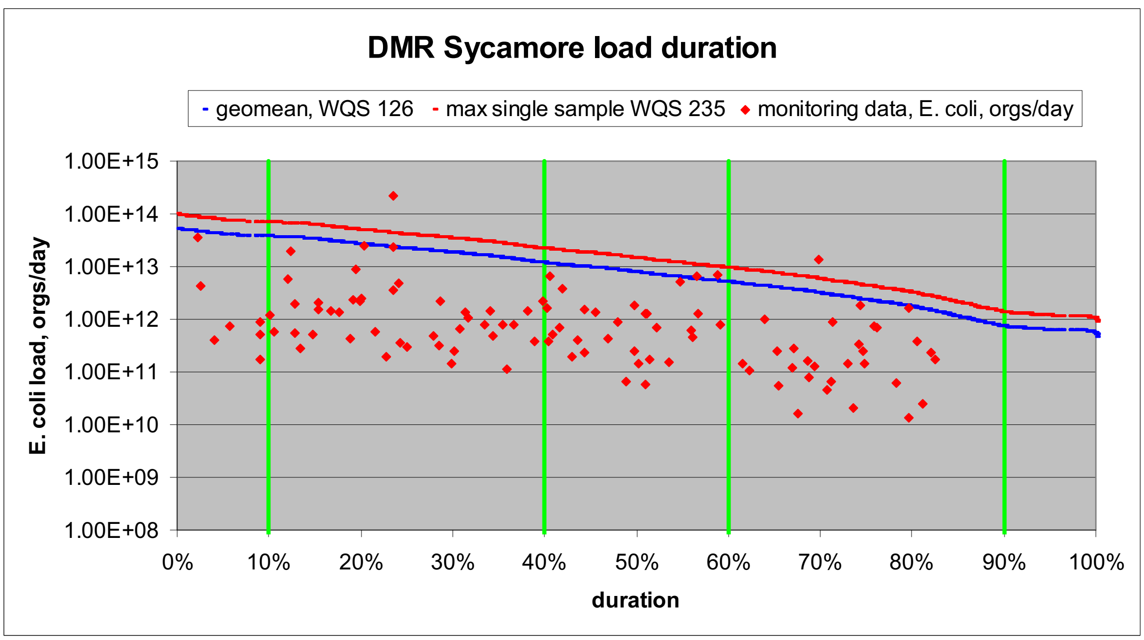

Figure D2 Sycamore load duration curves

The Beaver Creek flow and load duration curves, Figure D3 and D4, show *E. coli* criteria frequently exceeded in four of the five flow conditions. There are more samples that exceed the standards (4 of 5) at the higher flows when runoff is the primary source of flow than at low flow (1 out of 8) when continuous sources have the most impact.

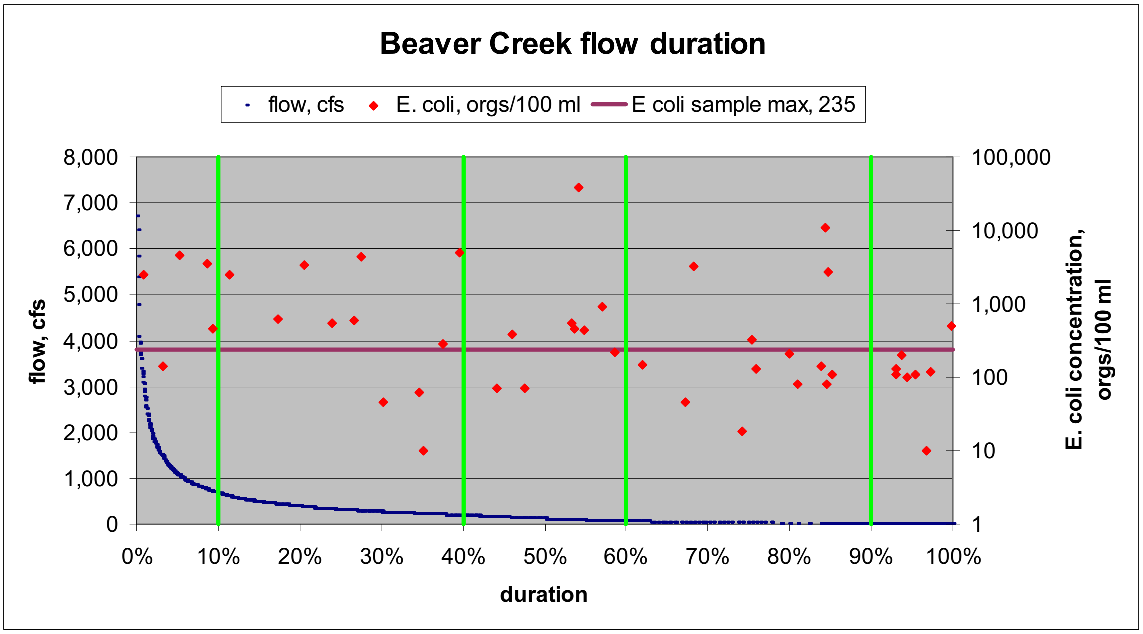

Figure D3 Beaver Creek flow duration curve

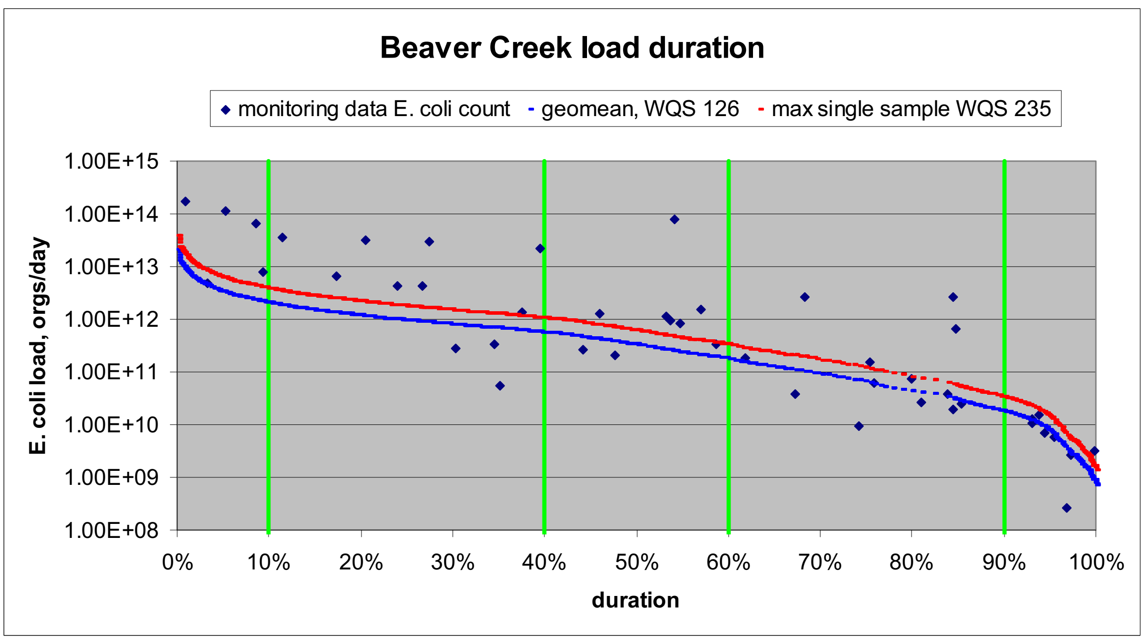

Figure D4 Beaver Creek load duration curves

The *E. coli* samples that have been used to develop the Second Avenue TMDLs were collected daily by the Des Moines waterworks at their DMR intake 1.5 miles upstream from the Second Avenue USGS gage. There are not any significant tributaries between these. As has been done throughout this entire report, only recreation seasonl flow and *E. coli* data have been used for TMDL analysis and development. Second Avenue is the only one of the three TMDL development sites that has daily *E. coli* data for the analysis period. Most of the load at this site originates in the Beaver Creek subbasin. Figure D5 shows the existing and target *E. coli* loads for the Second Avenue TMDL site as well as the load duration curve for the geometric mean criteria. Table D2 shows the reductions needed to meet the criteria for each flow condition as a percentage of the existing loads.

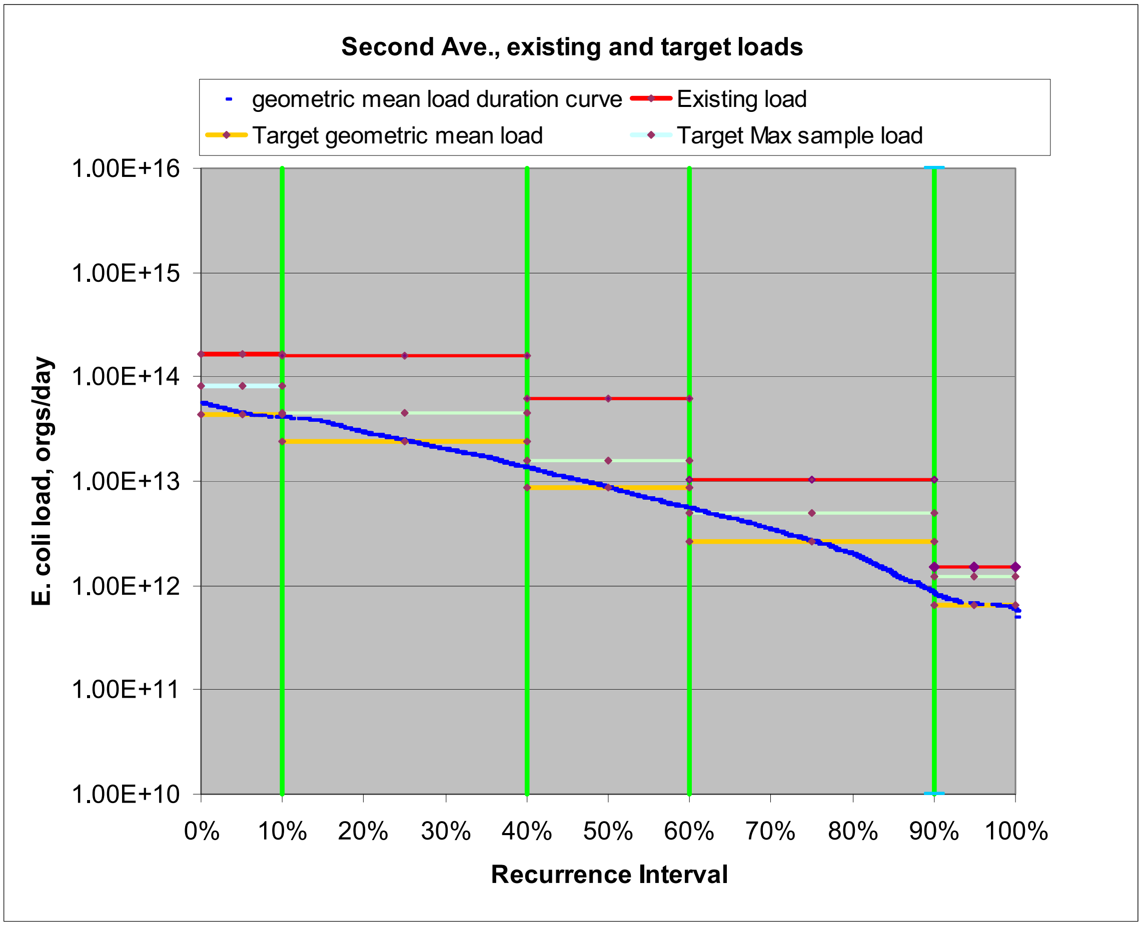

Figure D5 Second Avenue existing and target loads at the five flow conditions

Table D2 Second Avenue load reductions from existing conditions needed to meet *E. coli* targets

Flow percent recurrence	Geometric mean departure from capacity, org/day	Single sample max departure from capacity, org/day	Geometric mean percent reduction needed	Single sample max percent reduction needed
0 to 10 %	1.19E+14	8.11E+13	73.0%	49.7%
10 to 40 %	1.33E+14	1.12E+14	84.7%	71.5%
40 to 60 %	5.44E+13	4.70E+13	86.4%	74.7%
60 to 90 %	7.72E+12	5.45E+12	74.7%	52.7%
90 to 100 %	8.59E+11	2.88E+11	56.6%	19.0%

Site below the Raccoon River confluence (State Road 46/Highway 65).
The Route 46/Highway 65 monitoring site is part of the contract that the USACE has with ISU. The monitoring site was located at Route 46 until August 1998 when it was moved 1.4 miles downstream to Highway 65. The USGS gage that has been associated

with this site is located downstream of the Raccoon River confluence about five miles upstream from the ISU/USACE monitoring site.

The flows to this site are the upstream Des Moines River, the urban runoff from the City of Des Moines and some of its suburbs, and the Raccoon River. The only tributary to the Des Moines River between the USGS gage and the monitoring site is Yeader Creek. Yeader Creek drains a 5.4 square mile watershed into Easter Lake. The watershed includes the Des Moines Airport but is mostly residential. Easter Lake discharges to the Des Moines River. The City of Des Moines wastewater treatment plant also discharges disinfected effluent to the Des Moines River upstream of the sampling site.

The flows and loads from the Raccoon River are a significant fraction of those measured below the confluence with the Des Moines River. The Raccoon River and its watershed were evaluated in an earlier bacteria TMDL report and wasteload allocations, load allocations, and margins of safety were developed for the sources in that watershed at that time. These loads are input into the TMDLs for the segments below the confluence and are included as a fraction of the load allocation, as are loads from the upstream segments of the Des Moines River. Figures D6 and D7 show flow and load duration curves for the Raccoon River at Fleur Drive in the City of Des Moines, just upstream of its confluence with the Des Moines River.

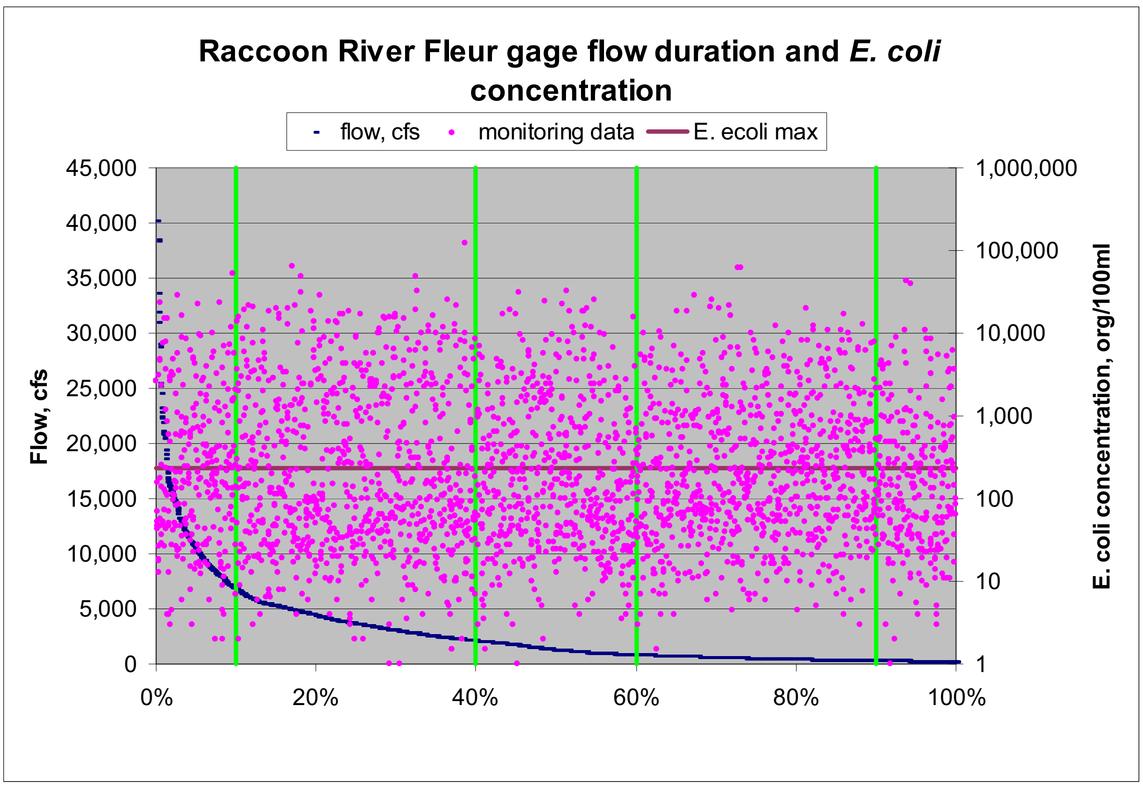

Figure D6 Raccoon River Fleur gage flow duration curve

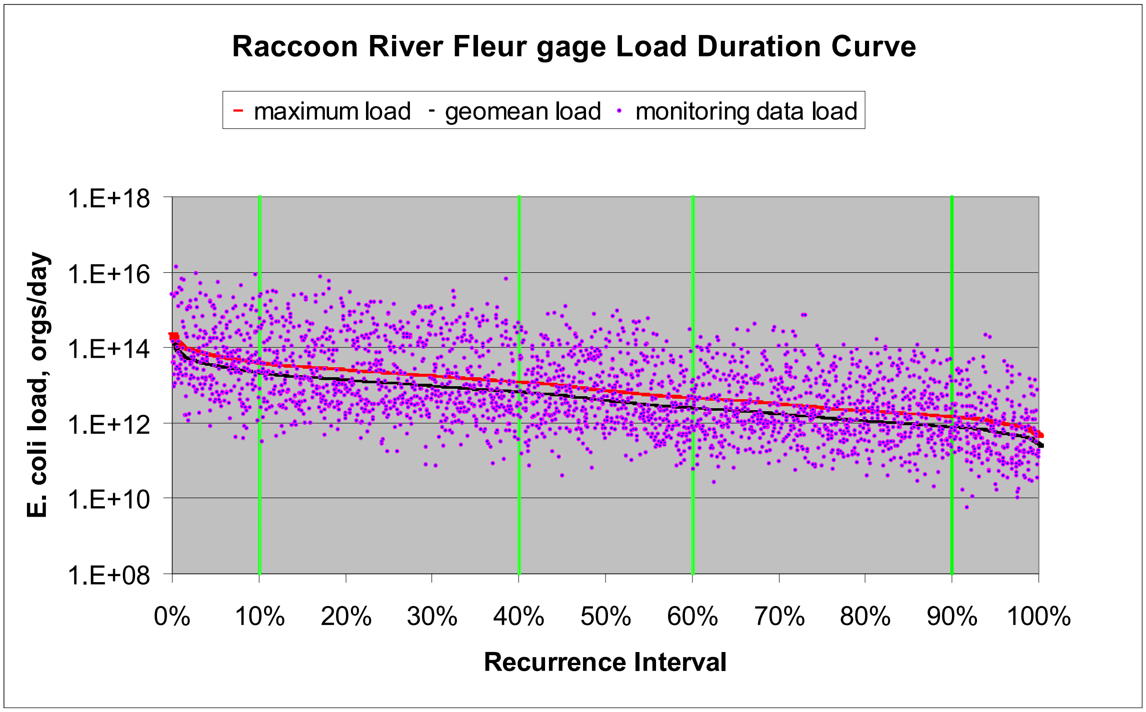

Figure D7 Raccoon River Fleur gage load duration curves

The Raccoon River Fleur gage monitoring data used to generate the flow and load duration curves shown in Figures D6 and D7 is summarized in Figure D8. This figure shows the existing load (based on the 90th percentile of the data for each flow condition) and the geometric mean target load (based on the median target load for each flow condition) plotted on a load duration curve. Since the Raccoon River flow is such a large part of the flow in the Des Moines River, it is assumed that *E. coli* load from the Raccoon must meet the bacteria criteria at the confluence. Table D3 shows the reductions needed to meet the criteria for each flow condition as a percentage of the existing loads.

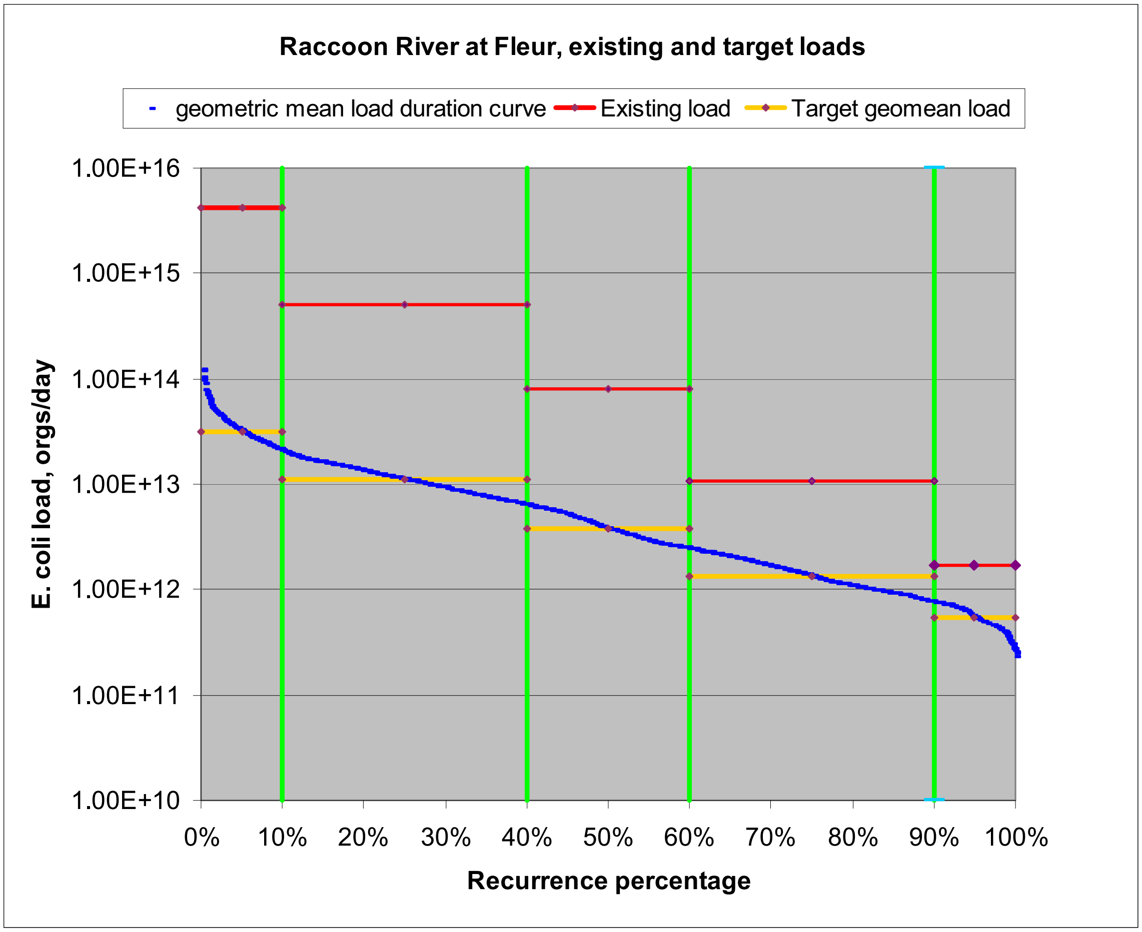

Figure D8 Raccoon River at Fleur - existing and target loads at the five flow conditions

Table D3 Percent reductions from existing conditions needed for the Raccoon River at Fleur to meet *E. coli* targets

Flow percent recurrence	Geometric mean departure from capacity, org/day	Single sample max departure from capacity, org/day	Geometric mean percent reduction needed	Single sample max percent reduction needed
0 to 10 %	4.11E+15	4.08E+15	99.2%	98.6%
10 to 40 %	4.90E+14	4.80E+14	97.8%	95.9%
40 to 60 %	7.73E+13	7.41E+13	95.4%	91.4%
60 to 90 %	9.53E+12	8.38E+12	87.8%	77.2%
90 to 100 %	1.19E+12	7.23E+11	68.9%	41.9%

The flow and load duration curves for the Des Moines River TMDL site below the Raccoon River confluence are in Figure 12 and Figure 15. For each flow condition, the monitoring data and the geometric mean and single sample maximum load targets are summarized and plotted in Figure D9. Table D4 show the reductions needed to meet the TMDL criteria for each flow condition as a percentage of the existing loads.

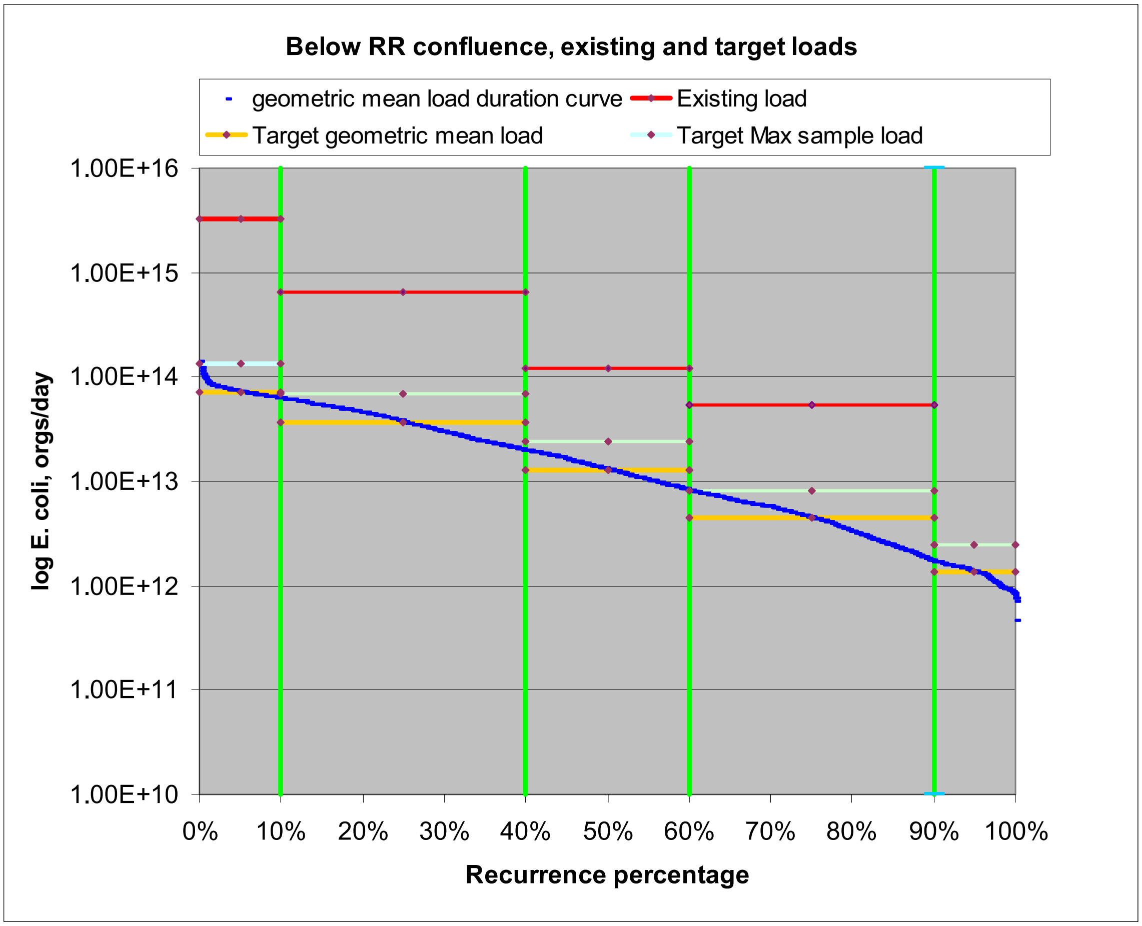

Figure D9 Des Moines River below the Raccoon River confluence showing existing and target loads at the five flow conditions

Table D4 Percent reductions from existing conditions needed for the Des Moines River below the Raccoon River confluence to meet *E. coli* targets

Flow percent recurrence	Geometric mean departure from capacity, org/day	Single sample max departure from capacity, org/day	Geometric mean percent reduction needed	Single sample max percent reduction needed
0 to 10 %	3.22E+15	3.15E+15	97.8%	96.0%
10 to 40 %	6.16E+14	5.84E+14	94.4%	89.5%
40 to 60 %	1.09E+14	9.83E+13	89.5%	80.4%
60 to 90 %	4.95E+13	4.57E+13	91.8%	84.7%
90 to 100 %	no data	no data	no data	no data

Site at Runnells.
The Runnells monitoring site and the USGS gage are both located at the same place on County Road S35 south of Runnells in Warren County. It is upstream of the conservation pool of Red Rock Reservoir but in the flood pool area and downstream of the Des Moines River confluences with Fourmile Creek and the North, Middle, and South Rivers. The site is 37 miles upstream of the Red Rock Dam and the monitoring site is part of the contract that the ACOE has with ISU.

The flow and load duration curves for the Des Moines River TMDL site at Runnells are in Figure 13 and Figure 16. The monitoring data shown in these curves are summarized and plotted in Figure D10 along with the geometric mean and single sample maximum *E. coli* loading criteria for each flow condition. Table D5 shows the reductions needed to meet the TMDL criteria for each flow condition as a percentage of the existing loads.

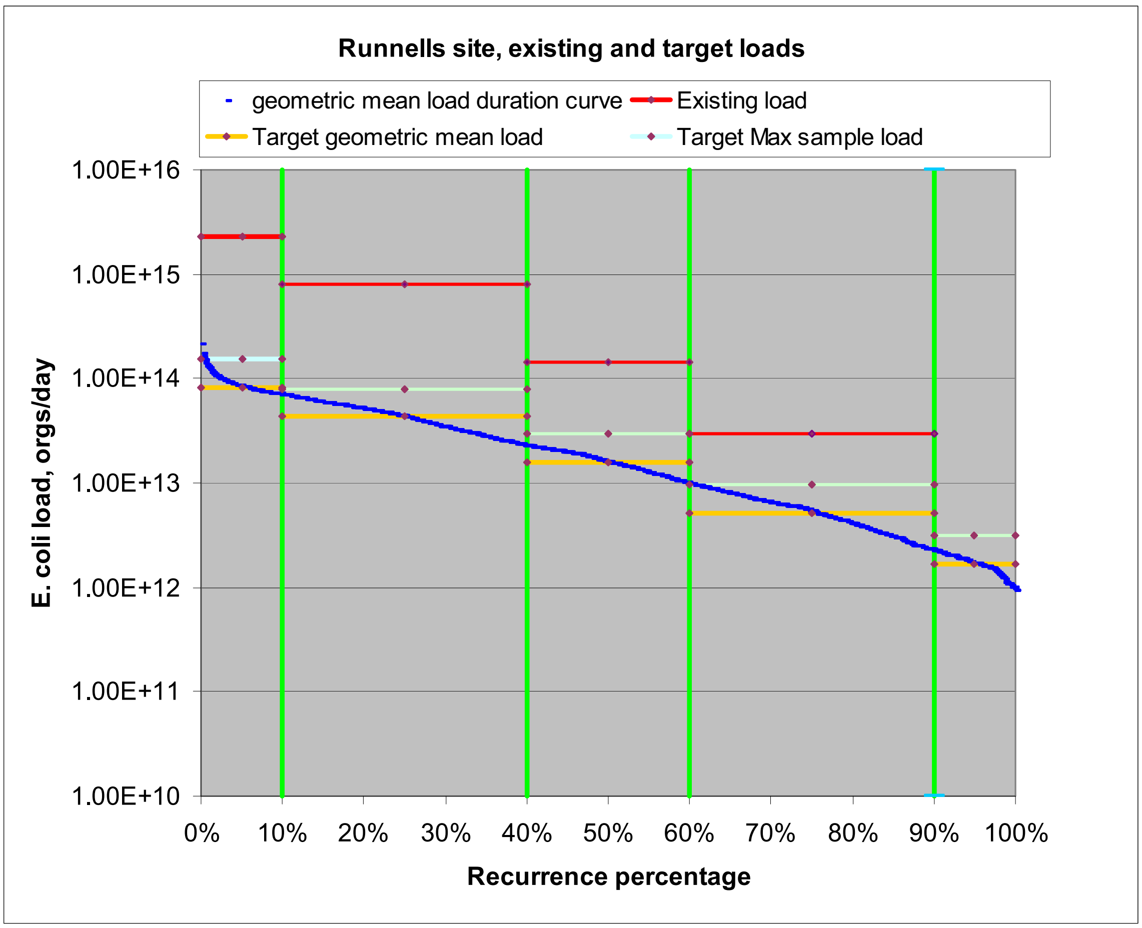

Figure D10 Des Moines River at Runnells site showing existing and target loads at the five flow conditions

Table D5 Percent reductions from existing conditions needed for the Des Moines River at the Runnells site to meet *E. coli* targets

Flow percent recurrence	Geometric mean departure from capacity, org/day	Single sample max departure from capacity, org/day	Geometric mean percent reduction needed	Single sample max percent reduction needed
0 to 10 %	2.21E+15	2.14E+15	96.4%	93.2%
10 to 40 %	7.50E+14	7.13E+14	94.6%	89.9%
40 to 60 %	1.30E+14	1.17E+14	89.2%	79.9%
60 to 90 %	2.48E+13	2.03E+13	82.6%	67.6%
90 to 100 %	no data	no data	no data	no data

The Bacteria Indicator Tool (BIT); Inventorying and Estimating Nonpoint Source Bacteria Loads

An EPA spreadsheet model called the Bacteria Indicator Tool was used to develop estimates for nonpoint source loads in the Des Moines River watershed. It has been modified by the IDNR to estimate bacteria loads available for washoff from each of the eight gage subbasins.

The landuse information comes from 2002 IDNR coverages that have been consolidated into the four landuses found in this spreadsheet. Some modifications have been made to the EPA worksheets and additional worksheets have been added as needed. The distribution and timing assumptions for manure application are based on information from Iowa Department of Agriculture and Land Stewardship (IDALS) staff and IDNR field and central office staff.

The BIT estimates the monthly accumulation rate of fecal coliform bacteria on four land uses (crop land, forest and ungrazed pastureland, built-up, and pastureland), as well as the upper limit for the accumulation that occurs when it does not rain and there is no wash off.

The BIT used the following assumptions for estimates of livestock and wildlife bacteria contributions:

- Dairy cattle are confined in feedlots and their waste is applied as manure.
- Access to pastureland for grazing cattle varies during the year. According to researchers at Iowa State University (Russell, Jim. Dept. of Animal Science, Iowa State University. Ames, IA 50011. December 2005. Personal communication) cattle are:
    - 80 percent confined from January through March.
    - During the spring and summer months (April through October) they spend 100% of their time grazing.
    - In November and December, they have slightly reduced access and spend approximately 80 percent of their time grazing.
- The grazing schedule for sheep is similar to cattle except that sheep are usually confined from January through March.

The contributions from each of these sources have been estimated using information from:

- IDNR and Iowa State University (ISU) wildlife biologists provided data on watershed wildlife populations.
- Natural Resources Conservation Service (NRCS) and ISU researchers provided information on manure application practices and loading rates for hog and cattle operations in the watershed.

The livestock have been spatially distributed to the eight gage subbasins using GIS based methods developed by IDNR. These methods incorporate CAFO and AFO registration and permitting data bases, surveys of buildings and feedlots using aerial photography, and county agricultural statistics to estimate livestock numbers.

Livestock in the watershed.
Livestock sources in the watershed were estimated using assessments made by IDNR staff based on aerial photography and monthly livestock statistics for each county. The livestock estimates used in the Bacteria Indicator Tool model for each of the sub watersheds are shown in Table D6:

Table D6 Estimated gage sub watershed livestock numbers

Subwatershed	Beef Cattle	CAFO Hogs	Dairy Cattle	CAFO Chickens	Sheep
Beaver Creek	6,588	65,496	185	161,384	806
Des Moines River, Lower	10,619	16,030	167	0	1,627
Fourmile Creek	1,231	6,650	58	0	378
Middle River	45,476	33,343	439	0	1,832
North River	21,421	5,560	227	3,113,000	886
South River	40,854	25,404	600	0	2,424
Des Moines River, Upper	930	0	42	0	268
Des Moines River, Middle	7,413	6,665	152	0	646
Total	**134,532**	**159,148**	**1,870**	**3,274,384**	**8,867**

There are two worksheets in the BIT that provide loading input for 'septics' and 'cattle in streams'. These are used to estimate loads from sources that are assumed to be continuous through the times that they are significant. For cattle in the stream, the loads are adjusted monthly to account for cattle spending more time in the stream during the warmer months. For failed septic tank systems, the loads are assumed to be continual and year round.

There are worksheets for each of the eight subbasins that summarize the bacteria load available for washoff from the four landuses for each month of the year. This represents the potential for nonpoint source loads. As noted, there are four landuse categories in the BIT spreadsheet that consolidate the landuse types in the IDNR GIS coverages. The landuse categories are:

- Cropland – includes the alfalfa, corn, soybean, and other row crop land use types.

- Grazed pastureland – includes only grazed grassland landuse. It is assumed that all grazing cattle manure except that from cattle in streams is deposited on pastureland.
- Forest and ungrazed pastureland – Includes three types of forest; bottomland, coniferous, and deciduous; and two types of pasture, ungrazed grasslands and CRP grasslands. It is assumed that the only bacteria loads to this category are from wildlife.
- Built-up areas – Includes roads, commercial/industrial, and residential categories. These three types are used in the Built-up worksheet to estimate loads.

In the worksheets for the four landuse categories the total bacteria accumulation from wildlife and the different livestock types is estimated month by month. The maximum number of fecal coliform organisms available for washoff is 1.5 times the maximum daily accumulation in the warm months (April to September) and 1.8 in the colder months (October to March).

The total loads by landuse and gage subbasin are calculated in separate worksheets for each of the eight subbasins. These worksheets summarize the accumulated daily loads available for wash off for the four land use categories by month and the daily loads from septics and cattle in the stream. Loads available for washoff and the continuous loads are entered into load delivery spreadsheets for each subbasin. In these spreadsheets the ratio of available to delivered *E. coli* is estimated using the existing load from the duration analysis at each of the three TMDL monitoring sites for high flow and moist conditions. For figuring delivery at decreasing flow values, it is assumed that, as loads from runoff diminish, the load fraction from continuous sources increases until it is the entire watershed load.

Estimating existing delivered load at the five flow conditions

The delivered load that is the result of washoff from nonpoint sources that has accumulated on the ground has been estimated using a ratio of the load available for washoff to the delivered load as measured at the three TMDL sites using load duration curves at the five different flow conditions. Delivery ratios are the ratio of the load measured in the stream by monitoring and the load at the sources as estimated with the BIT.

These ratios have been used to estimate the nonpoint source load delivered by runoff. The ratio is the percentage of the estimated load available for washoff from livestock and wildlife manure on croplands, pasture, and forest and runoff from built-up areas. It is assumed that some fraction (the delivery ratio) of the load available for washoff from each subbasin is delivered to the Des Moines River.

As noted, nonpoint source loading from the BIT has three components that are entered into these worksheets separately:

1. The totalized nonpoint source daily loads from event runoff of the four land uses are delivered at different rates for the five flow conditions. As flow decreases these loads rapidly decrease.

2. Cattle in the stream loads are generally from grazing cattle that spend some percentage of their grazing time directly in streams where their manure becomes a direct deposit. These include loads from livestock or wildlife in the stream when run-off is not occurring.

3. Failed septic tanks are rural household onsite wastewater treatment systems consisting of a septic tank system that discharges directly or indirectly to a ditch or tile. The urban population was subtracted from the total population to estimate the number of people using onsite wastewater treatment. Other assumptions and calculations are in the 'septics' worksheet in the BIT. IDNR staff responsible for the onsite wastewater treatment systems program estimate that the failure rate for septic tank systems in central Iowa is 25 percent.

Second Avenue monitoring site.
The loads delivered to the Second Avenue site are from the Beaver Creek subbasin and the discharge from the Saylorville dam. Since the dam discharge does not exceed the *E. coli* criteria, most of the loads causing the impairment at this TMDL site originate in the Beaver Creek watershed. Beaver Creek is the only tributary besides the Raccoon River for which *E. coli* monitoring data is available. The month of June has been used to determine the delivery ratio for Beaver Creek because it is the wettest month, loads available for washoff are among the highest of the season, and in-stream cattle are at a seasonal high. In this analysis, the primary source of Beaver Creek bacteria are pastureland and cattle in streams. Figure D11 shows the distribution of the loads to the four BIT landuses and the two continuous discharges and Table D7 tabulates the existing data for the five flow conditions.

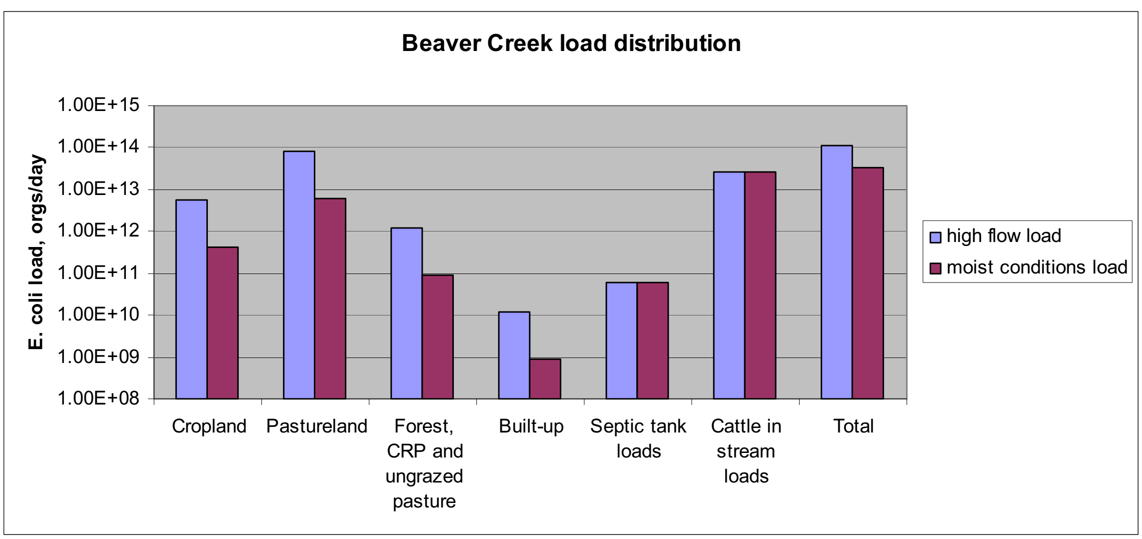

Figure D11 Nonpoint source *E. coli* load distribution for the Beaver Creek subbasin for runoff conditions

Table D7 Comparison of loads for Beaver Creek, DMR at Sycamore, and DMR at the Second Avenue TMDL site for the five flow conditions

Flow percent recurrence	Beaver Creek existing *E. coli*, orgs/day	DMR at Sycamore existing *E. coli*, orgs/day	Sum of Beaver and Sycamore *E. coli*, orgs/day	Second Ave. existing *E. coli*, orgs/day
0 to 10 %	1.10E+14	2.66E+13	1.37E+14	1.63E+14
10 to 40 %	3.25E+13	6.67E+12	3.92E+13	1.57E+14
40 to 60 %	2.23E+13	4.50E+12	2.68E+13	6.30E+13
60 to 90 %	1.57E+12	8.62E+11	2.43E+12	1.03E+13
90 to 100 %	1.77E+10	no data	1.77E+10	1.52E+12

There are some parts of the watershed that are not measured as part of the Beaver Creek basin or the in the Des Moines River at Sycamore and these are calculated in Table D8 and shown in the column labeled Direct drainage.

Table D8 Second Avenue TMDL site estimate for the direct draining loads to the Des Moines River

Flow percent recurrence	Sum of Beaver and Sycamore *E. coli*, orgs/day	Second Ave. existing *E. coli* orgs/day	Direct drainage load, *E. coli* orgs/day
0 to 10 %	1.37E+14	1.63E+14	2.60E+13
10 to 40 %	3.92E+13	1.57E+14	1.18E+14
40 to 60 %	2.68E+13	6.30E+13	3.62E+13
60 to 90 %	2.43E+12	1.03E+13	7.87E+12
90 to 100 %	1.77E+10	1.52E+12	7.01E+11

The fraction of the load estimate from the three major sources at the Second Avenue TMDL site are listed in Table D9.

Table D9 Second Avenue TMDL site load fraction estimates for major loads to the Des Moines River

Flow percent recurrence	Beaver Creek load fraction	DMR at Sycamore load fraction	Direct drainage load fraction
0 to 10 %	67.7%	16.3%	15.9%
10 to 40 %	20.7%	4.2%	75.0%
40 to 60 %	35.4%	7.1%	57.4%
60 to 90 %	15.3%	8.4%	76.4%
90 to 100 %	1.2%	52.7%	46.2%

Site below the Raccoon River confluence (State Road 46/Highway 65)
The loads delivered to the State Road 46/Highway 65 site below the Raccoon River confluence are from the upstream Des Moines River segment as represented by the Second Avenue site, the Raccoon River as represented by the Fleur Drive site, and the Des Moines River Upper gage subbasin (DMR upper). The Raccoon River contributes

the largest loads to this TMDL site. The month of June has been used to evaluate delivery from the gage watershed because it is the wettest month, loads available for washoff are among the highest of the season, and in-stream cattle loads are high. Figure D12 shows the distribution of the loads to the four BIT landuses and the two continuous discharges at the high flow and moist condition loadings and Table D10 tabulates the existing data for the five flow conditions. The fraction of the load estimate from the three major sources at the TMDL site below the Raccoon River are listed in Table D11.

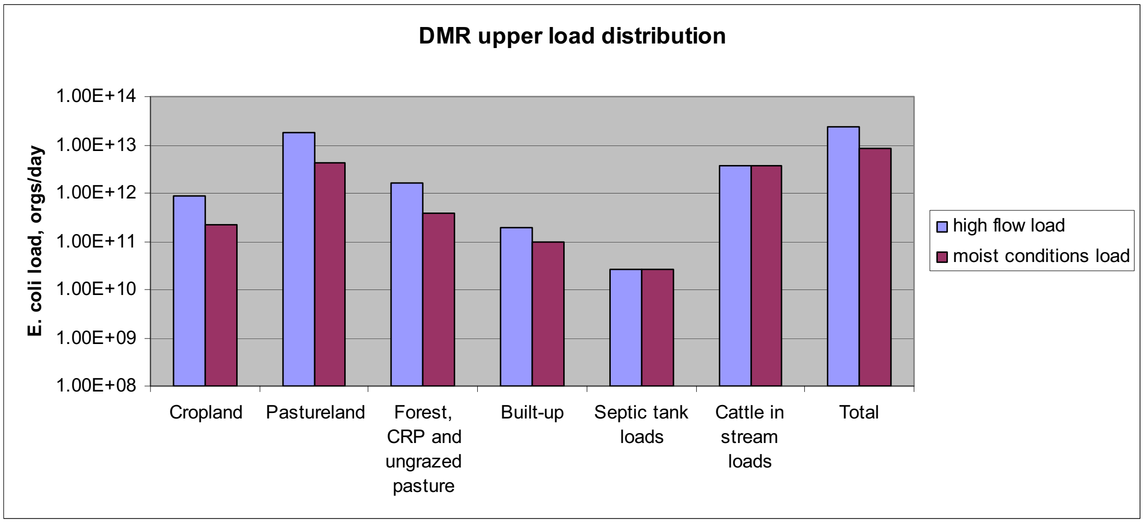

Figure D12 Nonpoint source *E. coli* load distribution for the DMR Upper subbasin for runoff conditions

Table D10 Comparison of loads for the TMDL site below the Raccoon River confluence from the direct draining basin (DMR Upper), the Raccoon River as measured at Fleur Drive, and the upstream Second Avenue site

Flow percent recurrence	DMR Upper basin total NPS load, orgs/day	RR at Fleur estimated existing *E. coli*, orgs/day	DMR Second Avenue estimated existing *E. coli*, orgs/day	DMR below RR confluence estimated existing *E. coli*, orgs/day
0 to 10 %	5.33E+13	4.14E+15	1.63E+14	3.29E+15
10 to 40 %	2.85E+13	5.01E+14	1.57E+14	6.52E+14
40 to 60 %	3.65E+12	8.11E+13	6.30E+13	1.22E+14
60 to 90 %	2.00E+12	1.09E+13	1.03E+13	5.39E+13
90 to 100 %	1.00E+12	1.72E+12	1.52E+12	5.24E+12

Table D11 Site fraction estimates for major loads to the Des Moines River below the Raccoon River confluence TMDL site

Flow percent recurrence	DMR Upper basin total NPS load, percent of total[1]	RR at Fleur estimated existing load, percent of total[2]	DMR Second Avenue estimated existing load, percent of total
0 to 10 %	1.6%	93.4%	5.0%
10 to 40 %	4.4%	71.6%	24.0%
40 to 60 %	3.0%	45.6%	51.5%
60 to 90 %	3.7%	77.1%	19.2%
90 to 100 %	19.1%	51.9%	29.0%

1. The loads from the DMR Upper basin include the urban runoff from the City of Des Moines and some of the suburbs and combined sewer overflow from some locations in the city.
2. The Raccoon River loads as measured at Fleur Drive have been adjusted to accommodate the estimated DMR Upper basin estimates and the upstream loads as measured at the Second Avenue TMDL site.

Site at Runnells.
The loads delivered to the Runnells site are from the upstream Des Moines River segment as represented by the site below the Raccoon River confluence (State Road 46/Highway 65 site) and several major tributaries, Fourmile Creek, North River, Middle River, South River and the area directly draining to the Des Moines River called DMR Mid (See map in Figure 2). There is also a subbasin downstream of the Runnells monitoring site called DMR Lower that is included in the TMDL for the Runnells site since there is not any monitoring data between Runnells and Red Rock Reservoir. However, none of the loads from this subbasin are included in the load estimates for the Runnells site since they are not part of those measured there.

The month of June has been used to evaluate delivery from the gage watershed because critical conditions for pollutant delivery occur then. June is the wettest month, loads available for washoff are some of the highest of the season and cattle are often in-stream. There are USGS gages on all of these tributaries but there has not been any bacteria monitoring at the gages. Figures D13 through D17 show the distribution of the loads to the four BIT landuses and the two continuous discharges at high flow and moist conditions for each of the five subbasins that discharge upstream of the Runnells site.

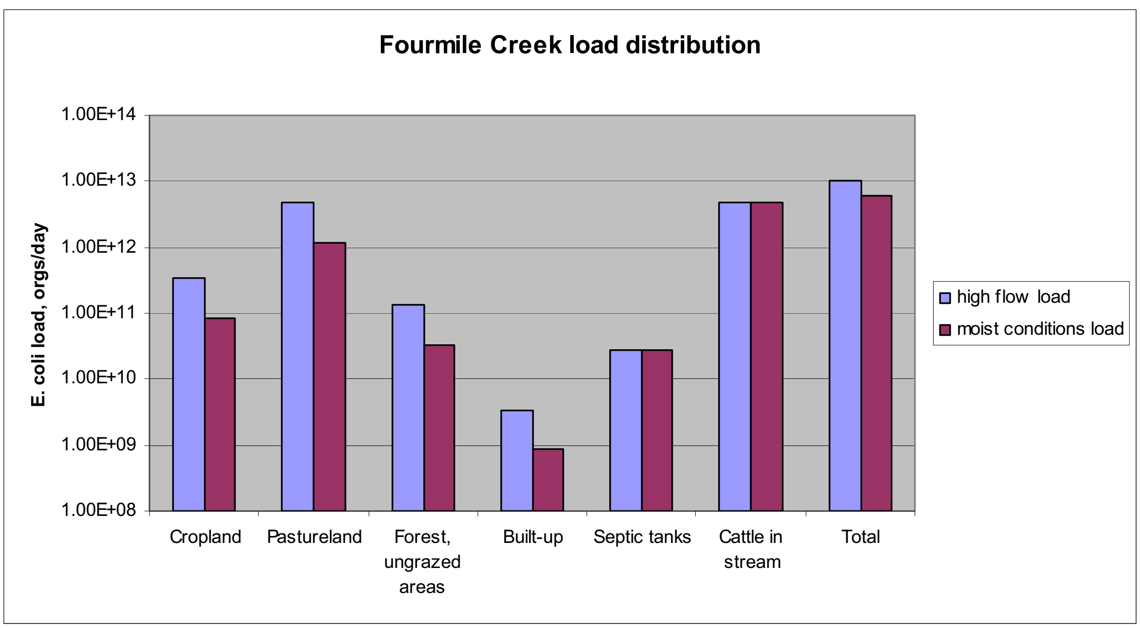

Figure D13 Nonpoint source *E. coli* load distribution for the Fourmile Creek subbasin for runoff conditions

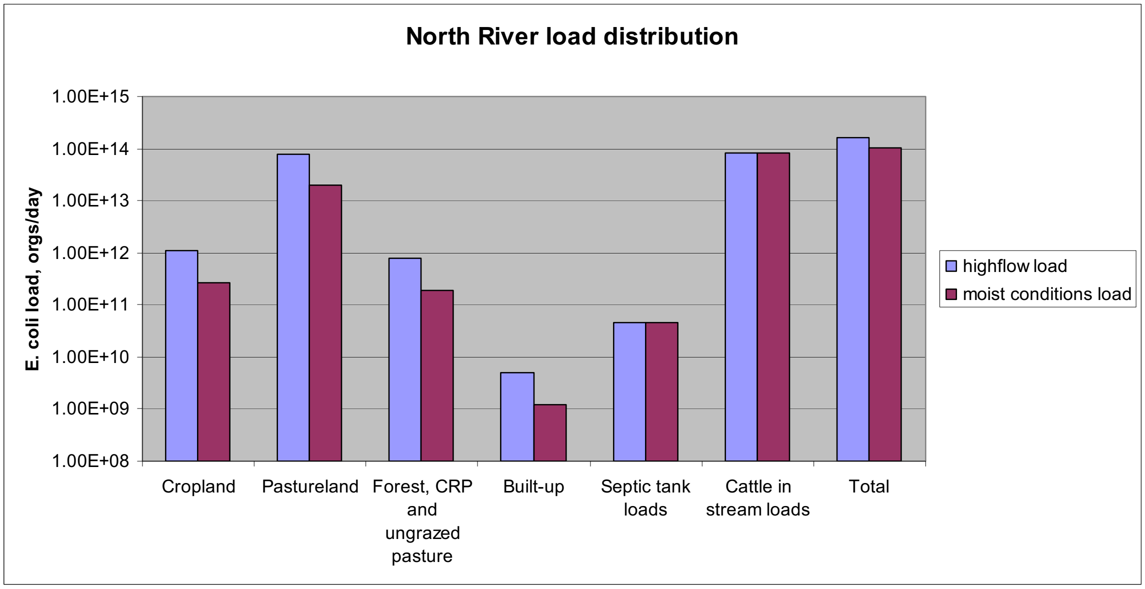

Figure D14 Nonpoint source *E. coli* load distribution for the North River subbasin for runoff conditions

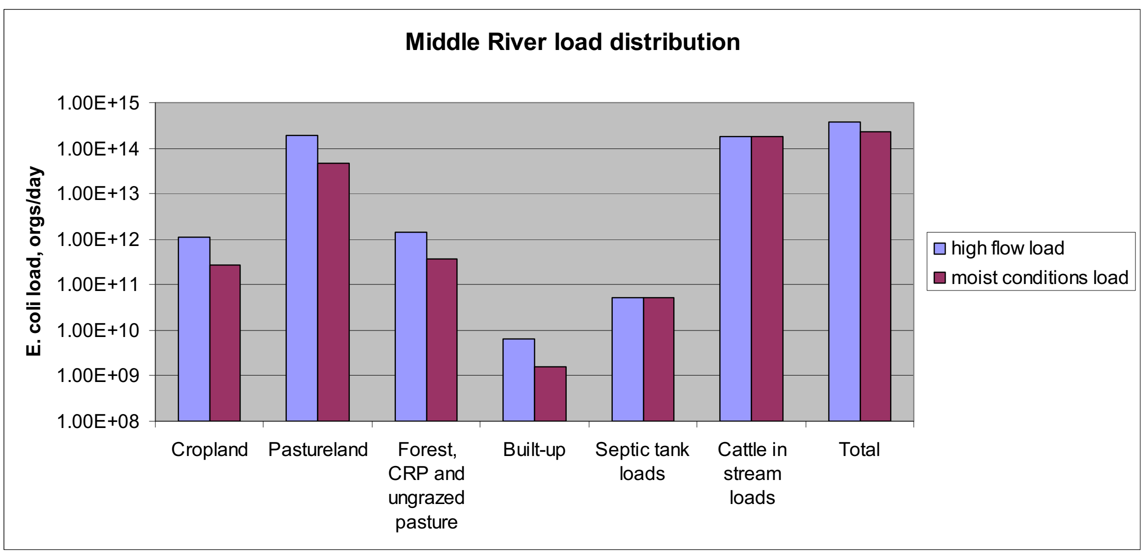

Figure D15 Nonpoint source *E. coli* load distribution for the Middle River Creek subbasin for runoff conditions

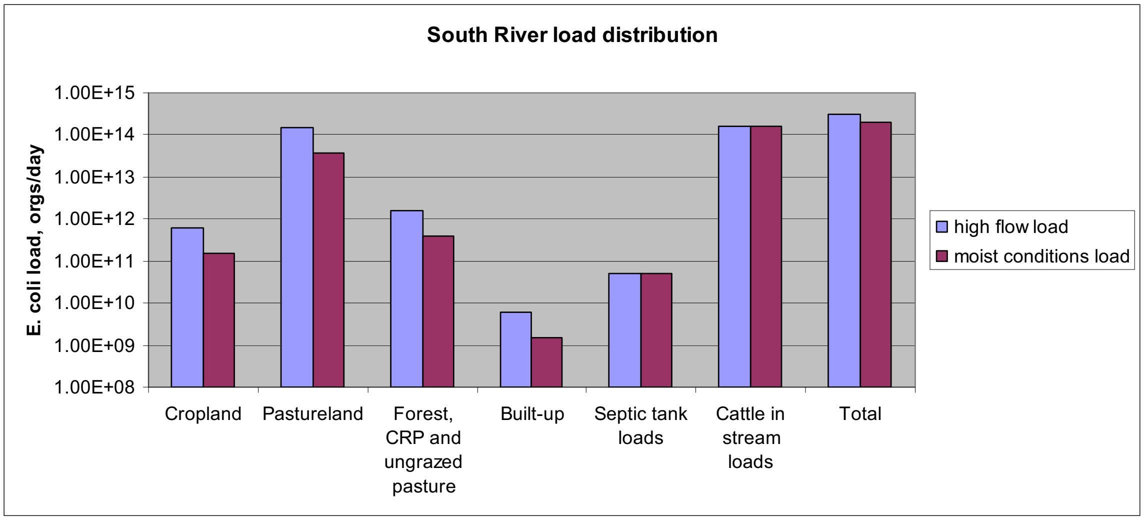

Figure D16 Nonpoint source *E. coli* load distribution for the South River subbasin for runoff conditions

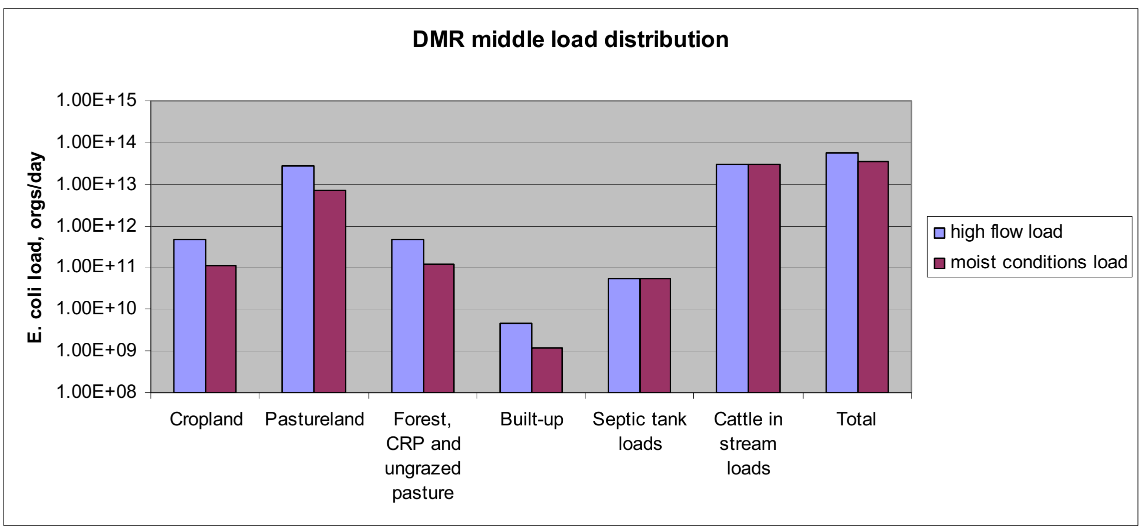

Figure D17 Nonpoint source *E. coli* load distribution for the DMR Middle subbasin for runoff conditions

Table D12 tabulates the estimated loads from each of the major load sources. Since there were not any data for the separate subbasins, the delivery ratio for all of the subbasins has been assumed to be the same for each flow condition based on total load to the Runnels site. These ratios were applied to the load available for washoff for each subbasin during the three flow conditions when runoff is occurring. The result is that the fraction of the load from each subbasin is the same for each flow condition as shown in Table D13.

Table D12 Comparison of loads at Runnells from the upstream site below the Raccoon River confluence, Fourmile Creek, North River, Middle River, South River, and DMR Mid subbasins

Flow condition recurrence	0 to 10%	10 to 40%	40 to 60%	60 to 90%	90 to 100%
DMR below RR confluence *E. coli* load, orgs/day	1.38E+15	4.76E+14	8.75E+13	1.80E+13	1.90E+12
Fourmile Creek *E. coli* load, orgs/day	1.04E+13	3.57E+12	6.57E+11	1.35E+11	1.43E+10
North River *E. coli* load, orgs/day	1.63E+14	5.57E+13	1.03E+13	2.11E+12	2.22E+11
Middle River *E. coli* load, orgs/day	3.82E+14	1.31E+14	2.40E+13	4.94E+12	5.21E+11
South River *E. coli* load, orgs/day	3.14E+14	1.07E+14	1.98E+13	4.07E+12	4.28E+11
DMR mid load, *E. coli* orgs/day	5.79E+13	1.98E+13	3.64E+12	7.50E+11	7.91E+10

Table D13 Runnells site fraction estimates for major loads to the Des Moines River below the Raccoon River confluence, Fourmile Creek, North River, Middle River, South River, and DMR Mid subbasins

Flow condition recurrence	0 to 10%	10 to 40%	40 to 60%	60 to 9 %	90 to 100%
DMR below RR confluence *E. coli* load, orgs/day	60.0%	60.0%	60.0%	60.0%	60.0%
Fourmile Creek *E. coli* load, orgs/day	0.5%	0.5%	0.5%	0.5%	0.5%
North River *E. coli* load, orgs/day	7.0%	7.0%	7.0%	7.0%	7.0%
Middle River *E. coli* load, orgs/day	16.5%	16.5%	16.5%	16.5%	16.5%
South River *E. coli* load, orgs/day	13.7%	13.5%	13.5%	13.5%	13.5%
DMR mid load, *E. coli* orgs/day	2.5%	2.5%	2.5%	2.5%	2.5%

Analysis Documentation and Guide

The data analysis and modeling for the Des Moines River bacteria TMDL are contained in the spreadsheet and model input files listed below in Tables D14 through D18. These folders, data, spreadsheets, and model input files are located in the folder S*upport Documentation* and contain the data and information used to develop this water quality improvement plan. The documentation files can be downloaded from an IDNR ftp site on request.

Table D14 Data and analysis spreadsheets

Folder and file name	Description of contents
Data (folder)	**Data and analysis spreadsheets**
Gage data (subfolder)	
second ave flow 2.xls	DMR flow data from the USGS gage at Second Avenue in Des Moines. Seasonal 1997 to 2007 data from this gage used to develop duration curves for TMDL analysis.
beaver gage 1980.xls	Flow data from the USGS gage on Beaver Creek. Seasonal 1997 to 2007 data from this gage used to develop duration curves.
Sycamore gage flow.xls	DMR flow data from the USGS gage at the Saylorville dam discharge to the Des Moines River. Seasonal data 1997 to 2007 from this gage used to develop duration curves.
Raccoon at Fleur.xls	Raccoon River flow data from the USGS gage at Fleur Drive near the DMR confluence.
gage below raccoon.xls	DMR flow data from the USGS gage at Sixth Avenue in Des Moines. Seasonal 1997 to 2007 data from this gage used to develop duration curves for TMDL analysis.
four mile creek.xls	Flow data from the USGS gage on Fourmile Creek.
north river.xls	Flow data from the USGS gage on the North River.
middle river.xls	Flow data from the USGS gage on the Middle River.
south river.xls	Flow data from the USGS gage on the South River.
LDM runnells1985.xls	DMR flow data from the USGS gage at Second Avenue in Des Moines. Seasonal data 1997 to 2007 from this gage used to develop duration curves
Monitoring data (subfolder)	
beaver creek monitoring langel.xls	*E. coli* monitoring data collected by IDNR on Beaver Creek from 1999 to 2005.
sycamore USACE 5.xlsx	DMR *E. coli* and fecal coliform monitoring data collected by ISU for the ACOE from 1997 to 2007.
DMWW 2nd ave E coli since 1996.xls	DMR *E. coli* data collected daily from 1997 to 2007 by the Des Moines Water Works at their intake near the Second Avenue gage. Used to develop duration curves for existing loads.

DMWW Raccoon E coli since 1996.xls	Raccoon River *E. coli* data collected daily from 1997 to 2007 by the Des Moines Water Works at their intake just upstream of the Fleur Drive gage.
below RR USACE 6.xlsx	DMR *E. coli* and fecal coliform monitoring data collected by ISU for the ACOE from 1997 to 2007 six miles downstream from the RR confluence at Rte. 46/Highway 5. Used to develop duration curves for existing loads.
at Runnells USACE 7.xlsx	DMR *E. coli* and fecal coliform monitoring data collected by ISU for the ACOE from 1997 to 2007 at the Runnells gage site. Used to develop duration curves for existing loads.

Table D15 Load and Flow Duration spreadsheets

Folder and file name	Description of contents
Load and flow duration curves (folder)	**Duration analysis spreadsheets**
DMR second ave TMDL (subfolder)	
LDC second ave_2.xls	Load and flow duration curve analysis.
load calcs second ave.xls	Calculation of the existing and target loads for the Second Ave. site.
Second ave existing and target_2.xls	Chart showing existing and target loads for each flow condition with a load duration curve.
Beaver Creek (sub-subfolder)	Duration analysis and load estimate for Beaver Creek upstream of the 2nd Avenue TMDL site.
LDC Beaver_2.xls	Load and flow duration curve analysis.
load calcs at Beaver.xls	Calculation of the existing and target loads for the Beaver Creek site.
Sycamore (sub-subfolder)	Duration analysis and load estimate for the DMR discharge from Saylorville dam upstream of the 2nd Avenue TMDL site.
LDC Sycamore_2.xls	Load and flow duration curve analysis.
load calcs at sycamore.xls	Calculation of the existing and target loads for the Sycamore site.
DMR at RR confluence TMDL (subfolder)	
LDC below RR confluence.xls	Load and flow duration curve analysis.
load calcs below RR confluence_2.xls	Calculation of the existing and target loads for the site below the RR confluence.
below RR confluence existing and target_2.xls	Chart showing existing and target loads for each flow condition with a load duration curve.
Raccoon River (sub-subfolder)	Duration analysis and load estimate for the RR (at Fleur) flow into the DMR dam upstream of the DMR gage and monitoring TMDL sites.
LDC RR at Fleur_2.xls	Load and flow duration curve analysis.
load calcs RR at Fleur.xls	Calculation of the existing and target loads for the site below the RR confluence.
Raccoon at fleur existing and target_2.xls	Chart showing existing and target loads for each flow condition with a load duration curve.
DMR at runnells TMDL (subfolder)	
LDC at Runnells.xls	Load and flow duration curve analysis.
load calcs at Runnells.xls	Calculation of the existing and target loads for the Runnells site.
Runnells site existing and target_2.xls	Chart showing existing and target loads for each flow condition with a load duration curve.

Table D16 Bacteria Indicator Tool (BIT) spreadsheets

Folder and file name	Description of contents
BIT work (folder)	**BIT input data and analysis spreadsheets**
LDMBIT5.xls	The BIT model spreadsheet used to estimate nonpoint source loads.
subbasin landuse.xls	Land uses from GIS coverage consolidated into the four BIT landuses.
subbasins and areas.xls	Areas of the watershed subbasins calculated from GIS coverages.
septics calc.xls	Calculations used to estimate the number of failed septic tanks in each subbasin.
Livestock (subfolder)	
huc12 beef.xls	Beef cattle estimates by HUC 12 subwatershed.
dairy huc 12.xls	Dairy cattle estimates by HUC 12 subwatershed.
cafo huc12.xls	Confined hogs and chickens estimates by HUC 12 subwatershed.
sheep huc 12.xls	Sheep estimates by HUC 12 subwatershed.
Livestock_Summary_by_Gage_Watershed.xls	Livestock numbers by gage subwatershed that is input into the BIT nonpoint source model.

Table D17 Allocation spreadsheets

Folder and file name	Description of contents
Allocations (folder)	**Allocation calculation spreadsheets**
Wwtp (subfolder)	
wwtp WLA table 8_31_09.xls	Calculation of the WLAs for the wastewater treatment plants in the DMR watershed.
uses wwtp saylor and beaver.xls	Designated uses of the streams in the Beaver and Saylor Creek subbasins.
uses wwtp impaired.xls	Designated uses of the streams in the DMR subbasins downstream of Second Avenue..
MS4 stormwater WLA(subfolder)	
MS4 INFO.xls	General information on the watershed cities that have MS4 NPDES permits.
metro land use.xls	Land use tables for MS4 cities used to develop load estimates.
MS4 city WLA total orgs.xls	Calculation of the WLA load for each city with an MS4 permit.
unsewered WLA (subfolder)	
Apr 2009 Unsewered Community List.xls	IDNR list of unsewered communities in the DMR and Raccoon watersheds.
unsewered final.xls	Calculation of the overall set aside WLAs for the DMR and Raccoon watersheds.
2nd Ave (subfolder)	
2nd ave wwtp WLA_2.xls	List of wwtp in the sub watershed upstream of Second Avenue.
2nd ave wwtp and MS4 summed WLA_2.xls	Summation for the Second Avenue WLAs including wwtp, MS4, and unsewered set aside at each of the five flow conditions.
2nd Ave LA and MOS and WLA_2.xls	LAs and MOS' for the Second Avenue TMDL calculations for each of the five flow conditions.
Below RR confluence (subfolder)	
Below RR wwtp WLA sum.xls	List of wwtp in the sub watershed upstream of Second Avenue.
below RR confluence wwtp and MS4 summed WLA_2.xls	Summation for the below RR confluence site LAs including wwtp, MS4, and unsewered set aside at each of the five flow conditions.
below RR confluence site LA and MOS and WLA_2.xls	LAs and MOS' for the below RR confluence site TMDL calculations for each of the five flow conditions.
Runnels site (subfolder)	
Runnells wwtp WLA sum_2.xls	List of wwtp in the sub watershed upstream of the Runnells site.
Runnells wwtp and MS4 summed WLA_2.xls	Summation for the Runnells site WLAs including wwtp, MS4, and unsewered set aside at each of the five flow conditions.
Runnels site LA and MOS and WLA_2.xls	LAs and MOS' for the Runnells site TMDL calculations for each of the five flow conditions.

Table D18 Load delivery spreadsheets

Folder and file name	Description of contents
Load delivery	**Estimates of pollutant source delivered loads.**
Second ave (subfolder)	
Second Ave source load.xls	Second Avenue site *E. coli* source evaluation and construction of pie charts for the major load sources.
Beaver load_2.xls	Beaver Creek subbasin nonpoint source evaluation and source bar chart construction based on BIT output
Below RR confluence (subfolder)	
below RR source load_2.xls	Site below the Raccoon River confluence *E. coli* source evaluation and construction of pie charts for the major load sources.
DMR upper load_2.xls	Des Moines River Upper subbasin nonpoint source evaluation and source bar chart construction based on BIT output
Runnels (subfolder)	
Runnells source load_2.xls	Runnells site evaluation and development of pie charts for the major load sources.
Four mile load_2.xls	Fourmile Creek subbasin nonpoint source evaluation and source bar chart construction based on BIT output
North River load_2.xls	North River subbasin nonpoint source evaluation and source bar chart construction based on BIT output
Middle River load_2.xls	Middle River subbasin nonpoint source evaluation and source bar chart construction based on BIT output
South River load_2.xls	South River subbasin nonpoint source evaluation and source bar chart construction based on BIT output
DMR middle load_2.xls	Des Moines River Middle subbasin nonpoint source evaluation and source bar chart construction based on BIT output
DMR lower load_2.xls	Des Moines River Lower subbasin nonpoint source evaluation and source bar chart construction based on BIT output

Appendix E --- Water Quality Assessments, 305 (b) Report

The Water Quality Assessment 305 (b) Reports for the five segments of the Des Moines River included in this TMDL are given below. These assessments are from the 2008 Water Quality Assessment Report and reflect only the sections relevant to the pathogen indicator impairment. They are sequenced from the segment beginning at Red Rock Lake north to the interstate 80/35 bridge. The same assessment applies to Segments 1 and 2 of the reach IA 04-LDM-0040.

Waterbody ID Code: IA 04-LDM-0040 Segments 1 and 2

The Class A1 (primary contact recreation) uses are assessed (monitored) as "not supporting" due to levels of indicator bacteria (E. coli) that exceed state water quality standards. The assessments of support of the beneficial uses are based on results of (1) water quality monitoring conducted from 2004-2006 by Iowa State University (under contract with the US Army Corps of Engineers) (ISU/ACOE) upstream from Red Rock Reservoir (ISU/ACOE Station 7 at County Road S35 near Runnells (STORET Station 17770003) as part of the Des Moines River Water Quality Study (see Lutz et al. 2005, Lutz and Francois 2006, and Lutz and Francois 2007) and (2) IDNR/UHL ambient city monitoring downstream from Des Moines near Runnells from 2004 through 2006 (STORET station 10770003). This is the same assessment as that developed for the adjacent upstream assessment segment (IA 04-LDM-0040-2).

Due to recent changes in Iowa's Water Quality Standards, Iowa's assessment methodology for indicator bacteria has changed. Prior to 2003, the Iowa WQ Standards contained a high-flow exemption for the Class A criterion for indicator bacteria (fecal coliform) designed to protect primary contact recreation uses: the water quality criterion for fecal coliform bacteria (200 orgs/100 ml) did not apply "when the waters [were] materially affected by surface runoff." Due to a change in the Standards in July 2003, E. coli is now the indicator bacterium, and the high flow exemption was eliminated and replaced with language stating that the Class A criteria for E. coli apply when Class A1, A2, or A3 uses "can reasonably be expected to occur. Because the IDNR Technical Advisory Committee on WQ Standards could not agree on what flow conditions would define periods when uses would not be reasonably expected to occur, all monitoring data generated for E. coli during the assessment period, regardless of flow conditions during sample collection, will be considered for determining support of Class A uses for purposes of Section 305(b) assessments and Section 303(d) listings.

Monitoring results from both ISU/ACOE and IDNR stations at Des Moines and near Runnells showed that the overall geometric means for E. coli (indicator) bacteria in summer periods of 2002, 2003, and 2004 (166 orgs/100 ml from IDNR/UHL; 198 orgs/100 ml from ISU/ACOE) were greater than the state WQ criterion of 126 organisms/100 ml. In addition, moderately high percentages of *samples exceeded Iowa's single sample maximum criterion for E. coli (235 orgs/100 ml): 7 of 24 samples (29%) at the IDNR/UHL station, and 16 of 35 samples (46%) at the ISU/ACOE station, exceeded this value. According to US EPA guidelines for Section 305(b) reporting, and according to IDNR's assessment/listing methodology, if the geometric mean of E. coli is greater than the state criterion of 126 orgs/100 ml, the primary contact recreation uses should be assessed as "not supported" (see pgs 3-33 to 3-35of US EPA 1997b). Also, these EPA guidelines state that if more than 10% of the samples exceed the state's single-sample maximum criterion, the primary contact recreation uses should be assessed as "partially supported." According to IDNR's assessment/listing methodology, the results from both monitoring agencies suggest that significantly greater than 10% of the samples exceed IDNR's single-sample maximum criterion, thus suggesting that the Class A1 uses should be assessed as "partially supported/impaired." Thus, the percentages of violations of Iowa's single-sample maximum criterion (29% from IDNR/UHL monitoring and 46% from ISU/ACOE monitoring) also suggest impairment of the Class A1 uses. Note: both the geometric means and the percentages of samples that exceeded Iowa's single sample maximum criterion in this river segment declined from the 2002-2004 to the current (2004-2006) assessment periods. At the IDNR/UHL station, the geometric mean declined from 235 to 166 orgs/100ml and the percentage greater than the single-sample maximum criterion declined from 46 to 29%. At the ISU/ACOE station, the geometric mean declined from 405 to 198 orgs/100ml and the percentage greater than the single-sample maximum declined from 56 to 46%. While nonetheless still indicating impairment of the Class A1 uses, the levels of E. coli during the 2004-2006 assessment period do appear to have declined. Whether this decline (i.e., improvement) is related to human or natural (weather) causes is unknown.*

Waterbody ID Code: IA 04-LDM-0040 Segment 3

The Class A1 (primary contact recreation) uses remain assessed (monitored) as "not supporting" based on ambient monitoring for indicator bacteria (E. coli). Due to recent changes in Iowa's Water Quality Standards, Iowa's assessment methodology for indicator bacteria has changed. Prior to 2003, the Iowa WQ Standards contained a high-flow exemption for the Class A criterion for indicator bacteria (fecal coliform) designed to protect primary contact recreation uses: the water quality criterion for fecal coliform bacteria (200 orgs/100 ml) did not apply "when the waters [were] materially affected by surface runoff." Due to a change in the Standards in July 2003, E. coli is now the indicator bacterium, and the high flow exemption was eliminated and replaced with language stating that the Class A criteria for E. coli apply when Class A1, A2, or A3 uses "can reasonably be expected to occur." Because the IDNR Technical Advisory Committee on WQ Standards could not agree on what flow conditions would define periods when uses would not be reasonably expected to occur, all monitoring data generated for E. coli during the assessment period, regardless of flow conditions during *sample collection, will be considered for determining support of Class A uses for purposes of Section 305(b) assessments and Section 303(d) listings.*

The geometric mean level of indicator bacteria (E. coli) in the 36 samples collected (269 orgs/100ml) from at ISU/ACOE Station 6 during recreational seasons of 2004-2006 exceeded the Iowa Class A1 water quality criterion of 126 orgs/100ml. In addition, 16 of the 36 samples (44%) exceeded Iowa's single-sample maximum criterion of 235 orgs/100 ml. According to US EPA guidelines for Section 305(b) reporting, and according to IDNR's assessment/listing methodology, if the geometric mean of E. coli is greater than the state criterion of 126 orgs/100 ml., the primary contact recreation uses should be assessed as "not supported" (see pgs 3-33 to 3-35 of US EPA 1997b). Also, these EPA guidelines state that if more than 10% of the samples exceed the state's single-sample maximum criterion, the primary contact recreation uses should be assessed as "partially supported." According to IDNR's assessment/listing methodology, these results suggest that significantly greater than 10% of the samples exceed IDNR's single-sample maximum criterion, thus suggesting that the Class A uses should be assessed as "partially supported/impaired." Thus, the percentage of violations of Iowa's single-sample maximum criterion also suggests impairment of the Class A1 uses.

Waterbody ID Code: IA 04-UDM-0010 Segment 1

(Note: Prior to the current (2008) Section 305(b) cycle; this stream segment was designated only for Class B (WW) aquatic life uses, including fish consumption uses. Due to changes in Iowa's surface water classification that were approved by US EPA in February 2008 (see http://www.iowadnr.com/water/standards/files/06mar_swc.pdf), and due to the completion of a Use Attainability Analysis in 2007, this segment is also now designated for Class A1 (primary contact recreation) uses.

The Class A1 (primary contact recreation) uses are assessed (monitored) as "not supported" based on results of ambient monitoring for indicator bacteria (E. coli) by the Des Moines Water Works. Despite this impairment, results from ambient bacterial monitoring conducted by ISU/ACOE and by IDNR/UHL at the next upstream monitoring station (Sycamore Access) located approximately two miles downstream from Saylorville Dam continue to suggest that Class A1 uses of the Des Moines River upriver from Interstate 80 (i.e., segment IA 04-UDM-0010_3) are fully supported. Due to recent changes in Iowa's Water Quality Standards, Iowa's 2006 assessment methodology for indicator bacteria has changed. Prior to 2003, the Iowa WQ Standards contained a high-flow exemption for the Class A criterion for indicator bacteria (fecal coliform) designed to protect primary contact recreation uses: the water quality criterion for fecal coliform bacteria (200 orgs/100 ml) did not apply "when the waters [were] materially affected by surface runoff." Due to a change in the Standards in July 2003, E. coli is now the indicator bacterium, and the high flow exemption was eliminated and replaced *with language stating that the Class A criteria for E. coli apply when Class A1, A2, or A3 uses "can reasonably be expected to occur." Because the IDNR Technical Advisory Committee on WQ Standards could not agree on what flow conditions would define periods when uses would not be reasonably expected to occur, all monitoring data generated for E. coli during the assessment period, regardless of flow conditions during sample collection, will be considered for determining support of Class A uses for purposes of the 2006 Section 305(b) assessments and Section 303(d) listings.*

As noted in the assessment for upstream segment IA 04-UDM-0010_3 (I80/I35 bridge to Saylorville Dam), the geometric mean levels of indicator bacteria (E. coli) in the 36 samples collected during the recreational seasons of 2004 through 2006 at the ISU/ACOE station (11 orgs/100 ml) and in the 24 samples collected at the IDNR/UHL station during this period (20 orgs/100ml) are far below the Iowa Class A1 water quality criterion of 126 orgs/100ml. Only two of the combined 60 samples exceeded Iowa's single-sample maximum criterion of 235 orgs/100 ml. According to US EPA guidelines for Section 305(b) reporting (pgs 3-33 to 3-35 of US EPA 1997b) and according to IDNR's assessment/listing methodology, these results strongly indicate "full support" of the Class A1 uses. These results are consistent with the pattern of the lowest levels of indicator bacteria in Iowa rivers occurring immediately downriver from the federal flood control reservoirs.

In sharp contrast to the results from ISU/ACOE and IDNR/UHL monitoring near Saylorville Dam, the results of bacterial monitoring by the Des Moines Water Works downriver from the I80/I35 bridge near the Second Avenue Bridge during recreational seasons of 2004 and 2006 suggest that the Class A1 uses are "not supported." Levels of indicator bacteria (E. coli) in the Des Moines River were monitored by DMWW on most weekdays during the recreational seasons of 2004 and 2006. The generally low monitoring frequency on Iowa rivers (e.g., monthly) usually does not allow strict application of the assessment EPA guidelines for assessing support of primary contact recreation uses. These guidelines specify that a geometric mean based on at least five samples collected over a 30-day period be compared to a state water quality criterion for indicator bacteria. The dataset from DMWW, however, contains sufficient data to implement these assessment methods. Results of DMWW monitoring on the Des Moines River show that moderately large numbers of the 30-day geometric means (with approximately 20 samples collected per each 30-day period) violated Iowa's geometric mean criterion of 126 orgs/100 ml: 26 of 58 geometric means were in violation in 2004 and 95 of 217 geometric means were in violation in 2006. Also, a moderately large percentage of the samples exceeded Iowa's single-sample maximum criterion of 235 orgs/100 ml: 12 of 49 samples (25%) in 2004 and 33 of 170 (19%) in 2006. According to US EPA guidelines for determining support of primary contact recreation uses (US EPA 1997b, page 3-35), if the geometric mean of E. coli from at least five samples collected over a thirty-day period exceeds the state water quality standard of 126 orgs/100 ml, the primary contact recreation uses should be assessed as "not supported." In addition, the US EPA *guidelines state that if more than 10% of the total samples taken during any thirty-day period has a bacterial density that exceeds the state's single-sample maximum criterion of 235 E. coli organsims/100 ml, the primary contact recreation uses should be assessed as "partially supported."*

Waterbody ID Code: IA 04-UDM-0010_2

The Class A1 (primary contact recreation) uses are assessed (monitored) as "not supported" based on results of ambient monitoring for indicator bacteria (E. coli) by the Des Moines Water Works. Despite this impairment, results from ambient bacterial monitoring conducted by ISU/ACOE and by IDNR/UHL at the next upstream monitoring station (Sycamore Access) located approximately two miles downstream from Saylorville Dam continue to suggest that Class A1 uses of the Des Moines River upriver from Interstate 80 (i.e., segment IA 04-UDM-0010_3) are fully supported. Due to recent changes in Iowa's Water Quality Standards, Iowa's 2006 assessment methodology for indicator bacteria has changed. Prior to 2003, the Iowa WQ Standards contained a high-flow exemption for the Class A criterion for indicator bacteria (fecal coliform) designed to protect primary contact recreation uses: the water quality criterion for fecal coliform bacteria (200 orgs/100 ml) did not apply "when the waters [were] materially affected by surface runoff." Due to a change in the Standards in July 2003, E. coli is now the indicator bacterium, and the high flow exemption was eliminated and replaced with language stating that the Class A criteria for E. coli apply when Class A1, A2, or A3 uses "can reasonably be expected to occur." Because the IDNR Technical Advisory Committee on WQ Standards could not agree on what flow conditions would define periods when uses would not be reasonably expected to occur, all monitoring data generated for E. coli during the assessment period, regardless of flow conditions during sample collection, will be considered for determining support of Class A uses for purposes of the 2006 Section 305(b) assessments and Section 303(d) listings.

As noted in the assessment for upstream segment IA 04-UDM-0010_3 (I80/I35 bridge to Saylorville Dam), the geometric mean levels of indicator bacteria (E. coli) in the 36 samples collected during the recreational seasons of 2004 through 2006 at the ISU/ACOE station (11 orgs/100 ml) and in the 24 samples collected at the IDNR/UHL station during this period (20 orgs/100ml) are far below the Iowa Class A1 water quality criterion of 126 orgs/100ml. Only two of the combined 60 samples exceeded Iowa's single-sample maximum criterion of 235 orgs/100 ml. According to US EPA guidelines for Section 305(b) reporting (pgs 3-33 to 3-35 of US EPA 1997b) and according to IDNR's assessment/listing methodology, these results strongly indicate "full support" of the Class A1 uses. These results are consistent with the pattern of the lowest levels of indicator bacteria in Iowa rivers occurring immediately downriver from the federal flood control reservoirs.

In sharp contrast to the results from ISU/ACOE and IDNR/UHL monitoring near Saylorville Dam, the results of bacterial monitoring by the Des Moines Water

Works downriver from the I80/I35 bridge near the Second Avenue Bridge during recreational seasons of 2004 and 2006 suggest that the Class A1 uses are "not supported." Levels of indicator bacteria (E. coli) in the Des Moines River were monitored by DMWW on most weekdays during the recreational seasons of 2004 and 2006. The generally low monitoring frequency on Iowa rivers (e.g., monthly) usually does not allow strict application of the assessment EPA guidelines for assessing support of primary contact recreation uses. These guidelines specify that a geometric mean based on at least five samples collected over a 30-day period be compared to a state water quality criterion for indicator bacteria. The dataset from DMWW, however, contains sufficient data to implement these assessment methods. Results of DMWW monitoring on the Des Moines River show that moderately large numbers of the five-sample, 30-day geometric means (with approximately 20 samples (minimum of 13 samples) collected per each 30-day period) violated Iowa's geometric mean criterion of 126 orgs/100 ml: 26 of 58 geometric means were in violation in 2004 and 95 of 217 geometric means were in violation in 2006. Also, a moderately large percentage of the samples exceeded Iowa's single-sample maximum criterion of 235 orgs/100 ml: 12 of 49 samples (25%) in 2004 and 33 of 170 (19%) in 2006. According to US EPA guidelines for determining support of primary contact recreation uses (US EPA 1997b, page 3-35), if the geometric mean of E. coli from at least five samples collected over a thirty-day period exceeds the state water quality standard of 126 orgs/100 ml, the primary contact recreation uses should be assessed as "not supported." In addition, the US EPA guidelines state that if more than 10% of the total samples taken during any thirty-day period has a bacterial density that exceeds the state's single-sample maximum criterion of 235 E. coli organsims/100 ml, the primary contact recreation uses should be assessed as "partially supported."

Appendix F --- List of Unsewered Communities for WLA Set-Aside

The unsewered communities that have part of the wasteload allocation set-aside are listed in Tables F1 and F2. The wasteload allocation set-asides are for the Raccoon River Basin and the subbasins of the five impaired Des Moines River segments covered in this TMDL.

Table F1 Unsewered communities in the Des Moines River subbasins with WLA set aside

Community	County
Dana	Greene
Granger Homestead	Dallas
Moran	Dallas
Avon	Polk
Berwick	Polk
Nordwoodville	Polk
Vandalia	Jasper
Swan	Marion
Spring Hill	Warren
Ford	Warren
Palmyra	Warren
Conger	Warren
Wick	Warren
Sandyville	Warren
Summerset	Warren
Prole	Warren
Scoth Ridge	Warren
Churchville	Warren
Orilla	Warren
Ackworth	Warren
Beech	Warren
Medora	Warren
Norwood	Lucas
Jamison	Clarke
USD 1 Highway 152/Clarke	Clarke
Bevengton	Madison

Table F2 Unsewered communities in the Raccoon River Basin with WLA set aside

Community	County
Hanover	Buena Vista
Truesdale	Buena Vista
South Shore-Storm Lake (7) Casino Beach	Buena Vista
Casino Beach South	Buena Vista
Lake Creek	Buena Vista
South Shore	Buena Vista
Stoney Point	Buena Vista
Bel-Air	Buena Vista
South Cove	Buena Vista
Sulphur Springs	Buena Vista
Varina	Pocahontas
Nemaha	Sac
Carnarvon	Sac
Ulmer	Sac
Somers	Calhoun
Knierim	Calhoun
Jolly	Calhoun
Yetter	Calhoun
Lanyon	Webster
Willey	Carrol
Maple River	Carrol
Roselle	Carrol
Copper	Greene
Farlin	Greene
Yale	Guthrie
Monteith	Guthrie
Herndon	Guthrie
Linden	Dallas
USD 28/Raccoon Heights/Dallas	Dallas
Barnes Heights	Dallas
USD 23/Allcott/Dallas	Dallas
USD 11/Clark/Dallas	Dallas
USD 13/Timber Valley/Dallas	Dallas
USD 26/River Bye Ranch/Dallas	Dallas

Appendix G --- Public Comments

City Hall
6221 Merle Hay Road
P.O. Box 410
Johnston, IA 50131
515-278-2344
Fax 515-278-2033

Police Department
6221 Merle Hay Road
P.O. Box 410
Johnston, IA 50131
515-278-2345

Public Works
6400 NW Beaver Dr.
P.O. Box 410
Johnston, IA 50131
515-278-0822
Fax 515-727-8092

Crown Point
Community Center
6300 Pioneer Parkway
P.O. Box 410
Johnston, IA 50131
515-251-3707

Public Library
6700 Merle Hay Road
P.O. Box 327
Johnston, IA 50131
515-278-5233
Fax 515-278-4975

October 15, 2009

Jeff Berckes
Iowa Department of Natural Resources
Watershed Improvement
Sent via email: jeff.berckes@dnr.iowa.gov

SUBJECT: Iowa Department of Natural Resources (Iowa DNR); Draft River Water Quality Improvement Plan for Five Segments of the Lower Des Moines River (Polk, Warren and Marion Counties)

Jeff:

As the Iowa DNR moves forward to implementation of this Des Moines River Water Quality Plan and submittal to the Environmental Protection Agency, we offer the following:

1. Concern regarding this comment: "The Plan is a springboard so local communities can address it. The Iowa DNR will pass the baton on to the local groups who will respond with a community watershed management plan."

   The City of Johnston has a Municipal Separate Storm Sewer System (MS4) permit and has completed a watershed assessment and stormwater management plan. The City is actively supporting ways to improve water quality and quantity issues. However, it is important to note that the City is limited by its jurisdictional boundaries. We work in partnership whenever possible, but until the MS4 permits are written in a watershed-based context, significant improvements within the Beaver Creek and Des Moines River watershed will be difficult.

2. Concern regarding the predominance of rural land uses in the watershed area.

   Referencing the Water Quality Improvement Plan for the Upper Des Moines River and Beaver Creek (submitted to EPA on August 17, 2009 with a Total Maximum Daily Load for Nitrate), we understand that approximately 78% of the Des Moines River watershed is rural and in row crop land use. As with the impairment (E. coli) stated in *the Lower Des Moines River Plan, we encourage Iowa DNR to look beyond the MS4 cities for implementation and cooperation in the 16 Iowa county areas that are outside cities and a part of the watershed too.*

3. <u>We are concerned about the last bullet point under Section 4.2, Best Management Practices</u>: "Control of bacteria from urban runoff through storm sewers. Disinfection may be needed."

   We encourage Iowa DNR to consider a cost-benefit analysis of this statement prior to making this recommendation.

4. Consider revisiting this Plan in 5 – 10 years, to review water quality data and determine if efforts in the Des Moines River watershed are making a positive difference.

5. We have a concern that the public meeting for Polk County held in Urbandale on Thursday, October 8, 2009 was very lightly attended. Johnston city staff were notified of the meeting through a citizen who saw the notice in a local newspaper – we would have missed it otherwise. We believe the public meetings would be better attended if Iowa DNR staff directly contacted the cities in the study area.

6. We also have a concern that the public meetings are held so close to the end of the comment period; in this case it is less than 10 days.

Once again, thank you for your efforts.

Sincerely,

Deb Schiel-Larson

Deb Schiel-Larson, AICP
Planner II/ Landscape Architect
Tele.: 515/727-7763
Email: dlarson@ci.johnston.ia.us

Copy: David Wilwerding, City of Johnston;
Greg Pierce, Nilles Associates

Fields of Opportunities

STATE OF IOWA

CHESTER J. CULVER, GOVERNOR
PATTY JUDGE, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
RICHARD A. LEOPOLD, DIRECTOR

October 21, 2009

Deb Schiel-Larson
City of Johnston
6221 Merle Hay Road
Johnston, IA 50131
515-727-7763

Dear Ms. Schiel-Larson:

Thank you for taking the time to comment on the Des Moines River Water Quality Improvement Plan (WQIP) for bacteria. We value your interest in affecting positive change in the Des Moines River watershed and look forward to working with you in the future.

The following is a response to your comment letter dated October 15, 2009:

Point 1: *"...until the MS4 permits are written in a watershed-based context, significant improvements within the Beaver Creek and Des Moines River watershed will be difficult."*
Unfortunately, political boundaries usually do not correspond to watershed boundaries. The MS4 permits are an important component of watershed improvement and the Department encourages the City of Johnston to continue their efforts to improve the water quality in the city's portion of Beaver Creek and the Des Moines River. Your comment regarding the structure of MS4 permits was relayed to Joe Griffin, who is in charge of MS4 permits for the DNR.

Point 2: *"...we understand that approximately 78% of the Des Moines River watershed is in row crop land use...we encourage Iowa DNR to look beyond the MS4 cities for implementation and cooperation in the 16 Iowa county areas that are outside cities and a part of the watershed too.*
The WQIP speaks to the land use and relative contributions of bacteria to the Des Moines River. Local watershed groups are encouraged to engage all stakeholders in the watershed, including agricultural landowners and producers. For the TMDL to be reached, the implementation plan of the WQIP cites best management practices that can be utilized by local groups throughout the watershed.

Point 3: *"We are concerned about the last bullet point under Section 4.2, Best Management Practices:* 'Control of bacteria from urban runoff through storm sewers. Disinfection may be needed.' *We encourage Iowa DNR to consider a cost-benefit analysis of this statement prior to making this recommendation."*
The best management practices listed in Section 4 of the document are not "recommendations" but rather a set of practices that are available to address the impairment. The contents of Section 4 are not a requirement for an EPA Water Quality Improvement Plan and are included solely to provide stakeholders a reference as to the amount and type of work that will address the

impairment. It is the responsibility of the local watershed group to determine the relative cost efficiency and effectiveness of any practice.

Point 4: "*Consider revisiting this Plan in 5 – 10 years, to review water quality data and determine if efforts in the Des Moines River watershed are making a positive difference.*"
The impaired waters list for Iowa contains hundreds of waterbodies throughout the state. The Clean Water Act requires the State of Iowa to develop a TMDL for all impaired waters listed on the 303(d) list. With limited resources, the TMDL program has the capacity to complete 10-12 WQIPs annually. Given the workload for the program, and the current resources, a revision of the Des Moines Bacteria TMDL is not currently planned.

Point 5: "*We have a concern that the public meeting for Polk County held in Urbandale on Thursday, October 8, 2009 was very lightly attended... We believe the public meeting would be better attended if Iowa DNR staff directly contacted the cities in the study area.*"
The meeting on October 8, 2009 was one of three public meetings held to present and discuss the WQIP for the Des Moines River Bacteria TMDL. Information regarding the 30 day public comment period and public meetings are posted on the DNR website for the entire public comment period. In addition, a press release notice is distributed to all registered media outlets and other interested parties at the inception of the public comment period. The DNR would like to see better meeting attendance for these public meetings and we will continue to look into ways to strengthen our notification network in the future.

Point 5: "*We also have a concern that the public meetings are held so close to the end of the comment period; in this case it is less than 10 days.*"
The DNR issues a press release to notify the start of the public notice period and to identify the location and date of the public meeting(s). The standard time for a public notice period is 30 days and usually starts on a Thursday to coincide with DNR's "EcoNewsWire". The DNR tries to set the meetings to allow enough time for weekly newspapers to report the meeting plans (they typically require 2 weeks advance notice). The DNR also tries to allow enough time for stakeholders to make arrangements to attend the meeting and have enough time to prepare comments after the meeting. In this case, the public notice period started on September 17 with meetings on October 6 and 8. The comment period ended on October 9, 11 days after the last meeting. The DNR will continue to work with stakeholders to provide the most accommodating combination of advanced meeting notice and time after the meeting to prepare an official public comment.

Thank you again for your support and your letter. If you have further questions, I can be reached at 515-281-4791.

Sincerely,

Jeff Berckes, TMDL Program Coordinator
Watershed Improvement Section

Berckes, Jeff [DNR]

From: Virginia Soelberg [soelbergv@dwx.com]
Sent: Friday, October 16, 2009 4:04 PM
To: Berckes, Jeff [DNR]
Subject: Lower Des Moines River WQ Plan Comments

Follow Up Flag: Follow up
Flag Status: Completed

Jeff,

I was unable to attend the TMDL meeting for the Des Moines River (e. coli.) Following are some brief comments:

The issues need to be dealt with through a watershed approach, rather than piece-meal efforts. As a community, Johnston has no control over the towns and farms upstream. Expecting our Beaver Creek subwatershed group to "attract" all other stakeholders to participate is unrealistic. Best management practices can't be just "suggested." They need to be expected by the DNR. Permits for discharge from treatment plants need to be adequate and enforced. Find the offending sources and take action where it will make the most difference in water quality. Much of the pollution into the Beaver Creek watershed comes from unincorporated, rural areas; primarily cropland. Hold them accountable. There must be regulation and oversight.

Thanks for your work for water quality in Iowa.

Virginia H. Soelberg
5979 Dogwood Circle
Johnston, Iowa 50131

Fields of Opportunities

STATE OF IOWA

CHESTER J. CULVER, GOVERNOR
PATTY JUDGE, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
RICHARD A. LEOPOLD, DIRECTOR

October 21, 2009

Virginia Soelberg
5979 Dogwood Circle
Johnston, IA 50131

Dear Ms. Soelberg:

Thank you for taking the time to comment on the Des Moines River Water Quality Improvement Plan for bacteria. We value your interest in affecting positive change in the Des Moines River watershed and look forward to working with you in the future. The following is a response to your comments delivered via e-mail on October 16, 2009:

The Water Quality Improvement Plan for the Des Moines River serves two purposes. First, it satisfies a requirement of the Clean Water Act to develop a TMDL for the bacteria impairments. Second, it is a document that can be used by local stakeholders as a guide to improve water quality. Nonpoint source pollution, such as runoff from farmland, is not regulated at this time. Therefore, best management practices are suggested to local watershed groups that will improve water quality.

As discussed at the public meeting, a small watershed approach is preferred for improving water quality. Active community groups have been effective across the state in engaging citizens and landowners throughout their watershed to adopt pollutant reducing practices, both residential and agricultural. Communities can use the Water Quality Improvement Plan to identify watersheds that are the most problematic for bacteria contributions and start their efforts there. By targeting the most problematic watersheds first, the Des Moines River should theoretically benefit from reductions in bacteria. Once progress is made in the first watershed, a community can move on to the next most problematic watershed, and begin restoration efforts there.

Wastewater treatment plants are permitted and enforced by the DNR NPDES program. All permits issued to wastewater facilities must be approved by the EPA. The department will continue to work with permitted facilities to ensure compliance with their permits.

I hope the Water Quality Improvement Plan proves helpful in any watershed work you are involved with. If you have further questions, I can be reached at 515-281-4791.

Sincerely,

Jeff Berckes, TMDL Program Coordinator
Watershed Improvement Section