

# 2017 Annual Report

For the period of July 1, 2016 - June 30, 2017  
Prepared by the City of Tulsa Streets and Stormwater Department



Municipal Stormwater  
Discharge Permit #OKS000201



CITY OF  
**Tulsa**  
*A New Kind of Energy.*

# Annual Report



OPDES Stormwater Permit #OKS000201  
July 1, 2016 to June 30, 2017

## **Co-Permittees:**

Oklahoma Turnpike Authority

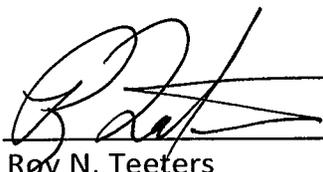
Oklahoma Department of  
Transportation

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CERTIFICATION STATEMENT  
OPDES Permit No. OKS000201  
Review of Stormwater Annual  
Report

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations.



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Roy N. Teeters

Manager

Stormwater & Land Management Division

9.28.17

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Date

Section 1 – Status of Implementing the Stormwater Management Program

## Section 1

### The Status of Implementing the Stormwater Management Program (SWMP)

The Stormwater Management Program (SWMP) of the City of Tulsa’s municipal stormwater discharge permit #OKS000201, Part II, consists of 12 separate programs. A brief review of each of the individual programs and tasks performed during the period of July 1, 2016 through June 30, 2017, will result in the effective assessment of permit compliance.

#### Part II(A)(1) Structural Controls and Stormwater Collection System Operation

*Status: Compliant and Ongoing*

The City of Tulsa’s SWMP provides for the maintenance of both above and below ground structural stormwater controls including detention ponds, inlets, conduits and channels. The primary purpose of this program is to assure proper operation of these structural controls for better control of stormwater quantity. Additionally, stormwater quality benefited from the removal of sediment, floatables, and regular inspections of all structures. The following table is an inventory of the work performed on these structures during this reporting period.

#### Maintenance of Above Ground Stormwater Structural Controls

ABOVE GROUND STRUCTURE(S)	INVENTORY (FOR REPORTING PERIOD)	OPERATIONS & MAINTENANCE (O&M) ACTIVITY	O&M ACTIVITY (COMPLETED EACH REPORTING PERIOD)
Channels/ Streams/ Detention Ponds	1,679 acres	Mowing	12 x/year of mowable property (totaling 20,152 acres)
Channels & Streams/ Detention Ponds	1,712 acres	Weed control (Herbicide)	All parcels 1 x/year for broad leaf weed control (totaling 1,712 acres)
Channels & Streams (Hydro Mulch Plus)	418 acres	Weed Control (Herbicide)	All parcels 5 x/year for growth control (totaling 2,090 acres)
Channels & Streams (Inhouse)	253 acres	Weed Control (Herbicide)	All parcels 5 x/year for growth control (totaling 1,265 acres)
Wet Ponds	64 acres	Algae Control	All ponds 6 x/year for growth control (totaling 383 acres)
Channels/ Streams/ Detention Ponds	1,366 acres	Cleaning/ Sediment Removal (Ponds/Streams)	110,716 cubic yards/period
Roadside Ditches	974 miles	Sediment Removal (Roadside Ditching)	72,036 linear feet/period

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**Maintenance of Below Ground Stormwater Structural Controls**

BELOW GROUND STRUCTURE(S)	INVENTORY (FOR REPORTING PERIOD)	OPERATIONS & MAINTENANCE (O&M) ACTIVITY	O&M ACTIVITY (COMPLETED EACH REPORTING PERIOD)
Storm Sewer Pipe (all pipe - driveway pipe, crossover pipe, etc...)	1,178 miles	Inspect Flush/clean Repair or Replace	2.25 miles/period 4.32 miles/period 5,564 linear feet units/period
Catch Basin/Inlets	68,453 units	Inspect & Clean Repair	11,786 units/period 451 units/period
Pump Station	12 units	Clean interior, Inspect & Maintain	1,449 maintenance activities

Additionally, prior to mowing of all stormwater control structures, all trash was collected and disposed of properly. Detention ponds that are multi-use had trash cans for disposal of litter. These cans were emptied on a regular basis.

Compliance shall be based on completion of the O&M ACTIVITY column found in the charts.

**Part II(A)(2) Areas of New Development and Significant Redevelopment**

*Status: Compliant and ongoing*

This requirement was met through the continued implementation of the Stormwater Master Drainage Plan, Stormwater Design Criteria Manual and ordinances (Title 11-A, Chapter 3, Watershed Development Regulations; Title 11-A, Chapter 5, Pollution; Title 42, Chapter 11, Planned Unit Development) that relate to any new development and significant re-development that occurs in Tulsa. These documents were created in order to reduce flooding due to new development and significant re-development. A secondary benefit was to reduce the impact on water quality as a result of construction. The City of Tulsa follows a city-wide Comprehensive Plan. This plan addresses all facets of activities including water quality and has recently (August 2016) undergone an update with guidance from many groups, including Stormwater Quality and Engineering Services - Stormwater Design Section. The City of Tulsa also utilizes the Master Drainage plans, which are planning tools used to determine areas of watersheds that need capital improvements to reduce flooding that is caused from development as well as providing solutions to stormwater drainage, maintenance and management issues which are

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prioritized based on benefits and costs. These Master Drainage Plans are being updated as funds become available.

The City of Tulsa continues to implement the Tulsa Stormwater Design Criteria Manual. This manual, created and adopted in 1994, is a comprehensive manual designed to assist engineers, designers and construction operators in aspects of stormwater runoff control before, during and after construction activities are completed. This includes both water quality and quantity. The Stormwater Design Criteria Manual has several purposes including minimizing water quality degradation by preventing siltation and erosion of the City waterways and preserving environmental quality. This manual is utilized by City of Tulsa staff, as well as site development engineers during the design and review phases of all new developments and significant redevelopment projects that occur within the City of Tulsa. Tulsa is in the process of updating this document to reflect more current policies and practices. This update has been nearly completed, and is awaiting final Board approval. Additionally, the Watershed Development Regulations (Title 11-A, Chapter 3) lists the current practices regarding regulation of new development and significant redevelopment for the control of stormwater runoff.

Anyone planning to develop or redevelop areas of Tulsa has to follow a process with the Development Services Division of the City of Tulsa. This process requires developers to follow extensive planning, designing, and review. This ensures the area targeted for development meets all City requirements, including reducing the impact of flooding, impacts on city owned utilities, traffic needs, etc., after construction is completed.

The City of Tulsa had recently completed work on a major update of its zoning code. However incorporating additional landscape requirements into the initial update would have delayed the overall project, so it was decided that the Landscaping Chapter would be updated separately. This process began in March of 2017 and a Stormwater Quality representative has been involved in the working group and draft updates to ensure Low Impact development (LID) impediments are removed and LID is incentivized to the maximum extent practicable. More information on these updates will likely be available next year, after the Landscaping Chapter is finalized and approved.



The Subdivision Regulations are also currently under review and will be updated by late 2017. This effort is a recommended strategy from our Comprehensive Plan, PLANiTULSA, which was approved by City Council in 2010. The guiding principles of this plan include a desire for Tulsa to become a more environmentally and fiscally sustainable city. The City of Tulsa has hired a contractor to perform tasks associated

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with the subdivision regulation update outlined in a Request for Proposals. Stormwater Quality staff has been actively involved in the public comment period to remove barriers and encourage LID. Staff will continue to follow the project through to completion in the overall effort of improving water quality.

The Stormwater Design Criteria Manual has undergone a complete update, including Chapter 1100, now titled Low Impact Development. This Chapter simply references the Low Impact Development Design Manual which is currently nearing completion, led by Dr. Jason Vogel at Oklahoma State University. When this Manual is completed, Tulsa will have taken a big step toward promoting and providing guidance on LID projects in Tulsa. Further promotion of LID was accomplished by implementation of the following:

- LID was promoted at 37 educational functions, particularly those with key personnel, including engineers and planners.
- Continued review of Tulsa’s development regulations to determine if they are LID friendly.
- Conducted public education events promoting LID, especially with developers/contractors.
- Continued LID workgroup to work on incentivizing LID as well as design and maintenance specifications.
- Developed “Guide to Low Impact Development” that is distributed at public events.

The City of Tulsa is continuing the pervious pavement pilot project where five concrete companies poured their pervious pavement mix and Tulsa. Tulsa, in cooperation with Oklahoma State University, continues to monitor and maintain the site and showcase it to the development and construction communities. This project will be taken over by the University of Oklahoma since Dr. Jason Vogel has begun working there since April 2017.

The City of Tulsa has adopted an already existing City of Tulsa Program to recognize Low Impact Development practices in Tulsa. The program, Partners for A Clean Environment (PACE) is a voluntary, non-regulatory recognition program coordinated by the City of Tulsa’s Quality Assurance and Stormwater Quality groups. The focus of the program is to provide recognition to businesses, individuals and groups who go above and beyond environmental regulations in an effort to be better stewards of our land and water.



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Further promotion of LID in Tulsa has been accomplished through the continued effort of the LID workgroup. The Stormwater Quality group coordinates these regularly scheduled meetings. The working group meets to discuss a variety of LID related topics and is currently developing design guidelines for LID practices as well as a strategy for requiring/incentivizing LID. The group consists of City of Tulsa employees from a variety of departments: Engineering Services, Development Services, Planning and Stormwater Quality, as well as faculty and students from Oklahoma State University’s, landscape architects, INCOG and surrounding municipalities.

**Part II(A)(3) Roadways**

*Status: Compliant and ongoing*

This requirement was met through the City’s street sweeping and mowing activities performed and managed by the Streets and Stormwater Department.

Through the utilization of private contractors, Streets and Stormwater swept arterial streets 8 times. Emphasis was placed on sweeping after de-icing material was no longer required as a result of a snow or ice event. Residential streets were swept 4 times. The program’s progress is measured in curb miles swept and yds<sup>3</sup> of material removed. Arterial and residential mileage per year may vary due to weather variations as well as contractor issues from one year to the next. BMP’s that prevent run-off from deicing material are in place at Tulsa’s east and west maintenance yards. All of Tulsa’s trucks washing facilities drain to the sanitary sewer, thus avoiding potential contamination in the storm sewer.

Street Sweeping

Type	Sweeping Requirement	Sweeping completed	O & M Activity (for reporting period)	Material Removed
<b>Arterial</b>	~8x annually	8	5,200 miles	2,824 yds <sup>3</sup>
<b>Residential</b>	~4x annually	4	10,489 miles	28,483 yds <sup>3</sup>

Contractors have reviewed the MS4 Permit and the Pollution Ordinance, in order to be familiar with the MS4 regulations and requirements, to prevent contamination of the waters of the State. As contracts for sweeping and mowing come up for renewal, addendums were and will continue to be added to include a water quality requirement. This addendum will require the contractor to review and sign off on the SWMP, Pollution Ordinance and the MS4 permit.

During this reporting period, trash removal was also conducted on all street right-of-ways prior to any mowing. Numbers for inmate work crews are as follows:

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Litter Removal from Roadways

Collected by	Amount Collected	
<b>Inmate work crews</b>	17,386 bags	520.45 tons

Tulsa Stadium Improvement District (TSID) conducted concentrated street and sidewalk cleaning efforts in the Central Business District, of the downtown area of Tulsa. This area consists of 1.4 square miles containing 58.37 curb miles.

Central Business District

Type of Activity	Interval
<b>Street sweeping</b>	58 curb miles/week
<b>Storm sewer intake structure cleaning</b>	1x/week
<b>110 sidewalk mounted trash cans (inspect/clean)</b>	5x/week
<b>4 Pet Waste Stations (refilled)</b>	Weekly

The Streets and Stormwater Department continued to warn citizens and companies not to sweep or blow grass/leaves/debris into the street or storm sewer as it is a violation of Tulsa’s Ordinance’s and could result in a fine. In addition literature was distributed titled “Landscaping BMP”. This literature is given to anyone believed to be disposing of leaves and grass into the MS4 (Municipal Separate Storm Sewer System). It directs the alleged disposer against further disposal of this material into the MS4.

Permit compliance was achieved with the completion of the specified street sweeping and litter removal.

**Part II(A)(4) Flood Control Projects**

*Status: Compliant and ongoing*

To address this program requirement, the City of Tulsa has continued to implement the following activities:

1. Flood Management Project Design Review
2. Utilization of the NPDES Permit Evaluation Study – Water Quality Enhancement Assessment of Existing Flood Control Detention Facilities, September 15, 1998.

A discussion of the procedures for each activity is presented below.

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**Flood Management Project Design Review**

To ensure that proposed flood control projects assess the impacts on the water quality of receiving water bodies, the City has and will perform a project design review for all current and future major flood control projects. The project design review utilizes criteria derived from design considerations included in the Stormwater Design Criteria Manual.

By definition, the purpose of a flood control project is to reduce flood damage. Flood control and water quality management strategies differ greatly. Flood control projects are designed to manage stormwater runoff resulting from large, infrequent storm events. Normally, these projects are designed to quickly convey runoff resulting from up to a 100-year storm event. Conversely, water quality management facilities are designed to handle runoff from much smaller, more frequent storm events (1-2 year storm event). In a given year, 70-90 percent of all runoff (and generally the associated pollutants) typically result from storm events producing less than 2 inches of rainfall. Water quality management facilities attempt to slow stormwater runoff, maximizing hydraulic detention periods to facilitate sedimentation and biological uptake. Therefore, this program element does not attempt to provide comprehensive water quality management utilizing "flood control" structures. The goal is to assure that project impacts to receiving waters are assessed and minimized through the use of sound engineering design principles. Where possible, water quality treatment principles will be incorporated into the design of flood control projects.

Sections 700 and 900 of the City of Tulsa Stormwater Design Criteria Manual document minimum design criteria. These criteria address the following design considerations:

- Channel Design
  - Maximum velocity
  - Channel geometry, side slopes
  - Channel material/stabilization
  - Side slope vegetation

Additional City review will take into consideration:

- Detention Structure Design
  - Storage volume to maximize residence time
  - Outflow structure design to slowly release detained flows without causing flooding
  - Energy Dissipaters to slow velocity
- Location
  - Downstream effects
  - Existing receiving water quality
  - Maintainability
  - Proximity in the watershed with respect to impervious areas

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**Existing Flood Control Structure Evaluation - NPDES Permit Evaluation Study**

In September 1998, Tulsa evaluated the feasibility of retrofitting 19 existing flood control structures to provide additional pollutant removal. This study recommended using upper watershed BMP's or control of pollutants at the source rather than retrofitting existing flood control structures. This is currently addressed through the implementation of a number of stormwater management programs. This includes street sweeping, construction site erosion control and public education. These programs will continue to be utilized.

The City of Tulsa has guidelines for development in the upper 1/3 of drainage basins to have detention. These detention ponds help slow the rate of stormwater runoff allowing pollutants to settle out.

Currently the City of Tulsa, in cooperation with the Oklahoma Conservation Commission, is studying the issue of fish migration upstream from receiving waters, especially in Crow Creek. The motivation behind these efforts is to allow repopulation and therefore potentially improve biotic integrity of the creek which could qualify it for removal from the state list of impaired waters. The Stormwater Quality group is heavily involved in this initiative.



Compliance will be based upon the assessment of the impact(s) to receiving water quality during the design phase of flood control project. Where possible, water quality treatment principles will be incorporated into the design of these projects.

**Part II(A)(5) Pesticide, Herbicide, and Fertilizer Application**

*Status: Compliant and ongoing*

All City of Tulsa personnel, as well as all contract applicators that applied pesticides and herbicides were required to be licensed and subject to all regulations under the Oklahoma Pesticide Applicators Law, including re-certification. City personnel that applied pesticides, herbicides and fertilizers received annual in-house training on specific types of pesticides, herbicides and fertilizers.

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Stormwater and Land Management (SLM) employees attended the following events regarding the proper application and disposal of pesticides, fertilizers and herbicides:

- 10/5/2016 - Oklahoma Vegetation Management Association Fall Conference – Tulsa, OK
- 10/13/2016 – Winfield Solutions Workshop – Tulsa, OK
- 11/17/2016 - Global Horticulture – OSU Stillwater, OK
- 11/30/2016 – Oklahoma Turfgrass Conference – OSU Stillwater, OK
- 2/21-24/2017 – International Erosion Control Association Conference – Atlanta, GA
- 3/1/2017 - Oklahoma Vegetation Management Assoc. Spring Conference – Midwest City
- 3/8/2017 – In-house training, Round-up Custom SDS – Tulsa, OK
- 4/11/2017 – In-house training, Aqua King SDS – Tulsa, OK
- 5/11/2017 – In-house training, Spray tank tips and pressure settings – Tulsa, OK
- 5/31/2017 – Native Plant Conference – OSU Stillwater, OK

With the issuance of the Environmental Protection Agency’s (EPA) (now Oklahoma Department of Agriculture Food and Forestry’s) Pesticide General Permit in October 2011, the City of Tulsa was required to formulate a Pesticide Discharge Management Plan (PDMP) as per the “Weed and Algae Control” category. The primary purpose of the PDMP is to protect water quality from abuse and misuse of pesticides. The City of Tulsa is compliant with all requirements of the PDMP and will continue to remain vigilant in their protection of waterways from pesticide misuse.



The Master Gardeners Program, available through the Oklahoma State University (OSU) Cooperative Extension Service, is a free service that offers expert advice to the

public on all aspects of gardening, including the proper application of pesticides, herbicides and fertilizers as well as other gardening and lawn care tips and information. This service is available to the public either by visiting the extension services at 4116 East 15<sup>th</sup>, accessing the website [www.tulsamastergardeners.org/](http://www.tulsamastergardeners.org/) or utilizing the telephone hotline at (918) 746-3701.

The Tulsa Master Gardeners answers approximately 100,000 garden related questions annually.



These questions are answered by volunteers trained in various horticultural issues including proper application of pesticides, herbicides and fertilizers. This program also distributes "Fact Sheets", which discuss choice of chemicals and application rates for most of the common uses of pesticides and fertilizers in urban areas. Gardening

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education is further accomplished by various media outlets including TV, radio, print, and online newsletters. This is also accomplished by numerous Home and Garden Shows throughout the year. The Master Gardener Program was also promoted through distribution of the “City Life” newsletter in September 2016 and January 2017. The City of Tulsa further promoted the Master Gardeners Program through the distribution of brochures and on the City of Tulsa’s stormwater quality website. See Attachment A for a list of brochures distributed.

In accordance with Part II(13)(5)(b) of Tulsa’s current MS4 permit, in FY 14-15, Tulsa sent a letter to 227 pesticide applicators licensed by the Oklahoma Department of Food and Forestry to apply pesticides in Tulsa County. This letter contained information on the importance of proper application of pesticides, herbicides and fertilizers, instructed to not blow grass clippings and/or leaves into the street and advised applicators that non-compliance is a violation of the City of Tulsa’s Pollution Ordinance, which could result in a fine.

Tulsa continued to maintain a website that is accessible to the public, which contains guidance for pesticide and fertilizer application for both commercial and residential applicators. This website is located at [www.cityoftulsa.org/sos](http://www.cityoftulsa.org/sos) and is regularly promoted. With increased marketing last year and this year, the number of pageviews has remained high with almost 7,000 visits.

See Part II(A)(10)(c) “Public Education” for additional public education on the proper use, storage and disposal of pesticides, herbicides and fertilizers by Tulsa during this period.

### **Part II(A)(6) Illicit Discharge and Improper Disposal**

*Status: Compliant and ongoing*

The location and removal of illicit discharges and improper disposal continued to be an important aspect of the City of Tulsa’s SWMP. Many departments within the City of Tulsa maintain various programs that involve locating and removing non-stormwater discharges to the storm sewer system and/or educating the public on proper disposal practices.

#### **a.) Non-stormwater discharges**

Tulsa allows the discharge of exempt non-stormwater discharges, as defined by 40 CFR 122.26(d)(2)(iv)(B)(1), to the storm sewer unless these discharges are determined to be contributing significant amounts of pollutants to the storm sewer. When an exempt non-stormwater discharge is found to be contributing significant amounts of pollutants to the storm sewer, enforcement action will be taken using Tulsa’s Pollution Ordinance.

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Other categories of allowable non-stormwater discharges to the MS4 are:

- Car Washing (non-commercial and charity)
- Swimming Pool / Hot Tub
- Outside Washing (pavement washing)

For the above discharges, Tulsa has established BMP's that must be implemented prior to allowing the discharge to the MS4. Failure to implement these measures may result in a violation of the Pollution Ordinance.

Discharges from emergency firefighting activities were monitored during all phases of Tulsa's firefighting activities for potential releases of pollutants. This was accomplished through the continued implementation of Tulsa's Fire Department (TFD) policies. These policies were implemented to ensure public health and safety and reduce the release of pollutants.

During this reporting period 302 investigations were conducted identifying 10 illicit discharges to the storm sewers. Tulsa's Pollution Ordinance was adopted November 1995 and continues to be utilized for the removal of non-stormwater discharges (see Section 6). This Ordinance allows the City of Tulsa to recover cleanup cost from the responsible party.

Additionally, the City of Tulsa achieves permit compliance by performing industrial stormwater inspections at City of Tulsa facilities. These inspections are performed to control pollutants that may be discharged into the MS4 system through routine operations and maintenance. These inspections focus on the proper storage of outdoor parts and materials, the condition of tanks and containers that store liquids and processes that may be conducted outdoors. As of the writing of this report, all City facilities are compliant with Permit objectives.

Once an illicit discharge was identified, the responsible party was required to stop the discharge, redirect the discharge to the sanitary sewer or obtain an OPDES wastewater discharge permit from the Oklahoma Department of Environmental Quality (ODEQ). This was accomplished through the use of the Pollution Ordinance.



Public reporting of an illicit discharge or illegal disposal by concerned citizens (via the Mayor's Action Center/Customer Care Center or directly to the Stormwater & Land Management Division), other City departments and government agencies (ODEQ or the EPA) are regularly promoted on the city's website or at educational events (see

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Attachment B). Multiple channels for reporting illicit discharges are a valuable part of the City's effort to locate illicit discharges and improper disposals. This year Stormwater Quality staff responded to 274 service requests. Dry weather field screening and dry weather flow follow-up continue to be used, resulting in the location, identification and removal of illicit discharges and improper disposals that occurred during this reporting period (see Part II(A)(6)(e)) and Part II(A)(6)(f)).

**b.) Sanitary sewer overflows**

In a continuing effort to eliminate sanitary sewer overflows during this reporting period, the City initiated four sanitary sewer manhole and/or pipeline rehabilitation projects. One sanitary sewer evaluation studies was initiated during this reporting period but no evaluation studies were completed. Excess wet weather flow to the sanitary sewer was diverted to seven flow equalization basins which reduce the amount of non-target rainwater from entering the sanitary sewer system.

The City of Tulsa's Working in Neighborhood's Department utilizes two programs that help eliminate sanitary sewer contamination of waterways. The Emergency Repair Grant consists of a \$5,000 maximum grant to very low income residents to make emergency repairs to conditions that threaten the health and safety of the occupants. Areas of service include: electrical, plumbing, roofs, heating, and sewer lines. The Rehabilitation Loan Program is a \$35,000 maximum rehabilitation loan available for moderate to very low income residents to assist citizens with home repairs, weatherization, and energy efficiency. Each residence is given a rigorous inspection to include lead based paint (LBP), electrical/mechanical/plumbing (EMP), structural, and interior repairs. Areas of service include: lead based paint, electrical, plumbing, security (doors and windows), roofs, heating, interior issues, weatherization, and sewer lines. Thirty-five sewer lines were repaired/rehabilitated under these programs in the past fiscal year.

Sewer cleaning crews specifically targeted 26.93 miles of sewer lines known for grease accumulation problems. This maintenance program reduced the likelihood of sanitary sewer backups and overflows. Emergency cleaning of 3.42 miles of sanitary sewer was also conducted to remove grease and reduce sanitary sewer overflows. Additionally, in an effort to reduce grease blockages that result in sanitary sewer overflows, Tulsa continued its grease abatement program, better known as FOG (Fats, Oils, Grease) Best Management Practices Program, for the sanitary sewer. This voluntary program encourages restaurant owners to follow best management practices that ensure proper kitchen and grease management practices. Various meetings with business owners also facilitated discussion on the proper care and maintenance for trash receptacles, grease rendering bins, and parking lots.

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As a result of the FOG BMP program the following actions took place during this reporting period:

Action	Results
<b>Businesses Inspected</b>	1,293
<b>Fog Trainings Conducted</b>	6 trainings/ 135 total attendees
<b>Businesses Participating in the FOG Program</b>	592
<b>Samples Obtained</b>	54
<b>Number of Enforcement Actions</b>	12
<b>Fines Issued</b>	\$450

Tulsa continued efforts to reduce sanitary sewer overflows into storm sewer through the use of TV inspection and smoke testing techniques. Work completed during the reporting period included:

- 169.22 miles of sanitary sewer TV inspected
- 87 sanitary manholes raised to grade
- 214 main line sanitary sewer repairs
- 19,231 feet of main line sanitary sewer replaced or rehabilitated

In addition to investigating the private sewer defects located through smoke testing, the smoke inspector program also investigates private businesses that have a history of sewer defects. These businesses include apartment complexes, nursing homes and assisted living apartments, mobile home and RV parks, office complexes, motels, hotels, hospitals, schools, and shopping centers. The following statistics are from some of these sources. For the fiscal year 2016 – 2017, the smoke inspectors investigated and closed 220 cases. Forty-nine of these cases were closed by cleanout repairs made by the inspectors.

These repairs reduced stormwater inflow to the sanitary sewer, which in turn reduced sanitary sewer overflows and illicit discharges to the stormwater sewer. Permit compliance was achieved through implementation of these programs.

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c.) Floatables

The City of Tulsa, the “Keep Oklahoma Beautiful” organization and the Metropolitan Environmental Trust (the M.e.t.) sponsor many programs that directly or indirectly target litter control. These programs include but are not limited to:

- *Annual Creek Cleanup* – Co-sponsored by Tulsa County Conservation District (TCCD) and the City of Tulsa on May 6, 2017, 40 volunteers removed litter from Dirty Butter Creek. Not only did this clean-up remove litter from the creek, it also helped to bring attention to the importance of reducing litter discharges to urban streams and waterways.
- *Earth Month* – This program throughout the month of April consisted of activities targeting the protection of resources including the reduction of litter and non-point source pollution.
- *Free Landfill Day* – Free dump days were held at the landfill on October 8-9, 2016.
- *Earth Day* – April 22, 2017 was set aside to draw attention to environmental efforts by citizens and area businesses, including reduction of litter and pollutants.

Tulsa took advantage of the opportunity to educate citizens on the importance of eliminating litter at many special events during this reporting period. Public education at these events usually involved setting up a display and handing out materials such as brochures, pencils, etc. These events included:

- The Greater Tulsa Home and Garden Show (30,000 attendees): March 9-12, 2017
- Tulsa Public Schools Earth Day Event at TU (1,600 Children): April 21, 2017
- Enviro-Expo at Bartlett Square (1,000 attendees): April 19, 2017
- Tulsa Community College EcoFest (1,500 attendees): March 25, 2017

A full list of public education activities conducted by the City of Tulsa can be found in Attachment B.

Tulsa’s exhibit booth at “The Greater Tulsa Home and Garden Show” introduced citizens to recycling, pollution prevention, proper use and disposal of fertilizers and pesticides and reminded Tulsans about the monthly curbside recycling program.

The Curbside Recycling Program continued offering every week pick-up of plastic, glass, paper, bimetals, aluminum, and other recyclables. Approximately 109,000 Tulsans participated which has resulted in the collection of approximately 20,621 tons of recyclables for this reporting period. This program is promoted on the City website.

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Environmental educational activities were conducted this year at various children’s events. These events involved 2,768 children who were educated on the importance of reducing litter, non-point source pollution and recycling through various activities. Other education activities included the use of videos, hands on landscape displays (i.e. “Enviroscape”), distribution of hand outs and material containing non-point source pollution information, hands on stream monitoring of the creeks and performing park clean-ups.

Tulsa, in conjunction with the Tulsa County Conservation District/Blue Thumb continued maintenance of its storm sewer inlet placarding program during this reporting period. The message on the placard reads “No Dumping Save



Our Streams Tulsa” or “Dump No Waste Drains to River” and has a telephone number to report violators. All new storm sewer inlets have a similar message prestamped on the hood. Therefore any placarded inlets will eventually be replaced with stamped inlets, making the placarding program obsolete.

The Metropolitan Environmental Trust (M.e.t.) continued to operate 11 recycling depots that are conveniently located throughout the metropolitan Tulsa area. Citizens can bring plastics, newspapers, glass, aluminum, batteries, cooking grease, used motor oil and antifreeze for recycling. These depots were also used for the distribution of environmental educational information, including brochures and posters at some locations addressing the reduction of litter. Additionally, the M.e.t. distributed approximately 500 car litterbags, and displayed anti-litter posters at the depots and booths throughout the year. The M.e.t. supplied trash bags and gloves for Scouts who have picked up litter. In FY 16/17, the M.e.t. provided these items for one group. In addition, the M.e.t. staff had roughly 47 educational booths, as well as gave 31 speeches to school classrooms and scouting groups on trash, recycling and litter. The M.e.t. has a recycling Bin Borrow Program for community events. The M.e.t. lent out bins to 52 events in the FY 16/17 and with their volunteers took the recycling from the event to the various M.e.t. recycling centers.

Tulsa Parks emptied 1,056 trash containers (placed at 102 parks and 15 stormwater detention sites) 1-2 times per week. Stormwater detention structures are multiple use facilities, which serve as city parks when not in use for stormwater detention. Additional trash containers were placed in parks to serve special events and scheduled activities. In addition, maintenance crews picked up loose trash from parks a minimum of once per week. Trash containers with hinged lids have replaced opened topped barrels which have resulted in a reduction of loose trash.

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The Stormwater and Land Management Division has crews that removed litter from 10 wet ponds and miles of lined and earthen channels that comprise Tulsa’s storm sewer, thus reducing the amount of floatables discharged to waters of the state.

The City of Tulsa’s Public Facilities Section continued to utilize inmate work crews to remove litter along streets and expressways throughout Tulsa in an effort to keep the city free of roadside trash and debris.

Streets within the Inner Dispersal Loop (Downtown Business District) were cleaned on a daily basis. During this cleaning, crews simultaneously removed debris from the storm sewer intake structures. Pole mounted trashcans were inspected and emptied daily as needed.



The removal of 1,547 tons of trash was accomplished by placing 30 yd<sup>3</sup> trash dumpsters 1,556 times in neighborhoods throughout Tulsa. Tulsa had approximately 17,826 requests by citizens to pick up bulky waste (appliances, white goods, furniture), of which 314 Freon bearing items were properly evacuated.

The illegal dumping program uses the visual observation efforts of various field officers and citizen reports to identify and locate dumpsites throughout the City of Tulsa. Active sites are monitored through the use of visual observation and when possible, concealed surveillance. After these activities are completed, the sites are cleaned, charted and monitored for new dump activity. These activities serve to deter the reactivation of dumping in the area and encourage the use of proper disposal methods. Signage at four routine illegal dumping locations which read “No Dumping” and describe the enforcement possible if someone were caught. Some highlights from the Solid Waste illegal dumping effort are: 210 trail camera placements, 14 police reports filed, 4 tickets issued, and 2 arrests made.

This year the Floatable Control Program located 1,324 illegal dumpsites and conducted 258 investigations of illegal dumpsites within the city limits. Dumpsite contents were from construction activities, demolitions, green waste, furniture, appliances, tires and other household items. The City of Tulsa Security Patrol also made 112 field inspections of chronic illegal dumpsites, but no arrests or tickets were given as a result of their inspections. During this fiscal year, they collected 514.54 tons of debris. This amount is an increase from last year, due to a recent increase in resources allocated toward this issue.

In addition, the City of Tulsa continued to collect and dispose of trash at its five floatable monitoring locations (see Section 4-Monitoring Data).

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**d.) Collection of used motor vehicle fluids and household hazardous wastes**

Financial support continued for the M.e.t.’s recycling depots, which accept oil, antifreeze (only 2 of the 11 locations collect antifreeze), cooking grease and batteries, as well as other recyclable materials. All depots are open 24 hours per day (attended approximately 6 to 8 hours/day), seven days per week and are located throughout the Tulsa Metro area. The amount of material collected at these depots for the reporting period can be found in the following table.

<b>Material</b>	<b>Amount</b>
<b>Oil</b>	30,140 gals.
<b>Antifreeze</b>	1,270 gals.
<b>Plastics</b>	358,555 lbs.
<b>Aluminum and Steel</b>	211,211 lbs.
<b>Glass</b>	1,034, 801 lbs.
<b>Batteries</b>	18,990 lbs. automobile 21,400 lbs. household
<b>Newspaper</b>	2,565,749 lbs. newspaper
<b>Cooking Grease</b>	2,385 gals.
<b>E-waste</b>	127,374 lbs.

The City sponsored two household pollutant collection events during this reporting period. The events took place on April 29<sup>th</sup> and May 20<sup>th</sup>. These events differed from the routine collection of household pollutants by accepting items such as medicine, ammunition, tires, and large electronics. Local radio and television news spots, utility bill stuffers, distribution of brochures, Facebook posts, Twitter, and organizational newsletters were all utilized to advertise these events.

The events were very successful with participation of 341 vehicles from Tulsa and surrounding communities resulting in the collection of the following:

<b>Material</b>	<b>Amount</b>
Tires	135 tires
Ammunition	200 lbs.
Medicine	119 lbs
Electronics	4,192 lbs.

During this collection event, educational fliers were distributed to the public. Each car

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received fliers regarding the following topics: locations of the recycling depots, latex paint disposal, grease, stormwater quality issues and alternative cleaning products.

On January 6, 2016 the City of Tulsa opened the new Household Pollutant Collection Facility at 4502 South Galveston Ave. The facility is open 2 days a week (Wednesdays and Saturdays) from 8:00am till 4:30pm. This facility replaced the biannual collection events and resulted in an easier and quicker method of pollutant disposal for Tulsans and the surrounding communities. Below is a summary of the amounts of pollutants collected this fiscal year:



Total weight collected: 97,664  
Total Tulsa customers: 1,361  
Total Met customers: 263

The following is a breakdown of the total amount of weight collected per category:

Wastestream	Amount Collected (lbs.)
Toxic Liquid	8,176
Toxic Solid	3750
Aerosols	6342
Low Viscous Flammable	6582
High Viscous Flammable	8398
Bulbs	894
Bases	4412
Acids	3392
Oxidizers	846

In addition to the above household pollutants, the facility also collected and disposed of:

- 800 gallons of used oil
- 225 gallons of antifreeze
- 4,494 lbs. of batteries
- 120 gallons of cooking oil

Through a voucher system, The M.e.t. staff answered thousands of calls the past FY16/17 year answering questions from non-Tulsa citizens on what to do with their

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pollutants. Staff has educated citizens on where to take items or handle responsibly. Staff gave out voucher numbers to citizens who live in outlying communities so the citizen is able to use the Tulsa facility at no charge (if their disposal is below 60 pounds). The charge is given to the community through a contract arrangement.

In an effort to reduce the practice of disposing of leaves and grass into the storm sewer, the Streets and Stormwater Department distributed a “Landscaping BMP” to apparent violators of Title 11-A, Ch.5, Pollution Ordinance.

Fliers titled, “Responsible Pet Ownership” and “Stormwater Quality Programs”, were distributed at events and activities during this reporting period. These flyers educated the reader on the negative aspects of not collecting and disposing of pet waste properly. These programs were also promoted on the City of Tulsa’s Stormwater Quality website.

The City of Tulsa co-sponsored the “Bark in the Park” theme night at the Tulsa Drillers baseball games as well as two Tulsa Roughneck soccer games. “Responsible Pet Ownership” flyers and pet waste bags were passed out to Tulsa area pet owners. The attendance at those games averaged 4,200 and 3,100 respectively.



In an effort to control runoff from pet waste, seven Tulsa parks have a total of 25 pet waste stations. These stations provide pet waste disposal bags to properly dispose of pet waste in the trash. The stations are checked weekly and filled as needed.

**e.) Locate and eliminate illicit discharges and improper disposal**

Dry weather field screening was conducted on approximately 36 square miles (22,581 acres) of the Tulsa’s storm sewer system during the period of July 1, 2016 to June 30, 2017. Thus compliance with this section of the permit was achieved by screening 19 % of the Tulsa’s MS4. The dry weather field screening program was designed to locate illicit discharges and illegal disposals into Tulsa’s storm sewer.



A total of 190 outfalls were screened, of which 23 contained flows during dry weather periods. Once dry weather flow was located, the flow was sampled and tested for pH, temperature, appearance, conductivity, detergents, chlorine, copper, ammonia and fluoride (See Section 4 for specific data collected during dry weather field screening). If contaminants were identified in concentrations above action levels then a dry weather flow follow-up investigation was conducted. Dry weather flow follow-up investigations continued until the source of the flow was identified. When the source of the illicit discharge was identified it was eliminated.

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The Stormwater & Land Management Division continued to conduct random industrial inspections. Inspections were conducted to achieve compliance with Part II(A)(8) Industrial and High Risk Runoff. During these inspections, inspectors were checking for illicit discharges to the MS4 or the potential for an illicit discharge. If an illicit discharge was found, action was taken to halt the discharge using the Pollution Ordinance.

As addressed in Part II(A)(6)(b), Tulsa continued efforts to reduce sanitary sewer overflows into storm sewers during this reporting period. This was accomplished through the use of TV inspections and smoke testing techniques. Work completed during the reporting period included:

- 169.22 miles of sanitary sewer TV inspected
- 2.25 miles of storm sewer TV inspected
- 87 sanitary manholes raised to grade
- 5,564 linear feet of main line storm sewer repairs
- 214 main line sanitary sewer repairs
- 19,231 feet of main line sanitary sewer replaced or rehabilitated

These repairs resulted in the reduction of stormwater inflow and infiltration into the sanitary sewer, which in turn reduced sanitary sewer overflows and illicit discharges to the storm sewer system. Rehabilitation projects supplemented Tulsa's efforts by correcting known structural storm sewer problem areas (see Part II(A)(6)(b) Sanitary Sewer Overflows).

As previously mentioned, investigation/complaint procedures currently in place continue to be very effective in locating illicit discharges and improper disposal practices during this reporting period.

**f.) Removal of illicit discharges**

Once the source of an illicit discharge was located the responsible party was required to halt the discharge, redirect the discharge to the sanitary sewer or obtain an OPDES wastewater discharge permit from the ODEQ. Ten illicit discharges were eliminated from Tulsa's MS4 during this reporting period as a result of enforcement of the Pollution Ordinance.

**g.) Maintain a list of OPDES permit holders within the City of Tulsa**

Databases are maintained for all OPDES permits for all discharges from construction, industrial activities, and OPDES wastewater discharge permittees within Tulsa. These databases include the name, address, OPDES permit number, contact person, SIC code(s) and other information. Updates were made when information became available. This information is usually obtained through inspections or ODEQ notification.

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**Part II(A)(7) Spill Prevention and Response**

*Status: Compliant and ongoing*

All agencies and City Departments responding to spills are instructed to follow the City’s Pollution Ordinance. This ordinance requires the removal of a pollutant rather than disposing to the storm sewer, unless there is an immediate threat to life and health. The Pollution Ordinance provides Stormwater and Land Management with the authority to require the responsible party to clean up the spill. This Ordinance also gives the Stormwater & Land Management Division the authority to recoup all cost incurred from the responsible party. The Stormwater & Land Management Division has authority to oversee all clean-up work involving spills within the City of Tulsa.

This requirement was achieved as delineated in a Memorandum of Agreement between the Tulsa Fire Department (TFD) Hazardous Materials Unit, the Tulsa City – County Health Department and the Streets and Stormwater Department. In accordance with Section 300 of the TFD Emergency Operation Procedures, all agencies and City departments responding to spills ensured compliance with the Pollution Ordinance by removing spilled pollutants rather than flushing it into the storm sewer, unless there was an immediate threat to public health and safety.



The TFD Haz-Mat Unit responded to incidents involving spills or possible releases of chemicals or pollutants which either had the potential to, or were discharged to the City’s sanitary or storm sewer. Whenever the TFD responded to a spill that had entered either the sanitary or storm sewer system, the Streets and Stormwater Department was notified to evaluate impact on sewer systems and coordinate remediation activities.

If the responsible party was identified, they were required to conduct the clean up or hire a remediation company. In cases involving remediation, all work was inspected to ensure a proper and thorough clean up.

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Below is a summary of the investigations conducted by the Stormwater and Land Management Division:

Number of Investigations	Description of Investigations
14	<b>Construction</b> (relating to construction site potential violations)
16	<b>Hazmat</b> (relating to potential discharges of pollutants from fire department responses involving the hazardous materials unit)
302	<b>Stormwater</b> (relating to potential releases of pollutants to the storm sewer or violations of the Pollution Ordinance)
19	<b>Drug Labs</b> (relating to the potential release of pollutants from drug lab remediation to the storm sewer or violations of the Pollution Ordinance)
351	<b>Total number of investigations for this reporting year</b>

Stormwater and Land Management inspectors conducted 286 industrial stormwater runoff inspections, each involving a discussion regarding spill prevention and management with industrial representatives.

Agreements have been put into place between Tulsa and both the Oklahoma Turnpike Authority (OTA) and the Oklahoma Department of Transportation (ODOT) that address spills that occur on OTA or ODOT MS4s within Tulsa.

**Part II(A)(8) Industrial & High Risk Runoff**

*Status: Compliant and ongoing*

Tulsa continued to use the Industrial & High Risk Runoff program to identify, monitor and control pollutants from municipal landfills; treatment, storage and disposal facilities for municipal waste; facilities subject to EPCRA (Emergency Planning and Community Right-to-know Act) Title III, Section 313 reporting requirements; and any other industrial or commercial discharge the City determined had the potential to contribute substantial pollutant loading to the City’s storm sewer system. This program contains procedures for inspecting, monitoring and controlling pollution from the aforementioned sources. A database of industrial stormwater sources discharging to the City’s storm sewer continues to be maintained.



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During this reporting period, 286 industrial stormwater inspections were conducted. Ten enforcement actions were taken against industries or facilities in order to eliminate illegal or illicit discharges. No fines were associated with these enforcement actions.

This program has also provided an opportunity to educate owners and operators of industrial or commercial facilities concerning stormwater quality regulations and requirements as per ordinances and regulations.

**Part II(A)(9) Construction Site Runoff**

*Status: Compliant and ongoing*

**a.) Structural and non-structural best management practices**

Through inspections and enforcement actions, Tulsa required construction sites to implement and maintain adequate structural and non-structural (BMPs) during this reporting period. The use and maintenance of structural and nonstructural best management practices (BMPs) to reduce pollutants discharged to the City’s storm sewer from construction sites has been achieved through control measures provided in Title 11-A, Chapter 3 (Watershed Development Regulations), Chapter 5 (Pollution Ordinance), Title 35 Infrastructure Development Process (IDP), and building permits.

During this reporting period Tulsa’s Development Services section issued:

- 1,049 Watershed Development permits, which include Earth Change permits.
- 240 Stormwater Drainage permits
- 702 Stormwater Connection permits
- 152 Floodplain permits
- 1 Floodway permit

These permits require the operator to have adequate erosion control measures in place and maintained prior to, and throughout the duration of the project until final stabilization. Prior to receiving an Earth Change permit; applicants were required to submit an NOI and storm water pollution prevention plan for all sites disturbing at least one acre. Additionally, 46 Stormwater Pollution Prevention plans were reviewed to ensure the use and maintenance of structural and nonstructural erosion control BMPs at construction sites.

**b.) Inspection and control of construction sites**

Inspection and enforcement of control measures to reduce soil erosion at construction sites is shared between several City groups (Stormwater and Land Management, Development Services and Engineering Services). Stormwater and Land Management conducted a total of 1,463 construction site inspections for compliance with erosion

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control measures and issued 29 enforcement actions. The total amount of fines and penalties collected was \$2,600.

Development Services conducted 806 soil erosion inspections at construction sites. The “Inspection Services Soil Erosion Control Program” was utilized by Development Services during this reporting period. This program defines the roles and responsibilities of building inspectors regarding erosion control at construction sites and appropriate action to be taken if construction sites are non-compliant with City Ordinance. The inspector contacts the builder and informs him/her of the actions which must be taken to come into compliance. If voluntary compliance is not achieved, the Stormwater and Land Management Division conducts follow-up inspection to ensure compliance with the Pollution Ordinance. If the site is still non-compliant appropriate enforcement action is taken. Building permits were not issued for construction sites larger than one acre until a stormwater pollution prevention plan was in place.

Engineering Services Division conducted daily inspections on 91 city and privately funded Infrastructure Development Process (IDP) projects. Implementation and continued compliance with the Pollution Ordinance was enforced. Appropriate structural and nonstructural erosion control measures were inspected during these site inspections. If the existing erosion control methods were inadequate, additional structural or nonstructural BMPs were required. Engineering Services has the authority to revoke Watershed Development Permits as a result of failure to implement and maintain adequate erosion control measures. None of these permits were revoked during this reporting period, but violations were reported to the contractors at weekly progress meetings. This resulted in corrective action leading to compliance.

**c.) Education and training of construction site operators**

The brochure “Construction Site Best Management Practices” was available to construction operators at the Permit Center. Construction operators must visit the Permit Center in order to obtain Watershed Development permits from the City of Tulsa. This brochure lists erosion and sediment controls that can be utilized at construction activities. This brochure was also available at other events (see Attachment B). There were 552 of these brochures distributed during this reporting period.

To assist local developers and builders with the use, installation and maintenance of erosion control measures, City of Tulsa representatives attended monthly Builders Council as well as Developer Council meetings held at the Greater Tulsa Home Builders Association.

Whenever a contractor was out of compliance, Field Engineering took the time to train contractors on the correct installation of erosion control measures.

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City inspectors conducting soil erosion control inspections at construction sites, informed construction site operators on aspects of use and maintenance of appropriate structural and nonstructural BMP's. Additionally, City of Tulsa supervisors answered questions regarding construction site OPDES requirements and erosion control requirements.



**d.) Building permit applicants notification**

Building permit applicants of all private developments were notified of their responsibility under the OPDES permitting program during the building permit application review process and during any pre-submittal meetings. Through the infrastructure development process (IDP), proposed developments were reviewed and applicants were notified of the OPDES erosion and sediment control requirements prior to issuing IDP project permits. The City of Tulsa offers pre-development meetings to those considering a new development within the City. These meetings are site specific and provide guidance on all requirements. Included in the discussion are the requirements for erosion control throughout the construction period and the permanent requirements to prevent stormwater pollution.

In addition, the City explains stormwater pollution including the use of Low Impact Development (LID) as an effective Best Management Practice. Utilizing the predevelopment meetings and the IDP process to open the discussion about implementing LID practices before any development has actually taken place makes successful implementation of practices more likely to occur. In addition, the City explains stormwater pollution requirements and the benefits of LID when conducting presentations or training to the development and building communities.

Developers and design engineers were provided the "OPDES General Permit for Stormwater Discharges from Construction Activities (OKR10)" information. Anyone obtaining an OPDES General Permit for Stormwater Discharges from Construction Activities (OKR10) submitted a stormwater pollution prevention plan along with an NOI, for review and approval prior to receiving an Earth Change permit. A stormwater pollution prevention plan checklist was utilized during the review process.

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**Part II(A)(10) Public Education**

*Status: Compliant and ongoing*

During FY14/15 the City of Tulsa significantly increased its public education efforts by implementing a more robust stormwater quality media campaign. The Stormwater Quality group, through a competitive bid process, collaborated with Grasshorse Studios to develop two endearing characters and a series of six commercials to help deliver stormwater quality public education messages. The characters developed were Sgt. Red, a sharp-tongued red ear slider turtle, who happens to be a drill sergeant. Sgt. Red allows no “dishonorable discharges” to the storm drain. Mingo, the orange-throat darter (a native fish to the Tulsa area that is pollution intolerant) is Sgt. Red’s friend and suffers from the effects of pollution. This campaign has been very successful and was continued during this reporting period. The below table summarizes the number of views from the commercials, in addition to the number of radio and billboard impressions during this period.

MEDIA	IMPRESSIONS (# VIEWS/LISTENS)
KOTV Ch. 6	3,140,372
KTUL Ch. 8	4,613,596
Cox Radio*	6,271,900
Billboards	127,112,474

\*Estimate based on previous FY

The City of Tulsa passes out tote bags, pens, pencils, rain gauges all with the City of Tulsa website printed on them, pet waste bags with City of Tulsa printed on them, temporary tattoos of Sgt. Red and Mingo, fishing poles with a sticker that has our SOS logo, website and phone number on it.

Tulsa and its educational partners continued to educate the public on the prevention of pollution at the source. To get the most from each educational opportunity, many public educational activities targeted multiple sources of non-point source pollution, including vehicle fluids, pesticides, herbicides, fertilizers and erosion control practices. Stormwater education material was viewed approximately 72,435,779 during the reporting period. The significant increase in this number from last reporting period is due to the implementation of the stormwater quality media campaign mentioned at the beginning of this section. A detailed description of the City of Tulsa’s public education efforts can be found in Section 6(c).

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The following groups participated in various public education events during this reporting period:

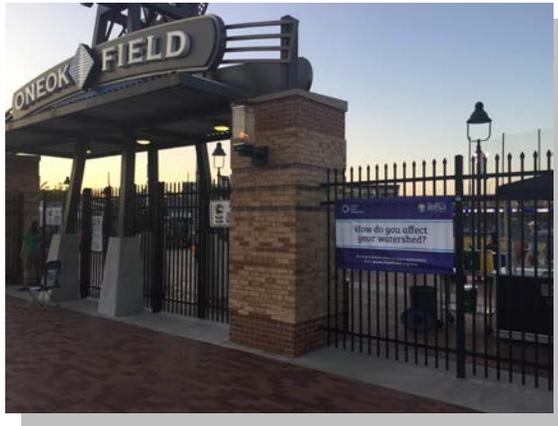
- City of Tulsa
  - Streets and Stormwater Department
  - Parks Department
  - Communications Department
  - Planning and Economic Development Department
  - Water and Sewer Department
- Tulsa County Conservation District (Blue Thumb Program)
- Metropolitan Environmental Trust (M.e.t.)

Education Activities Included:

- Displays at workshops and conferences
- Public presentations at conferences and seminars
- Presentations at local schools
- Presentations at home owners associations and neighborhood gatherings
- Creation and distribution of educational material (brochures, activity sheets, note pads, etc.) at a number of events
- Newspaper press releases and articles informing the public about environmental issues, including non-point source pollution
- Environmental awareness at numerous events (Enviro Expo, TPS Earth Day Festival, TCC Eco Fest, and Household Pollutant Collection Facility)
- Utility bill stuffer – stormwater information sent to all citizens that purchase water and sewer as well as pay utility bills to the City of Tulsa
- Billboards, TV commercials, newsletters and radio advertisements
- Handing out literature at HPCF.

See Attachment B for a full list of Educational Activities.

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During this reporting period, Tulsa continued to create and utilize existing brochures, pamphlets and handouts to meet and exceed all its public education requirements. A complete listing of this material can be found as Attachment A “Educational Material Distributed 2016-2017”. Attachment B “Education Events 2016-2017” is a complete listing of all the public education events the Stormwater Quality group participated in during this reporting period. Both these attachments can be found in the appendix of Section 6.

The Tulsa County Blue Thumb Program continued its efforts to reduce non-point source pollution. The Tulsa County Conservation District (TCCD) is involved with this Clean Water Act Section 319 funded program, which utilizes citizen volunteers. This past fiscal year, the TCCD volunteers contributed 200 hours of work to the program’s Earth Team, which includes Blue Thumb monitoring. The program’s goal is to make citizens of Tulsa aware of non-point source pollution and to encourage the adoption of practices that protect Tulsa’s streams. This program has contributed greatly to the education of the public through the organization and training of citizen watershed monitoring groups and distribution of the “Blue Thumb Fish Prints”. The Blue Thumb Program continues to collect data from area streams and uses this data to focus educational activities within the affected watersheds. This education involves informing local citizens on how to protect their streams against non-point source pollution. The TCCD continues to promote the Blue Thumb Program and encourage participation at public events, such as the Greater Tulsa Home and Garden Show and the Enviro Expo.



The Stormwater Quality group administers an electronic newsletter that is sent out to an estimated 1,905 email addresses. The newsletter is sent out a total of four times per year, in March, June, September and December which is equivalent to 9,525 contacts a year. There is also a special Spring Events newsletter sent out in April every year. Through this newsletter recipients are educated on stormwater issues such as proper

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disposal of grass clippings, businesses that are practicing Best Management Practices are recognized and stormwater quality educational events are promoted. The public is informed of ways they can help improve and maintain stormwater quality, how they can contact the City of Tulsa for more information, request personnel to come speak at an event and how to report illicit discharges. Additionally, through the newsletter, the City of Tulsa provides recognition of a Tulsa builder by the designation as the Erosion Control Builder of the Quarter'. This includes highlighting that builders good building practices to protect water quality for those downstream.

The Stormwater Quality group partners with the City of Tulsa's Working in Neighborhoods (WIN) department to further public education efforts. The WIN department has a weekly newsletter that goes out to approximately 470 neighborhood leaders and 28,500 citizens via the Nextdoor app. The Stormwater Quality group utilizes this newsletter to help spread the word about upcoming educational events and programs. Details of WIN newsletter announcements can be found in Appendix B.

**a.) Public reporting of illicit discharges and improper disposal**

Numerous publications that promote the public reporting of illicit discharges and improper disposal were created and distributed by the City of Tulsa. Regular distribution locations included Tulsa Parks and Recreation Centers. Material was also distributed at events such as the Greater Tulsa Home and Garden Show, Environmental Expo, TCC Eco Fest, and all school educational demonstrations. Last year there were 5,742 publications distributed that promote the reporting of illicit discharges and improper disposal. The following is a partial list of publications distributed:

*"Stormwater Quality Programs"* is a general brochure highlighting the current stormwater quality programs in the City of Tulsa. Also provided in the brochure are ten solutions to stormwater pollution, including the reporting of illicit discharges, and lists a telephone number and instructions on how to do so. This number is promoted all educational material distributed through our stormwater quality programs.

*"City of Tulsa – General Guide to Regulatory Floodplains"* is a map designed to guide the public through floodplain requirements within the City of Tulsa. It provides a telephone number and encourages the public to report illegal discharges into the storm sewer.

*"City of Tulsa Official 2016 Flood Notice – Flood Hazard Information About Your Property"*, are two brochures that were sent to approximately 15,828 residences that live in or near the floodplain, have the potential to experience flooding and what to do in case of flooding. It provides a contact telephone number and encourages the public to report illegal discharges into the storm sewer.

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During this reporting period, information was placed into two monthly utility bill stuffers September 2016 and January 2017 encouraging the public to report illegal discharges. These articles gave instructions on the proper procedures for reporting along with telephone numbers for the 311 Center, which is the primary method for reporting of citizen concerns. Additionally the 311 Center has ‘on hold’ messages that deliver stormwater quality information to callers. Last year 464,713 customers utilized the Customer Care Center.

Tulsa maintains a website, [www.cityoftulsa.org/sos](http://www.cityoftulsa.org/sos) that has several links to tips that promote ways to reduce stormwater runoff pollution including the public reporting of illegal discharges to the storm sewer. With increased marketing last year and this year, the number of pageviews has remained high with almost 7,000 visits. While conducting inspections, City of Tulsa personnel continued to instruct citizens, business owners or operators to report any unusual discharge into the City’s storm sewer immediately.

Tulsa’s annual Creek Cleanup was co-sponsored by Tulsa County Conservation District (TCCD) and the City of Tulsa on May 6, 2017. Forty volunteers removed litter from Dirty Butter Creek. Not only did this clean-up remove litter from the creek, it also helped to bring attention to the importance of reducing litter discharges to urban streams and waterways.

As a result of public awareness of the reporting of illicit discharges and improper disposal, 302 investigations were conducted involving the identification and removal of 10 illicit discharges to the storm sewer during this reporting period.

**b.) Proper management and disposal of used motor vehicle fluids and household hazardous wastes**

Public education in the proper management and disposal of used motor vehicle fluids and household hazardous wastes was accomplished through various methods. These methods include the distribution of the following educational material:

*“Motor Oil”* is a brochure distributed during this reporting period that targeted the proper use, storage and disposal of motor oil.

*“Stormwater Quality Programs”* is a brochure given to the public detailing our stormwater quality programs. Included in the brochure is information on the adverse effects of household chemicals on the environment as well as instructions on how to dispose of chemicals properly.

*“City of Tulsa 2016 Official Flood Notice”* and *“Flood Hazard Information”* are two brochures that were sent to approximately 15,828 residences that have the

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potential to experience flooding and what to do in case of flooding. It also encourages the public to dispose of used motor oil and antifreeze properly.

*“City of Tulsa – General Guide to Regulatory Floodplains”* is a map designed to guide the public through floodplain requirements within the City of Tulsa. It provides a telephone number and encourages the public to report illegal discharges into the storm sewer.

On January 6, 2016, the City of Tulsa opened the new Household Pollutant Collection Facility at 4502 South Galveston Ave. The facility is open 2 days a week (Wednesdays and Saturdays) from 8:00 am till 4:30 pm. See Part II(A)(6)(d) for a summary of the pollutants collected this year.

The following is a list of some of the events where material was distributed to the public:

Educational Events	
Enviro Expo	STEM Alliance
Tulsa State Fair	Household Pollutant Collection Event
Greater Tulsa Home and Garden Show	TPS Earth Day Event

Currently, The M.e.t. has 11 drop-off recycling depots with collection containers for used motor oil, cooking grease and batteries. Two of the eleven locations have containers for antifreeze collections. The “Recycling Locations” map flier and the “Tulsa Area Recycling Directory” both provide locations to the depots. These handouts are given during speeches, booths and events. The website, [www.metrecycle.com](http://www.metrecycle.com) promotes the event (now Household Pollutant Collection Facility) and depots. Fliers are distributed at booths, speeches and events throughout the year (see list below).

The following is a list detailing the quantity of materials the M.e.t. distributed:

- Tulsa area Recycling Directory: 2,000
- Buy Recycled, Close the Loop: 25
- Latex Paint and the Environment: 1,000
- Don’t Flush Your Unused Medications Down the Toilet or the Frog Gets It: 50
- Deep Green Clean (cleaning alternatives): 400
- Recycling Locations Map: 2,000
- Focus on the Four: 500
- City of Tulsa Household Pollutant Collection Facility: 500
- Backyard Composting: 500

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The revised specifications for new storm sewer inlet hoods include the message “Dump No Waste, Drains to River”. These specifications were accepted by the City of Tulsa and the new inlet hoods have been obtained. As a result, all new or repaired catch basins will now have the message permanently cast into the hood therefore not requiring a placard.

Public education was conducted at Tulsa Parks, Tulsa Public Schools, Union Public Schools, the YMCA, Community Action Project, and STEM Alliance involving approximately 2,768 children. Activities included videos, handouts, demonstrations and arts and craft. More details about this program can be found on Attachment C in the appendix of Section 6.

Public education and outreach in the proper management and disposal of household grease waste was accomplished through the City of Tulsa’s FOG grease abatement program. Through this program 3,605 FOG BMP door hangers and 3,945 apartment packets (can toppers, grease bags, FOG BMP literature) were handed to residents involved in grease-related sewer blockage/overflow investigations. The FOG program ran television commercials highlighting the importance of proper household grease disposal through the trash rather than through the sanitary sewer.

The commercials were aired on the following television networks.

Television Network	Frequency (# times aired)	Impressions (# views)
KOTV Channel 6	206	1,067,000
KJRH Channel 2	119	545,000 100,000 (desktop & mobile)
KTUL Channel 8	36	277,048
Cox Cable	130	45,272
FOX 23	62	601,000

In addition to television, the FOG program ran radio advertisements 88 times on Scripps Radio stations (KBEZ-FM and KHTT-FM) for a total of 181,100 impressions. AM 740 KRMG ran the FOG commercial 98 times for a total of 695,000 impressions.

The FOG program increases residential educational activities during the holiday months to prevent residential grease



Section 1 – Status of Implementing the Stormwater Management Program

blockages due to holiday cooking activities. This year these activities included ‘Trap the Grease’ booths at two area grocery store locations distributing grease related promotional items with a total of around 200 participants. Also, a fryer oil collection event was held which collected 93 gallons of fryer oil for proper disposal from 16 participants.

**c.) Proper use, application and disposal of pesticides, herbicides and fertilizers**

The responsibility of educating the public on the proper use, application and disposal of pesticides, herbicides and fertilizers was accomplished through the distribution of educational material (brochures, bookmarks, notepads, bumper stickers, etc.), public speaking engagements, and utility bill stuffers. The following section lists some of the materials and activities used to comply with this requirement. An extensive list along with the number of pamphlets distributed can be found in Appendix A and B of Section 6.

*“Fertilizers” and “Pesticides”* are two brochures which emphasize the proper application and disposal for the use of pesticides and fertilizers. It also lists alternatives to chemicals to control pests and fertilize lawns.

*“Stormwater Quality Programs”* is a brochure given to the public detailing our stormwater quality programs. Included in the brochure is information on the adverse effects of pesticides and fertilizers on the environment as well as instructions on how to dispose of them properly.

*“Pollution Prevention Plan”* is a Best Management Practice (BMP) created to guide citizens to do their part to keep our storm sewer clean. It addresses a number of pollutants including but not limited to fertilizers, herbicides and pesticides.

The Master Gardeners Program sponsored by Oklahoma State University - Tulsa Cooperative Extension Office maintains a telephone information service for the public regarding all aspects of gardening and landscaping, including the proper application and disposal of pesticides, herbicides and fertilizers. This service is offered five days a week, between 9 a.m. and 4 p.m. and has numerous brochures available to the public. See Part II (A) (5) “Pesticide, Herbicide and Fertilizer Application” for more information about this program. This program was publicized by Tulsa through the distribution of the *“Fertilizers”* brochure. OSU provided additional advertising through various means.

The TCCD’s Blue Thumb Program continued to stress the importance of the proper application and disposal of pesticides, herbicides and fertilizers in their presentations to schools, conferences, educational activities and expositions. Speakers from this program conveyed the detrimental impacts to water quality from misuse and improper disposal.

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The City of Tulsa requires all City personnel, as well as all City contractors that apply pesticides and herbicides to be licensed and subject to all the regulations under the Oklahoma Pesticide Applicators Law, including re-certification. City personnel that apply pesticides, herbicides and fertilizers received annual in-house training on specific types of pesticides, herbicides and fertilizers that are applied. When available, employees attended workshops, conferences and additional training on pesticides, herbicides and fertilizers application and disposal. The Tulsa Parks Department received training in October and December of 2016. The City of Tulsa's Stormwater and Land Management Division received training many times throughout the fiscal year.

Tulsa's website contains guidance for pesticide and fertilizers application for both commercial and residential applicators. This website is located at [www.cityoftulsa.org/sos](http://www.cityoftulsa.org/sos) and is regularly promoted.

**Part II(A)(11) Employee Education**

*Status: Compliant and ongoing*

Presentations were made to personnel from Water Distribution, Water Dept. Mainline, Development Services, Stormwater and Land Management, and Solid Waste on their responsibilities at facilities and job sites. Open discussion followed the presentation where information was exchanged resulting in program improvement.

All new employees at the City of Tulsa are required to attend new employee orientation. Stormwater quality information including how to report illicit discharges and what they can do as a City of Tulsa employee is placed in the information they receive during this orientation. Two hundred and ninety non-sworn employees were hired by the city in the FY 16/17.

City of Tulsa Stormwater and Land Management personnel attended an EPA MS4 Region 6 Stormwater Conference in Oklahoma City, OK on October 3-6, 2016. The conference featured presentations on stormwater management including topics on low impact development and green infrastructure, TMDLs, construction and industrial stormwater and stormwater programs and training.

All City of Tulsa contractors as well as all employees that are required to apply pesticides, herbicides and fertilizers are required to be licensed under the Oklahoma Pesticide Applicators Law. In-house training regarding the application of various chemicals was conducted for city applicators during this reporting period. See Part II (A) (5) Pesticide, Herbicide, and Fertilizer Application.

City contractors responsible for herbicide, pesticide and fertilizer application, as well as landscape specialists and other lawn care providers were specifically educated on the proper use of chemicals, disposal thereof and spill prevention procedures. The City of

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Tulsa requires all contract applicators to be licensed under the Oklahoma Combined Pesticide Law and Rules (Title 2 of the Oklahoma Statutes). This license requires each applicator to properly apply, dispose and address spills in an environmentally friendly manner.

During this reporting period, Tulsa began the Stormwater Operators Certification program. This program targeted labor and trade employees within the Streets and Stormwater Department with the goal of certifying employees as operators of Tulsa’s MS4. Employees were provided information specific to Tulsa’s storm sewer through 8 hours of classroom and field training. This training was focused on the MS4 permit, nonpoint source pollutants, water quality concerns, how to recognize illegal discharges, as well as ordinances, Stormwater funding, etc. Employees were certified only after they demonstrated good knowledge by passing a written test with a minimum of a score of 70.

**Part II(A)(12) Monitoring Programs**

*Status: Compliant and ongoing*

**a.) Dry weather field screening program**

The dry weather field screening program continued during this reporting period. The details of this program are previously mentioned in Part II (A) (6) (e).

**b.) Watershed characterization program**

See Section 4

**c.) Industrial and high risk runoff**

The following table is a list of facilities classified under the SWMP as “Industrial and High Risk Runoff”. This designation requires them to conduct self monitoring of their stormwater runoff. A summary of the number of industries that conducted monitoring during the permit life are as follows:

## Section 1 – Status of Implementing the Stormwater Management Program

<b>I&amp;HRR Facility Categories</b>	<b># of facilities identified</b>	<b># conducting monitoring</b>
Municipal landfills	<b>1</b>	<b>0</b>
Other treatment, storage and disposal facilities of municipal waste (e.g. transfer stations, incinerators, etc.)	<b>2</b>	<b>0</b>
Hazardous waste treatment, storage, disposal and recovery facilities	<b>4</b>	<b>0</b>
Facilities that are subject to EPCRA Title III, Section 313	<b>44</b>	<b>0</b>
Industrial or commercial discharges the permittee determines are contributing a substantial pollutant loading to the MS4.	<b>8</b>	<b>1</b>

Letters informing industries of their responsibility to conduct monitoring were sent out at the end of FY 13-14. All monitoring results were required to be submitted to the Stormwater and Land Management Division within one year. All monitoring results were reviewed and placed in the industry's activity file. Additional information regarding this program can be found at Part II (A) (8) Industrial & High Risk Runoff.

#### **Legal Authority**

The City of Tulsa utilizes several Ordinances to ensure compliance with OPDES Permit #OKS000201. The following is a list of the most commonly used Ordinances accompanied by a brief description.

**Title 11-A Chapter 3 (Watershed Development Regulations)** – This Ordinance allows for the regulation of the methods for handling and disposing of stormwater run-off; the development, excavation, grading, regrading, paving, land filling, berming and diking of land; allows for the regulation of development within flood plains in order to assure that development is not dangerous to health, safety or property due to stormwater run-off; and allows for the regulation of the connection to and use of the stormwater drainage system. Through this Ordinance, Tulsa permits construction activities that are one acre or greater.

**Title 11-A, Chapter 5 (Pollution)** – This Ordinance was adopted in November of 1995 in order to give Tulsa the legal authority needed to comply with all of the municipal separate storm sewer system discharge permit requirements that were not covered by existing Ordinances. It prohibits illicit discharges to the storm sewer; allows for the control and monitoring of stormwater runoff; provides Tulsa with the legal means to inspect and investigate potential sources of pollution to the storm sewer; and contains judicial enforcement remedies. This Ordinance was revised during 2006-2007 reporting period to include provision for recovery of cost incurred by Tulsa against violators of this Ordinance. Maximum amount of fines per violation per day is \$1,000.00.

**Title 11-C, Chapter 12 (Requirements For Industrial Users To Discharge To The Sanitary Sewer Systems)** – This Ordinance provides general sewer use requirements; allows for wastewater

Section 1 – Status of Implementing the Stormwater Management Program

discharge permit issuance and inspection of all industries that discharge to the sanitary sewer; prohibit the inflow of stormwater into the sanitary sewer system; and contains judicial enforcement remedies.

**Title 24, Chapters 1 and 2 (Nuisances)** - These Ordinances provides for abatement of nuisances, including litter, industrial wastes, sewage, etc. from any area lake, basin, public park, alley, highway or street through enforcement actions including total cost recovery to the City of Tulsa from the any person, firm corporation, partnership, or other legal entity who commits or who permits the creation or continuation of a nuisance.

**Title 42, Chapter 11 (Planned Unit Development)** – This ordinance encourages innovative land development while maintaining appropriate limitation on the character and intensity of use and assuring compatibility with adjoining and proximate properties. It also promotes greater flexibility within the development to best utilize the unique physical features of a particular site. Creative land use design and open space preservation are also promoted in this Ordinance. Further, the final purpose of this Ordinance is to achieve a continuity of function and design within the development.

## **Section 2**

### **Proposed Changes to the Stormwater Management Program**

The City of Tulsa is currently in the process of negotiating a renewal of Permit OKS000201. The permit changes the City of Tulsa is recommending are aimed to improve the performance of the Stormwater Management Program. Any changes made in the requirements of the permit during the negotiation process will be incorporated into the SWMP within 6 months of effective date of the final permit. This requirement is in accordance with Tulsa's MS4 Permit OKS000201 Part III(A)(1).

### **Section 3**

**Revisions, if necessary, to the assessment of controls and the fiscal analysis reported in the permit application under OAC 252.606-1-3(b)(3)(L) adopting and incorporating by reference 40 CFR 122.26(d)(2)(iv) and (d)(2)(v)**

No revisions to the “Controls” have been made during this reporting period.

## Section 4

### A Summary of the Data/Monitoring Data Accumulated Throughout the Reporting Year

To comply with the permit, individual programs were created or adopted and then implemented. Implementation resulted in the creation of databases that track dry weather field screening and floatables monitoring. Data was collected during this reporting period, reviewed for accuracy and completeness and then entered into specific databases. Each program is explained in the following paragraphs along with associated data.

#### Dry Weather Field Screening

Dry weather field screening was continued during this reporting period in an ongoing effort to detect the presence of illicit connections and improper disposal. One hundred ninety outfalls were screened, covering approximately 24,073 acres (36 square miles). Of the 190 outfalls screened, 23 contained dry weather flow. Once dry weather flow was located, the flow was sampled and tested for pH, temperature, appearance, conductivity, detergents, chlorine, copper, ammonia and fluoride. If contaminants were identified in concentrations above action levels, then dry weather flow follow-up activities were implemented. Dry weather flow follow-up procedures continued until the source was identified. When an illicit discharge was identified, it was eliminated. Specific numbers for this reporting period are as follows:

<b>Total # of outfalls screened</b>	<b>190</b>
<b>Total area screened</b>	24,073 acres 36 sq. mi.
<b># of outfalls that did not require follow-up (without flow)</b>	167
<b># of outfalls with dry weather flows not requiring follow-up (flows present but pollutant concentration below action levels)</b>	20
<b># of outfalls requiring dry weather flow follow-up (flow with concentrations of pollutants above the action levels)</b>	3

#### Floatable Monitoring Summary

Data was obtained from five floatable monitoring locations. Inspections were performed after rainfall events (> 0.1 in.) during this reporting period. If floatables were present during an inspection, they were collected and data was gathered regarding the quantity in cubic yards and make-up in percent (organic and inorganic). A summary of the data is as follows:

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Section 4 – Summary of the Data

<b>Fire Station Floating Monitoring Summary</b>				
Station: 4800 W. 8th St.				
<b>Date</b>	<b>Floatables Present</b>	<b>Collection (Cubic Yards)</b>	<b>% Organic</b>	<b>% Inorganic</b>
7/6/16	No	0	0%	0%
7/19/16	yes	1.1	100%	0%
7/27/16	no	0	0%	0%
7/30/16	no	0	0%	0%
8/9/16	yes	20	75%	25%
8/25/16	no	0	0%	0%
8/30/16	no	0	0%	0%
8/31/16	yes	0.25	70%	30%
9/9/16	yes	0.2	100%	0%
9/23/16	yes	1	90%	10%
9/27/16	yes	2	90%	10%
10/5/16	no	0	0%	0%
10/7/16	yes	1	80%	20%
11/1/16	no	0	0%	0%
11/8/16	yes	2	80%	20%
11/29/16	yes	0.5	100%	0%
12/29/16	no	0	0%	0%
1/18/2017	yes	0.75	50%	50%
1/24/2017	yes	1.75	90%	10%
2/16/17	yes	0.5	80%	20%
2/21/17	yes	0.5	50%	50%
3/7/17	yes	2	80%	20%
3/14/17	no	0	0%	0%
3/28/17	yes	0.5	90%	10%
3/30/17	yes	0.5	80%	20%
4/4/2017	yes	0.25	80%	20%
4/7/17	no	0	0%	0%
4/18/18	yes	0.25	80%	20%
4/25/17	yes	2	50%	50%
4/26/2017	yes	0.5	80%	20%
5/2/17	yes	0.5	50%	50%
5/4/17	yes	0.25	80%	20%
5/16/17	yes	0.5	80%	20%
5/17/17	yes	0.25	80%	20%
5/23/17	no	0	0%	0%
6/16/17	no	0	0%	0%
6/20/17	no	0	0%	0%
6/30/2017	no	0	0%	0%
Total Cubic Yards Collected...				
39.05				
Average Floatable make-up (%) .....			75%	25%

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<b>Osage Detention Floating Monitoring Summary</b>				
Station: 1101 West Pine Street				
<b>Date</b>	<b>Floatables Present</b>	<b>Collection (Cubic Yards)</b>	<b>% Organic</b>	<b>% Inorganic</b>
7/6/16	No	0	0%	0%
7/19/16	yes	3	100%	0%
7/27/16	yes	7	60%	40%
7/30/16	no	0	0%	0%
8/9/16	yes	4	75%	25%
8/25/16	no	0	0%	0%
8/30/16	no	0	0%	0%
8/31/16	no	0	0%	0%
9/9/16	yes	0.5	100%	0%
9/23/16	yes	2	70%	30%
9/27/16	no	0	0%	0%
10/5/16	yes	0.5	90%	10%
10/7/16	yes	3	80%	20%
11/1/16	No	0	0%	0%
11/8/16	yes	2	90%	10%
11/29/16	yes	0.75	70%	30%
12/29/2016	no	0	0%	0%
1/18/2017	yes	0.5	100%	0%
1/24/17	yes	13	80%	20%
2/16/17	yes	0.5	90%	10%
2/21/17	no	0	0%	0%
3/7/17	no	0	0%	0%
3/14/17	no	0	0%	0%
3/28/17	no	0	0%	0%
3/30/17	yes	1	90%	10%
4/4/17	no	0	0%	0%
4/7/17	no	0	0%	0%
4/18/17	yes	0.75	90%	10%
4/25/17	yes	13	80%	20%
4/26/17	yes	1	90%	10%
5/2/17	yes	1	90%	10%
5/4/17	no	0	0%	0%
5/16/17	no	0	0%	0%
5/17/17	no	0	0%	0%
5/23/17	no	0	0%	0%
6/16/17	yes	0.5	100%	0%
6/20/17	no	0	0%	0%
6/30/17	no	0	0%	0%
Total Cubic Yards Collected...		54		
Average Floatable make-up (%) .....			85%	15%

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<b>Reed Park Floating Monitoring Summary</b>				
Station: 4200 S. Union Ave.				
<b>Date</b>	<b>Floatables Present</b>	<b>Collection (Cubic Yards)</b>	<b>% Organic</b>	<b>% Inorganic</b>
7/6/16	Yes	0.1	100%	0%
7/19/16	yes	1.3	100%	0%
7/27/16	no	0	0%	0%
7/30/16	no	0	0%	0%
8/9/16	yes	2	95%	5%
8/25/16	no	0	0%	0%
8/30/16	no	0	0%	0%
8/31/16	no	0	0%	0%
9/9/16	yes	0.4	90%	10%
9/23/16	no	0	0%	0%
9/27/16	no	0	0%	0%
10/5/16	Yes	0.3	100%	0%
10/7/16	Yes	1	100%	0%
11/1/16	no	0	0%	0%
11/8/16	Yes	4	90%	10%
11/29/16	Yes	0.25	90%	10%
12/29/16	Yes	3	95%	5%
1/18/2017	Yes	1	90%	10%
1/24/2017	no	0	0%	0%
2/16/17	yes	0.25	90%	10%
2/21/17	no	0	0%	0%
3/7/17	yes	0.25	95%	5%
3/14/17	no	0	0%	0%
3/28/17	no	0	0%	0%
3/30/17	no	0	0%	0%
4/4/17	no	0	0%	0%
4/7/17	no	0	0%	0%
4/18/17	no	0	0%	0%
4/25/17	no	0	0%	0%
4/26/17	no	0	0%	0%
5/2/17	no	0	0%	0%
5/4/17	no	0	0%	0%
5/16/17	no	0	0%	0%
5/17/17	Yes	0.25	100%	0%
5/23/17	no	0	0%	0%
6/16/17	no	0	0%	0%
6/20/17	no	0	0%	0%
6/30/17	no	0	0%	0%
Total Cubic Yards Collected... 14.1				
Average Floatable make-up (%) .....			95%	5%

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Section 4 – Summary of the Data

<b>Sheridan Park Floating Monitoring Summary</b>				
Station: 10400 South 67th East Avenue				
<b>Date</b>	<b>Floatables Present</b>	<b>Collection (Cubic Yards)</b>	<b>% Organic</b>	<b>% Inorganic</b>
7/6/16	Yes	0.1	100%	0%
7/19/16	yes	1.5	90%	10%
7/27/16	yes	2	80%	20%
7/30/16	no	0	0%	0%
8/9/16	yes	0.5	100%	0%
8/25/16	yes	0.25	100%	0%
8/30/16	no	0	0%	0%
8/31/16	yes	0.5	90%	10%
9/9/16	no	0	0%	0%
9/23/16	yes	1.5	90%	10%
9/27/16	Yes	0.25	80%	20%
10/5/16	Yes	6	90%	10%
10/7/16	Yes	0.25	50%	50%
11/1/16	Yes	2	50%	50%
11/8/16	Yes	0.5	100%	0%
11/29/16	Yes	0.5	90%	10%
12/29/16	Yes	0.25	100%	0%
1/18/2017	Yes	1.5	90%	10%
1/24/17	no	0	0%	0%
2/16/17	Yes	0.75	100%	0%
2/21/17	yes	0.5	100%	0%
3/7/17	yes	1	100%	0%
3/14/17	yes	2	90%	10%
3/28/17	no	0	0%	0%
3/30/17	yes	0.5	80%	20%
4/4/17	yes	0.25	80%	20%
4/7/17	no	0	0%	0%
4/18/17	Yes	1.5	80%	20%
4/25/17	yes	1	90%	10%
4/26/17	yes	0.25	100%	0%
5/2/17	no	0	0%	0%
5/4/17	no	0	0%	0%
5/16/17	Yes	1.25	80%	20%
5/17/17	yes	0.25	80%	20%
6/16/17	yes	1.25	100%	0%
6/20/17	no	0	0%	0%
6/30/2017	Yes	0.25	90%	10%
Total Cubic Yards Collected... 28.35				
Average Floatable make-up (%) .....			85%	15%

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Section 4 – Summary of the Data

<b>Vensel Creek Floating Monitoring Summary</b>				
Station: 11100 S. Yale Ave.				
<b>Date</b>	<b>Floatables Present</b>	<b>Collection (Cubic Yards)</b>	<b>% Organic</b>	<b>% Inorganic</b>
7/6/16	Yes	0.3	80%	20%
7/19/16	no	0	0%	0%
7/27/16	yes	2	90%	10%
7/30/16	yes	1	90%	10%
8/9/16	yes	0.25	100%	0%
8/25/16	yes	0.5	90%	10%
8/30/16	Yes	0.3	90%	10%
8/31/16	yes	0.25	100%	0%
9/9/16	yes	0.25	90%	10%
9/23/16	no	0	0%	0%
9/27/16	Yes	0.5	90%	10%
10/5/16	Yes	2	60%	40%
10/7/16	Yes	0.25	100%	0%
11/1/16	Yes	0.5	100%	0%
11/8/16	Yes	0.25	100%	0%
11/29/16	Yes	0.25	100%	0%
12/29/2016	Yes	0.5	90%	10%
1/18/17	Yes	1	100%	0%
1/24/17	no	0	0%	0%
2/16/17	yes	0.35	80%	20%
2/21/17	yes	0.25	90%	10%
3/7/17	yes	0.5	90%	10%
3/14/17	no	0	0%	0%
3/28/17	no	0	0%	0%
3/30/17	yes	1	80%	20%
4/4/17	no	0	0%	0%
4/7/17	Yes	1.25	90%	10%
4/18/17	Yes	1	90%	10%
4/25/17	Yes	0.5	90%	10%
4/26/17	Yes	0.5	90%	10%
5/2/17	Yes	0.25	90%	10%
5/4/17	no	0	0%	0%
5/16/17	Yes	1	90%	10%
5/17/17	yes	0.25	90%	10%
6/16/17	yes	0.5	95%	5%
6/20/17	Yes	0.5	80%	20%
6/30/17	yes	0.25	80%	20%
Total Cubic Yards Collected...		18.2		
Average Floatable make-up (%) .....			90%	10%

## **Watershed Characterization - Stream Monitoring Reports**



CITY OF  
**Tulsa**  
A New Kind of *Energy*™



**Save  
Our  
Streams**

## **CITY OF TULSA WATERSHED CHARACTERIZATION PROGRAM**

**Comprehensive Watershed Characterization  
Assessment Year 1 (2016-2017):**

### **CROW CREEK**

City of Tulsa Streets and Stormwater  
Stormwater and Land Management Division  
4502 South Galveston  
Tulsa, OK 74107

Prepared by

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Senior Environmental Monitoring Technician  
Watershed Characterization Project

**September 19, 2017**

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## 1.0 INTRODUCTION

### 1.1 Objective

The purpose of this document is to serve as a comprehensive report of results from the biological, habitat, and analytical assessments of Crow Creek. These assessments were performed in order to comply with requirements set forth in Part II(A)(13)(12)(b) and (13)(a) and (b) and Part IV(A)(1) and (2) of Oklahoma Pollutant Discharge Elimination System (OPDES) municipal stormwater (MS4) Permit No. OKS000201 for the City of Tulsa, Oklahoma (ODEQ, OPDES Permit OKS000201, 2011). In addition, assessment results are applied to Oklahoma Water Quality Standards. These standards are described in both (OWRB, 2013a) and (OWRB, 2013b). Where applicable, reference conditions will not be established until the conclusion of the current permit. Until such references are established, those standards will result in an “insufficient data” designation with regards to support within the Fish and Wildlife propagation beneficial use. While these implementations describe a multitude of surface water quality standards, this document will compare and describe only the standards applicable to the parameters required in the Watershed Characterization Program sub section of the Municipal Separate Storm Sewer System permit (ODEQ, OPDES Permit OKS000201, 2011). All remaining parameter results without applicable water quality standards will still be included in this report.

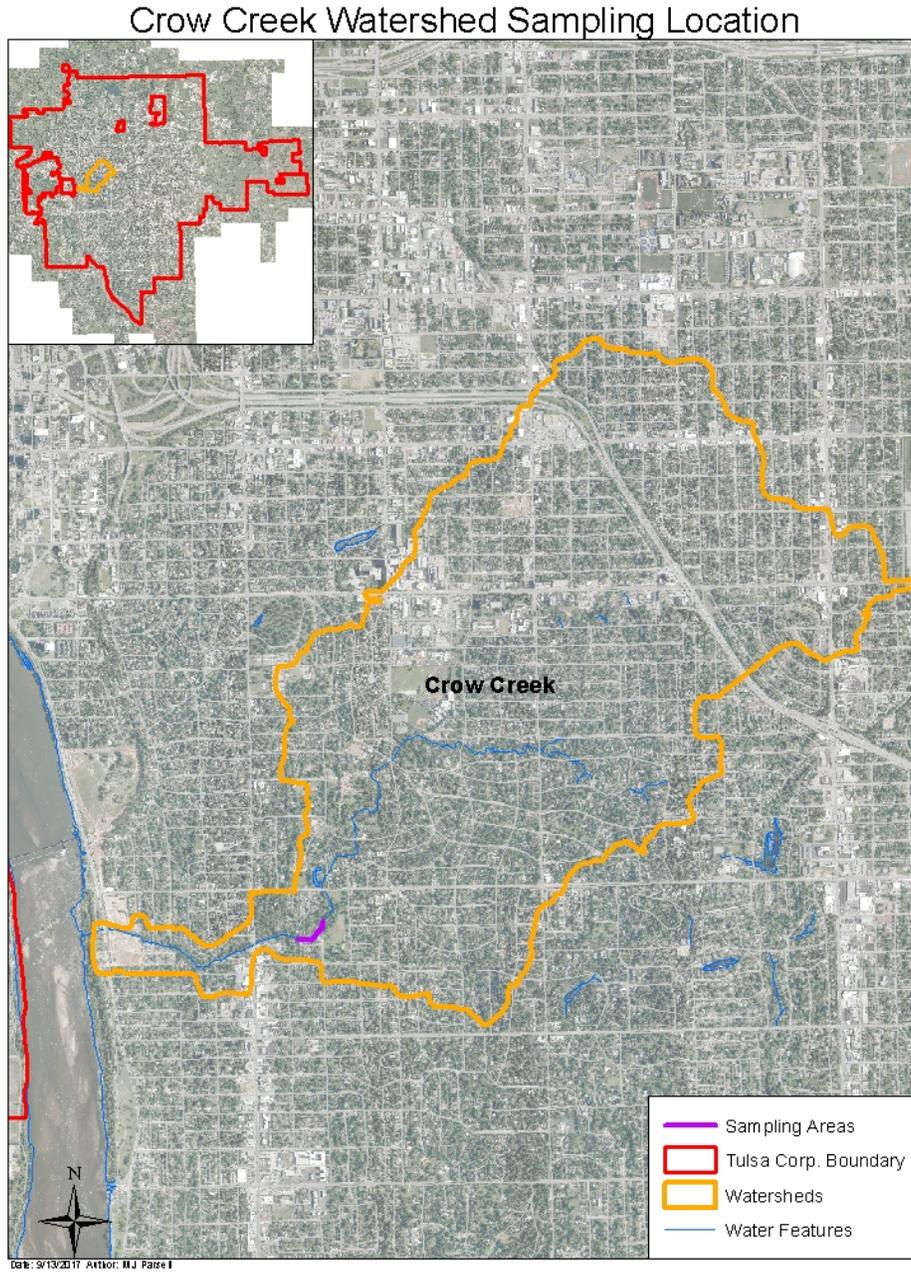
The data presented in this comprehensive report was collected over a one year period beginning in July of 2016 with completion in June of 2017. Field collection and assessment methodology followed project standard operating procedures (SOPs) as provided in the quality assurance project plans (QAPPs) for the biological component (CCRC & FTN, 2014) and the analytical component (CCRC & FTN, 2014). These QAPPs provide quality assurance and quality control procedures for all aspects of the watershed characterization program. They were submitted to and received approval from the Oklahoma Department of Environmental Quality as per MS4 permit requirements. All field data sheets were scanned electronically and archived at the City of Tulsa Stormwater and Land Management Division. All field measurements (in situ measurements, flows, observations), biological information (taxonomic identification, organism counts), and analytical results were compiled in Excel spreadsheets and verified (data entry, formula calculations) per project QA/QC procedures (CCRC & FTN, 2014) (CCRC & FTN, 2014). All raw data, SOPs, and QAPPs are available upon request.

**Crow Creek**  
**WBID: OK120420010090\_00**

Figure 1 - Sampling location on Crow Creek during Year 1

Waterbody	Sample Location		Watershed Area (mi <sup>2</sup> )*	Sampling/Evaluation Date			
	Latitude	Longitude		Fish	Benthic (Summer)	Benthic (Winter)	Habitat
Crow Creek	36.116401	-95.981791	2.51	08/05/2016	06/28/2016	02/08/2017	09/27/2016

\* Collection area captured by sampling point



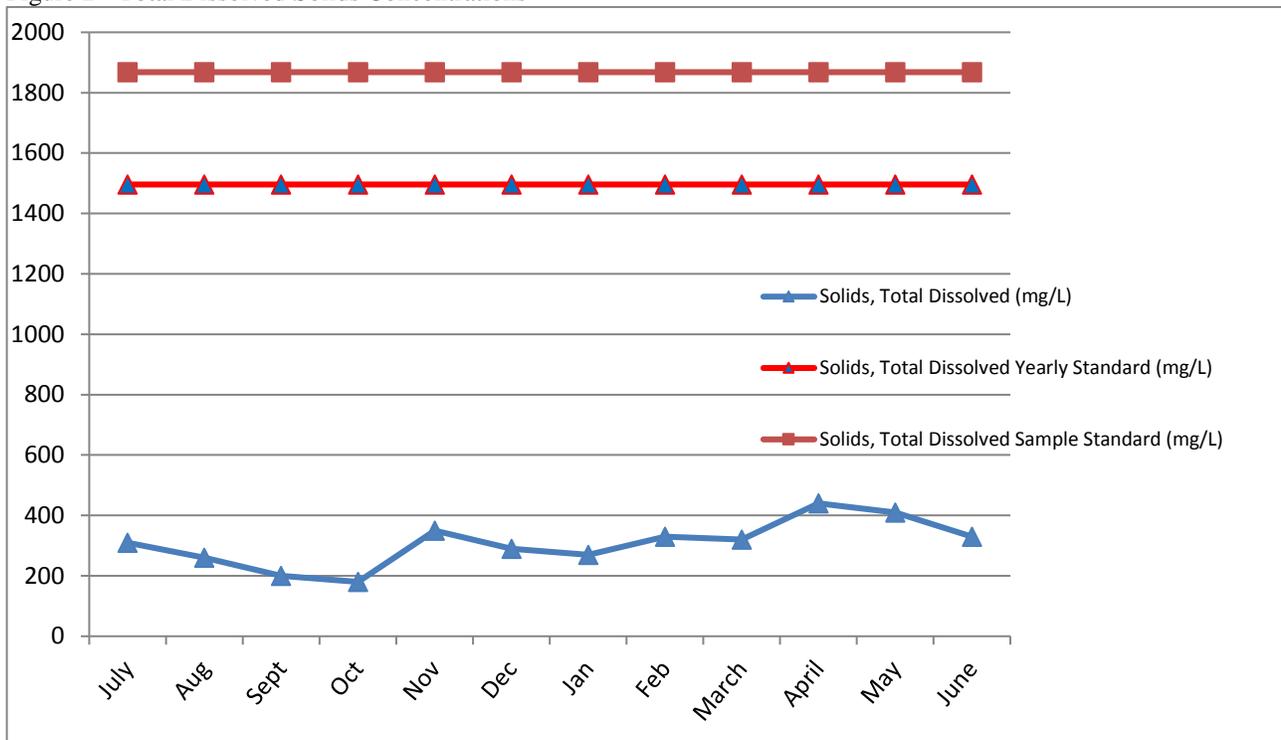
## 2.0 BENEFICIAL USES

**2.1 Agriculture** – Data collected on Total Dissolved Solids for Crow Creek indicates attainment of the agricultural beneficial use. The number of samples collected exceeds the number of samples required. The sample mean does not exceed the yearly standard and none of the samples exceeded the sample standard.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Dissolved Solids	308	440	Sample: 1868, Yearly: 1496	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard

Table 1 – Agriculture standards for Crow Creek

Figure 2 - Total Dissolved Solids Concentrations



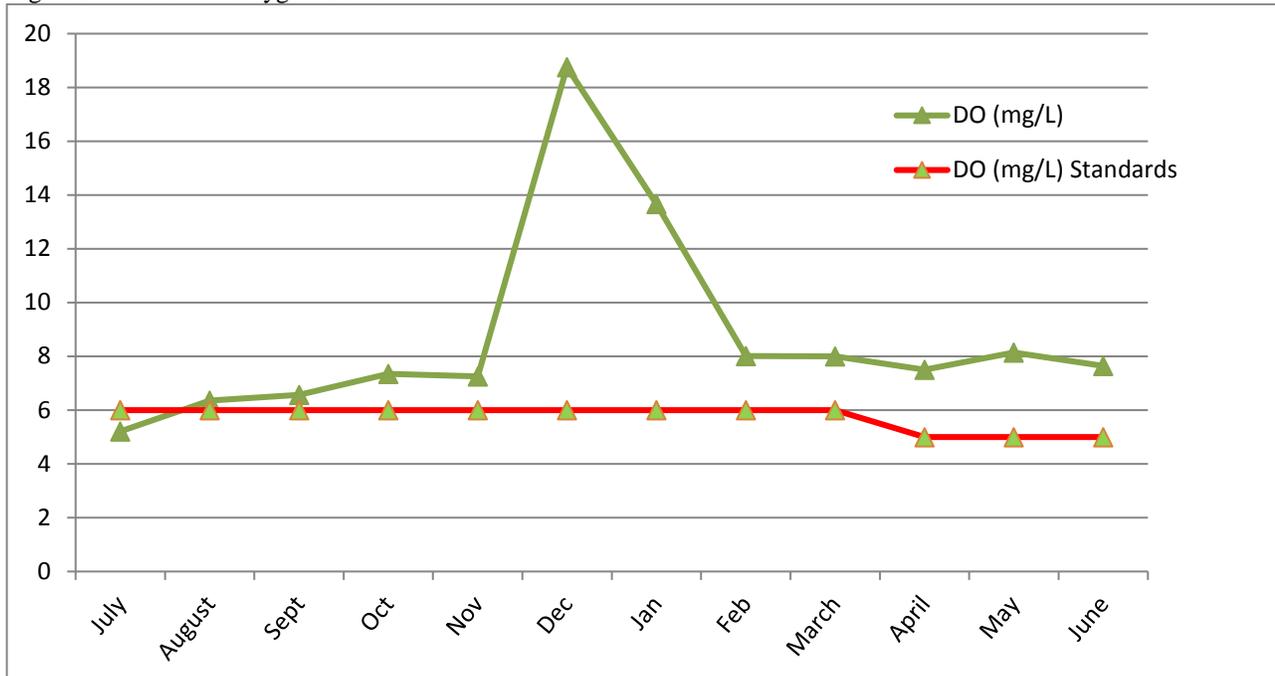
## 2.2 Fish and Wildlife Propagation: Warm Water Aquatic Community

**2.2.1 Dissolved Oxygen** - Data collected on Dissolved Oxygen concentrations shows the beneficial use is supported. The number of samples collected exceeds the number of required samples. Out of 12 samples, there was only 1 sample found to be below the standard. Therefore, less than 10% of the samples were outside the standard range.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
D.O.	0 samples below 5.0	na	April - June: 5.0	3	10 total	No more than 10% of samples outside range
	1 samples below 6.0	na	June - Mar: 6.0	9		

Table 2 – Dissolved Oxygen standards for Crow Creek

Figure 3 - Dissolved Oxygen Concentrations



**2.2.2 Toxicants/Metals** - Data collected indicate full support of the beneficial use for Toxicants and Metals.

<u>Parameter</u>	<u>Sample Mean (µg/L)</u>	<u>Single Sample (µg/L)</u>	<u>Water Quality Standard (µg/L)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Cadmium	0.50	0.50	Acute: 102.36, Chronic: 2.46	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper	2.86	6.54	Acute: 48.56, Chronic: 29.69	12	5	
Lead	0.88	2.74	Acute: 286.15, Chronic: 11.15	12	5	
Zinc	16.26	39.60	Acute: 269.64, Chronic: 244.23	12	5	

Table 3 – Toxicants/Metals standards for Crow Creek

**2.2.3 pH (Hydrogen Ion Activity)** - Data collected on pH readings for Crow Creek show full support of the beneficial use. The number of pH measurements taken exceeds the number of required measurements. All pH measurements fell within the standard range.

<u>Parameter</u>	<u>Sample Range (s.u.)</u>	<u>Single Sample (s.u.)</u>	<u>Water Quality Standard Range (s.u.)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
pH	7.5 – 7.9	na	6.5-9.0	12	10	No more than 10% of samples outside range

Table 4 – pH standards for Crow Creek

**2.2.4 Oil and Grease** - Oil and Grease is based on visual assessment. Visual observations do not indicate the presence of Oil and Grease pollution, supporting the beneficial use.

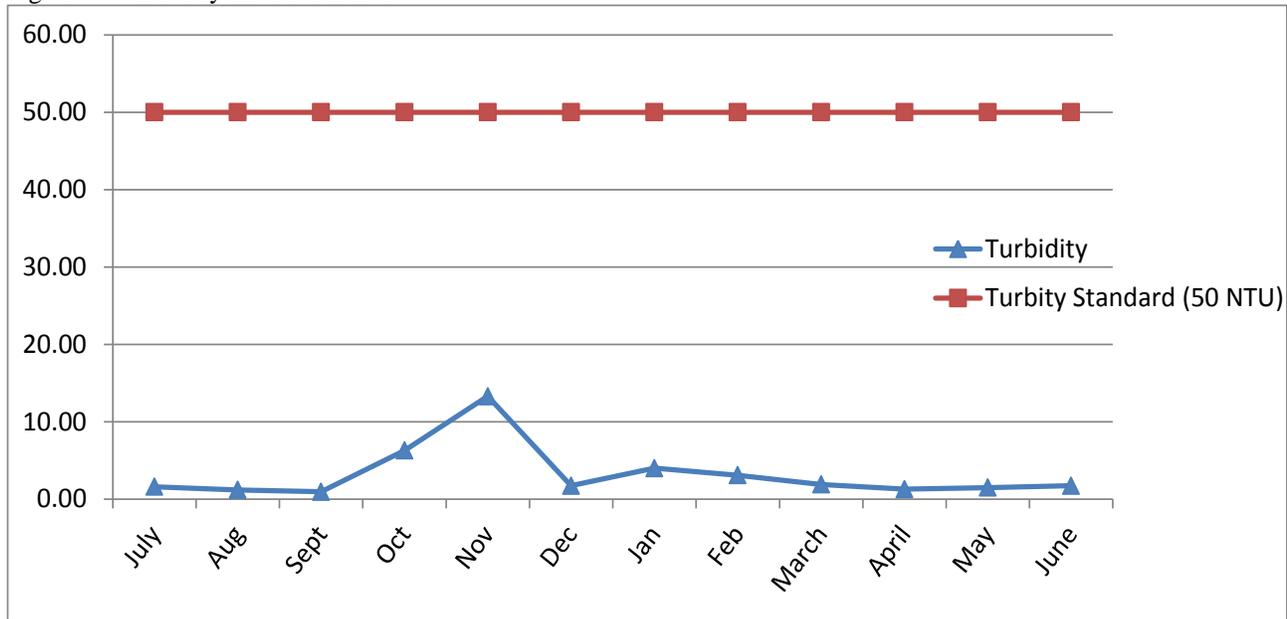
**2.2.5 Suspended and Bedded Sediments** - Using habitat assessment data to determine support of the beneficial use is conditional upon the support of turbidity data and fish collection data.

**2.2.5.1 Turbidity** – Data collected on Turbidity readings for Crow Creek show full support of the beneficial use.

<u>Parameter</u>	<u>Sample Mean (NTU)</u>	<u>Single Sample (NTU)</u>	<u>Water Quality Standard (NTU)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Turbidity	3.22	13.29	50	12	10	No more than 10% exceeding sample standard

Table 5 – Turbidity standards for Crow Creek

Figure 4 – Turbidity Concentrations



**2.2.5.2 Habitat Assessment** - The resulting score of the habitat assessment on Crow Creek can be compared to the average score of high quality sites within the same ecoregion provided by the Oklahoma Conservation Commission using a scoring workbook derived from OWRB (OWRB, 2001). The results of the habitat assessment produced a score above average for the central irregular plains ecoregion.

Metric	Score
Instream habitat	16.3
Pool bottom substrate	12.5
Pool variability	5.0
Canopy cover	20.0
Presence of rocky runs and riffles	14.1
Flow (at representative low flow)	2.1
Channel alteration	5.8
Channel sinuosity	0.1
Bank stability	5.2
Bank vegetation stability	4.9
Stream side Cover	10.0
<b>Total Score</b>	<b>96.00</b>
<b>Central Irregular Plains Mean Score</b>	<b>84.09</b>

Table 6 – Habitat assessment metric and total results with ecoregion mean score

## 2.2.6 Biological

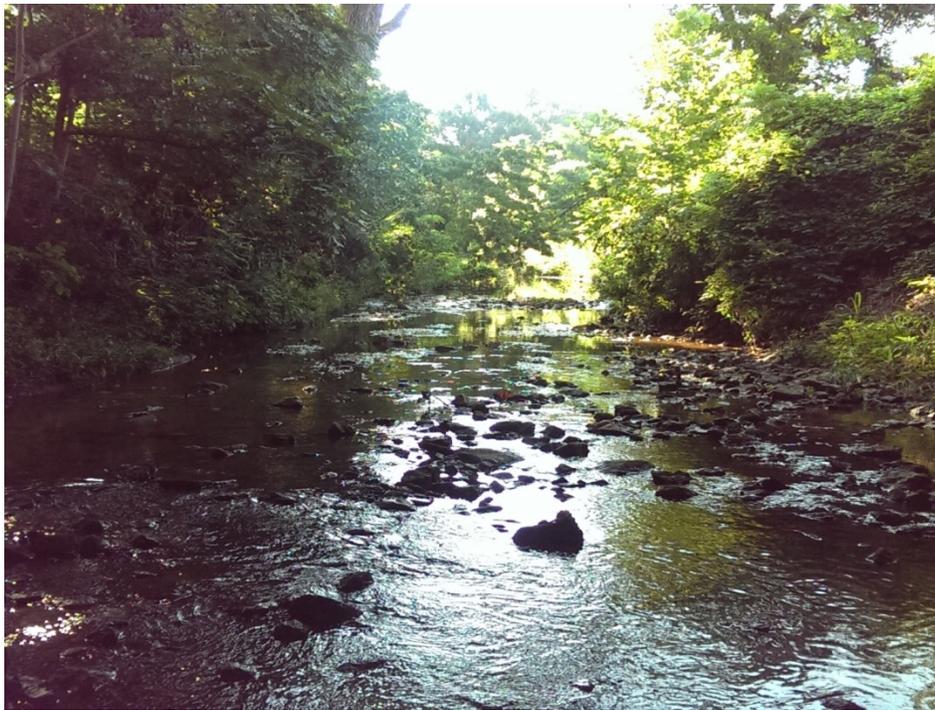
**2.2.6.1 Fish Collections** - Data recorded from Fish collections performed on Crow Creek show that the beneficial use is undetermined. A lack of intolerant species prevents full support, however a small increase in species diversity would also be beneficial. Analytical parameters and habitat assessments do not indicate the presence of water quality inhibitors. Downstream water quality impacts may prevent repopulations.

Index of Biotic Integrity		5	3	1	Score
Sample Composition	Total no. of species	See Figure 1, OAC 785: CH. 46			5
	Shannon's diversity	> 2.50	2.49 - 1.50	< 1.50	3
	No. of sunfish sp.	>3	2 - 3	< 2	5
	No. of sp. Comprising 75% of sample	> 5	4 - 3	< 3	3
	No. of intolerant species	> 5	3 - 5	< 3	1
	Percentage of tolerant species	See Figure 3, OAC 785: CH. 46			1
Fish Condition	Percentage of lithophils	> 36	18 - 36	< 18	3
	Percentage of DELT anomalies	< 0.1	0.1 - 1.3	> 1.3	3
	Fish Numbers (total individuals)	> 200	200 - 75	< 75	5
Score Key: 30 + Beneficial Use Supported : 23 - 29 Undetermined : < 22 Impaired				Total	29

Table 7 – Fish IBI score for Crow Creek

Family	Species Name	Common Name	Number of Fish	Percentage
Ictaluridae	<i>Ameirus natalis</i>	Yellow bullhead catfish	44	11.4%
	<i>Ameirus melas</i>	Black bullhead	1	0.3%
Centrarchidae	<i>Lepomis cyanellus</i>	Green sunfish	100	26.0%
	<i>Lepomis macrochirus</i>	Bluegill sunfish	2	0.5%
	<i>Lepomis megalotis</i>	Longear sunfish	100	26.0%
	<i>Micropterus salmoides</i>	Largemouth bass	7	1.8%
	Lepomis YOY	YOY sunfish	23	6.0%
Cyprinidae	<i>Campostoma anomalum</i>	Central stoneroller	97	25.2%
Percidae	<i>Etheostoma spectabile</i>	Orangethroat darter	1	0.3%
Poeciliidae	<i>Gambusia affinis</i>	Mosquitofish	10	2.6%
<b>Total Number:</b>			385	100.0%
<b>Total Number of Taxa:</b>			10	

Table 8 – Fish collection counts for Crow Creek



^Photograph taken of Crow Creek sample site

**2.2.6.2 Benthic Macroinvertebrate Collections** – Data recorded from benthic macroinvertebrate collection during the summer and winter index periods collections shows impairment for the summer index period and undetermined for the winter index period (ODEQ, Continuing Planning Process, 2012). Scores were above average in the richness of taxa for the winter index period, but low in percent dominance of any two families for both summer and winter index periods. Analytical data and habitat assessments do not reflect any water quality impacts. Further sampling may show improvements.

Sampling protocol to determine attainment of water quality standards, (ODEQ, Water Quality in Oklahoma Integrated Report, 2014) requires a minimum of four sampling events within a two year period. Further sampling will be implemented to determine support.

Metric	6	4	2	0	Score
Taxa Richness			56%		2
Modified HBI		83%			4
EPT/Total			10%		2
EPT Taxa				30%	0
% Dominant 2 Taxa				79%	0
Shannon - Weaver				1.2	0
Crow - Summer (Central Irregular Plains): >80% Attaining : 50-80% - Undetermined : < 50% Impaired	Total				26%

Metric	6	4	2	0	Score
Taxa Richness	120%				6
Modified HBI		80%			4
EPT/Total		21%			4
EPT Taxa				58%	0
% Dominant 2 Taxa				44%	0
Shannon - Weaver			2.3		2
Crow - Winter (Central Irregular Plains): >80% Attaining : 50-80% - Undetermined : < 50% Impaired	Total				59%

Table 9 – Benthic macroinvertebrate metrics for summer and winter index periods at Crow Creek

Phylum	Class	Order	Family	Genus	Common Class	6/28/2016			
						Count	%		
Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Fallceon quilleri</i>	Minnow Mayfly	1	0.9%		
		Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	Netspinner Caddisfly	10	9.3%		
		Diptera	Chironomidae	<i>Dicrotendipes</i> sp.	Midge	1	0.9%		
				<i>Polypedilum flavum</i>		5	4.7%		
				<i>Polypedilum illinoense</i> gr.		9	8.4%		
				<i>Rheotanytarsus exiguus</i> gr.		74	69.2%		
		<i>Thienemannimyia</i> gr. sp.	5	4.7%					
Lepidoptera	Crambidae	<i>Petrophila</i> sp.	Snout Moth	1	0.9%				
Crustacea	Malacostraca	Amphipoda	Hyalellidae	<i>Hyalella</i> sp.	Scud	1	0.9%		
<b>Crow Creek Summer Index Period</b>						Total		107	100.0%
						Total Number of Taxa		9	

Phylum	Class	Order	Family	Genus	Common Class	2/8/2017	
						Count	%
Arthropoda	Insecta	Ephemeroptera	Caenidae	<i>Caenis</i> sp.	Squaregilled Mayfly	22	18.3%
		Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	Netspinner Caddisfly	2	1.7%
			Hydroptilidae	<i>Hydroptila</i> sp.	Micro Caddisfly	1	0.8%
		Odonata	Coenagrionidae	<i>Argia plana</i>	Narrowwinged Damselfly	1	0.8%
				<i>Argia sedula</i>	Narrowwinged Damselfly	1	0.8%
		Diptera	Chironomidae	<i>Cricotopus bicinctus</i> gr.	Midge	1	0.8%
				<i>Cricotopus</i> sp.		29	24.2%
				<i>Cricotopus/Orthocladius</i> sp.		9	7.5%
				<i>Orthocladius</i> sp.		4	3.3%
				<i>Paratanytarsus</i> sp.		1	0.8%
				<i>Polypedium flavum</i>		5	4.2%
				<i>Rheotanytarsus exiguus</i> gr.		24	20.0%
				<i>Thienemanniella</i> sp.		5	4.2%
		<i>Thienemannimyia</i> gr. sp.	1	0.8%			
Lepidoptera	Crambidae	<i>Petrophila</i> sp.	Snout Mouth	4	3.3%		
Archnida/Acari	Acari			Water Mite	1	0.8%	
Annelida	Hirudinea	Arhynchobdellida	Erpobdella	<i>Erpobdella</i> sp.	Leech	1	0.8%
Mollusca	Bivalvia	Veneroida	Corbiculidae	<i>Corbicula</i> sp.	Asian Freshwater Clam	5	4.2%
	Gastropoda	Pulmonata	Physidae	<i>Physa</i> sp.	Lung snail	1	0.8%
Playhelminthes	Turbellaria			Flatworm	2	1.7%	
<b>Crow Creek Winter Index Period</b>			Total			120	100.0%
<b>Crow Creek Winter Index Period</b>			Total Number of Taxa			20	

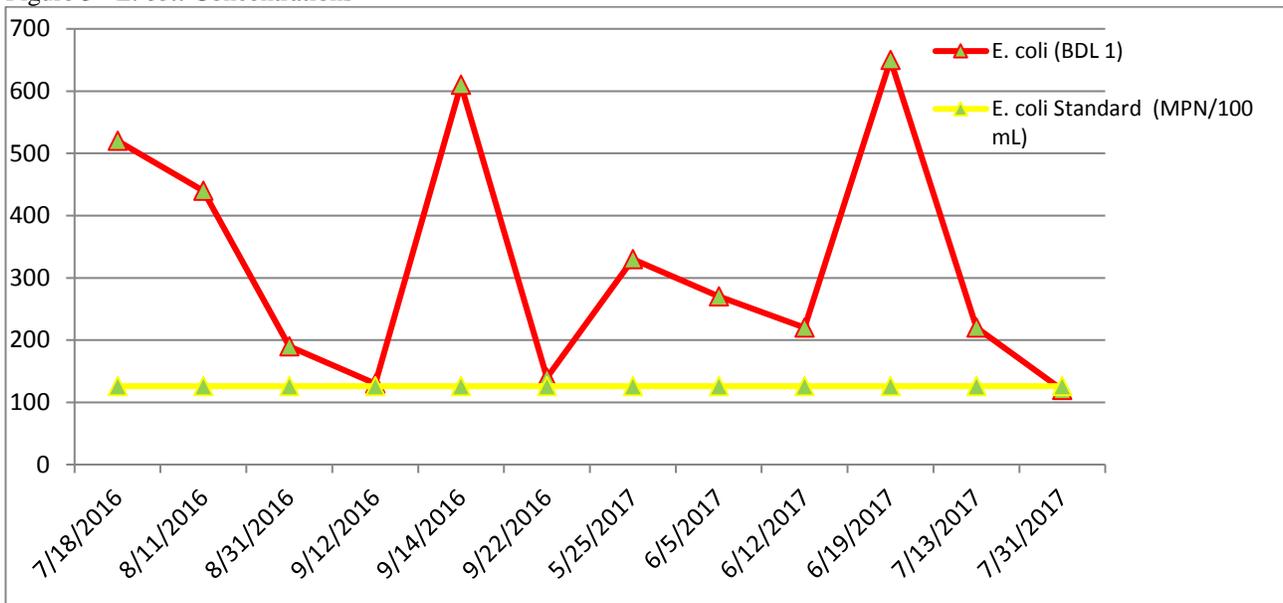
Table 10 – Benthic macroinvertebrate counts for Crow Creek summer and winter index periods

**2.3 Primary Body Contact** - The data collected on *E. coli* and *Enterococcus* concentrations show that Crow Creek is impaired for both *E. coli* and *Enterococcus*. The number of samples collected exceeds the number of samples required. Due to high bacteria results, 3 DNA samples were taken at minimum 7 days apart to help further illustrate the source of impairment. The results of the DNA testing indicates that the primary problem could be caused by pet waste not being picked up and properly disposed of as well as a possibility of sanitary sewer/septic tank issues.

<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>E. coli</i>	272	na	126	12	5	Geometric mean not exceeding standard

Table 11 – *E. coli* totals for Crow Creek

Figure 5 - *E. coli* Concentrations



<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>Enterococcus</i>	264	na	33	12	5	Geometric mean not exceeding standard

Table 12 – *Enterococcus* totals for Crow Creek

Figure 6 – *Enterococcus* Concentrations

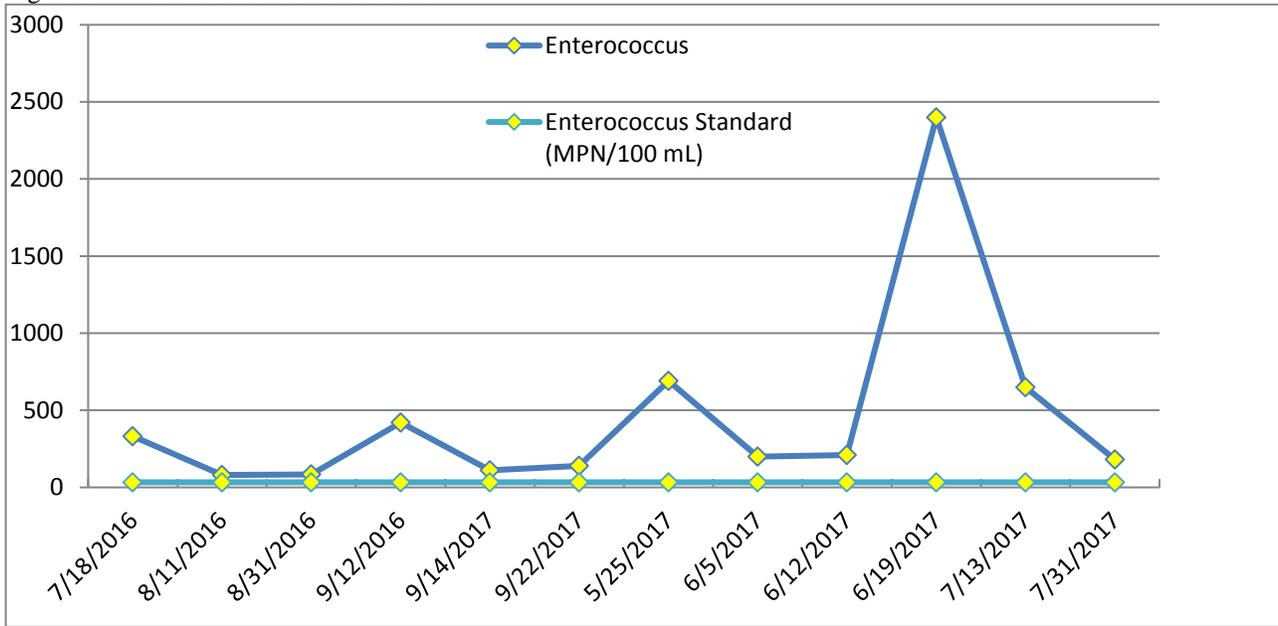
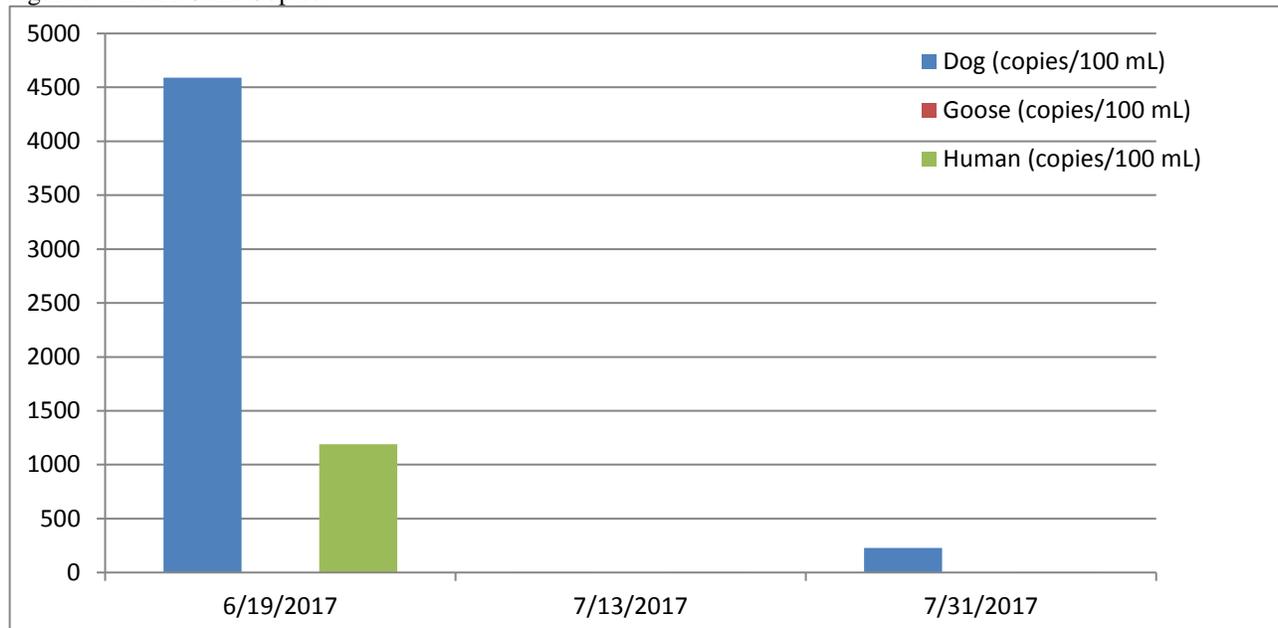


Figure 7 – DNA Gene Copies



## 2.4 Anti-Degradation Policy

2.4.1 Nutrients - Analytical results for Total Phosphorus and Nitrate/Nitrite show no need for further investigation to show support of the beneficial use. The number of samples collected exceeds the number of required samples, and less than 10% of samples exceeded the threshold for further sampling. While Nitrate/Nitrite concentrations have an action level, it is not a required parameter within the MS4 permit (ODEQ, OPDES Permit OKS000201, 2011).

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Threshold (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Phosphorus	0.06	na	0.24	12	10	No more than 10% of samples outside range
Nitrite - Nitrate	1.08	na	4.95	12	10	No more than 10% of samples outside range

Table 13 – Nutrient totals for Crow Creek

Figure 8 - Total Phosphorus Concentrations

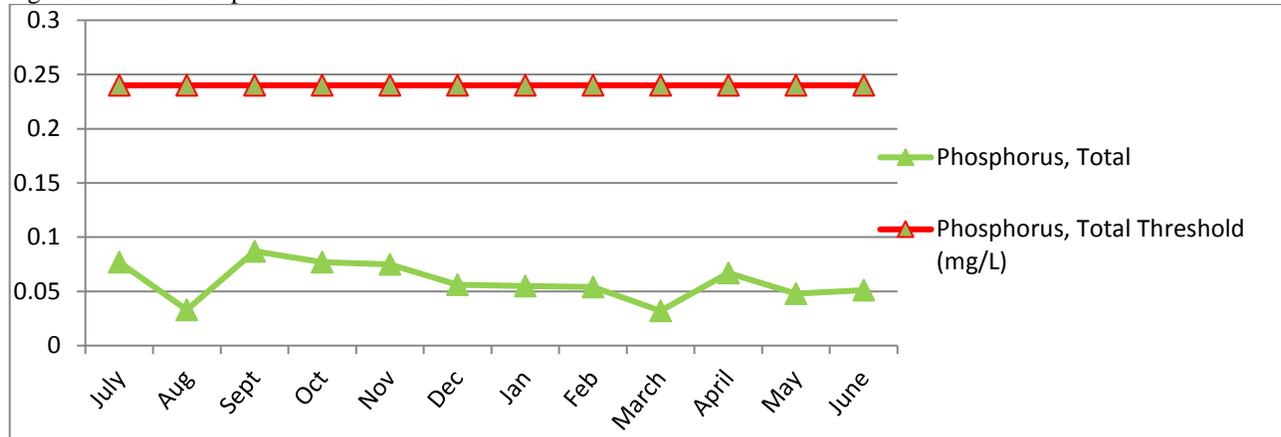
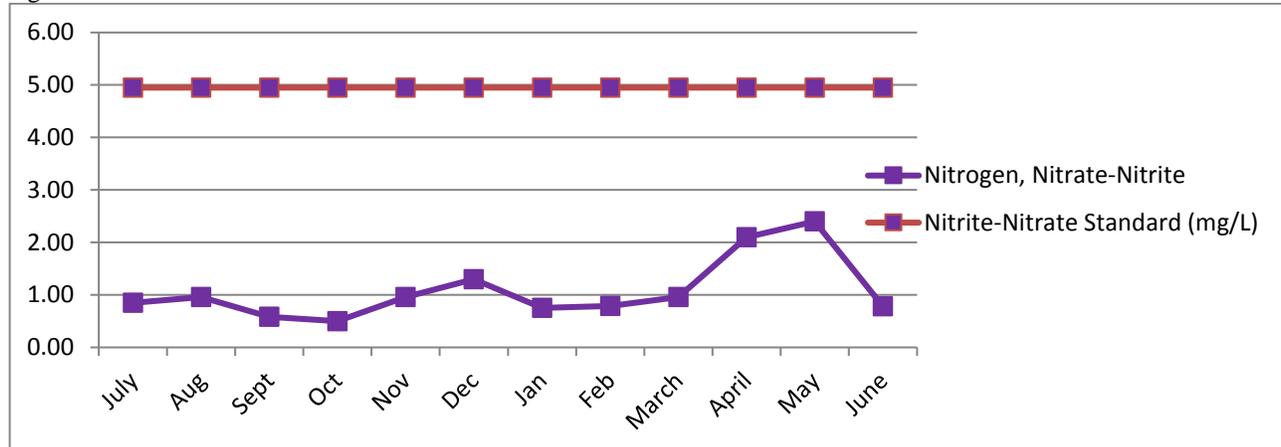


Figure 9 - Nitrate/Nitrite Concentrations



### 3.0 SUMMARY

Analytically, Crow Creek does not reflect any water quality impacts to the stream during the year of sampling with the exception of bacteria. DNA testing was performed to help determine the cause of impairment in regards to bacteria. The results showed that issues with sanitary sewer/septic tanks may need to be addressed. In addition, a continued push in public education addressing proper disposal of pet waste could be beneficial. Fish collections reflected an undetermined classification according to water quality standards despite being at the edge of supporting. A disappointing benthic macroinvertebrate IBI score could be related to the lack of intolerant species which prevents support of the beneficial use. Overall, Crow Creek possesses all of the ingredients to support a thriving biological community, but the populations were not up to the expected standard.

<b>Crow</b>						
<b>Parameter</b>	<b>Sample Mean</b>	<b>Single Sample</b>	<b>Water Quality Standard</b>	<b>No. of Samples</b>	<b>No. of Samples Required (WQS)</b>	<b>How Standard is Violated</b>
Cadmium (µg/L)	0.50	0.50	Acute: 102.36, Chronic: 2.46	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper (µg/L)	2.86	6.54	Acute: 48.56, Chronic: 29.69	12	5	
Lead (µg/L)	0.88	2.74	Acute: 286.15, Chronic: 11.15	12	5	
Zinc (µg/L)	16.26	39.60	Acute: 269.64, Chronic: 244.23	12	5	
E. coli (MPN/100ml)	272	Na	126	12	5	Geometric mean not exceeding standard
Enterococcus (MPN/100ml)	264	Na	33	12	5	Geometric mean not exceeding standard
Oil and Grease (visual)	none	Na	No visible sheen	12	10	No more than 10% of observations with oil & grease
Total Phosphorus (mg/L)	0.06	Na	0.24	12	10	No more than 10% of samples outside range
<i>Nitrite – Nitrate (mg/L)</i>	1.08	Na	4.95	12	10	<i>No more than 10% of samples outside range</i>
Total Dissolved Solids (mg/L)	308	440	Sample: 1868, Yearly: 1496	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard
pH (s.u.)	7.5 – 7.9	Na	6.5-9.0	12	10	No more than 10% of samples outside range
Turbidity (NTU)	3.22	13.29	50	12	10	No more than 10% of samples outside of range
<i>D.O. (mg/L)</i>	<i>0 samples below 5.0</i>	<i>Na</i>	<i>April -June 5.0</i>	<i>3</i>	<i>10 total</i>	<i>No more than 10% of samples outside range</i>
	<i>1 samples below 6.0</i>	<i>Na</i>	<i>June -Mar 6.0</i>	<i>9</i>		
*Analytes in italics not required by permit Analytes in red exceed standards						

Table 14 – Oklahoma Water Quality Standards summary of collected data

Analyte	Result			Number of Samples	Number of Attempts
	Minimum	Mean	Maximum		
Cadmium, Total (µg/L) (DL 0.5 µg/L)	--	0.50	0.50	12	12
Copper, Total (µg/L) (DL 0.5 µg/L)	--	2.86	6.54	12	12
<i>E. coli</i> (MPN/100 mL) (DL 1 MPN/100 mL)	--	272	650	12	12
<i>Enterococcus</i> (MPN/100 mL)(DL 1 CFU/100 mL)	--	264	2400	12	12
Hardness, Total (mg/L) (DL 3.6 mg/L)	110	207	380	12	12
Lead, Total (µg/L) (DL 0.5 µg/L)	--	0.88	2.74	12	12
Nitrogen, Nitrate-Nitrite (mg/L) (DL 0.2 mg/L)	--	1.08	2.40	12	12
Nitrogen, Total Kjeldahl (mg/L)(DL 0.50 mg/L)	--	0.59	0.86	12	12
Nitrogen, Total as Nitrogen (mg/L)(DL 0.50 mg/L)	--	1.33	2.30	12	12
Phosphorus, Dissolved (mg/L) (DL 0.010 mg/L)	--	0.05	0.08	12	12
Phosphorus, Total (mg/L) (DL 0.010 mg/L)	--	0.06	0.09	12	12
Solids, Total Dissolved (mg/L) (DL 10 mg/L)	--	308	440	12	12
Solids, Total Suspended (mg/L) (DL 2.0 mg/L)	--	5.13	12.00	12	12
Zinc, Total (µg/L) (DL 10 µg/L)	--	16.26	39.60	12	12
Water Temperature (°C)	2.46	16.21	27.00	12	12
pH (su)	7.50	--	7.90	12	12
Flow (cfs)	0.93	1.32	2.47	12	12
Turbidity (NTU)	--	3.22	13.29	12	12
Results found to be below the detection limit are reported as the detection limit					

Table 15 – MS4 permit required analytical sampling parameters result summaries

ANALYTE	Date Sampled											
	7/18/16	8/11/16	9/12/16	10/13/16	11/16/16	12/15/16	1/11/17	2/6/17	3/16/17	4/19/17	5/23/17	6/14/17
Cadmium, Total (BDL 0.5) µg/L	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Copper, Total (BDL 0.5) µg/L	2.99	2.10	3.12	6.54	2.84	3.99	2.04	1.92	1.89	2.82	1.51	2.54
Hardness, Total (BDL 3.6) mg/L	190	180	130	110	380	210	180	190	210	230	260	210
Lead, Total (BDL 0.5) µg/L	0.50	0.50	0.50	1.85	2.74	0.50	1.36	0.65	0.50	0.50	0.50	0.50
Nitrogen, Kjeldahl, Total (BDL 0.50) mg/L	0.75	0.50	0.68	0.61	0.51	0.66	0.86	0.50	0.50	0.50	0.50	0.50
Nitrogen, Nitrate-Nitrite (BDL 0.2) mg/L	0.85	0.96	0.58	0.50	0.96	1.30	0.75	0.79	0.96	2.10	2.40	0.78
Nitrogen, Total as N (BDL 0.5) mg/L	0.85	0.95	1.20	1.10	1.50	1.90	1.60	0.75	0.94	2.10	2.30	0.74
pH (s.u.)	7.70	7.90	7.60	7.50	7.70	7.68	7.60	7.60	7.80	7.70	7.80	7.60
Phosphorus, Total (BDL 0.010) mg/L	0.08	0.03	0.09	0.08	0.08	0.06	0.06	0.05	0.03	0.07	0.05	0.05
Phosphorus, Total Dissolved BDL (0.010) mg/L	0.07	0.03	0.08	0.06	0.05	0.05	0.04	0.02	0.03	0.06	0.04	0.04
Solids, Total Dissolved (BDL 10) mg/L	310	260	200	180	350	290	270	330	320	440	410	330
Solids, Total Suspended (BDL 2.0) mg/L	2.40	2.00	2.00	5.60	12.00	8.20	2.00	8.50	5.60	7.50	2.00	3.70
Temperature, Water °C	26.00	27.00	21.00	16.00	13.00	2.46	7.60	9.50	8.90	20.00	18.00	25.00
Turbidity (NTU)	1.60	1.20	0.96	6.30	13.29	1.73	4.00	3.10	1.90	1.30	1.50	1.74
Zinc, Total (BDL 10) µg/L	11.50	10.00	10.00	10.00	14.90	12.20	10.40	10.40	12.50	39.60	27.30	26.30
Flow CFS	1.04	1.36	1.26	1.01	1.11	1.08	1.28	1.85	0.93	1.54	2.47	0.94
Conductivity µS	524	580	330	240	430	855	290	320	390	560	549	550
Dissolved Oxygen mg/L	5.21	6.35	6.57	7.35	7.26	18.76	13.67	8.01	8.00	7.50	8.14	7.64
Results found to be below the detection limit are reported as the detection limit												

Table 16 – Complete analytical sampling results for all parameters

ANALYTE	Date Sampled											
	7/18/16	8/11/16	8/31/16	9/12/16	9/14/16	9/22/16	5/25/17	6/5/17	6/12/17	6/19/17	7/13/17	7/31/17
<i>E. coli</i> (BDL 1) MPN/100mL	520	440	190	130	610	140	330	270	220	650	220	120
<i>Enterococcus</i> (BDL 1) MPN/100 mL	331	80.5	83.6	420	110	140	690	200	210	2400	650	180
Results found to be below the detection limit are reported as the detection limit												

Table 17 – Complete analytical results for bacteria samples

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**Save  
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Streams**

## **CITY OF TULSA WATERSHED CHARACTERIZATION PROGRAM**

**Comprehensive Watershed Characterization  
Assessment Year 1 (2016-2017):**

### **DIRTY BUTTER CREEK**

City of Tulsa Streets and Stormwater  
Stormwater and Land Management Division  
4502 South Galveston  
Tulsa, OK 74107

Prepared by

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**September 19, 2017**

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## 1.0 INTRODUCTION

### 1.1 Objective

The purpose of this document is to serve as a comprehensive report of results from the biological, habitat, and analytical assessments of Dirty Butter Creek. These assessments were performed in order to comply with requirements set forth in Part II(A)(13)(12)(b) and (13)(a) and (b) and Part IV(A)(1) and (2) of Oklahoma Pollutant Discharge Elimination System (OPDES) municipal stormwater (MS4) Permit No. OKS000201 for the City of Tulsa, Oklahoma (ODEQ, OPDES Permit OKS000201, 2011). In addition, assessment results are applied to Oklahoma Water Quality Standards. These standards are described in both (OWRB, 2013a) and (OWRB, 2013b). Where applicable, reference conditions will not be established until the conclusion of the current permit. Until such references are established, those standards will result in an “insufficient data” designation with regards to support within the Fish and Wildlife propagation beneficial use. While these implementations describe a multitude of surface water quality standards, this document will compare and describe only the standards applicable to the parameters required in the Watershed Characterization Program sub section of the Municipal Separate Storm Sewer System permit (ODEQ, OPDES Permit OKS000201, 2011). All remaining parameter results without applicable water quality standards will still be included in this report.

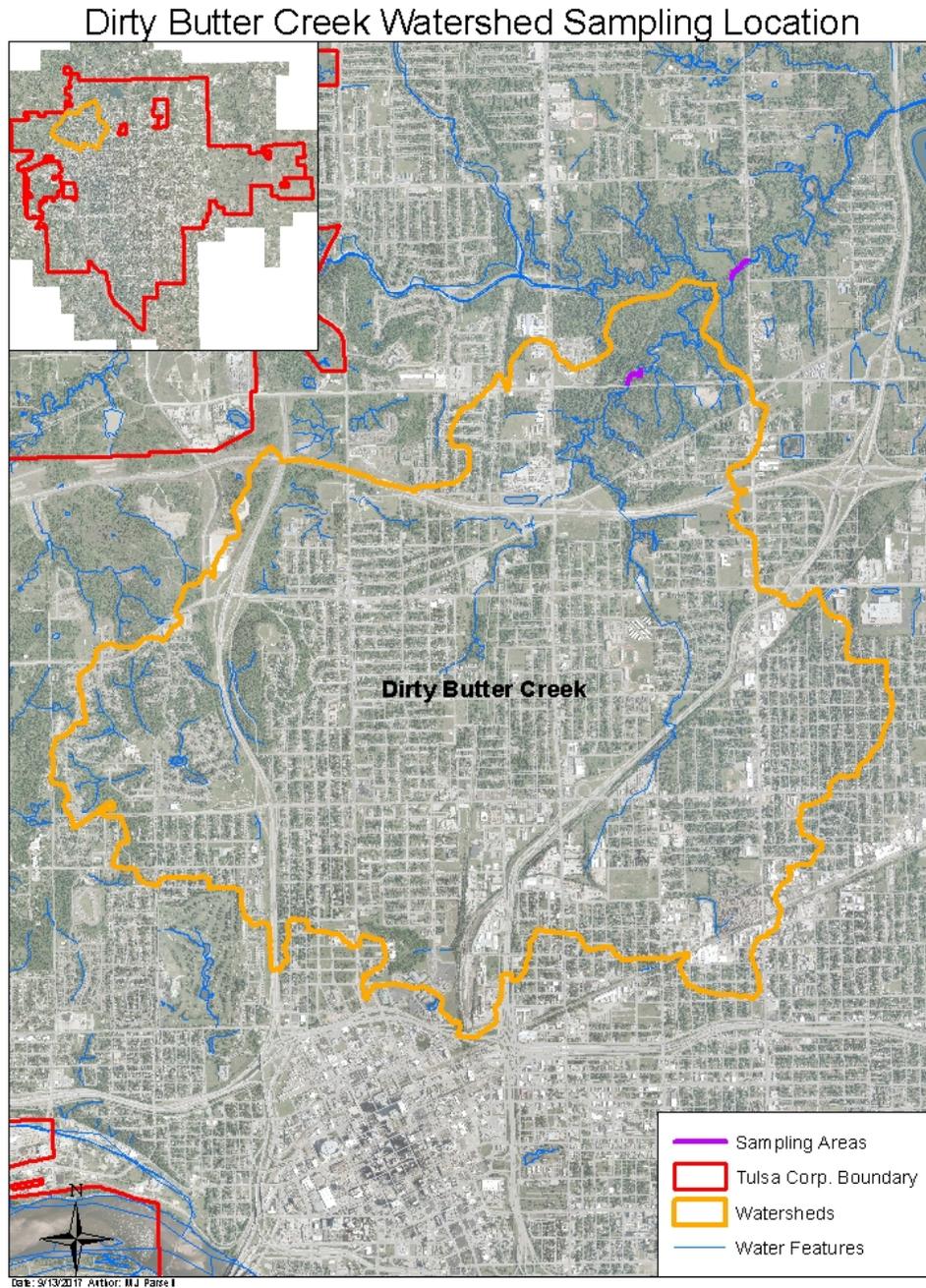
The data presented in this comprehensive report was collected over a one year period beginning in July of 2016 with completion in June of 2017. Field collection and assessment methodology followed project standard operating procedures (SOPs) as provided in the quality assurance project plans (QAPPs) for the biological component (CCRC & FTN, 2014) and the analytical component (CCRC & FTN, 2014). These QAPPs provide quality assurance and quality control procedures for all aspects of the watershed characterization program. They were submitted to and received approval from the Oklahoma Department of Environmental Quality as per MS4 permit requirements. All field data sheets were scanned electronically and archived at the City of Tulsa Stormwater and Land Management Division. All field measurements (in situ measurements, flows, observations), biological information (taxonomic identification, organism counts), and analytical results were compiled in Excel spreadsheets and verified (data entry, formula calculations) per project QA/QC procedures (CCRC & FTN, 2014) (CCRC & FTN, 2014). All raw data, SOPs, and QAPPs are available upon request.

**Dirty Butter Creek**  
**WBID: OK121300010140\_00**

Figure 1 - Sampling location on Dirty Butter Creek during Year 1

Waterbody	Sample Location		Watershed Area (mi <sup>2</sup> )*	Sampling/Evaluation Date			
	Latitude	Longitude		Fish	Benthic (Summer)	Benthic (Winter)	Habitat
Dirty Butter	36.206054	-95.969070	7.98	07/07/2016	06/24/2016	02/08/2017	07/17/2016

\* Collection area captured by sampling point



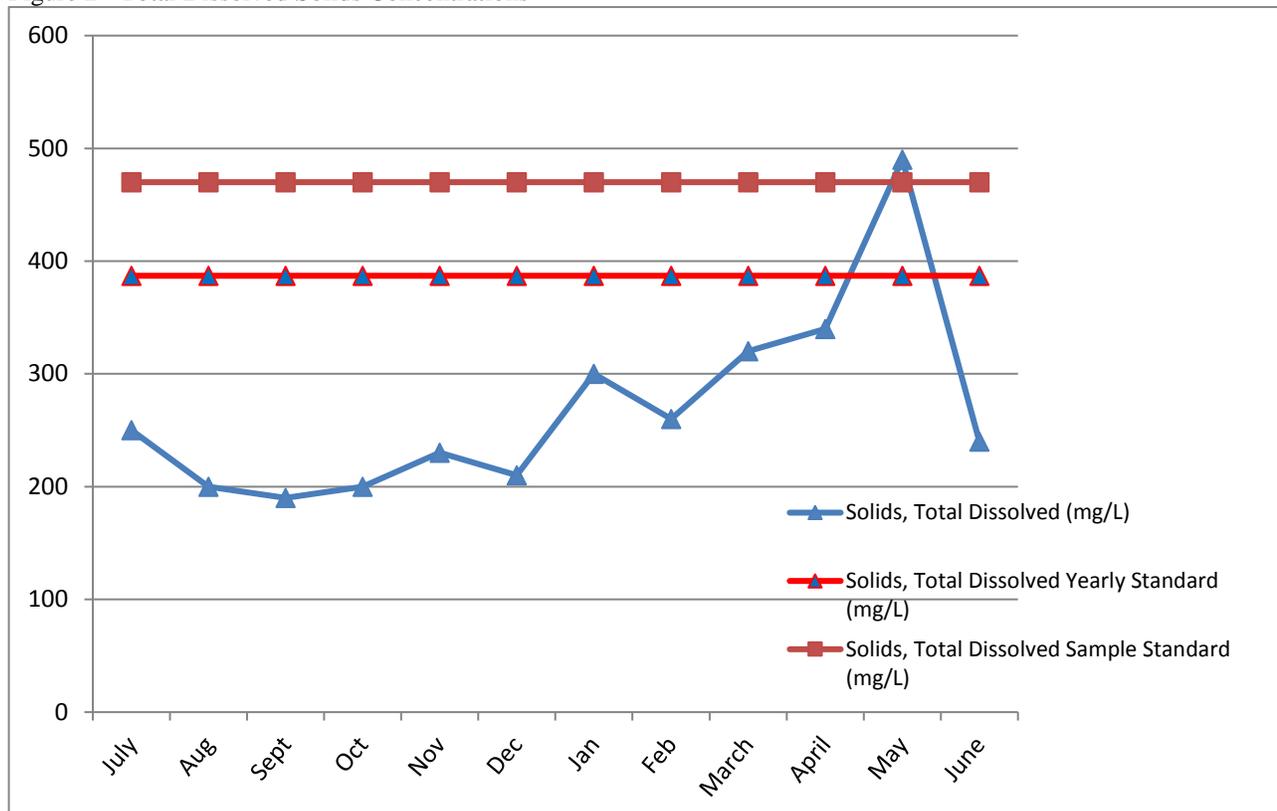
## 2.0 BENEFICIAL USES

**2.1 Agriculture** - Data collected on Total Dissolved Solids for Dirty Butter Creek indicates attainment of the agricultural beneficial use. The number of samples collected exceeds the number of samples required. The sample mean does not exceed the yearly standard and only one of the samples exceeded the sample standard.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Dissolved Solids	269	490	Sample: 470, Yearly: 387	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard

Table 1 – Agriculture standards for Dirty Butter Creek

Figure 2 - Total Dissolved Solids Concentrations



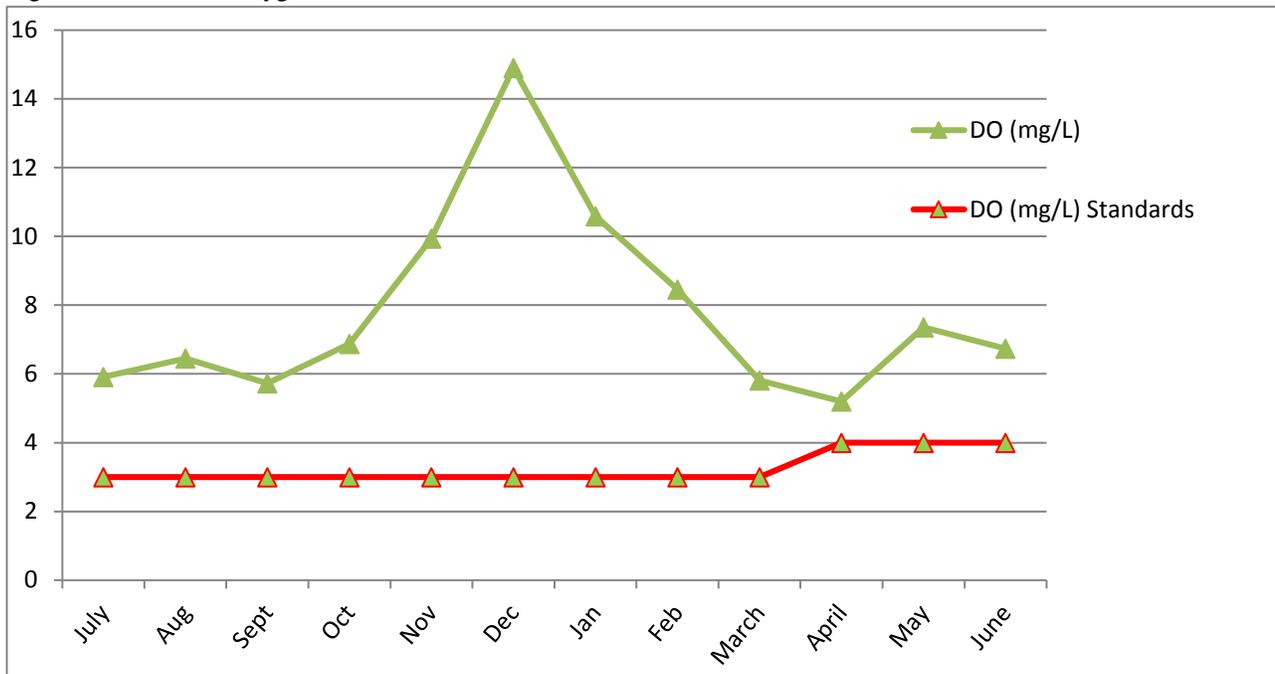
**2.2 Fish and Wildlife Propagation: Warm Water Aquatic Community**

**2.2.1 Dissolved Oxygen** - Data collected on Dissolved Oxygen concentrations shows the beneficial use is supported. The number of samples collected exceeds the number of required samples. Out of 12 samples, there were no samples found to be below the standard.

<u>Parameter</u>	<u>Sample Mean (mg/L)</u>	<u>Single Sample (mg/L)</u>	<u>Water Quality Standard (mg/L)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
D.O.	0 samples below 4.0	na	April - June: 4.0	3	10 total	No more than 10% of samples outside range
	0 samples below 3.0	na	June - Mar: 3.0	9		

Table 2 – Dissolved Oxygen standards for Dirty Butter Creek

Figure 3 - Dissolved Oxygen Concentrations



**2.2.2 Toxicants/Metals** - Data collected indicate full support of the beneficial use for Toxicants and Metals.

<u>Parameter</u>	<u>Sample Mean (µg/L)</u>	<u>Single Sample (µg/L)</u>	<u>Water Quality Standard (µg/L)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Cadmium	0.5	0.5	Acute: 54.43, Chronic: 1.58	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper	2.56	4.61	Acute: 28.65, Chronic: 18.40	12	5	
Lead	0.92	2.35	Acute: 140.30, Chronic: 5.47	12	5	
Zinc	14.78	26.80	Acute: 167.79, Chronic: 151.97	12	5	

Table 3 – Toxicants/Metals standards for Dirty Butter Creek

**2.2.3 pH (Hydrogen Ion Activity)** - Data collected on pH readings for Dirty Butter Creek show full support of the beneficial use. The number of pH measurements taken exceeds the number of required measurements. All pH measurements fell within the standard range.

<u>Parameter</u>	<u>Sample Range (s.u.)</u>	<u>Single Sample (s.u.)</u>	<u>Water Quality Standard Range (s.u.)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
pH	7.5 – 7.9	na	6.5-9.0	12	10	No more than 10% of samples outside range

Table 4 – pH standards for Dirty Butter Creek

**2.2.4 Oil and Grease** - Oil and Grease is based on visual assessment. Visual observations do not indicate the presence of Oil and Grease pollution, supporting the beneficial use.

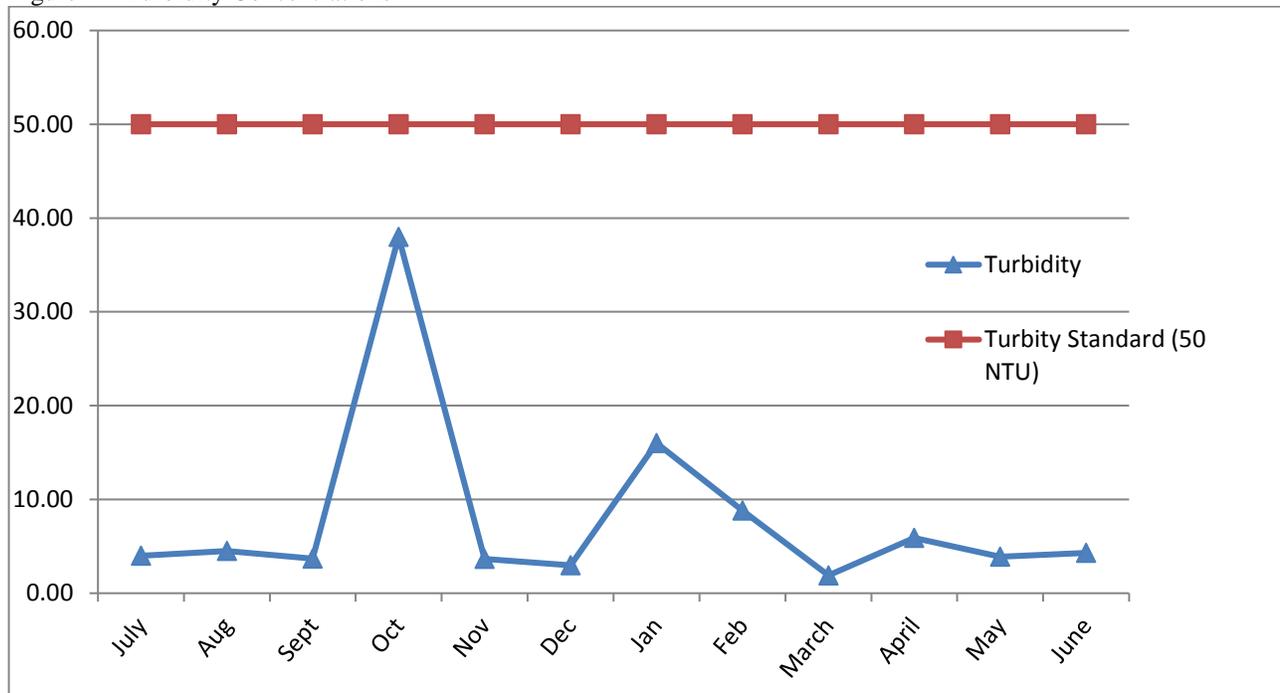
**2.2.5 Suspended and Bedded Sediments** - Using habitat assessment data to determine support of beneficial use is conditional upon the support of turbidity data and fish collection data.

**2.2.5.1 Turbidity** - Data collected on Turbidity readings for Dirty Butter Creek show full support of the beneficial use.

Parameter	Sample Mean (NTU)	Single Sample (NTU)	Water Quality Standard (NTU)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Turbidity	8.14	38.00	50	12	10	No more than 10% exceeding sample standard

Table 5 – Turbidity standards for Dirty Butter

Figure 4 – Turbidity Concentrations



**2.2.5.2 Habitat Assessment** – The resulting score of the habitat assessment on Dirty Butter Creek can be compared to the average score of high quality sites within the same ecoregion provided by the Oklahoma Conservation Commission using a scoring workbook derived from OWRB (OWRB, 2001). The results of the habitat assessment produced a score above average for the central irregular plains eco region.

Metric	Score
Instream habitat	17.4
Pool bottom substrate	4.8
Pool variability	13.3
Canopy cover	18.7
Presence of rocky runs and riffles	14.1
Flow (at representative low flow)	4.8
Channel alteration	1.4
Channel sinuosity	3.3
Bank stability	4.3
Bank vegetation stability	3.1
Stream side Cover	9.87
<b>Total Score</b>	<b>95.00</b>
<b>Central Irregular Plains Mean Score</b>	<b>84.09</b>

Table 6 – Habitat assessment metric and total results with ecoregion mean score

**2.2.6 Biological**

**2.2.6.1 Fish Collections** - Data recorded from Fish collections performed on Dirty Butter Creek show that the beneficial use is supported.

Index of Biotic Integrity		5	3	1	Score
Sample Composition	Total no. of species	See Figure 1, OAC 785: CH. 46			5
	Shannon's diversity	> 2.50	2.49 - 1.50	< 1.50	3
	No. of sunfish sp.	>3	2 - 3	< 2	5
	No. of sp. Comprising 75% of sample	> 5	4 - 3	< 3	3
	No. of intolerant species	> 5	3 - 5	< 3	3
	Percentage of tolerant species	See Figure 3, OAC 785: CH. 46			3
Fish Condition	Percentage of lithophils	> 36	18 - 36	< 18	5
	Percentage of DELT anomalies	< 0.1	0.1 - 1.3	> 1.3	5
	Fish Numbers (total individuals)	> 200	200 - 75	< 75	5
Score Key: 30 + Beneficial Use Supported : 23 - 29 Undetermined : < 22 Impaired				Total	37

Table 7 – Fish IBI score for Dirty Butter Creek

Family	Species Name	Common Name	Number of Fish	Percentage
Ictaluridae	<i>Ameirus natalis</i>	Yellow bullhead catfish	19	2.6%
	<i>Ameirus melas</i>	Black bullhead catfish	5	0.7%
Centrarchidae	<i>Lepomis cyanellus</i>	Green sunfish	54	7.5%
	<i>Lepomis macrochirus</i>	Bluegill sunfish	2	0.3%
	<i>Lepomis megalotis</i>	Longear sunfish	81	11.2%
	<i>Lepomis gulosus</i>	Warmouth sunfish	4	0.6%
	<i>Micropterus salmoides</i>	Largemouth bass	1	0.1%
Cyprinidae	<i>Cyprinella lutrensis</i>	Red shiner	29	4.0%
	<i>Campostoma anomalum</i>	Central stoneroller	347	47.9%
	<i>Pimephales notatus</i>	Bluntnose minnow	16	2.2%
	<i>Phenacobius mirabilis</i>	Suckermouth minnow	2	0.3%
Percidae	<i>Etheostoma spectabile</i>	Orangethroat darter	125	17.3%
Poeciliidae	<i>Gambusia affinis</i>	Mosquitofish	39	5.4%
<b>Total Number:</b>			724	100.00%
<b>Total Number of Taxa:</b>			12	

Table 8 – Fish collection counts for Dirty Butter Creek



^Photograph taken of the Dirty Butter Creek sample site

**2.2.6.2 Benthic Macroinvertebrate Collections** – Data recorded from benthic macroinvertebrate collection during the summer and winter index periods collections shows support is undetermined (ODEQ, Continuing Planning Process, 2012). Scores were above average in the richness of taxa, but low in percent dominance of any two families.

Sampling protocol to determine attainment of water quality standards, (ODEQ, Water Quality in Oklahoma Integrated Report, 2014) requires a minimum of four sampling events within a two year period. Further sampling will be implemented to determine support.

Metric	6	4	2	0	Score
Taxa Richness		68%			6
Modified HBI		83%			6
EPT/Total				2%	6
EPT Taxa				14%	0
% Dominant 2 Taxa				85%	0
Shannon - Weaver				1.2	2
Dirty Butter - Summer (Central Irregular Plains): >80% Attaining : 50 - 80% Undetermined : < 50% Impaired	Total				65%

Metric	6	4	2	0	Score
Taxa Richness	84%				6
Modified HBI	82%				4
EPT/Total				6%	2
EPT Taxa				0%	0
% Dominant 2 Taxa				50%	0
Shannon - Weaver			2.0		2
Dirty Butter - Winter (Central Irregular Plains): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				52%

Table 9 – Benthic macroinvertebrate metrics for summer and winter index periods at Dirty Butter Creek

Phylum	Class	Order	Family	Genus	Common Class	6/24/2016			
						Count	%		
Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Baetis intercalaris</i>	Minnow Mayfly	9	8.18%		
				<i>Fallceon quilleri</i>	Minnow Mayfly	23	20.9%		
		Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	Netspinner Caddisfly	3	2.7%		
			Philopotamidae	<i>Chimarra</i> sp.	Fingernet Caddisfly	1	0.9%		
		Coleoptera	Elmidae	<i>Stenelmis</i> sp.	Riffle Beetle	1	0.9%		
		Diptera	Chironomidae	<i>Phaenopsectra</i> sp.	Midge	1	0.9%		
				<i>Polypedilum flavum</i>	Midge	27	24.5%		
				<i>Polypedilum illinoense</i> gr.	Midge	8	7.3%		
				<i>Polypedilum scalaenum</i> gr.	Midge	1	0.9%		
				<i>Rheotanytarsus exiguus</i> gr.	Midge	1	0.9%		
				<i>Tanytarsus</i> sp.	Midge	5	4.5%		
				<i>Thienemanniella</i> sp.	Midge	28	25.5%		
		<i>Zavrelimyia</i> sp.	Midge	1	0.9%				
			Empididae	<i>Hemerodromia</i> sp.	Dance Fly	1	0.9%		
<b>Dirty Butter Creek Summer Index Period</b>						Total		110	100.0%
						Total Number of Taxa		14	

Phylum	Class	Order	Family	Genus	Common Class	2/8/2017		
						Count	%	
Arthropoda	Insecta	Ephemeroptera	Caenidae	<i>Caenis</i> sp.	Squaregilled Mayfly	14	14.0%	
		Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	Netspinner Caddisfly	1	1.0%	
		Diptera-Chironomidae	Chironomidae	<i>Cricotopus bicinctus</i> gr.	Midge	1	1.0%	
				<i>Cricotopus</i> sp.		47	47.0%	
				<i>Cricotopus/Orthocladius</i> sp.		21	21.0%	
				<i>Limnophyes</i> sp.		1	1.0%	
				<i>Phaenopsectra</i> sp.		1	1.0%	
				<i>Polypedilum flavum</i>		2	2.0%	
				<i>Polypedilum illinoense</i> gr.		1	1.0%	
				<i>Polypedilum scalaenum</i> gr.		1	1.0%	
				<i>Stenochironomus</i> sp.		1	1.0%	
				<i>Thienemanniella</i> sp.		1	1.0%	
		<i>Thienemannimyia</i> gr. sp.	2	2.0%				
Annelida	Oligochaeta	Enchytraeidae			Aquatic Worm	2	2.0%	
		Haplotaxida	Naididae	<i>Nais</i> sp.		1	1.0%	
	Gastropoda	Pulmonata	Planorbidae	<i>Ferrissia</i> sp.	Limpet	2	2.0%	
			Lymnaeidae	<i>Galba</i> sp.	Pond Snail	1	1.0%	
<b>Dirty Butter Creek Winter Index Period</b>						Total	100	100.0%
<b>Dirty Butter Creek Winter Index Period</b>						Total Number of Taxa	17	

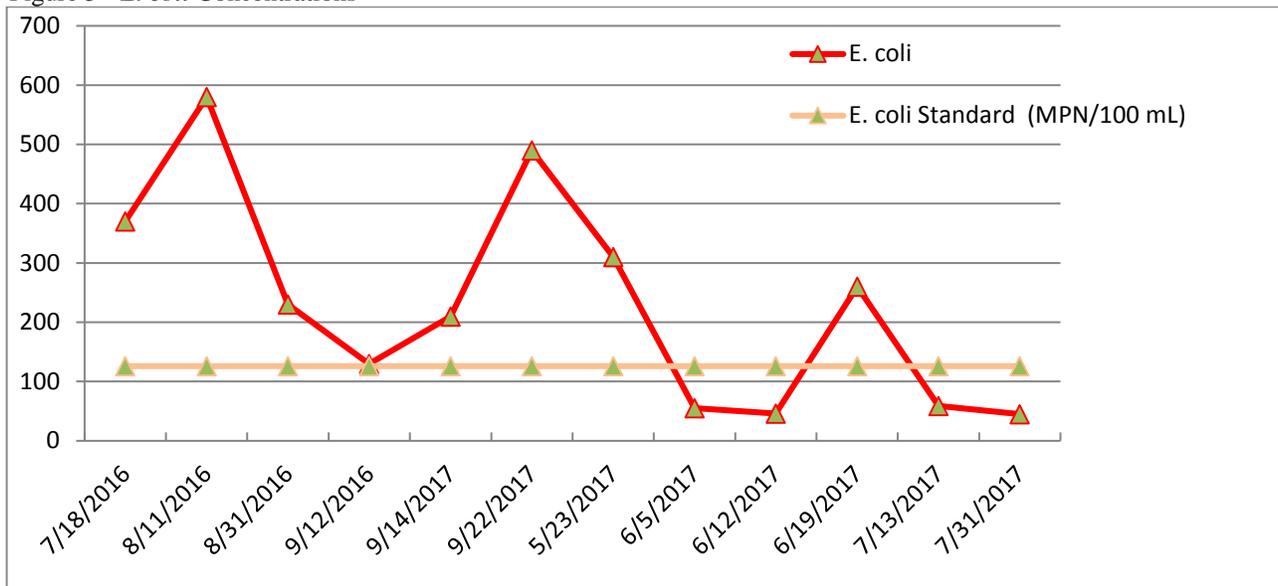
Table 10 – Benthic macroinvertebrate counts for Dirty Butter Creek summer and winter index periods

**2.3 Primary Body Contact** - The data collected on *E. coli* concentrations show that Dirty Butter Creek is impaired for both *E. coli* and *Enterococcus*. The number of samples collected exceeds the number of samples required. Due to high bacteria results, 3 DNA samples were taken at minimum 7 days apart to help further illustrate the source of impairment. The results of the DNA testing indicate that the primary problem could be caused by sanitary sewer/septic tank issues.

Parameter	Sample Geometric Mean (MPN/100mL)	Single Sample (MPN/100mL)	Water Quality Standard (MPN/100mL)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
<i>E. coli</i>	163	na	126	12	5	Geometric mean not exceeding standard

Table 11 – *E. coli* totals for Dirty Butter Creek

Figure 5 - *E. coli* Concentrations



<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>Enterococcus</i>	161	na	33	12	5	Geometric mean not exceeding standard

Table 12 – *Enterococcus* totals for Dirty Butter Creek

Figure 6 – *Enterococcus* Concentrations

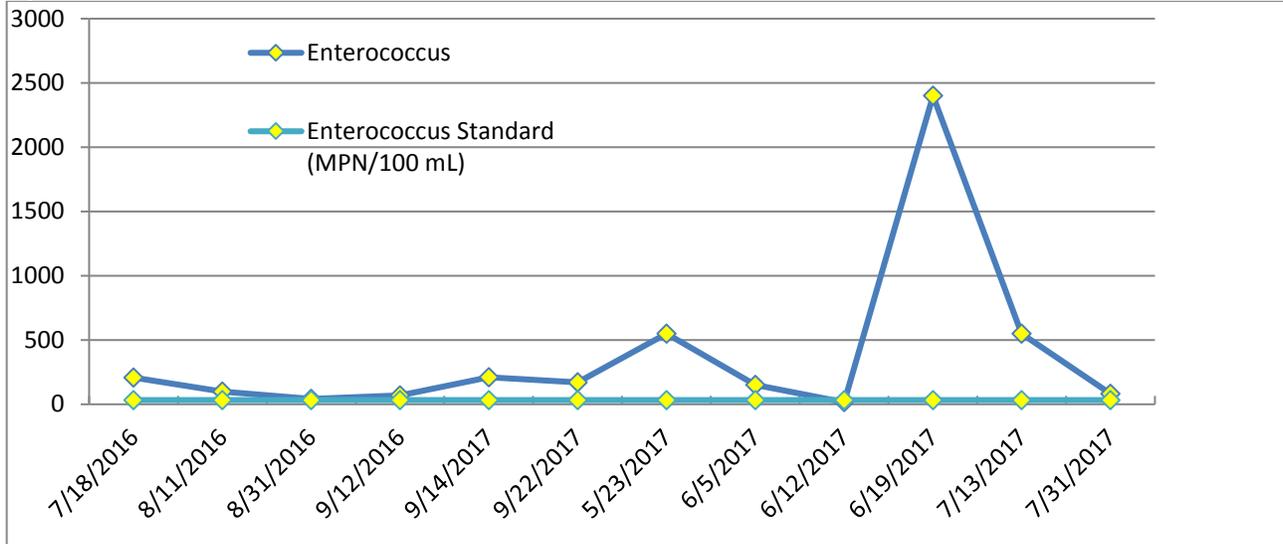
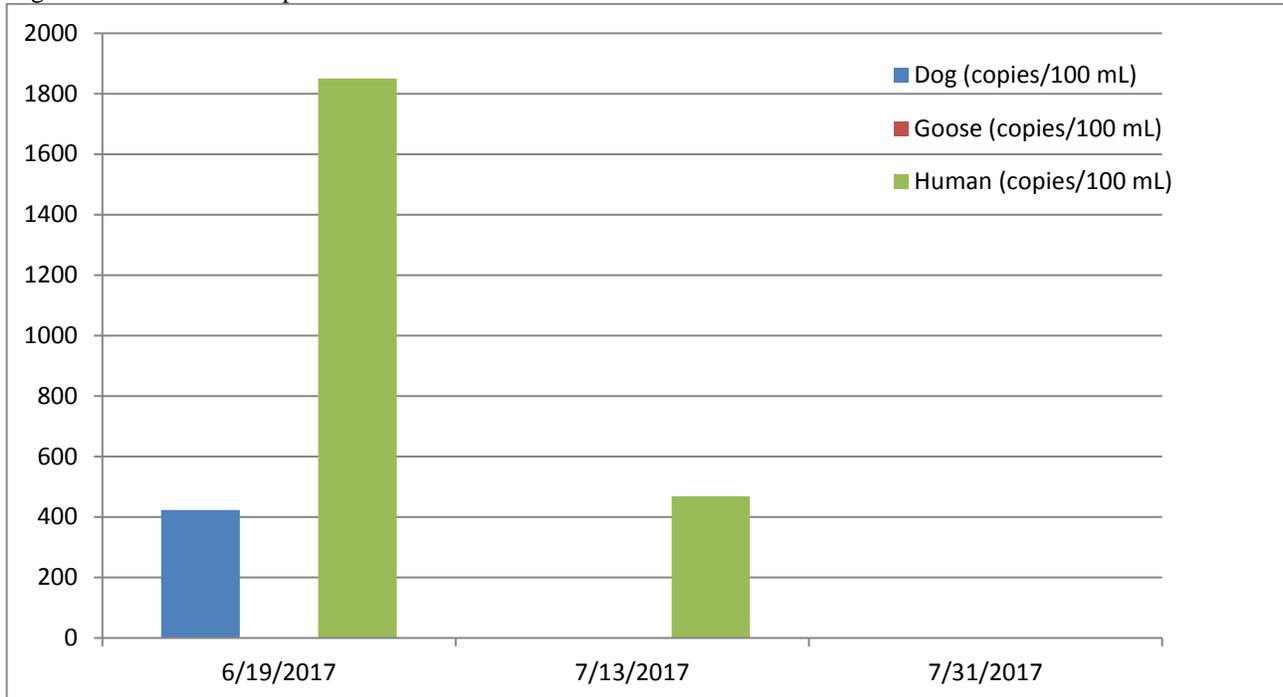


Figure 7 – DNA Gene Copies



## 2.4 Anti-Degradation Policy

2.4.1 Nutrients - Analytical results for Total Phosphorus and Nitrate/Nitrite show no need for further investigation to show support of the beneficial use. The number of samples collected exceeds the number of required samples, and less than 10% of samples exceeded the threshold for further sampling. While Nitrate/Nitrite concentrations have an action level, it is not a required parameter within the MS4 permit (ODEQ, OPDES Permit OKS000201, 2011).

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Threshold (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Phosphorus	0.04	na	0.24	12	10	No more than 10% of samples outside range
Nitrite - Nitrate	0.57	na	4.95	12	10	No more than 10% of samples outside range

Table 13 – Nutrient totals for Dirty Butter Creek

Figure 8 - Total Phosphorus Concentrations

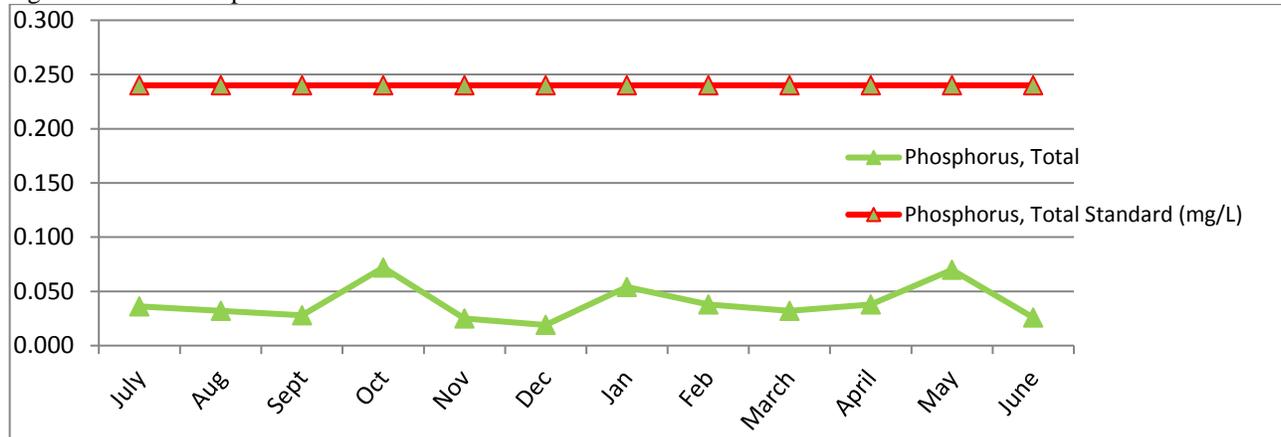
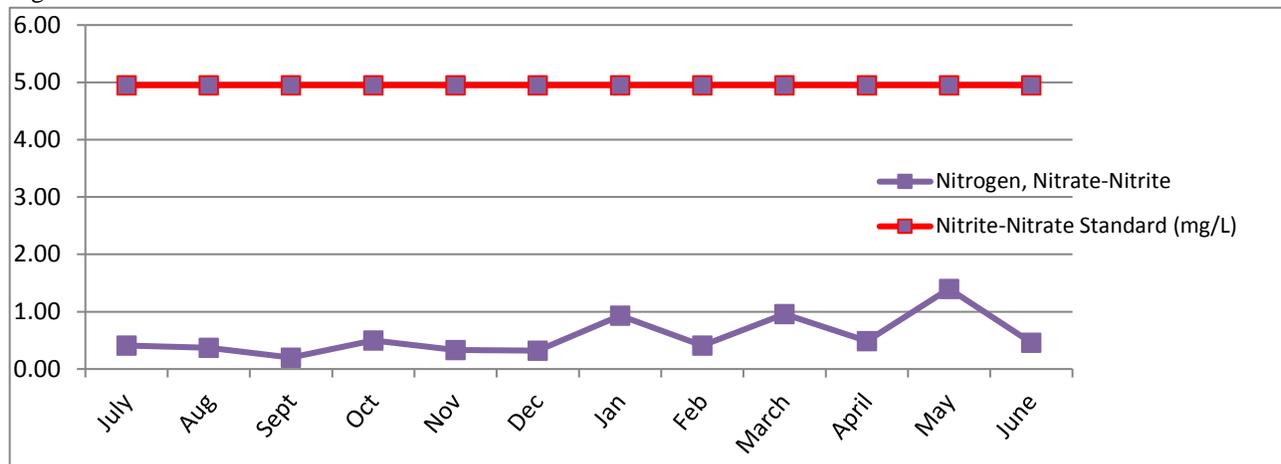


Figure 9 - Nitrate/Nitrite Concentrations



### 3.0 SUMMARY

Analytically, Dirty Butter Creek does not reflect any water quality impacts to the stream during the year of sampling with the exception of bacteria. DNA testing was performed to help determine the cause of impairment in regards to bacteria. The results showed that issues with sanitary sewer/septic tanks may need to be addressed. Fish collections reflected support of the beneficial use according to water quality standards. A disappointing benthic macroinvertebrate IBI score could be related to the lack of intolerant species which prevents support of the beneficial use. Overall, Dirty Butter Creek possesses all of the ingredients to support a thriving biological community, but the macroinvertebrate populations were not up to the expected standard.

Dirty Butter						
Parameter	Sample Mean	Single Sample	Water Quality Standard	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Cadmium (µg/L)	0.50	0.50	Acute: 54.43, Chronic: 1.58	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper (µg/L)	2.56	4.61	Acute: 28.65, Chronic: 18.40	12	5	
Lead (µg/L)	0.92	2.35	Acute: 140.30, Chronic: 5.47	12	5	
Zinc (µg/L)	14.78	26.80	Acute: 167.79, Chronic: 151.97	12	5	
E. coli (MPN/100ml)	163	Na	126	12	5	Geometric mean not exceeding standard
Enterococcus (MPN/100ml)	161	Na	33	12	5	Geometric mean not exceeding standard
Oil and Grease (visual)	none	Na	No visible sheen	12	10	No more than 10% of observations with oil & grease
Total Phosphorus (mg/L)	0.04	Na	0.24	12	10	No more than 10% of samples outside range
Nitrite – Nitrate (mg/L)	0.57	Na	4.95	12	10	No more than 10% of samples outside range
Total Dissolved Solids (mg/L)	269	490	Sample: 470, Yearly: 387	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard
pH (s.u.)	7.5 – 7.9	Na	6.5-9.0	12	10	No more than 10% of samples outside range
Turbidity (NTU)	8.14	38.00	50	12	10	No more than 10% of samples outside of range
D.O. (mg/L)	0 samples below 4.0	na	April - June: 4.0	3	10 total	No more than 10% of samples outside range
	0 samples below 3.0	na	June - Mar: 3.0	9		
*Analytes in italics not required by permit Analytes in red exceed standards						

Table 14 – Oklahoma Water Quality Standards summary of collected data

Analyte	Result			Number of Samples	Number of Attempts
	Minimum	Mean	Maximum		
Cadmium, Total (µg/L) (DL 0.5 µg/L)	--	0.50	0.50	12	12
Copper, Total (µg/L) (DL 0.5 µg/L)	--	2.56	4.61	12	12
<i>E. coli</i> (MPN/100 mL) (DL 1 MPN/100 mL)	--	163	580	12	12
<i>Enterococcus</i> (MPN/100 mL)(DL 1 CFU/100 mL)	--	161	2400	12	12
Hardness, Total (mg/L) (DL 3.6 mg/L)	130	173	320	12	12
Lead, Total (µg/L) (DL 0.5 µg/L)	--	0.92	2.35	12	12
Nitrogen, Nitrate-Nitrite (mg/L) (DL 0.2 mg/L)	--	0.57	1.40	12	12
Nitrogen, Total Kjeldahl (mg/L)(DL 0.50 mg/L)	--	0.54	0.75	12	12
Nitrogen, Total as Nitrogen (mg/L)(DL 0.50 mg/L)	--	0.66	1.30	12	12
Phosphorus, Dissolved (mg/L) (DL 0.010 mg/L)	--	0.02	0.03	12	12
Phosphorus, Total (mg/L) (DL 0.010 mg/L)	--	0.04	0.07	12	12
Solids, Total Dissolved (mg/L) (DL 10 mg/L)	--	269	490	12	12
Solids, Total Suspended (mg/L) (DL 2.0 mg/L)	--	7.48	26.00	12	12
Zinc, Total (µg/L) (DL 10 µg/L)	--	14.78	26.80	12	12
Water Temperature (°C)	3.70	16.84	28.00	12	12
pH (su)	7.50	--	7.90	12	12
Flow (cfs)	2.19	3.67	9.36	12	12
Turbidity (NTU)	--	8.14	38.00	12	12
Results found to be below the detection limit are reported as the detection limit					

Table 15 – MS4 permit required analytical sampling parameters result summaries

ANALYTE	Date Sampled											
	7/18/16	8/4/16	9/12/16	10/12/16	11/17/16	12/14/16	1/17/17	2/21/17	3/20/17	4/20/17	5/22/17	6/20/17
Cadmium, Total (BDL 0.5) µg/L	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Copper, Total (BDL 0.5) µg/L	1.93	2.16	3.78	4.08	1.05	1.04	4.61	4.53	1.89	2.12	1.77	1.81
Hardness, Total (BDL 3.6) mg/L	150	130	130	230	140	130	170	160	150	200	320	170
Lead, Total (BDL 0.5) µg/L	0.735	0.678	0.575	2.19	0.50	0.50	2.35	1.03	0.50	1.040	0.50	0.50
Nitrogen, Kjeldahl, Total (BDL 0.50) mg/L	0.75	0.55	0.50	0.50	0.50	0.50	0.66	0.50	0.50	0.50	0.50	0.50
Nitrogen, Nitrate-Nitrite (BDL 0.2) mg/L	0.41	0.37	0.20	0.50	0.33	0.32	0.93	0.41	0.96	0.49	1.40	0.46
Nitrogen, Total as N (BDL 0.5) mg/L	0.41	0.90	0.50	0.50	0.50	0.50	0.90	0.50	0.94	0.49	1.30	0.50
pH (s.u.)	7.90	7.80	7.70	7.50	7.73	7.78	7.70	7.60	7.80	7.50	7.60	7.53
Phosphorus, Total (BDL 0.010) mg/L	0.036	0.032	0.028	0.072	0.025	0.019	0.054	0.038	0.032	0.038	0.070	0.026
Phosphorus, Total Dissolved BDL (0.010) mg/L	0.026	0.025	0.023	0.027	0.027	0.016	0.032	0.019	0.029	0.023	0.019	0.016
Solids, Total Dissolved (BDL 10) mg/L	250	200	190	200	230	210	300	260	320	340	490	240
Solids, Total Suspended (BDL 2.0) mg/L	2.8	6	3.6	26	2.4	2.4	12	15	5.6	7	3.2	3.8
Temperature, Water °C	27	28	22	20	14.99	3.7	6.5	11	8.9	20	18	22
Turbidity (NTU)	4.00	4.50	3.70	38.00	3.64	2.98	16.00	8.80	1.90	5.90	3.90	4.30
Zinc, Total (BDL 10) µg/L	12.00	12.20	11.60	17.50	10.00	10.00	26.80	15.80	12.50	14.10	19.00	15.80
Flow CFS	3.12	2.8	2.41	2.19	2.23	2.69	3.83	3.84	2.85	5.44	9.36	3.29
Conductivity µS	287	400	340	250	284	199	330	350	390	530	660	420
Dissolved Oxygen mg/L	5.91	6.45	5.73	6.87	9.94	14.90	10.59	8.46	5.81	5.20	7.36	6.74
Results found to be below the detection limit are reported as the detection limit												

Table 16 – Complete analytical sampling results for all parameters

ANALYTE	Date Sampled											
	7/18/16	8/11/16	8/31/16	9/12/16	9/14/16	9/22/16	5/25/17	6/5/17	6/12/17	6/19/17	7/13/17	7/31/17
<i>E. coli</i> (BDL 1) MPN/100mL	370	580	230	130	210	490	310	55	46	260	59	45
<i>Enterococcus</i> (BDL 1) MPN/100 mL	208	98.4	42	69	210	170	550	150	16	2400	550	81
Results found to be below the detection limit are reported as the detection limit												

Table 17 – Complete analytical results for bacteria samples

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**Save  
Our  
Streams**

## **CITY OF TULSA WATERSHED CHARACTERIZATION PROGRAM**

**Comprehensive Watershed Characterization  
Assessment Year 1 (2016-2017):**

### **FLAT ROCK CREEK**

City of Tulsa Streets and Stormwater  
Stormwater and Land Management Division  
4502 South Galveston  
Tulsa, OK 74107

Prepared by

Jessica Bootenhoff  
Senior Environmental Monitoring Technician  
Watershed Characterization Project

**September 19, 2017**

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## 1.0 INTRODUCTION

### 1.1 Objective

The purpose of this document is to serve as a comprehensive report of results from the biological, habitat, and analytical assessments of Flat Rock Creek. These assessments were performed in order to comply with requirements set forth in Part II(A)(13)(12)(b) and (13)(a) and (b) and Part IV(A)(1) and (2) of Oklahoma Pollutant Discharge Elimination System (OPDES) municipal stormwater (MS4) Permit No. OKS000201 for the City of Tulsa, Oklahoma (ODEQ, OPDES Permit OKS000201, 2011). In addition, assessment results are applied to Oklahoma Water Quality Standards. These standards are described in both (OWRB, 2013a) and (OWRB, 2013b). Where applicable, reference conditions will not be established until the conclusion of the current permit. Until such references are established, those standards will result in an “insufficient data” designation with regards to support within the Fish and Wildlife propagation beneficial use. While these implementations describe a multitude of surface water quality standards, this document will compare and describe only the standards applicable to the parameters required in the Watershed Characterization Program sub section of the Municipal Separate Storm Sewer System permit (ODEQ, OPDES Permit OKS000201, 2011). All remaining parameter results without applicable water quality standards will still be included in this report.

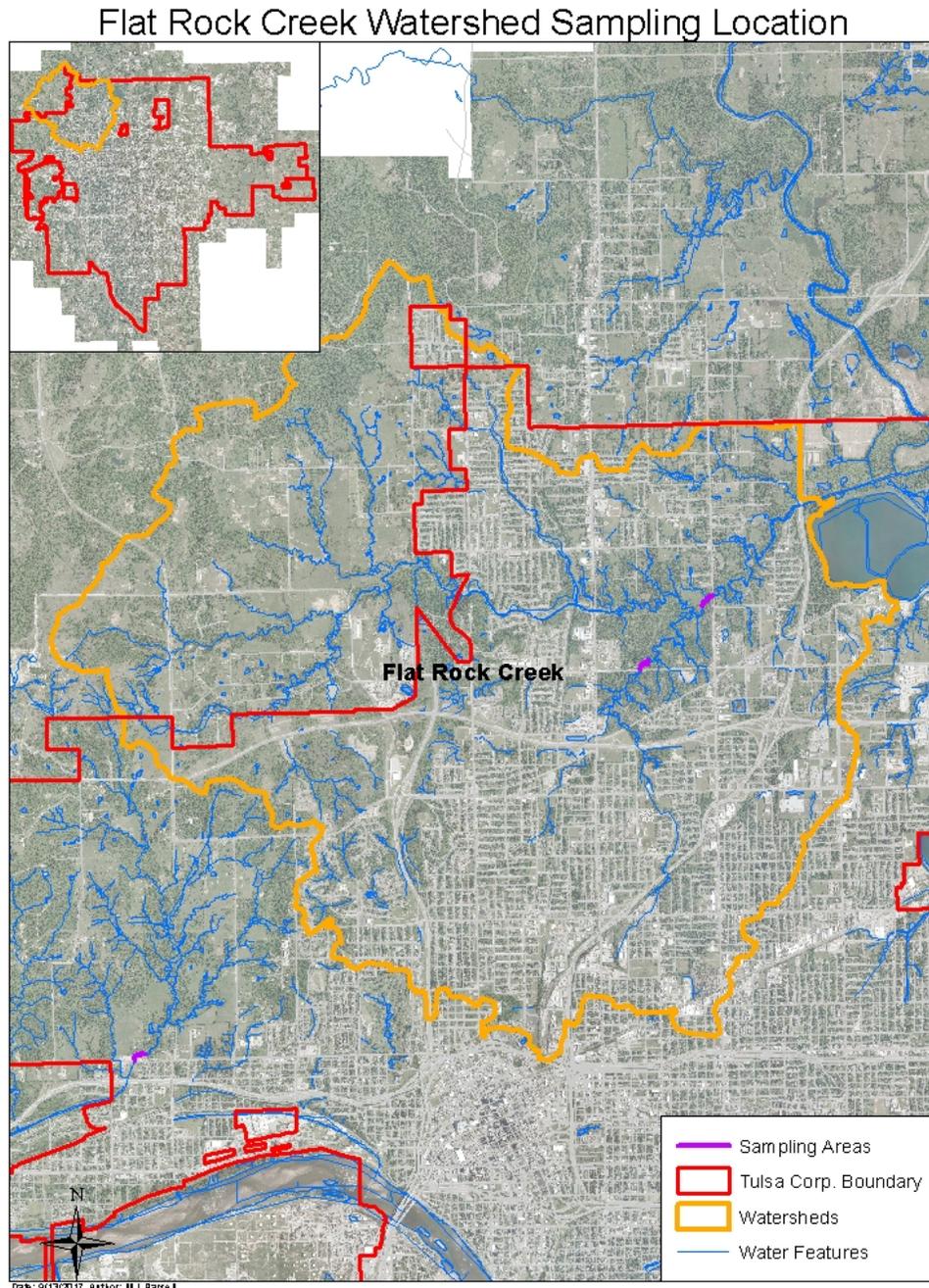
The data presented in this comprehensive report was collected over a one year period beginning in July of 2016 with completion in June of 2017. Field collection and assessment methodology followed project standard operating procedures (SOPs) as provided in the quality assurance project plans (QAPPs) for the biological component (CCRC & FTN, 2014) and the analytical component (CCRC & FTN, 2014). These QAPPs provide quality assurance and quality control procedures for all aspects of the watershed characterization program. They were submitted to and received approval from the Oklahoma Department of Environmental Quality as per MS4 permit requirements. All field data sheets were scanned electronically and archived at the City of Tulsa Stormwater and Land Management Division. All field measurements (in situ measurements, flows, observations), biological information (taxonomic identification, organism counts), and analytical results were compiled in Excel spreadsheets and verified (data entry, formula calculations) per project QA/QC procedures (CCRC & FTN, 2014) (CCRC & FTN, 2014). All raw data, SOPs, and QAPPs are available upon request.

**Flat Rock Creek**  
**WBID: OK121300010120\_00**

Figure 1 - Sampling location on Flat Rock Creek during Year 1

Waterbody	Sample Location		Watershed Area (mi <sup>2</sup> )*	Sampling/Evaluation Date			
	Latitude	Longitude		Fish	Benthic (Summer)	Benthic (Winter)	Habitat
Flat Rock	36.214762	-95.958248	21.25	10/18/2016	06/24/2016	02/08/2017	05/16/2017

\* Collection area captured by sampling point



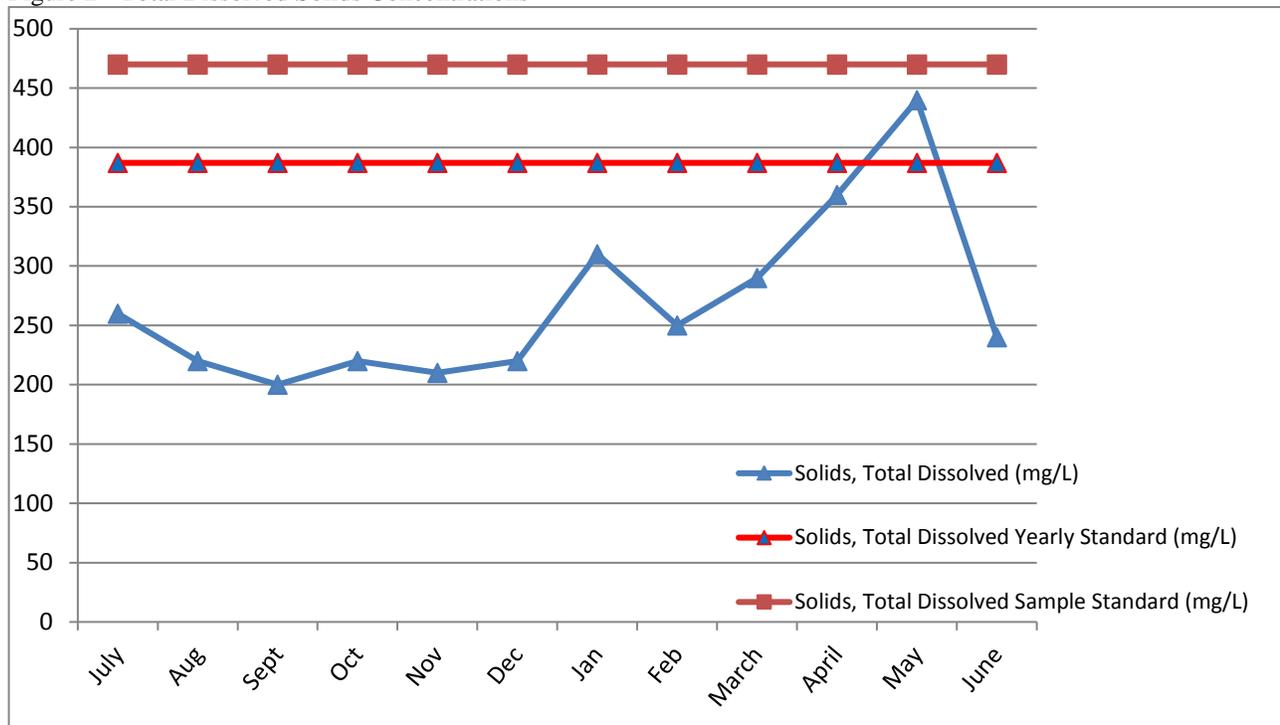
## 2.0 BENEFICIAL USES

**2.1 Agriculture** - Data collected on Total Dissolved Solids for Flat Rock Creek indicates attainment of the agricultural beneficial use. The number of samples collected exceeds the number of samples required. The sample mean does not exceed the yearly standard and none of the samples exceeded the sample standard.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Dissolved Solids	268	440	Sample: 470, Yearly: 387	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard

Table 1 – Agriculture standards for Flat Rock Creek

Figure 2 - Total Dissolved Solids Concentrations



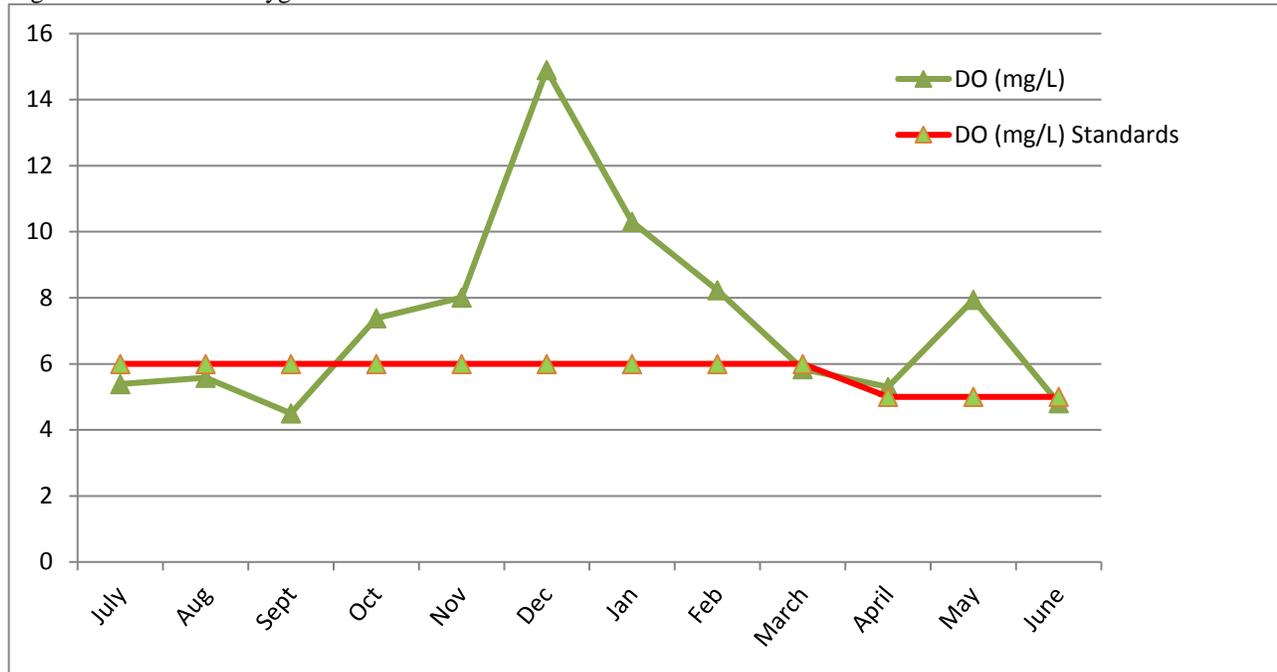
## 2.2 Fish and Wildlife Propagation: Warm Water Aquatic Community

**2.2.1 Dissolved Oxygen** - Data collected on Dissolved Oxygen concentrations shows the beneficial use is not supported. The number of samples collected exceeds the number of required samples. Out of 12 samples, there were 5 samples found to be below the standard. Therefore, more than 10% of the samples were outside the standard range.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
D.O.	1 samples below 5.0	na	April - June: 5.0	2	10 total	No more than 10% of samples outside range
	4 samples below 6.0	na	June - Mar: 6.0	10		

Table 2 – Dissolved Oxygen standards for Flat Rock Creek

Figure 3 - Dissolved Oxygen Concentrations



**2.2.2 Toxicants/Metals** - Data collected indicate full support of the beneficial use for Toxicants and Metals.

<u>Parameter</u>	<u>Sample Mean (µg/L)</u>	<u>Single Sample (µg/L)</u>	<u>Water Quality Standard (µg/L)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Cadmium	0.50	0.5	Acute: 54.43, Chronic: 1.58	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper	2.07	3.97	Acute: 28.65, Chronic: 18.40	12	5	
Lead	0.81	2.06	Acute: 140.30, Chronic: 5.47	12	5	
Zinc	13.19	23.90	Acute: 167.79, Chronic: 151.97	12	5	

Table 3 – Toxicants/Metals standards for Flat Rock Creek

**2.2.3 pH (Hydrogen Ion Activity)** - Data collected on pH readings for Flat Rock Creek show full support of the beneficial use. The number of pH measurements taken exceeds the number of required measurements. All pH measurements fell within the standard range.

<u>Parameter</u>	<u>Sample Range (s.u.)</u>	<u>Single Sample (s.u.)</u>	<u>Water Quality Standard Range (s.u.)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
pH	7.5 – 7.9	na	6.5-9.0	12	10	No more than 10% of samples outside range

Table 4 – pH standards for Flat Rock Creek

**2.2.4 Oil and Grease** - Oil and Grease is based on visual assessment. Visual observations do not indicate the presence of Oil and Grease pollution, supporting the beneficial use.

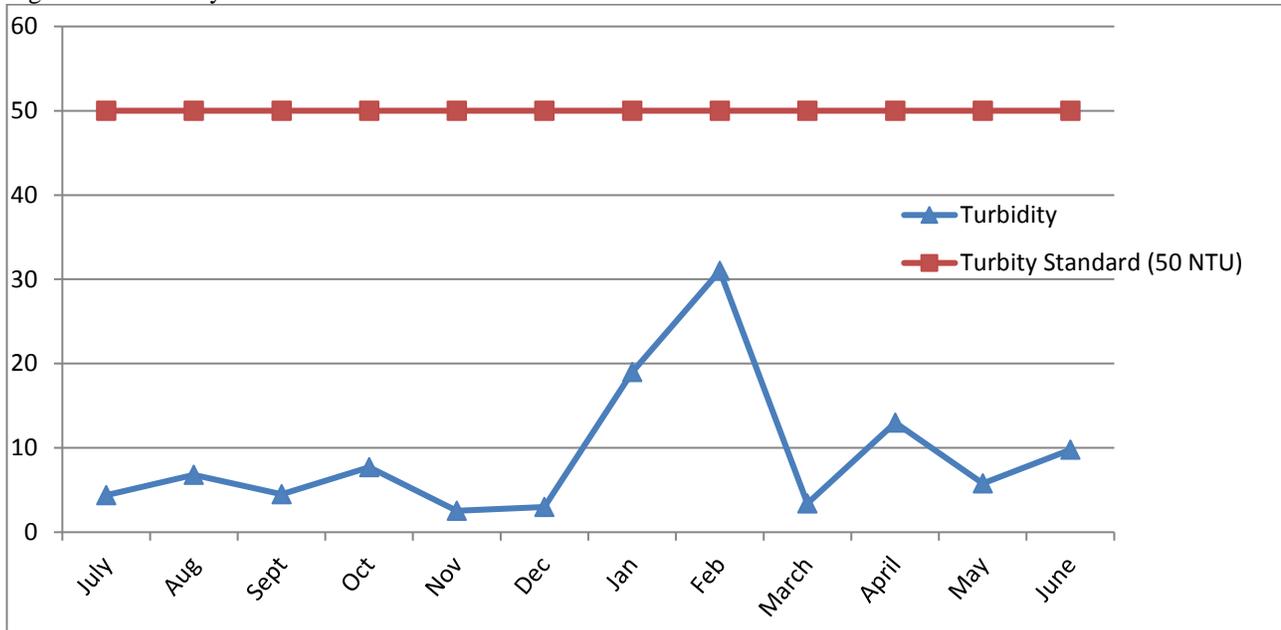
**2.2.5 Suspended and Bedded Sediments** - Using habitat assessment data to determine support of the beneficial use is conditional upon the support of Turbidity data and fish collection data.

**2.2.5.1 Turbidity** – Data collected on turbidity readings for Flat Rock Creek show full support of the beneficial use.

Parameter	Sample Mean (NTU)	Single Sample (NTU)	Water Quality Standard (NTU)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Turbidity	9.24	31.00	50	12	10	No more than 10% exceeding sample standard

Table 5 – Turbidity standards for Flat Rock Creek

Figure 4 – Turbidity Concentrations



**2.2.5.2 Habitat Assessment** – The resulting score of the habitat assessment on Flat Rock Creek can be compared to the average score of high quality sites within the same ecoregion provided by the Oklahoma Conservation Commission using a scoring workbook derived from OWRB (OWRB, 2001). The results of the habitat assessment produce a score above average for the central irregular plains ecoregion.

Metric	Score
Instream habitat	19.6
Pool bottom substrate	10.8
Pool variability	15.9
Canopy cover	20.0
Presence of rocky runs and riffles	15.6
Flow (at representative low flow)	4.8
Channel alteration	13.7
Channel sinuosity	3.2
Bank stability	5.8
Bank vegetation stability	1.3
Stream side Cover	3
<b>Total Score</b>	<b>113.70</b>
<b>Central Irregular Plains Mean Score</b>	<b>84.09</b>

Table 6 – Habitat assessment metric and total results with ecoregion mean score

**2.2.6 Biological**

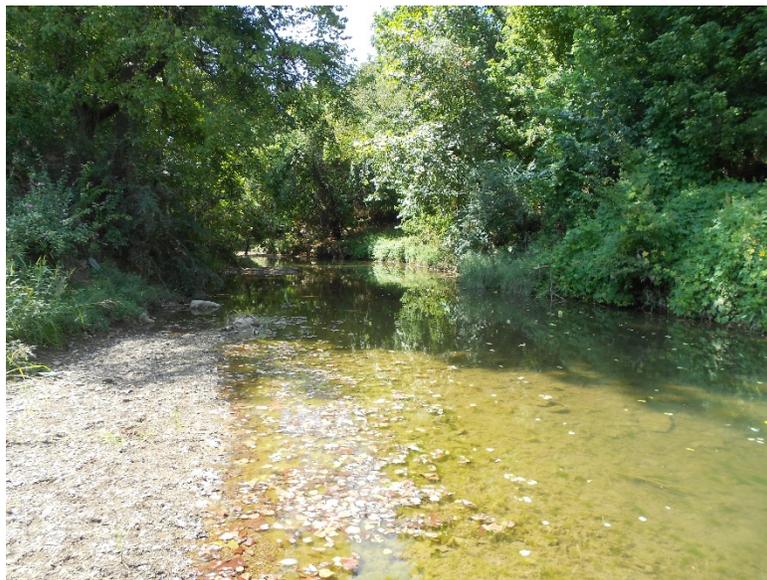
**2.2.6.1 Fish Collections** - Data recorded from Fish collections performed on Flat Rock Creek show that the beneficial use is supported.

Index of Biotic Integrity		5	3	1	Score
Sample Composition	Total no. of species	See Figure 1, OAC 785: CH. 46			5
	Shannon's diversity	> 2.50	2.49 - 1.50	< 1.50	3
	No. of sunfish sp.	>3	2 - 3	< 2	5
	No. of sp. Comprising 75% of sample	> 5	4 - 3	< 3	3
	No. of intolerant species	> 5	3 - 5	< 3	3
	Percentage of tolerant species	See Figure 3, OAC 785: CH. 46			1
Fish Condition	Percentage of lithophils	> 36	18 - 36	< 18	5
	Percentage of DELT anomalies	< 0.1	0.1 - 1.3	> 1.3	5
	Fish Numbers (total individuals)	> 200	200 - 75	< 75	5
Score Key: 30 + Beneficial Use Supported : 23 - 29 Undetermined : < 22 Impaired				Total	35

Table 7 – Fish IBI score for Flat Rock Creek

Family	Species Name	Common Name	Number of Fish	Percentage
Ictaluridae	<i>Ameiurus natalis</i>	Yellow bullhead catfish	67	6.72%
	<i>Ictalurus punctatus</i>	Channel catfish	7	0.70%
	<i>Noturus nocturnus</i>	Freckled madtom	7	0.70%
Centrarchidae	<i>Lepomis cyanellus</i>	Green sunfish	38	3.8%
	<i>Lepomis microlophus</i>	Redear sunfish	1	0.1%
	<i>Lepomis megalotis</i>	Longear sunfish	112	11.2%
	<i>Lepomis macrochirus</i>	Bluegill sunfish	27	2.7%
	<i>Lepomis gulosus</i>	Warmouth sunfish	9	0.9%
	<i>Lepomis humilis</i>	Orangespotted sunfish	5	0.5%
	<i>Lepomis YOY</i>	YOY sunfish	14	1.4%
	<i>Micropterus salmoides</i>	Largemouth bass	2	0.2%
Cyprinidae	<i>Camptostoma anomalum</i>	Central stoneroller	211	21.2%
	<i>Cyprinella humilis</i>	Red shiner	18	1.8%
	<i>Phenacobius mirabilis</i>	Suckermouth minnow	1	0.1%
	<i>Pimephales notatus</i>	Bluntnose minnow	284	28.5%
Percidae	<i>Etheostoma spectabile</i>	Orangethroat darter	134	13.4%
	<i>Percina caprodes</i>	Common logperch	8	0.8%
Catostomidae	<i>Moxostoma duquesnei</i>	Black redhorse	2	0.2%
Atherinospsidae	<i>Labidesthes sicculus</i>	Brook silverside	21	2.1%
Poeciliidae	<i>Gambusia affinis</i>	Mosquitofish	29	2.9%
<b>Total Number:</b>			997	100.00%
<b>Total Number of Taxa:</b>			20	

Table 8 – Fish collection counts for Flat Rock Creek



^Photograph taken of the Flat Rock Creek sample site

**2.2.6.2 Benthic Macroinvertebrate Collections** – Data recorded from benthic macroinvertebrate collection during the summer and winter index periods collections is undetermined (ODEQ, Continuing Planning Process, 2012). Scores were above average in the richness of taxa, but low in percent dominance of any two families. Analytical data and habitat assessments do not reflect any water quality impacts. Further sampling may show improvements.

Sampling protocol to determine attainment of water quality standards, (ODEQ, Water Quality in Oklahoma Integrated Report, 2014) requires a minimum of four sampling events within a two year period. Further sampling will be implemented to determine support.

Metric	6	4	2	0	Score
Taxa Richness	94%				6
Modified HBI	85%				6
EPT/Total	43%				6
EPT Taxa			72%		2
% Dominant 2 Taxa				46%	0
Shannon - Weaver			2.2		2
Flat Rock - Summer (Central Irregular Plains): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				71%

Metric	6	4	2	0	Score
Taxa Richness	90%				6
Modified HBI		76%			4
EPT/Total	72%				6
EPT Taxa				39%	0
% Dominant 2 Taxa				77%	0
Shannon - Weaver				1.3	0
Flat Rock - Winter (Central Irregular Plains): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				59%

Table 9 – Benthic macroinvertebrate metrics for summer and winter index periods at Flat Rock Creek

Phylum	Class	Order	Family	Genus	Common Class	6/24/2015	
						Count	%
Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Acerpenna</i> sp.	Minnow Mayfly	1	0.9%
				<i>Fallceon quilleri</i>	Minnow Mayfly	25	21.6%
			Caenidae	<i>Caenis</i> sp.	Squaregilled Mayfly	5	4.3%
			Heptageniidae	<i>Stenonema femoratum</i>	Flathead mayfly	2	1.7%
		Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	Netspinner Caddisfly	17	14.7%
		Coleoptera	Elmidae	<i>Stenelmis</i> sp.	Riffle Beetle	8	6.9%
		Megaloptera	Corydalidae	<i>Corydalis</i> sp.	Dobsonfly	3	2.6%
		Diptera	Chironomidae	<i>Polypedilum flavum</i>	Midge	29	25.0%
				<i>Polypedilum illinoense</i> gr.		6	5.2%
				<i>Polypedilum scalaenum</i> gr.		1	0.9%
				<i>Rheotanytarsus exiguus</i> gr.		2	1.7%
				<i>Tanytarsus</i> sp.		11	9.5%
				<i>Thienemannimyia</i> gr. sp.		4	3.4%
		<i>Zavrelimyia</i> sp.	2	1.7%			
<b>Flat Rock Creek Summer Index Period</b>					Total	116	100.0%
					Total Number of Taxa	14	

Phylum	Class	Order	Family	Genus	Common Class	2/8/2017	
						Count	%
Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Callibaetis</i> sp.	Minnow Mayfly	1	1.0%
			Caenidae	<i>Canis</i> sp.	Squaregilled Mayfly	70	70.7%
		Coleoptera	Elmidae	<i>Stenemis</i> sp.	Riffle Beetle	6	6.1%
		Diptera	Chironomidae	<i>Cricotopus bicinctus</i> gr.	Midge	1	1.0%
				<i>Cricotopus</i> sp.		6	6.1%
				<i>Cricotopus/Orthocladius</i> sp.		2	2.0%
				<i>Cryptochironomus</i> sp.		1	1.0%
				<i>Dicrotendipes fumidus</i>		1	1.0%
				<i>Phaenopsectra</i> sp.		1	1.0%
				<i>Polypedilum scalaenum</i> gr.		3	3.0%
				<i>Pseudochironomus</i> sp.		1	1.0%
				<i>Tanytarsus</i> sp.		2	2.0%
		<i>Thienemannimyia</i> gr. sp.	2	2.0%			
				Tipulidae	Large Crane Fly	1	1.0%
Mollusca	Gastropoda	Pulmonata	Lymnaeidae	Lung Snail	1	1.0%	
<b>Flat Rock Creek Winter Index Period</b>					Total	99	100.0%
					Total Number of Taxa	15	

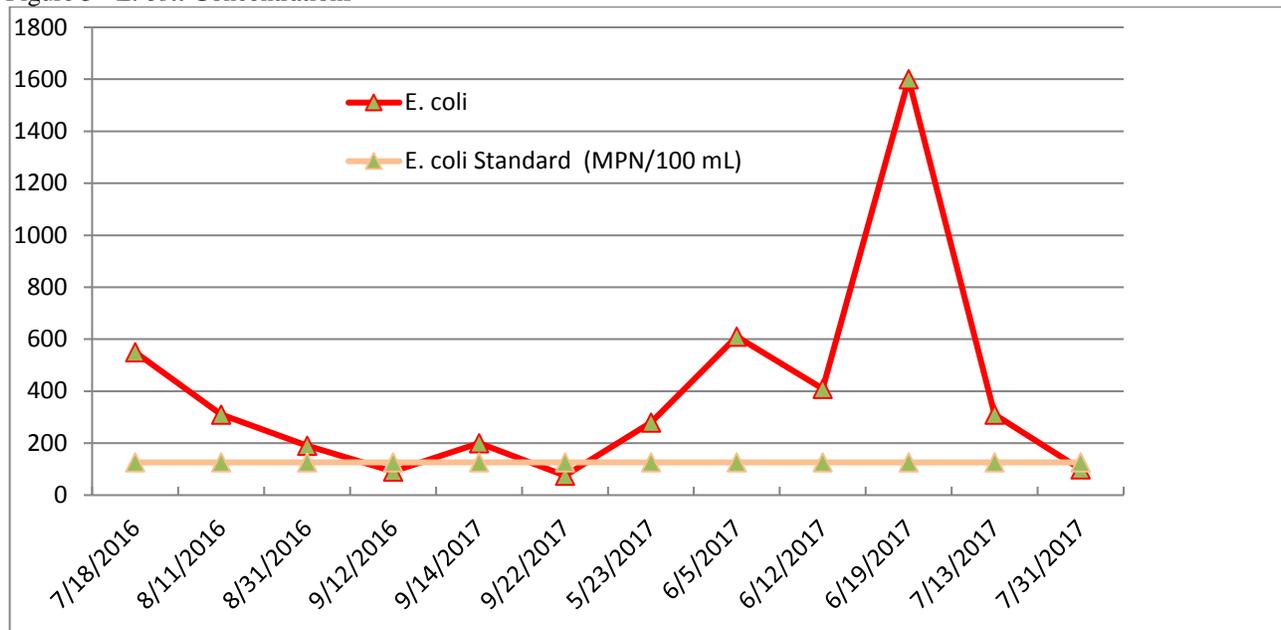
Table 10 – Benthic macroinvertebrate counts for Flat Rock Creek summer and winter index periods

**2.3 Primary Body Contact** - The data collected on *E. coli* concentrations show that Flat Rock Creek is impaired for both *E. coli* and *Enterococcus*. The number of samples collected exceeds the number of samples required. Due to high bacteria results, 3 DNA samples were taken at minimum 7 days apart to help further illustrate the source of impairment. The results of the DNA testing indicate that the primary problem could be caused by pet waste not being picked up and properly disposed of.

<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>E. coli</i>	271	na	126	12	5	Geometric mean not exceeding standard

Table 11 – *E. coli* totals for Flat Rock Creek

Figure 5 - *E. coli* Concentrations



<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>Enterococcus</i>	162	na	33	12	5	Geometric mean not exceeding standard

Table 12 – *Enterococcus* totals for Flat Rock Creek

Figure 6 – *Enterococcus* Concentrations

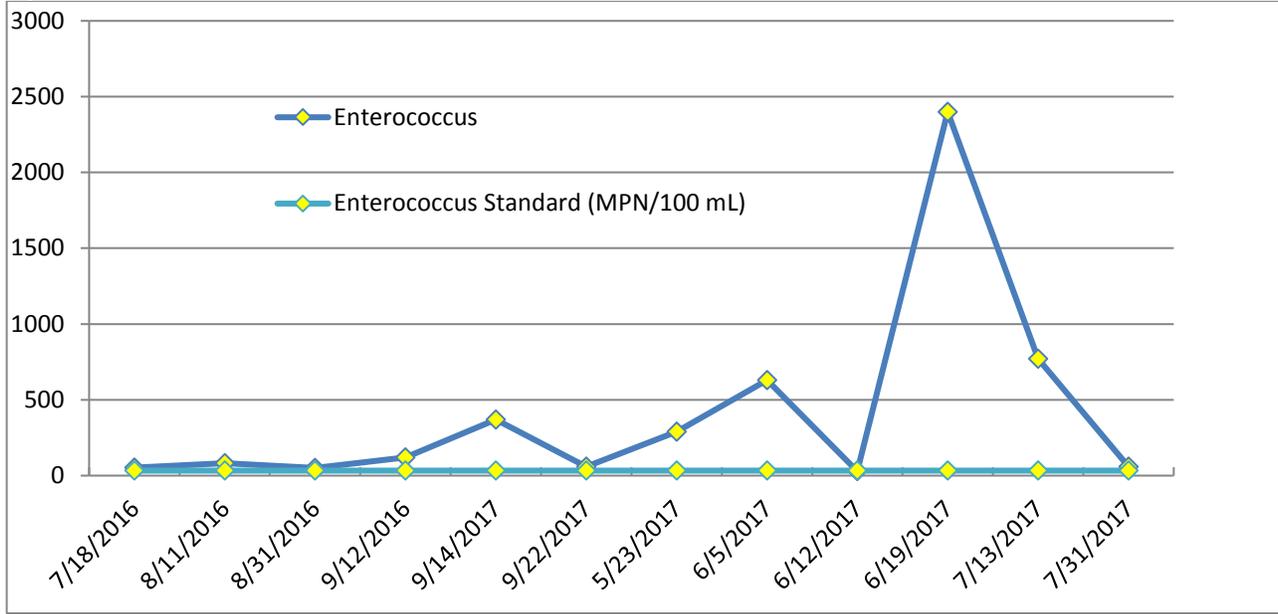
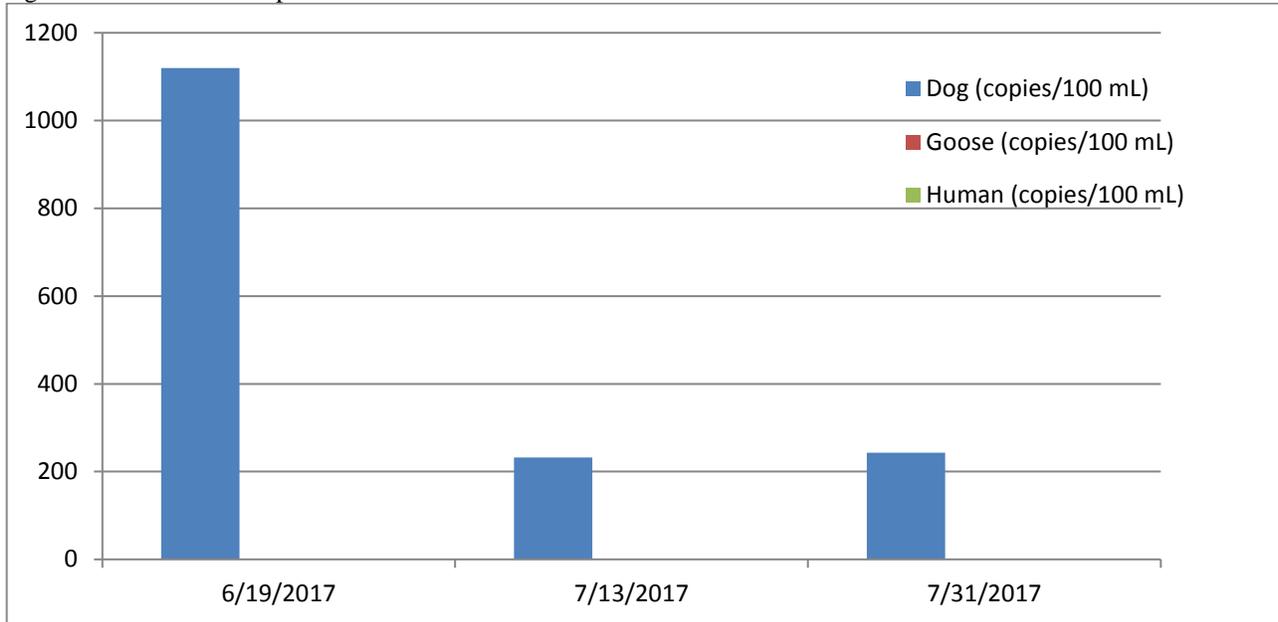


Figure 7 – DNA Gene Copies



## 2.4 Anti-Degradation Policy

2.4.1 Nutrients - Analytical results for Total Phosphorus and Nitrate/Nitrite show no need for further investigation to show support of the beneficial use. The number of samples collected exceeds the number of required samples, and less than 10% of samples exceeded the threshold for further sampling. While Nitrate/Nitrite concentrations have an action level, it is not a required parameter within the MS4 permit (ODEQ, OPDES Permit OKS000201, 2011).

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Threshold (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Phosphorus	0.04	na	0.24	12	10	No more than 10% of samples outside range
Nitrite - Nitrate	0.35	na	4.95	12	10	No more than 10% of samples outside range

Table 13 – Nutrient totals for Flat Rock Creek

Figure 8 - Total Phosphorus Concentrations

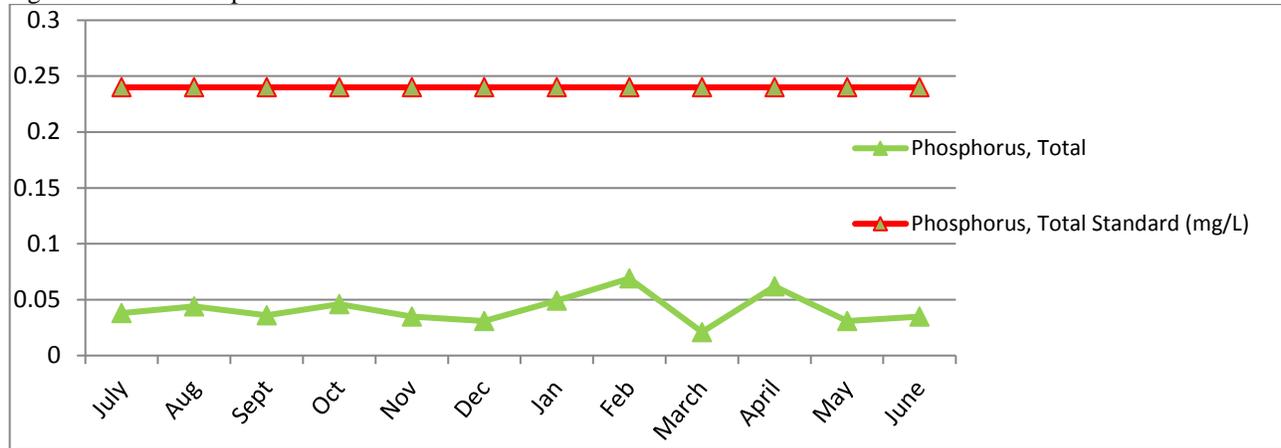
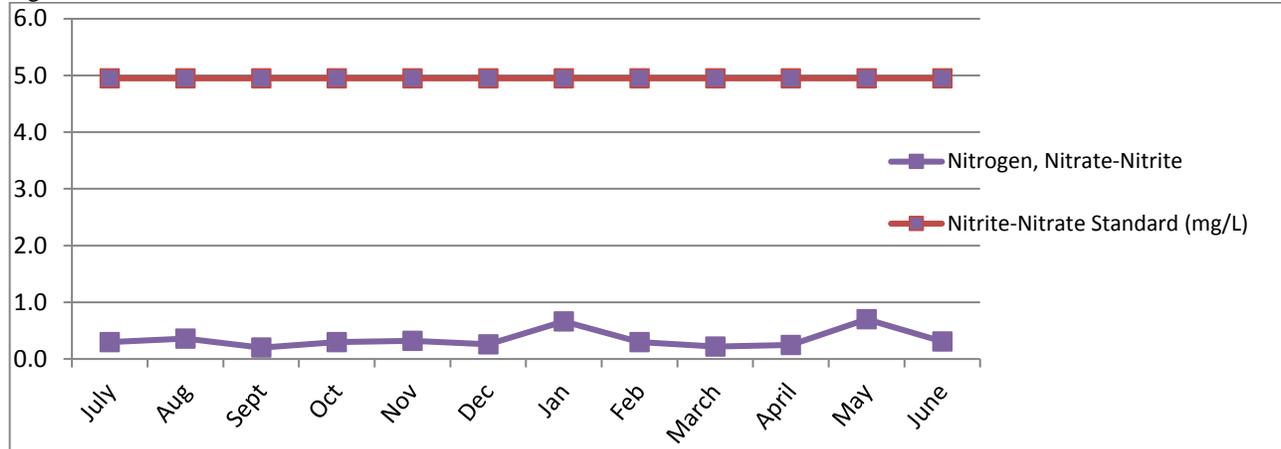


Figure 9 - Nitrate/Nitrite Concentrations



### 3.0 SUMMARY

Analytically, Flat Rock Creek does not reflect any water quality impacts to the stream during the year of sampling with the exception of dissolved oxygen and bacteria. DNA testing was performed to help determine the cause of impairment in regards to bacteria. The results showed that a continued push in public education addressing proper disposal of pet waste could be beneficial. Fish collections reflected a support of beneficial use according to water quality standards. A disappointing benthic macroinvertebrate IBI score could be related to the lack of intolerant species which prevents support of the beneficial use. Overall, Flat Rock Creek possesses all of the ingredients to support a thriving biological community, but the macroinvertebrate populations were not up to the expected standard.

Flat Rock						
Parameter	Sample Mean	Single Sample	Water Quality Standard	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Cadmium (µg/L)	0.50	0.50	Acute: 54.43, Chronic: 1.58	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper (µg/L)	2.07	3.97	Acute: 28.65, Chronic: 18.40	12	5	
Lead (µg/L)	0.81	2.06	Acute: 140.30, Chronic: 5.47	12	5	
Zinc (µg/L)	13.19	23.90	Acute: 167.79, Chronic: 151.97	12	5	
E. coli (MPN/100ml)	271	Na	126	12	5	Geometric mean not exceeding standard
Enterococcus (MPN/100ml)	162	Na	33	12	5	Geometric mean not exceeding standard
Oil and Grease (visual)	none	Na	No visible sheen	12	10	No more than 10% of observations with oil & grease
Total Phosphorus (mg/L)	0.04	Na	0.24	12	10	No more than 10% of samples outside range
Nitrite – Nitrate (mg/L)	0.35	Na	4.95	12	10	<i>No more than 10% of samples outside range</i>
Total Dissolved Solids (mg/L)	268	440	Sample: 470, Yearly: 387	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard
pH (s.u.)	7.5 – 7.9	Na	6.5-9.0	12	10	No more than 10% of samples outside range
Turbidity (NTU)	9.24	31.00	50	12	10	No more than 10% of samples outside of range
D.O. (mg/L)	1 samples below 5.0	na	April - June: 5.0	2	10 total	<i>No more than 10% of samples outside range</i>
	4 samples below 6.0	na	June - Mar: 6.0	10		
*Analytes in italics not required by permit Analytes in red exceed standards						

Table 14 – Oklahoma Water Quality Standards summary of collected data

Analyte	Result			Number of Samples	Number of Attempts
	Minimum	Mean	Maximum		
Cadmium, Total (µg/L) (DL 0.5 µg/L)	--	0.50	0.50	12	12
Copper, Total (µg/L) (DL 0.5 µg/L)	--	2.07	3.97	12	12
<i>E. coli</i> (MPN/100 mL) (DL 1 MPN/100 mL)	--	271	1600	12	12
<i>Enterococcus</i> (MPN/100 mL)(DL 1 CFU/100 mL)	--	162	2400	12	12
Hardness, Total (mg/L) (DL 3.6 mg/L)	130	154	250	12	12
Lead, Total (µg/L) (DL 0.5 µg/L)	--	0.81	2.06	12	12
Nitrogen, Nitrate-Nitrite (mg/L) (DL 0.2 mg/L)	--	0.35	0.70	12	12
Nitrogen, Total Kjeldahl (mg/L)(DL 0.50 mg/L)	--	0.57	0.93	12	12
Nitrogen, Total as Nitrogen (mg/L)(DL 0.50 mg/L)	--	0.55	1.20	12	12
Phosphorus, Dissolved (mg/L) (DL 0.010 mg/L)	--	0.03	0.04	12	12
Phosphorus, Total (mg/L) (DL 0.010 mg/L)	--	0.04	0.07	12	12
Solids, Total Dissolved (mg/L) (DL 10 mg/L)	--	268	440	12	12
Solids, Total Suspended (mg/L) (DL 2.0 mg/L)	--	7.93	40.00	12	12
Zinc, Total (µg/L) (DL 10 µg/L)	--	13.19	23.90	12	12
Water Temperature (°C)	3.70	17.91	27.60	12	12
pH (su)	7.50	--	7.90	12	12
Flow (cfs)	1.06	3.81	11.90	12	12
Turbidity (NTU)	--	9.24	31.00	12	12
Results found to be below the detection limit are reported as the detection limit					

Table 15 – MS4 permit required analytical sampling parameters result summaries

ANALYTE	Date Sampled											
	7/19/16	8/9/16	9/7/16	10/12/16	11/17/16	12/14/16	1/18/17	2/21/17	3/20/17	4/20/17	5/25/17	6/20/17
Cadmium, Total (BDL 0.5) µg/L	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Copper, Total (BDL 0.5) µg/L	2.01	2.32	2.01	1.64	1.61	1.62	2.09	3.97	1.32	2.21	1.59	2.48
Hardness, Total (BDL 3.6) mg/L	150	140	130	130	140	140	170	130	150	170	250	150
Lead, Total (BDL 0.5) µg/L	0.596	0.51	0.5	0.648	0.5	1.71	0.783	2.06	0.5	0.78	0.5	0.6
Nitrogen, Kjeldahl, Total (BDL 0.50) mg/L	0.75	0.5	0.5	0.5	0.5	0.62	0.5	0.55	0.5	0.93	0.5	0.5
Nitrogen, Nitrate-Nitrite (BDL 0.2) mg/L	0.3	0.36	0.2	0.3	0.32	0.26	0.66	0.3	0.22	0.25	0.7	0.31
Nitrogen, Total as N (BDL 0.5) mg/L	0.3	0.34	0.5	0.3	0.5	0.87	0.64	0.84	0	1.2	0.66	0.5
pH (s.u.)	7.7	7.8	7.7	7.6	7.79	7.78	7.8	7.7	7.7	7.65	7.9	7.5
Phosphorus, Total (BDL 0.010) mg/L	0.038	0.044	0.036	0.046	0.035	0.031	0.049	0.069	0.021	0.062	0.031	0.035
Phosphorus, Total Dissolved BDL (0.010) mg/L	0.034	0.035	0.029	0.033	0.029	0.014	0.024	0.018	0.013	0.04	0.021	0.019
Solids, Total Dissolved (BDL 10) mg/L	260	220	200	220	210	220	310	250	290	360	440	240
Solids, Total Suspended (BDL 2.0) mg/L	4.7	6.7	2	5	2	5	6.4	40	2	10	4.3	7
Temperature, Water °C	27.6	26.8	26.2	19.52	14.38	3.7	5.48	12.23	18.38	21.4	16.55	22.67
Zinc, Total (BDL 10) µg/L	10.5	10	12.1	10	12.6	11.4	14	15.7	10.3	12.6	15.2	23.9
Turbidity (NTU)	4.4	6.8	4.5	7.7	2.54	2.98	19	31	3.4	13	5.8	9.8
Flow CFS	2.8011	3.6537	1.7557	2.4322	1.0615	2.9238	4.5522	2.7044	2.2557	7.2738	11.8968	2.4091
Conductivity µS	276	455	384	342	315	199	345	329	417	584	609	390
Dissolved Oxygen mg/L	5.39	5.58	4.5	7.38	8.01	14.9	10.3	8.23	5.84	5.3	7.97	4.81
Results found to be below the detection limit are reported as the detection limit												

Table 16 – Complete analytical sampling results for all parameters

ANALYTE	Date Sampled											
	7/18/16	8/11/16	8/31/16	9/12/16	9/14/16	9/22/16	5/25/17	6/5/17	6/12/17	6/19/17	7/13/17	7/31/17
<i>E. coli</i> (BDL 1) MPN/100mL	550	310	190	91	200	75	280	610	410	1600	310	100
<i>Enterococcus</i> (BDL 1) MPN/100 mL	53.5	83	50	120	370	58	290	630	29	2400	770	59
Results found to be below the detection limit are reported as the detection limit												

Table 17 – Complete analytical results for bacteria samples

## REFERENCES

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**Save  
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## **CITY OF TULSA WATERSHED CHARACTERIZATION PROGRAM**

### **Comprehensive Watershed Characterization Assessment Year 1 (2016-2017):**

### **HAGER CREEK**

City of Tulsa Streets and Stormwater  
Stormwater and Land Management Division  
4502 South Galveston  
Tulsa, OK 74107

Prepared by

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Watershed Characterization Project

**September 19, 2017**

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## 1.0 INTRODUCTION

### 1.1 Objective

The purpose of this document is to serve as a comprehensive report of results from the biological, habitat, and analytical assessments of Hager Creek. These assessments were performed in order to comply with requirements set forth in Part II(A)(13)(12)(b) and (13)(a) and (b) and Part IV(A)(1) and (2) of Oklahoma Pollutant Discharge Elimination System (OPDES) municipal stormwater (MS4) Permit No. OKS000201 for the City of Tulsa, Oklahoma (ODEQ, OPDES Permit OKS000201, 2011). In addition, assessment results are applied to Oklahoma Water Quality Standards. These standards are described in both (OWRB, 2013a) and (OWRB, 2013b). Where applicable, reference conditions will not be established until the conclusion of the current permit. Until such references are established, those standards will result in an “insufficient data” designation with regards to support within the Fish and Wildlife propagation beneficial use. While these implementations describe a multitude of surface water quality standards, this document will compare and describe only the standards applicable to the parameters required in the Watershed Characterization Program sub section of the Municipal Separate Storm Sewer System permit (ODEQ, OPDES Permit OKS000201, 2011). All remaining parameter results without applicable water quality standards will still be included in this report.

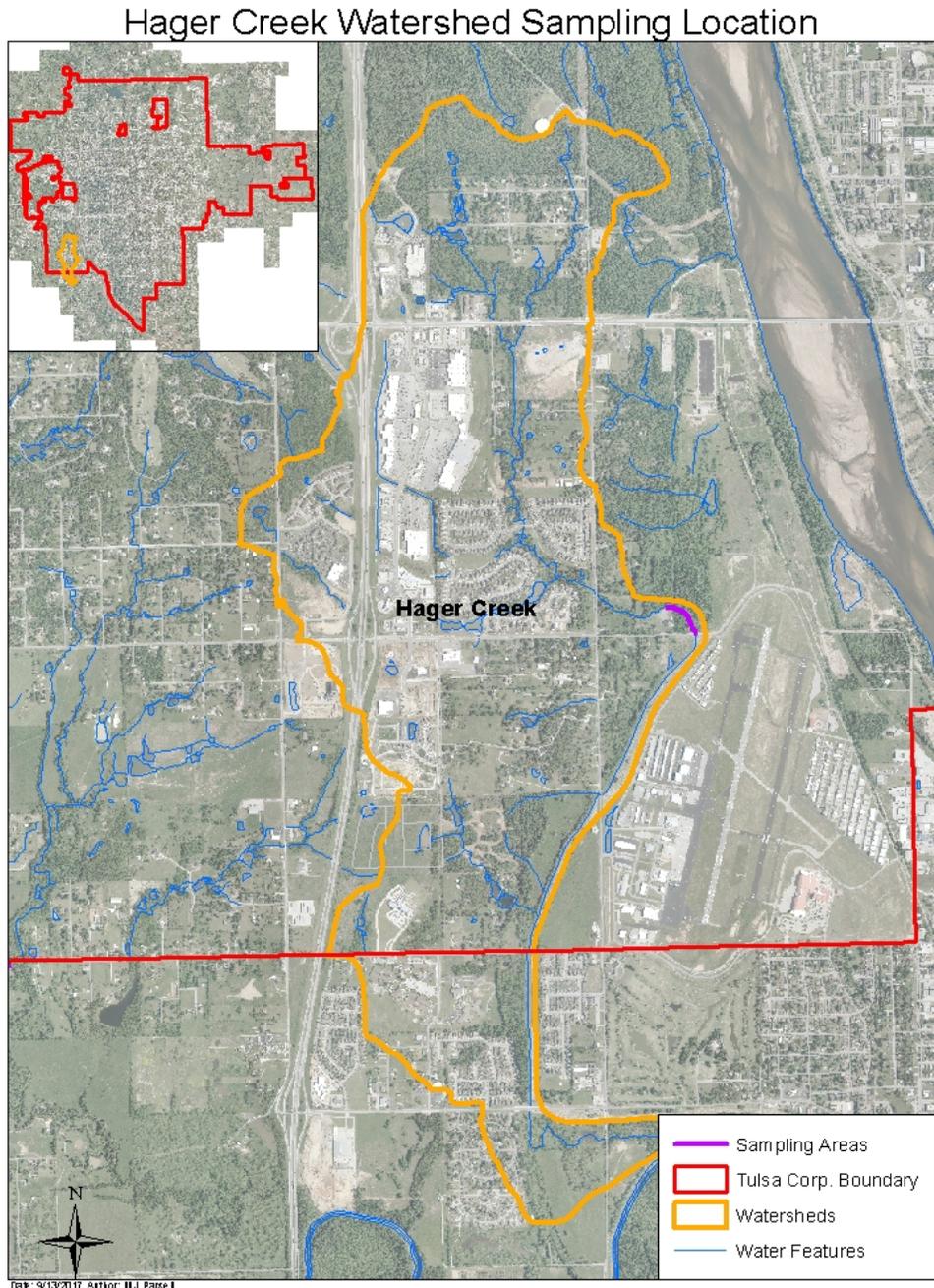
The data presented in this comprehensive report was collected over a one year period beginning in July of 2016 with completion in June of 2017. Field collection and assessment methodology followed project standard operating procedures (SOPs) as provided in the quality assurance project plans (QAPPs) for the biological component (CCRC & FTN, 2014) and the analytical component (CCRC & FTN, 2014). These QAPPs provide quality assurance and quality control procedures for all aspects of the watershed characterization program. They were submitted to and received approval from the Oklahoma Department of Environmental Quality as per MS4 permit requirements. All field data sheets were scanned electronically and archived at the City of Tulsa Stormwater and Land Management Division. All field measurements (in situ measurements, flows, observations), biological information (taxonomic identification, organism counts), and analytical results were compiled in Excel spreadsheets and verified (data entry, formula calculations) per project QA/QC procedures (CCRC & FTN, 2014) (CCRC & FTN, 2014). All raw data, SOPs, and QAPPs are available upon request.

**Hager Creek**  
**WBID: OK120420020020\_00**

Figure 1 - Sampling location on Hager Creek during Year 1

Waterbody	Sample Location		Watershed Area (mi <sup>2</sup> )*	Sampling/Evaluation Date			
	Latitude	Longitude		Fish	Benthic (Summer)	Benthic (Winter)	Habitat
Hager Creek	36.046401	-95.988091	2.97	10/18/2016	02/10/2017	11/18/2016	11/18/2016

\* Collection area captured by sampling point



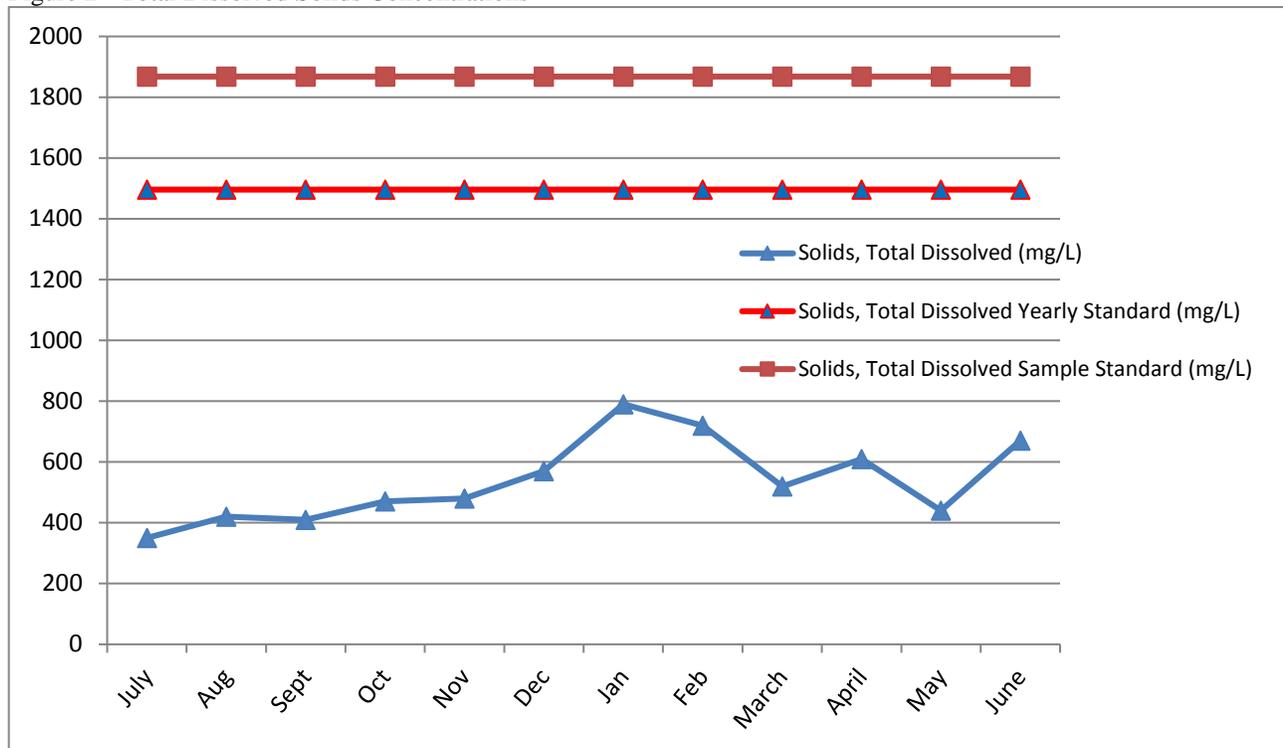
## 2.0 BENEFICIAL USES

**2.1 Agriculture** - Data collected on Total Dissolved Solids for Hager Creek indicates attainment of the agricultural beneficial use. The number of samples collected exceeds the number of samples required. The sample mean does not exceed the yearly standard and none of the samples exceeded the sample standard.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Dissolved Solids	538	790	Sample: 1868, Yearly: 1496	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard

Table 1 – Agriculture standards for Hager Creek

Figure 2 - Total Dissolved Solids Concentrations



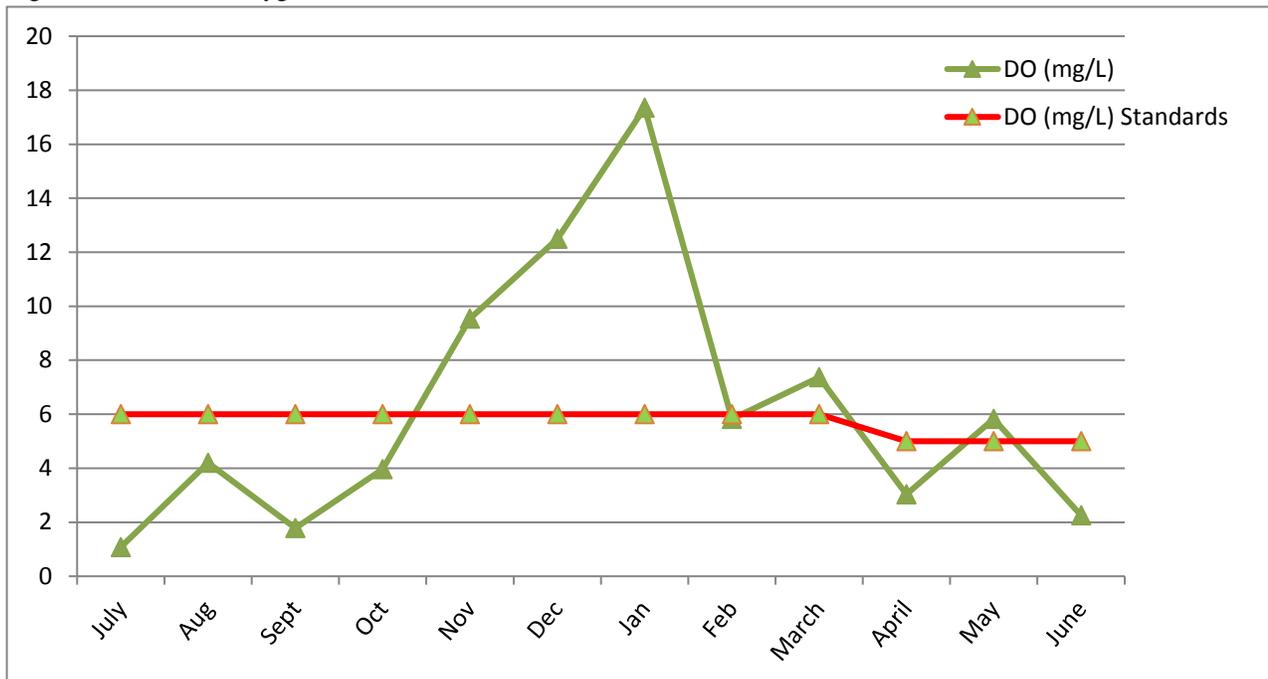
**2.2 Fish and Wildlife Propagation: Warm Water Aquatic Community**

**2.2.1 Dissolved Oxygen** - Data collected on Dissolved Oxygen concentrations shows the beneficial use is not supported. The number of samples collected exceeds the number of required samples. Out of 12 samples, there were 7 samples found to be below the standard. The low dissolved oxygen values in Hager Creek may be the result of the water having very little flow or no flow at all.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
D.O.	2 samples below 5.0	na	April - June: 5.0	3	10 total	No more than 10% of samples outside range
	5 samples below 6.0	na	June - Mar: 6.0	9		

Table 2 – Dissolved Oxygen standards for Hager Creek

Figure 3 - Dissolved Oxygen Concentrations



**2.2.2 Toxicants/Metals** - Data collected indicate full support of the beneficial use for Toxicants and Metals.

<u>Parameter</u>	<u>Sample Mean (µg/L)</u>	<u>Single Sample (µg/L)</u>	<u>Water Quality Standard (µg/L)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Cadmium	0.50	0.50	Acute: 102.36, Chronic: 2.46	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper	1.77	2.66	Acute: 48.56, Chronic: 29.69	12	5	
Lead	0.74	1.79	Acute: 286.15, Chronic: 11.15	12	5	
Zinc	13.25	27.90	Acute: 269.64, Chronic: 244.23	12	5	

Table 3 – Toxicants/Metals standards for Hager Creek

**2.2.3 pH (Hydrogen Ion Activity)** - Data collected on pH readings for Hager Creek show full support of the beneficial use. The number of pH measurements taken exceeds the number of required measurements. All pH measurements fell within the standard range.

<u>Parameter</u>	<u>Sample Range (s.u)</u>	<u>Single Sample (s.u.)</u>	<u>Water Quality Standard Range (s.u)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
pH	7.3 – 7.8	na	6.5-9.0	12	10	No more than 10% of samples outside range

Table 4 – pH standards for Hager Creek

**2.2.4 Oil and Grease** – Oil and Grease is based on visual assessment. Visual observations do not indicate the presence of Oil and Grease pollution, supporting the beneficial use.

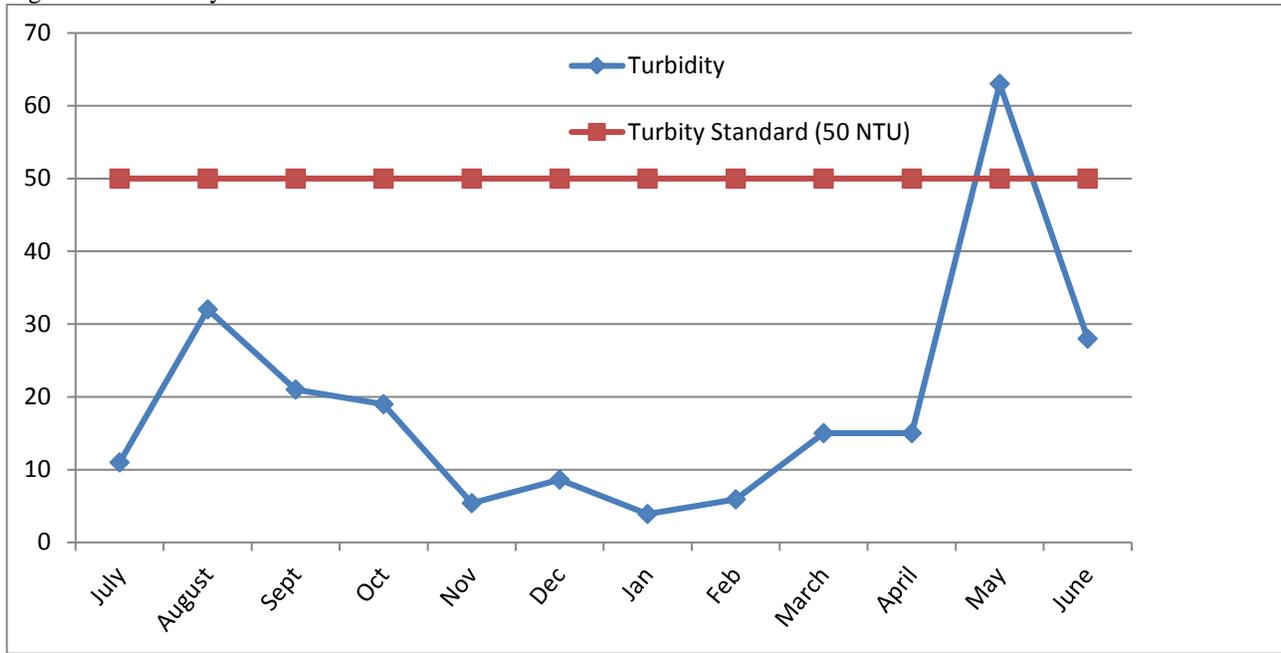
**2.2.5 Suspended and Bedded Sediments** – Using habitat assessment data to determine support of the beneficial use is conditional upon the support of turbidity data and fish collection data.

**2.2.5.1 Turbidity** – Data collected on Turbidity readings for Hager Creek show full support of the beneficial use. Only one out of twelve samples exceeded the sample standard, therefore, no more than 10% exceeded the sample standard

<u>Parameter</u>	<u>Sample Mean (NTU)</u>	<u>Single Sample (NTU)</u>	<u>Water Quality Standard (NTU)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Turbidity	18.23	63.20	50	12	10	No more than 10% exceeding sample standard

Table 5 – Turbidity standards for Hager Creek

Figure 4 – Turbidity Concentrations



**2.2.5.2 Habitat Assessment** - The resulting score of the habitat assessment on Hager Creek can be compared to the average score of high quality sites within the same ecoregion provided by the Oklahoma Conservation Commission using a scoring workbook derived from OWRB (OWRB, 2001). The results of the habitat assessment produced a score above average for the cross timbers ecoregion.

Metric	Score
Instream habitat	17.40
Pool bottom substrate	7.0
Pool variability	18.8
Canopy cover	19.2
Presence of rocky runs and riffles	0.0
Flow (at representative low flow)	0.3
Channel alteration	16.5
Channel sinuosity	1.1
Bank stability	4.8
Bank vegetation stability	2.1
Stream side Cover	9.87
<b>Total Score</b>	<b>97.1</b>
<b>Cross Timbers Mean Score</b>	<b>93.58</b>

Table 6 – Habitat assessment metric and total results with ecoregion mean score

**2.2.6 Biological**

**2.2.6.1 Fish Collections** - Data recorded from Fish collections performed on Hager Creek show that the beneficial use is impaired. A lack of intolerant species, a lack of diversity in the fish present in Hager Creek as well as a lack of lithophils prevents full support. The low values of dissolved oxygen as well as the little/no flow of water may be a contributing factor. Downstream water quality impacts may also prevent repopulations.

Index of Biotic Integrity		5	3	1	Score
Sample Composition	Total no. of species	See Figure 1, OAC 785: CH. 46			3
	Shannon's diversity	> 2.50	2.49 - 1.50	< 1.50	1
	No. of sunfish sp.	>3	2 - 3	< 2	5
	No. of sp. Comprising 75% of sample	>5	4 - 3	< 3	1
	No. of intolerant species	> 5	3 - 5	< 3	1
	Percentage of tolerant species	See Figure 3, OAC 785: CH. 46			0
Fish Condition	Percentage of lithophils	> 36	18 - 36	< 18	1
	Percentage of DELT anomalies	< 0.1	0.1 - 1.3	> 1.3	5
	Fish Numbers (total individuals)	> 200	200 - 75	< 75	5
Score Key: 30 + Beneficial Use Supported : 23 - 29 Undetermined : < 22 Impaired				Total	22

Table 7 – Fish IBI score for Hager Creek

Family	Species Name	Common Name	Number of Fish	Percentage
Ictaluridae	<i>Ameiurus melas</i>	Black bullhead catfish	57	15.6%
Centrarchidae	<i>Lepomis cyanellus</i>	Green sunfish	40	11.0%
	<i>Lepomis macrochirus</i>	Bluegill sunfish	231	63.3%
	<i>Lepomis megalotis</i>	Longear sunfish	15	4.1%
	<i>Lepomis gulosis</i>	Warmouth sunfish	4	1.1%
	<i>Lepomis microlophus</i>	Redear sunfish	5	1.4%
	<i>Lepomis YOY</i>	YOY sunfish	2	0.5%
	<i>Micropterus salmoides</i>	Largemouth bass	7	1.9%
	<i>Pomoxis annularis</i>	White crappie	3	0.8%
Poeciliidae	<i>Gambusia affinis</i>	Mosquitofish	1	0.3%
<b>Total Number:</b>			365	100.0%
<b>Total Number of Taxa:</b>			10	

Table 8 – Fish collection counts for Hager Creek



^Photograph taken of the Hager Creek sample site

**2.2.6.2 Benthic Macroinvertebrate Collections** – Data recorded from benthic macroinvertebrate collection during the summer and winter index periods collections shows impairment for the winter index period and undetermined for the summer index period (ODEQ, Continuing Planning Process, 2012). Scores were above average in the richness of taxa, but low in percent dominance of any two families. An increase in dissolved oxygen content and an increased flow could improve the macroinvertebrate population. Further sampling may show improvements.

Sampling protocol to determine attainment of water quality standards, (ODEQ, Water Quality in Oklahoma Integrated Report, 2014) requires a minimum of four sampling events within a two year period. Further sampling will be implemented to determine support.

Metric	6	4	2	0	Score
Taxa Richness	95%				6
Modified HBI		71%			4
EPT/Total		23%			4
EPT Taxa				15%	0
% Dominant 2 Taxa				62%	0
Shannon - Weaver			1.97		2
Hager - Summer (Cross Timbers): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				52%

Metric	6	4	2	0	Score
Taxa Richness	82%				6
Modified HBI		84%			4
EPT/Total				6%	0
EPT Taxa				18%	0
% Dominant 2 Taxa				65%	0
Shannon - Weaver			1.72		2
Hager - Winter (Cross Timbers): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				44%

Table 9 – Benthic macroinvertebrate metrics for summer and winter index periods at Hager Creek

Phylum	Class	Order	Family	Genus	Common Class	10/18/2016	
						Count	%
Arthropoda	Insecta	Ephemeroptera	Caenidae	<i>Caenis</i> sp.	Squaregilled Mayfly	24	22.6%
		Odonata	Coenagrionidae	<i>Coenagrion/Enallagma</i> sp.	Narrowwinged Damselfly	13	12.3%
				<i>Ischnura</i> sp.	Narrowwinged Damselfly	4	3.8%
		Diptera	Chironomidae	<i>Ablabesmyia mallochi</i>	Midge	1	0.9%
				<i>Apedilum</i> sp.		1	0.9%
				<i>Dicrotendipes simpsoni</i>		3	2.8%
				<i>Paratanytarsus</i> sp.		1	0.9%
				<i>Polypedilum flavum</i>		2	1.9%
				<i>Polypedilum illinoense</i> gr.		4	3.8%
				<i>Polypedilum scalaenum</i> gr.		1	0.9%
				<i>Rheotanytarsus exiguus</i> gr.		1	0.9%
			<i>Tanytarsus</i> sp.	2	1.9%		
			Ceratopogonidae	<i>Ceratopogoninae</i>	Biting Midge	1	0.9%
Annelida	Oligochaeta	Haplotaxida	Tubificidae	<i>Dero</i> sp.	Aquatic Worm	1	0.9%
				tubificoid <i>Naididae</i> w/o cap setae	Aquatic Worm (Bald)	1	0.9%
	Hirudinea	Rhynchobdellida	Glossiphoniidae	<i>Helobdella</i> sp.	Leech	1	0.9%
Mollusca	Bivalvia	Veneroida	Sphaeriidae	<i>Sphaeriidae</i>	Pea Clam	1	0.9%
	Gastropoda	Pulmonata	Lymnaeidae	<i>Lymnaeidae</i>	Lung Snail	2	1.9%
Crustacea	Malacostraca	Amphipoda	Hyaedllidae	<i>Hyaella</i> sp.	Scud	42	39.6%
<b>Hager Creek Summer Index Period</b>				Total		106	100.0%
				Total Number of Taxa		19	

Phylum	Class	Order	Family	Genus	Common Class	2/10/2017			
						Count	%		
Arthropoda	Insecta	Ephemeroptera	Caenidae	<i>Caenis</i> sp.	Squaregilled Mayfly	6	6.1%		
		Diptera	Chironomidae	<i>Ablabesmyia</i> sp.	Midge	1	1.0%		
				<i>Chironomus</i> sp.		2	2.0%		
				<i>Cricotopus/Orthocladius</i> sp.		1	1.0%		
				<i>Dicrotendipes modestus</i>		1	1.0%		
				<i>Orthocladius</i> sp.		2	2.0%		
				<i>Paratanytarsus</i> sp.		13	13.3%		
				<i>Phaenopsectra</i> sp.		5	5.1%		
				<i>Polypedilum illinoense</i> gr.		41	41.8%		
		Ceratopogonidae	<i>Ceratopogoninae</i>	1	1.0%				
Mollusca	Gastropoda	Pulmonata	Planorbidae	<i>Micromenetus</i> sp.	Lung Snail	2	2.0%		
Crustacea	Malacostraca	Amphipoda	Hyalellidae	<i>Hyalella</i> sp.	Scud	23	23.5%		
<b><u>Hager Creek Winter Index Period</u></b>						Total		98	100.0%
						Total Number of Taxa			

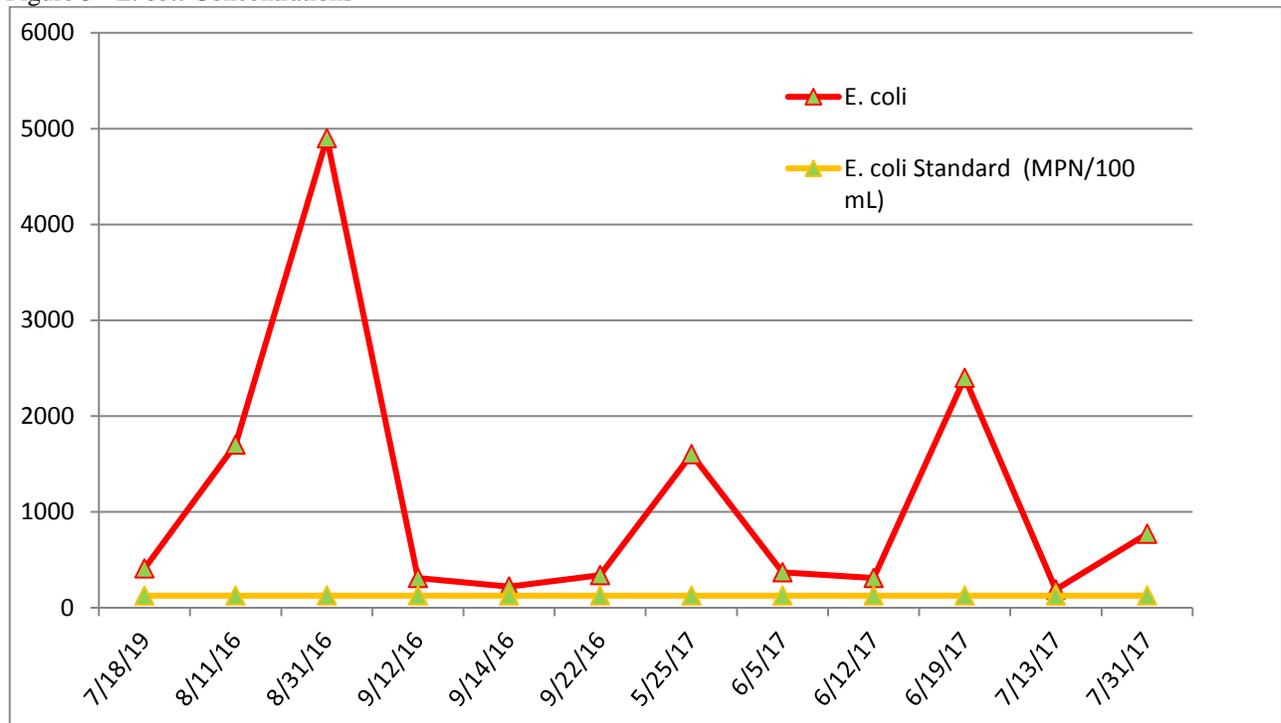
Table 10 – Benthic macroinvertebrate counts for Hager Creek summer and winter index periods

**2.3 Primary Body Contact** - The data collected on *E. coli* and *Enterococcus* concentrations show that Hager Creek is impaired for both *E. coli* and *Enterococcus*. The number of samples collected exceeds the number of samples required. Due to high bacteria results, 3 DNA samples were taken at minimum 7 days apart to help further illustrate the source of impairment. The results of the DNA testing indicates two possible problems exist; pet waste not being picked up and properly disposed of as well as sanitary sewer/septic tank issues.

<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>E. coli</i>	644	na	126	12	5	Geometric mean not exceeding standard

Table 11 – *E. coli* totals for Hager Creek

Figure 5 - *E. coli* Concentrations



<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>Enterococcus</i>	1074	na	33	12	5	Geometric mean not exceeding standard

Table 12 – *Enterococcus* totals for Hager Creek

Figure 6 – *Enterococcus* Concentrations

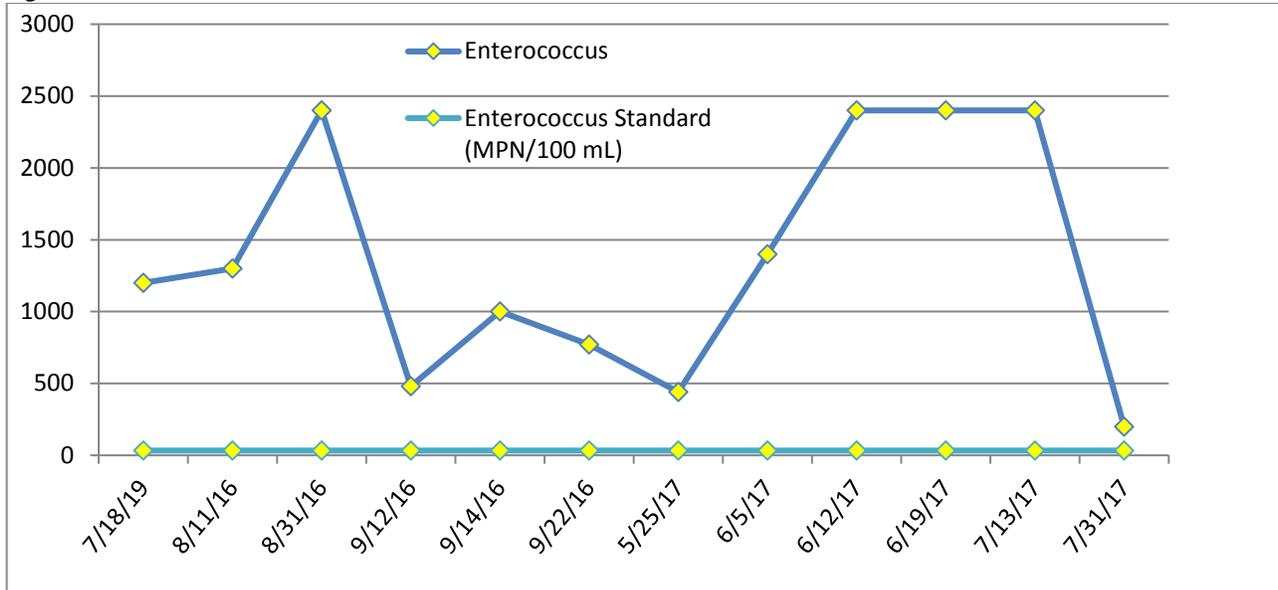
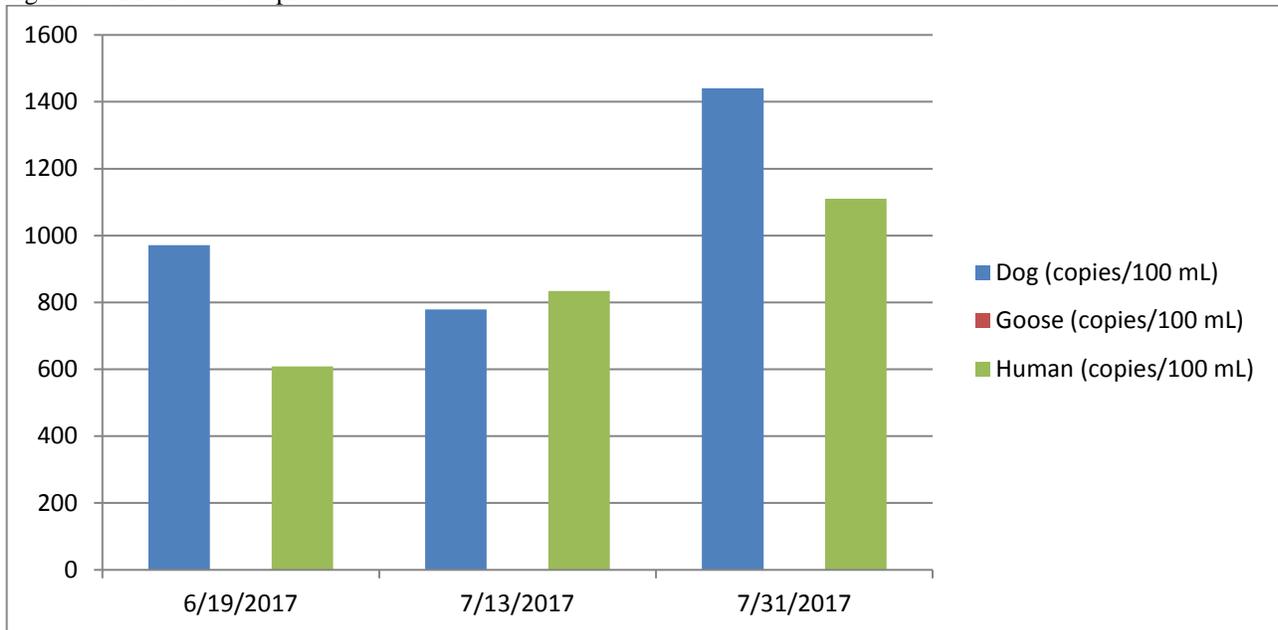


Figure 7 – DNA Gene Copies



## 2.4 Anti-Degradation Policy

2.4.1 Nutrients - Analytical results for Total Phosphorus and Nitrate/Nitrite show no need for further investigation to show support of the beneficial use. The number of samples collected exceeds the number of required samples, and less than 10% of samples exceeded the threshold for further sampling. While Nitrate/Nitrite concentrations have an action level, it is not a required parameter within the MS4 permit (ODEQ, OPDES Permit OKS000201, 2011).

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Threshold (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Phosphorus	0.06	na	0.24	12	10	No more than 10% of samples outside range
Nitrite - Nitrate	0.23	na	4.95	12	10	No more than 10% of samples outside range

Table 13 – Nutrient totals for Hager Creek

Figure 8 - Total Phosphorus Concentrations

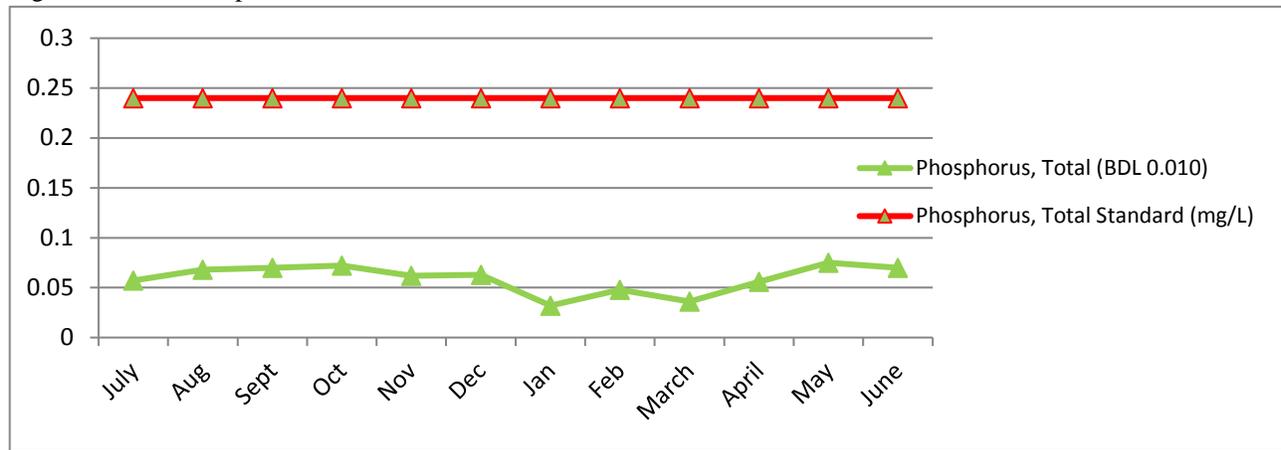
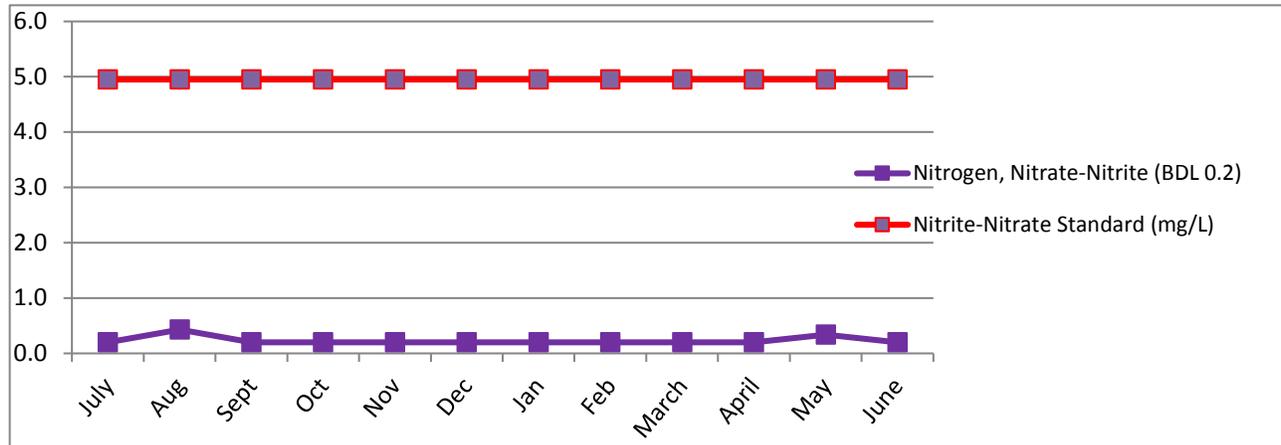


Figure 9 - Nitrate/Nitrite Concentrations



### 3.0 SUMMARY

Analytically, Hager Creek reflects a few water quality impacts to the stream during the year of sampling including dissolved oxygen and bacteria. DNA testing was performed to determine the cause of impairment in regards to bacteria. The results showed that issues with sanitary sewer/septic tanks may need to be addressed. In addition, a continued push in public education addressing proper disposal of pet waste could be beneficial. Poor dissolved oxygen readings could be attributed to the poor flow of the stream. Fish collections reflected an impaired classification according to water quality standards which would show improvement with an increase in the number of intolerant species and lithophils as well as an increase in the diversity of fish. A disappointing benthic macroinvertebrate IBI score could be related to the lack of intolerant species which prevents support of the beneficial use as well as the poor flow of the stream. In addition, Hager Creek does not have much gravel substrate to support macroinvertebrate populations.

<b>Hager</b>						
<b>Parameter</b>	<b>Sample Mean</b>	<b>Single Sample</b>	<b>Water Quality Standard</b>	<b>No. of Samples</b>	<b>No. of Samples Required (WQS)</b>	<b>How Standard is Violated</b>
Cadmium (µg/L)	0.50	0.50	Acute: 102.36, Chronic: 2.46	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper (µg/L)	1.77	2.66	Acute: 48.56, Chronic: 29.69	12	5	
Lead (µg/L)	0.74	1.79	Acute: 286.15, Chronic: 11.15	12	5	
Zinc (µg/L)	13.25	27.90	Acute: 269.64, Chronic: 244.23	12	5	
E. coli (MPN/100ml)	644	Na	126	12	5	Geometric mean not exceeding standard
Enterococcus (MPN/100ml)	1074	Na	33	12	5	Geometric mean not exceeding standard
Oil and Grease (visual)	none	Na	No visible sheen	12	10	No more than 10% of observations with oil & grease
Total Phosphorus (mg/L)	0.06	Na	0.24	12	10	No more than 10% of samples outside range
Nitrite – Nitrate (mg/L)	0.23	Na	4.95	12	10	No more than 10% of samples outside range
Total Dissolved Solids (mg/L)	538	790	Sample: 1868, Yearly: 1496	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard
pH (s.u.)	7.3 – 7.8	Na	6.5-9.0	12	10	No more than 10% of samples outside range
Turbidity (NTU)	18.23	63.20	50	12	10	No more than 10% of samples outside of range
D.O. (mg/L)	2 samples below 5.0	na	April - June: 5.0	3	10 total	No more than 10% of samples outside range
	5 samples below 6.0	na	June - Mar: 6.0	9		
*Analytes in italics not required by permit Analytes in red exceed standards						

Table 14 – Oklahoma Water Quality Standards summary of collected data

Analyte	Result			Number of Samples	Number of Attempts
	Minimum	Mean	Maximum		
Cadmium, Total (µg/L) (DL 0.5 µg/L)	--	0.50	0.50	12	12
Copper, Total (µg/L) (DL 0.5 µg/L)	--	1.77	2.66	12	12
<i>E. coli</i> (MPN/100 mL) (DL 1 MPN/100 mL)	--	644	4900	12	12
<i>Enterococcus</i> (MPN/100 mL)(DL 1 CFU/100 mL)	--	1074	2400	12	12
Hardness, Total (mg/L) (DL 3.6 mg/L)	210	306	450	12	12
Lead, Total (µg/L) (DL 0.5 µg/L)	--	0.74	1.79	12	12
Nitrogen, Nitrate-Nitrite (mg/L) (DL 0.2 mg/L)	--	0.23	0.43	12	12
Nitrogen, Total Kjeldahl (mg/L)(DL 0.50 mg/L)	--	0.60	1.10	12	12
Nitrogen, Total as Nitrogen (mg/L)(DL 0.50 mg/L)	--	0.57	1.10	12	12
Phosphorus, Dissolved (mg/L) (DL 0.010 mg/L)	--	0.03	0.05	12	12
Phosphorus, Total (mg/L) (DL 0.010 mg/L)	--	0.06	0.08	12	12
Solids, Total Dissolved (mg/L) (DL 10 mg/L)	--	538	790	12	12
Solids, Total Suspended (mg/L) (DL 2.0 mg/L)	--	14.25	39.00	12	12
Zinc, Total (µg/L) (DL 10 µg/L)	--	13.25	27.90	12	12
Water Temperature (°C)	3.75	15.78	26.80	12	12
pH (su)	7.30	--	7.73	12	12
Flow (cfs)	0.00	0.05	0.54	12	12
Turbidity (NTU)	--	18.23	63.20	12	12
Results found to be below the detection limit are reported as the detection limit					

Table 15 – MS4 permit required analytical sampling parameters result summaries

ANALYTE	Date Sampled											
	7/19/2016	8/9/2016	9/8/2016	10/13/2016	11/15/2016	12/15/2016	1/10/2017	2/9/2017	3/14/2017	4/12/2017	5/6/2017	6/8/2017
Cadmium, Total (BDL 1) µg/L	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Copper, Total (BDL 0.5) µg/L	1.72	2.14	2.32	2.66	1.19	1.27	0.94	1.02	1.92	1.78	2.38	1.95
Hardness, Total (BDL 3.6) mg/L	220	230	250	280	300	390	450	400	290	350	210	300
Lead, Total (BDL 0.5) µg/L	0.50	0.79	0.81	0.82	0.50	0.50	0.50	0.50	0.50	0.50	1.79	1.16
Nitrogen, Kjeldahl, Total (BDL 0.50) mg/L	0.75	0.50	0.65	0.57	0.50	0.50	0.50	0.50	0.50	1.10	0.60	0.50
Nitrogen, Nitrate-Nitrite (BDL 0.2) mg/L	0.20	0.43	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.34	0.20
Nitrogen, Total as N (BDL 0.5) mg/L	0.20	0.41	0.65	0.57	0.50	0.50	0.50	0.50	0.50	1.10	0.91	0.50
pH (s.u.)	7.30	7.73	7.49	7.49	7.40	7.52	7.45	7.47	7.53	7.46	7.41	7.31
Phosphorus, Total (BDL 0.010) mg/L	0.06	0.07	0.07	0.07	0.06	0.06	0.03	0.05	0.04	0.06	0.08	0.07
Phosphorus, Total Dissolved BDL (0.010) mg/L	0.03	0.03	0.04	0.03	0.04	0.05	0.03	0.03	0.02	0.02	0.01	0.02
Solids, Total Dissolved (BDL 10) mg/L	350	420	410	470	480	570	790	720	520	610	440	670
Solids, Total Suspended (BDL 2.0) mg/L	11.0	20.0	24.0	18.0	5.00	3.60	6.00	3.00	4.40	19.0	39.0	18.0
Temperature, Water °C	26.80	26.00	25.60	16.80	12.31	3.96	3.75	6.85	8.32	17.30	20.06	21.56
Turbidity (NTU)	11.3	31.6	21.1	19.1	5.48	8.62	3.93	5.78	5.90	15.0	63.2	27.8
Zinc, Total (BDL 10) µg/L	10.3	10.0	12.9	10.0	10.0	11.8	10.0	10.0	10.0	12.9	23.2	27.9
Flow CFS	0.00	0.54	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Conductivity µS	635	713	708	629	602	614	777	804	626	983	610	921
Dissolved Oxygen mg/L	1.08	4.20	1.79	3.97	9.54	12.5	17.35	5.83	7.37	3.03	5.83	2.26
Results found to be below the detection limit are reported as the detection limit												

Table 16 – Complete analytical sampling results for all parameters

ANALYTE	Date Sampled											
	7/18/16	8/11/16	8/31/16	9/12/16	9/14/16	9/22/16	5/25/17	6/5/17	6/12/17	6/19/17	7/13/17	7/31/17
<i>E. coli</i> (BDL 1) MPN/100mL	410	1700	4900	310	220	340	1600	370	310	2400	190	770
<i>Enterococcus</i> (BDL 1) MPN/100 mL	1200	1300	2400	480	1000	770	440	1400	2400	2400	2400	200
Results found to be below the detection limit are reported as the detection limit												

Table 17 – Complete analytical results for bacteria samples

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## **CITY OF TULSA WATERSHED CHARACTERIZATION PROGRAM**

### **Comprehensive Watershed Characterization Assessment Year 1 (2016-2017):**

### **HARLOW CREEK**

City of Tulsa Streets and Stormwater  
Stormwater and Land Management Division  
4502 South Galveston  
Tulsa, OK 74107

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**September 19, 2017**

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## 1.0 INTRODUCTION

### 1.1 Objective

The purpose of this document is to serve as a comprehensive report of results from the biological, habitat, and analytical assessments of Harlow Creek. These assessments were performed in order to comply with requirements set forth in Part II(A)(13)(12)(b) and (13)(a) and (b) and Part IV(A)(1) and (2) of Oklahoma Pollutant Discharge Elimination System (OPDES) municipal stormwater (MS4) Permit No. OKS000201 for the City of Tulsa, Oklahoma (ODEQ, OPDES Permit OKS000201, 2011). In addition, assessment results are applied to Oklahoma Water Quality Standards. These standards are described in both (OWRB, 2013a) and (OWRB, 2013b). Where applicable, reference conditions will not be established until the conclusion of the current permit. Until such references are established, those standards will result in an “insufficient data” designation with regards to support within the Fish and Wildlife propagation beneficial use. While these implementations describe a multitude of surface water quality standards, this document will compare and describe only the standards applicable to the parameters required in the Watershed Characterization Program sub section of the Municipal Separate Storm Sewer System permit (ODEQ, OPDES Permit OKS000201, 2011). All remaining parameter results without applicable water quality standards will still be included in this report.

The data presented in this comprehensive report was collected over a one year period beginning in July of 2016 with completion in June of 2017. Field collection and assessment methodology followed project standard operating procedures (SOPs) as provided in the quality assurance project plans (QAPPs) for the biological component (CCRC & FTN, 2014) and the analytical component (CCRC & FTN, 2014). These QAPPs provide quality assurance and quality control procedures for all aspects of the watershed characterization program. They were submitted to and received approval from the Oklahoma Department of Environmental Quality as per MS4 permit requirements. All field data sheets were scanned electronically and archived at the City of Tulsa Stormwater and Land Management Division. All field measurements (in situ measurements, flows, observations), biological information (taxonomic identification, organism counts), and analytical results were compiled in Excel spreadsheets and verified (data entry, formula calculations) per project QA/QC procedures (CCRC & FTN, 2014) (CCRC & FTN, 2014). All raw data, SOPs, and QAPPs are available upon request.

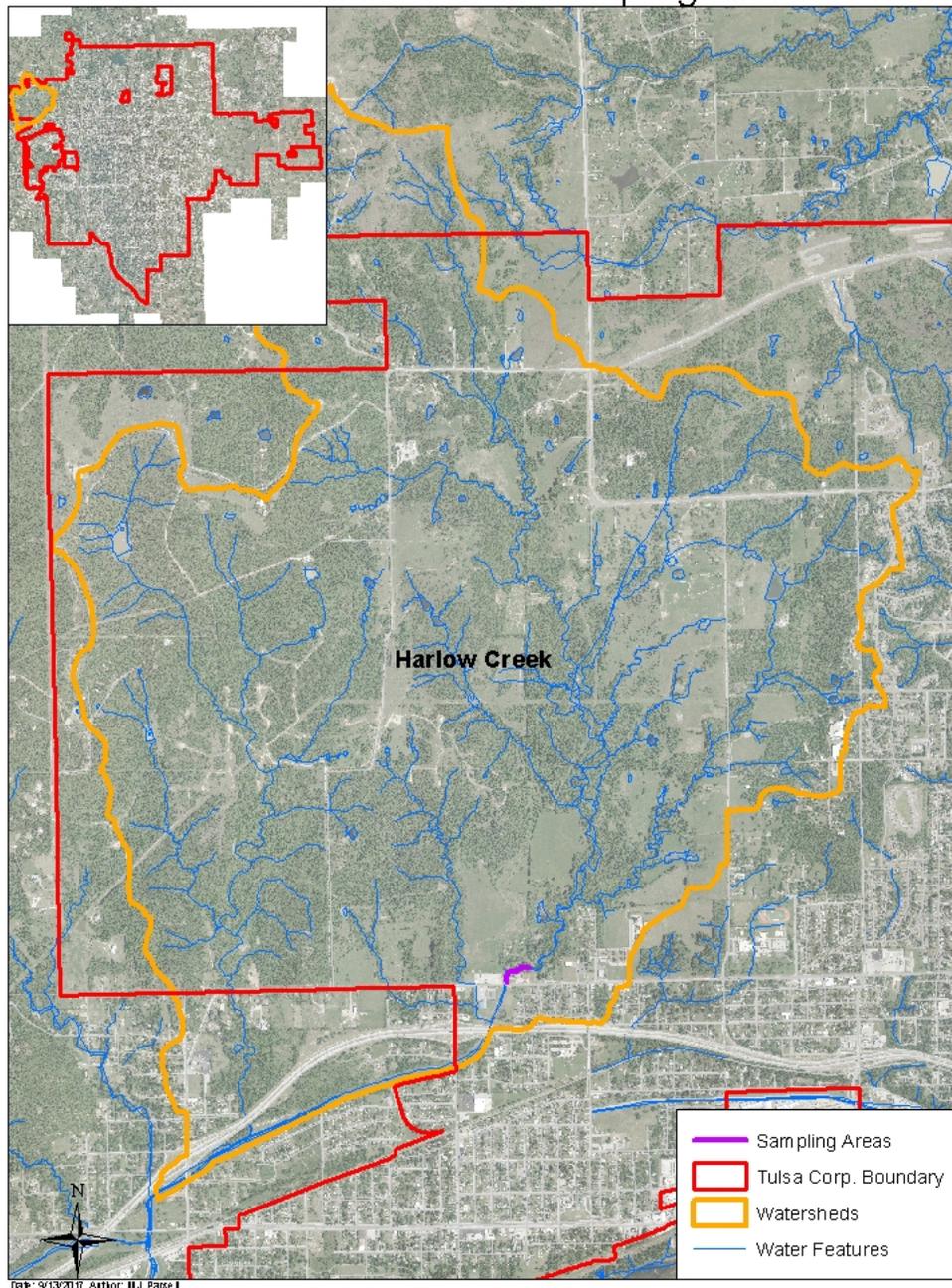
**Harlow Creek**  
**WBID: OK120420010170\_00**

Figure 1 - Sampling location on Harlow Creek during Year 1

Waterbody	Sample Location		Watershed Area (mi <sup>2</sup> )*	Sampling/Evaluation Date			
	Latitude	Longitude		Fish	Benthic (Summer)	Benthic (Winter)	Habitat
Harlow Creek	36.161391	-96.043700	4.17	10/19/2016	08/15/2016	02/10/2017	05/16/2017

\* Collection area captured by sampling point

Harlow Creek Watershed Sampling Location



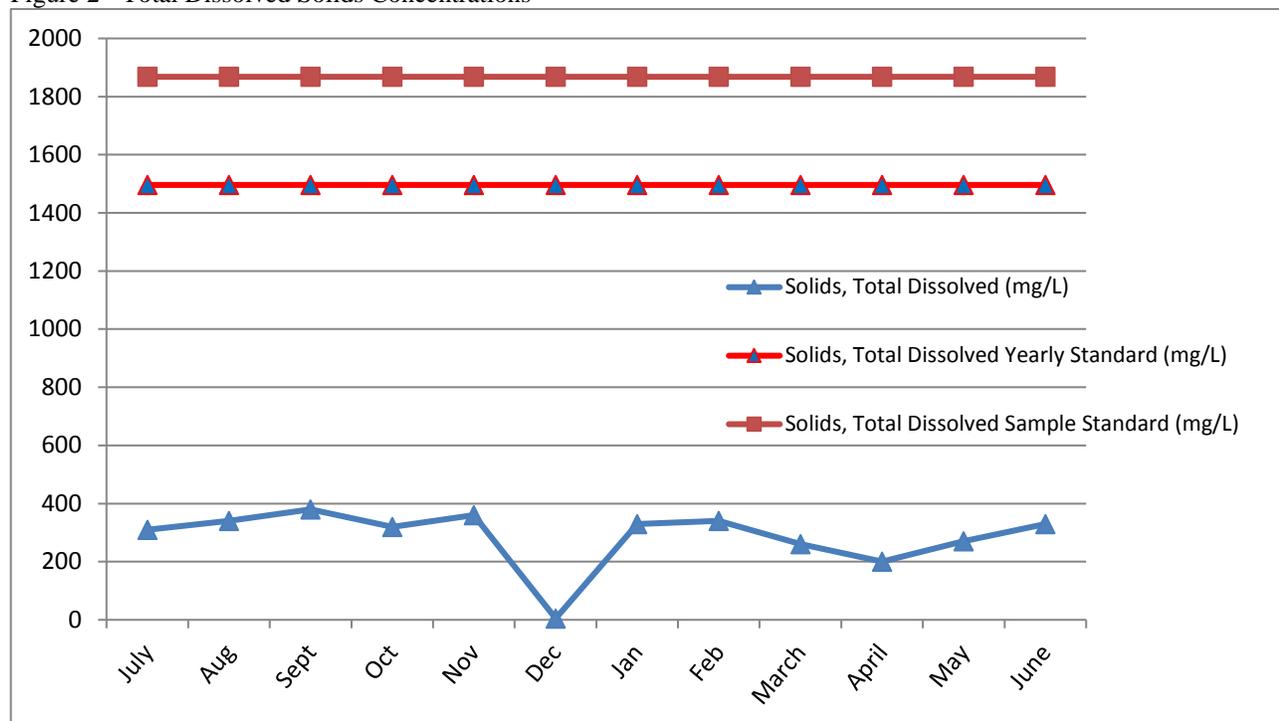
## 2.0 BENEFICIAL USES

**2.1 Agriculture** - Data collected on Total Dissolved Solids for Harlow Creek indicates attainment of the agricultural beneficial use. The number of samples collected exceeds the number of samples required. The sample mean does not exceed the yearly standard and none of the samples exceeded the sample standard.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Dissolved Solids	317	380	Sample: 1868, Yearly: 1496	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard

Table 1 – Agriculture standards for Harlow Creek

Figure 2 - Total Dissolved Solids Concentrations



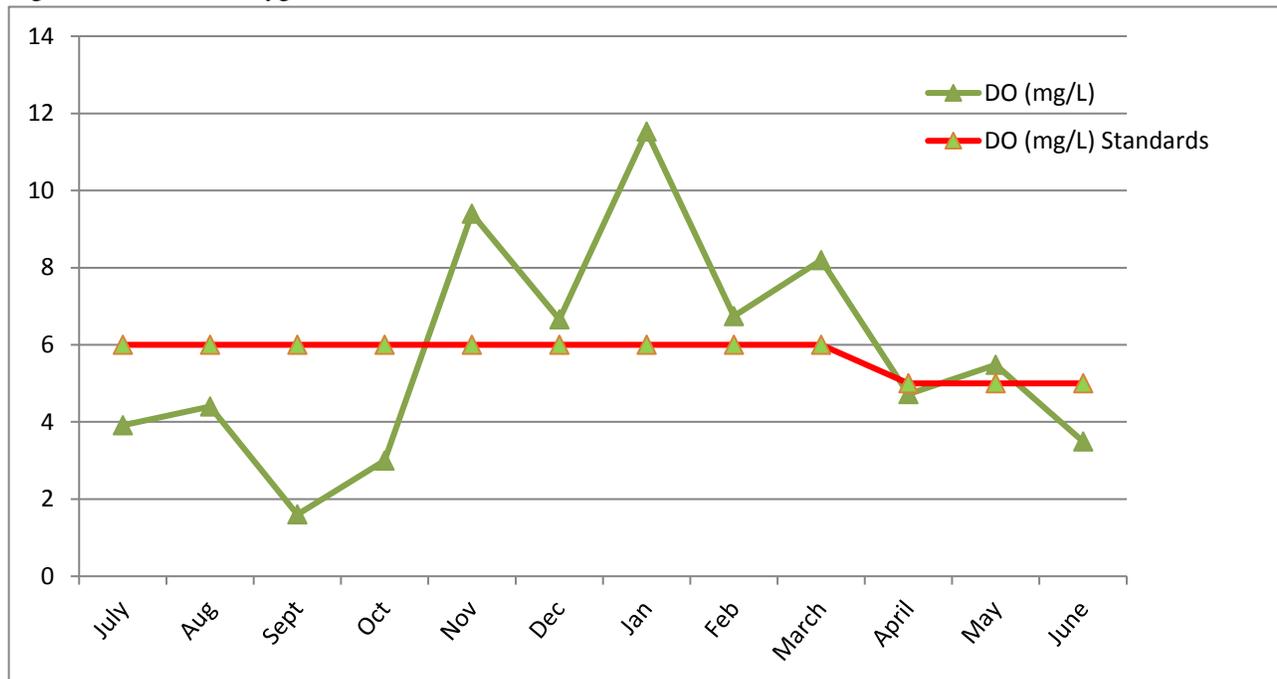
## 2.2 Fish and Wildlife Propagation: Warm Water Aquatic Community

**2.2.1 Dissolved Oxygen** - Data collected on Dissolved Oxygen concentrations shows the beneficial use is not supported. The number of samples collected exceeds the number of required samples. Out of 12 samples, there were 6 samples found to be below the standard. The low dissolved oxygen values in Harlow Creek may be the result of the water having very little flow or no flow at all.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
D.O.	2 samples below 5.0	na	April - June: 5.0	3	10 total	No more than 10% of samples outside range
	4 samples below 6.0	na	June - Mar: 6.0	9		

Table 2 – Dissolved Oxygen standards for Harlow Creek

Figure 3 - Dissolved Oxygen Concentrations



**2.2.2 Toxicants/Metals** - Data collected indicate full support of the beneficial use for Toxicants and Metals.

<u>Parameter</u>	<u>Sample Mean (µg/L)</u>	<u>Single Sample (µg/L)</u>	<u>Water Quality Standard (µg/L)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Cadmium	0.50	0.50	Acute: 102.36, Chronic: 2.46	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper	1.34	3.30	Acute: 48.56, Chronic: 29.69	12	5	
Lead	0.69	1.49	Acute: 286.15, Chronic: 11.15	12	5	
Zinc	16.12	52.50	Acute: 269.64, Chronic: 244.23	12	5	

Table 3 – Toxicants/Metals standards for Harlow Creek

**2.2.3 pH (Hydrogen Ion Activity)** - Data collected on pH readings for Crow Creek show full support of the beneficial use. The number of pH measurements taken exceeds the number of required measurements. All pH measurements fell within the standard range.

<u>Parameter</u>	<u>Sample Range (s.u.)</u>	<u>Single Sample (s.u.)</u>	<u>Water Quality Standard Range (s.u.)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
pH	7.2 – 7.8	na	6.5-9.0	12	10	No more than 10% of samples outside range

Table 4 – pH standards for Harlow Creek

**2.2.4 Oil and Grease** – Oil and Grease is based on visual assessment. Visual observations do not indicate the presence of Oil and Grease pollution, supporting the beneficial use.

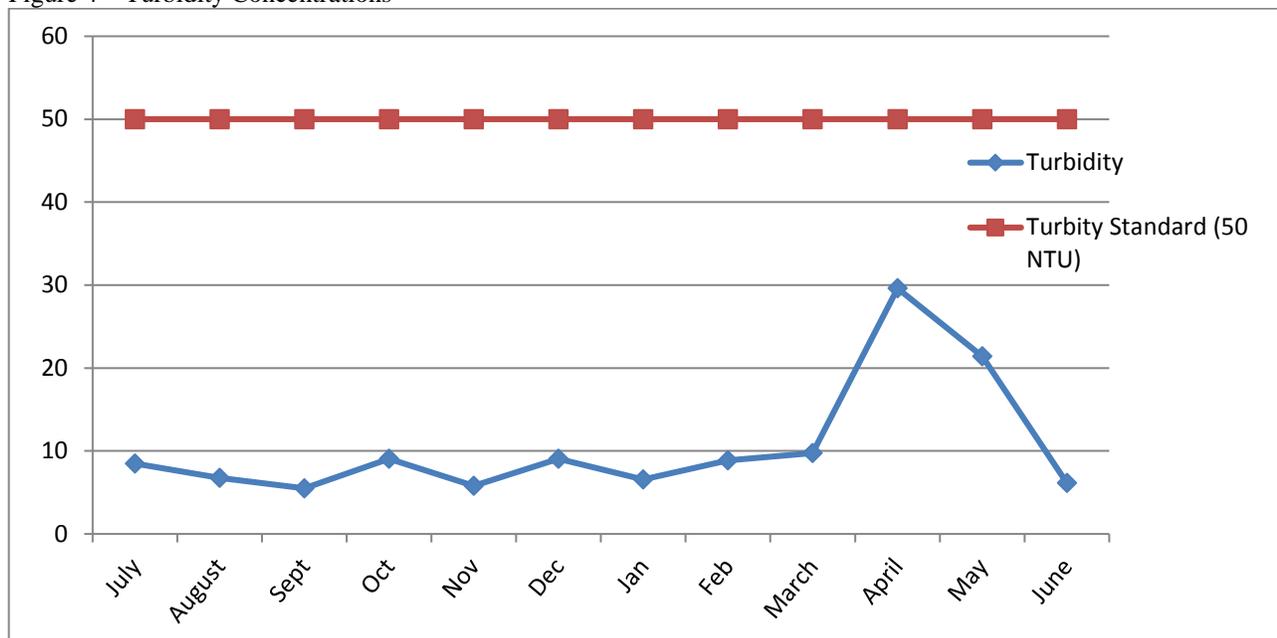
**2.2.5 Suspended and Bedded Sediments** - Using habitat assessment data to determine support of the beneficial use is conditional upon the support of Turbidity data and fish collection data.

**2.2.5.1 Turbidity** – Data collected on Turbidity readings for Harlow Creek show full support of the beneficial use.

<u>Parameter</u>	<u>Sample Mean (NTU)</u>	<u>Single Sample (NTU)</u>	<u>Water Quality Standard (NTU)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Turbidity	10.58	29.60	50	12	10	No more than 10% exceeding sample standard

Table 5 – Turbidity standards for Harlow Creek

Figure 4 – Turbidity Concentrations



**2.2.5.2 Habitat Assessment** - The resulting score of the habitat assessment on Harlow Creek can be compared to the average score of high quality sites within the same ecoregion provided by the Oklahoma Conservation Commission using a scoring workbook derived from OWRB (OWRB, 2001). The results of the habitat assessment produced a score just below average for the cross timbers ecoregion. A measurable flow would help Harlow Creek’s habitat assessment score.

Metric	Score
Instream habitat	19.50
Pool bottom substrate	8.40
Pool variability	17.20
Canopy cover	14.70
Presence of rocky runs and riffles	2.20
Flow (at representative low flow)	0.00
Channel alteration	15.10
Channel sinuosity	1.80
Bank stability	4.60
Bank vegetation stability	3.40
Stream side Cover	5.00
<b>Total Score</b>	<b>92.20</b>
<b>Cross Timbers Mean Score</b>	<b>93.58</b>

Table 6 – Habitat assessment metric and total results with ecoregion mean score

**2.2.6 Biological**

**2.2.6.1 Fish Collections** - Data recorded from Fish collections performed on Harlow Creek show that the beneficial use is impaired. A lack of intolerant species, a lack of diversity in the fish present in Harlow Creek as well as a lack of lithophils prevents full support. The low values of dissolved oxygen as well as the little/no flow of water may be a contributing factor. Downstream water quality impacts may prevent repopulations.

Index of Biotic Integrity		5	3	1	Score
Sample Composition	Total no. of species	See Figure 1, OAC 785: CH. 46			3
	Shannon's diversity	> 2.50	2.49 - 1.50	< 1.50	1
	No. of sunfish sp.	>3	2 - 3	< 2	5
	No. of sp. Comprising 75% of sample	> 5	4 - 3	< 3	1
	No. of intolerant species	> 5	3 - 5	< 3	1
	Percentage of tolerant species	See Figure 3, OAC 785: CH. 46			0
Fish Condition	Percentage of lithophils	> 36	18 - 36	< 18	1
	Percentage of DELT anomalies	< 0.1	0.1 - 1.3	> 1.3	5
	Fish Numbers (total individuals)	> 200	200 - 75	< 75	5
Score Key: 30 + Beneficial Use Supported : 23 - 29 Undetermined : < 22 Impaired				Total	22

Table 7 – Fish IBI score for Harlow Creek

Family	Species Name	Common Name	Number of Fish	Percentage
Ictaluridae	<i>Ameiurus melas</i>	Black bullhead catfish	19	7.66%
Centrarchidae	<i>Lepomis cyanellus</i>	Green sunfish	35	14.1%
	<i>Lepomis megalotis</i>	Longear sunfish	18	7.3%
	<i>Lepomis macrochirus</i>	Bluegill sunfish	141	56.9%
	<i>Lepomis microlophus</i>	Redear sunfish	7	2.8%
	<i>Lepomis gulosus</i>	Warmouth sunfish	7	2.8%
	<i>Micropterus salmoides</i>	Largemouth bass	6	2.4%
Atherinospsidae	<i>Labidesthes sicculus</i>	Brook silverside	12	4.8%
Poeciliidae	<i>Gambusia affinis</i>	Mosquitofish	3	1.2%
<b>Total Number:</b>			248	100.00%
<b>Total Number of Taxa:</b>			9	

Table 8 – Fish collection counts for Harlow Creek



^Photograph taken of the Harlow Creek sample site

**2.2.6.2 Benthic Macroinvertebrate Collections** – Data recorded from benthic macroinvertebrate collection during the summer and winter index periods collections shows impairment (ODEQ, Continuing Planning Process, 2012). Scores were above average in the richness of taxa in the winter index period, but low in percent dominance of any two families for both the summer and winter index periods. An increase in dissolved oxygen and in increased flow could improve the macroinvertebrate population. Further sampling may show improvements.

Sampling protocol to determine attainment of water quality standards, (ODEQ, Water Quality in Oklahoma Integrated Report, 2014) requires a minimum of four sampling events within a two year period. Further sampling will be implemented to determine support.

Metric	6	4	2	0	Score
Taxa Richness			55%		2
Modified HBI		70%			4
EPT/Total				1%	0
EPT Taxa				15%	0
% Dominant 2 Taxa				85%	0
Shannon - Weaver				1.0	0
Harlow - Summer (Cross Timbers): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				19%

Metric	6	4	2	0	Score
Taxa Richness	130%				6
Modified HBI		75%			4
EPT/Total				9%	0
EPT Taxa				35%	0
% Dominant 2 Taxa				54%	0
Shannon - Weaver			2.2		2
Harlow - Winter (Cross Timbers): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				44%

Table 9– Benthic macroinvertebrate metrics for summer and winter index periods at Harlow Creek

Phylum	Class	Order	Family	Genus	Common Class	8/15/2016		
						Count	%	
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	<i>Stenonema femoratum</i>	Flathead Mayfly	1	0.9%	
		Odonata	Coenagrionidae	<i>Coenagrion/E nallagma sp.</i>	Narrowwinged Damselfly	10	9.3%	
				<i>Ischnura sp.</i>	Narrowwinged Damselfly	1	0.9%	
			Libellulidae	<i>Libellulidae</i>	Skimmer Dragonfly	5	4.7%	
		Diptera	Chironomidae	<i>Chironomus sp.</i>	Midge	1	0.9%	
				<i>Tanypus sp.</i>		1	0.9%	
			Ceratopogonidae	<i>Bezzia/Palpomyia sp.</i>	Biting Midge	4	3.7%	
				<i>Ceratopogoninae</i>		1	0.9%	
		Arachnida/Acari	Acari			Water Mite	1	0.9%
		Gastropoda	Pulmonata	Lymnaeidae	<i>Lymnaeidae</i>	Lung Snail	1	0.9%
Crustacea	Malacostraca	Amphipoda	Hyalellidae	<i>Hyalella sp.</i>	Scud	81	75.7%	
<b>Harlow Creek Summer Index Period</b>						Total	107	100.0%
						Total Number of Taxa	11	

Phylum	Class	Order	Family	Genus	Common Class	2/10/2017	
						Count	%
Arthropoda	Insecta	Ephemeroptera	Caenidae	<i>Caenis</i> sp.	Squaregilled Mayfly	8	8.2%
			Baetidae	<i>Callibaetis</i> sp.	Minnow Mayfly	1	1.0%
		Odonata	Coenagrionidae	<i>Coenagrion/Enallagma</i> sp.	Narrowwinged Damselfly	7	7.1%
		Diptera	Chironomidae	<i>Clinotanypus</i> sp.	Midge	1	1.0%
				<i>Dicrotendipes modestus</i>		19	19.4%
				<i>Glyptotendipes</i> sp.		2	2.0%
				<i>Guttipelopia</i> sp.		1	1.0%
				<i>Labrundinia</i> sp.		2	2.0%
				<i>Orthocladius</i> sp.		3	3.1%
				<i>Paratanytarsus</i> sp.		1	1.0%
				<i>Polypedilum</i> sp.		7	7.1%
				Ceratopogonidae		<i>Bezzia/Palpomyia</i> sp.	Biting Midge
		<i>Ceratopogoninae</i>	6		6.1%		
		<i>Dasyhelea</i> sp.	1		1.0%		
		Arachnida/Acari	Acari			Water Mite	1
Annelida	Hirudinea	Rhynchobdellida	Glossiphoniidae	<i>Helobdella</i> sp.	Leech	1	1.0%
Mollusca	Bivalvia	Veneroida	Sphaeriidae	<i>Pisidium</i> sp.	Pea Clam	1	1.0%
	Gastropoda	Pulmonata	Lymnaeidae	<i>Lymnaeidae</i>	Lung Snail	1	1.0%
Crustacea	Malacostraca	Amphipoda	Hyalodrilidae	<i>Hyalella</i> sp.	Scud	34	34.7%
<b>Harlow Creek Winter Index Period</b>					Total	98	100.0%
					Total Number of Taxa	19	

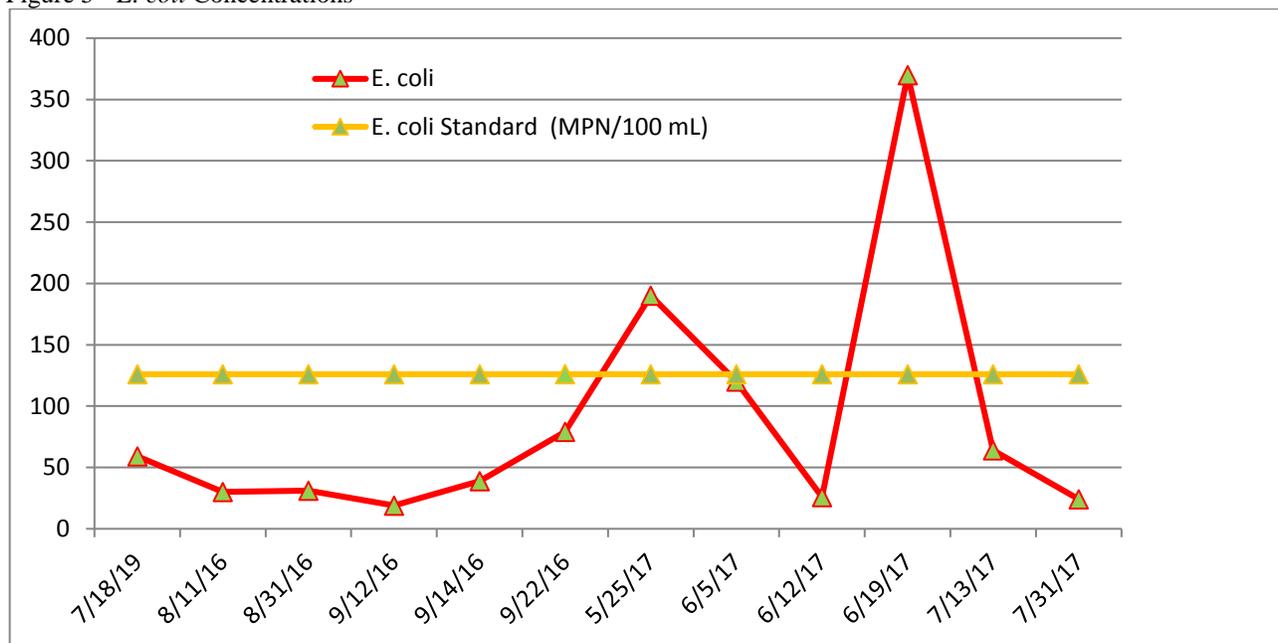
Table 10 – Benthic macroinvertebrate counts for Harlow Creek summer and winter index periods

**2.3 Primary Body Contact** - The data collected on *E. coli* and *Enterococcus* concentrations show that Harlow Creek is impaired *Enterococcus*. The number of samples collected exceeds the number of samples required. Due to high bacteria, DNA samples were taken at minimum 7 days apart to help further illustrate the source of impairment. The results of the DNA testing were inconclusive in determining why Harlow Creek is impaired for *Enterococcus*.

<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>E. coli</i>	57	na	126	12	5	Geometric mean not exceeding standard

Table 11 – *E. coli* totals for Harlow Creek

Figure 5 - *E. coli* Concentrations



Parameter	Sample Geometric Mean (MPN/100mL)	Single Sample (MPN/100mL)	Water Quality Standard (MPN/100mL)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
<i>Enterococcus</i>	90	na	33	12	5	Geometric mean not exceeding standard

Table 12 – *Enterococcus* totals for Harlow Creek

Figure 6 – *Enterococcus* Concentrations

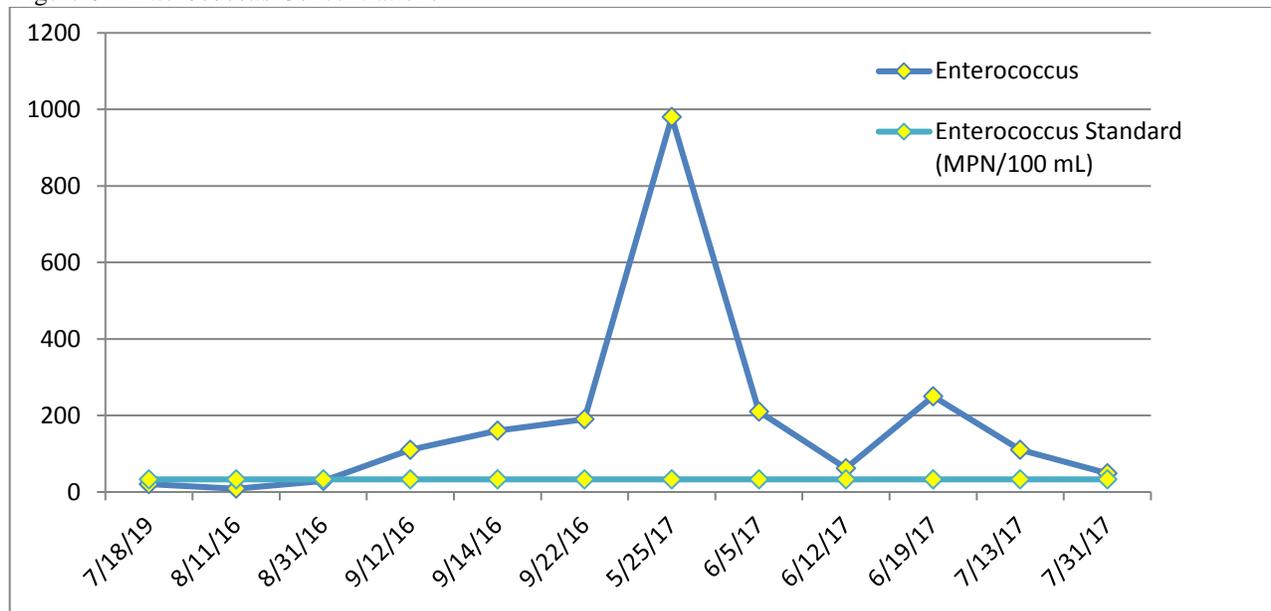
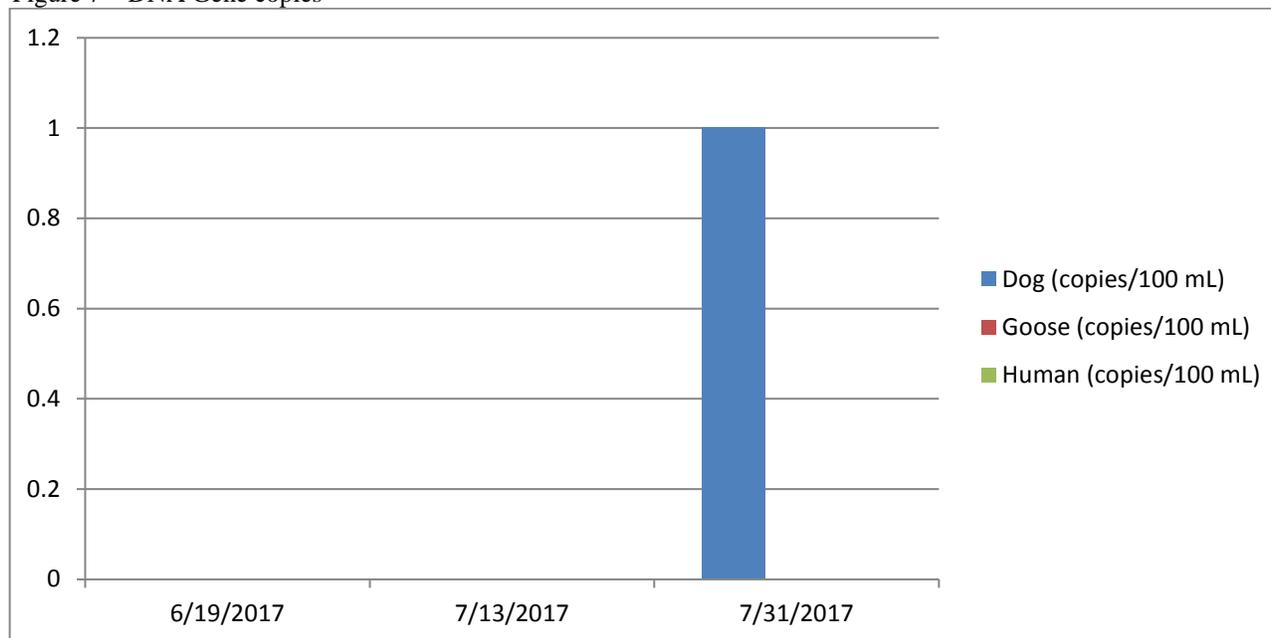


Figure 7 – DNA Gene copies



## 2.4 Anti-Degradation Policy

2.4.1 Nutrients - Analytical results for Total Phosphorus and Nitrate/Nitrite show no need for further investigation to show support of the beneficial use. The number of samples collected exceeds the number of required samples, and less than 10% of samples exceeded the threshold for further sampling. While Nitrate/Nitrite concentrations have an action level, it is not a required parameter within the MS4 permit (ODEQ, OPDES Permit OKS000201, 2011).

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Threshold (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Phosphorus	0.06	na	0.24	12	10	No more than 10% of samples outside range
Nitrite - Nitrate	0.26	na	4.95	12	10	No more than 10% of samples outside range

Table 13 – Nutrient totals for Harlow Creek

Figure 8 - Total Phosphorus Concentrations

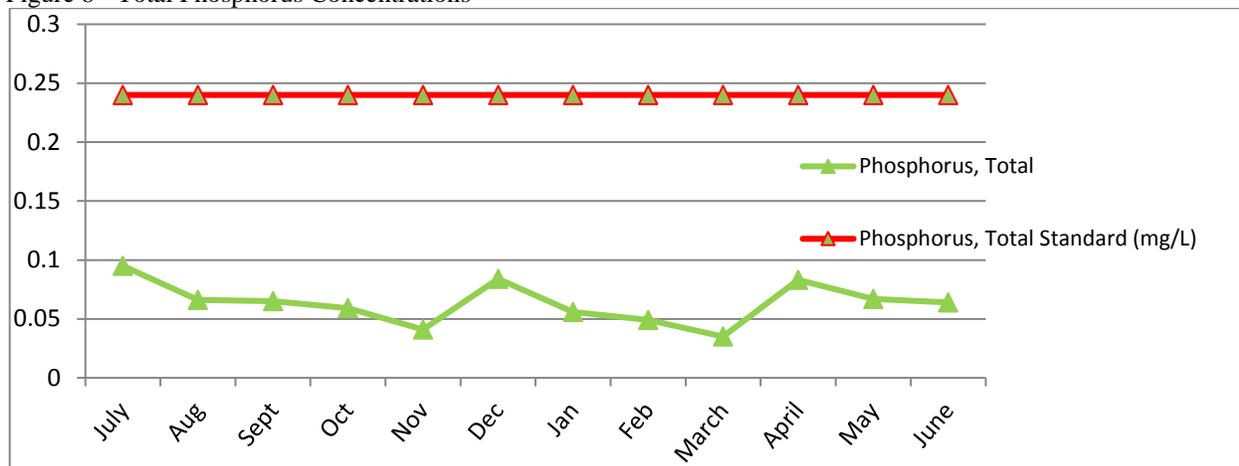
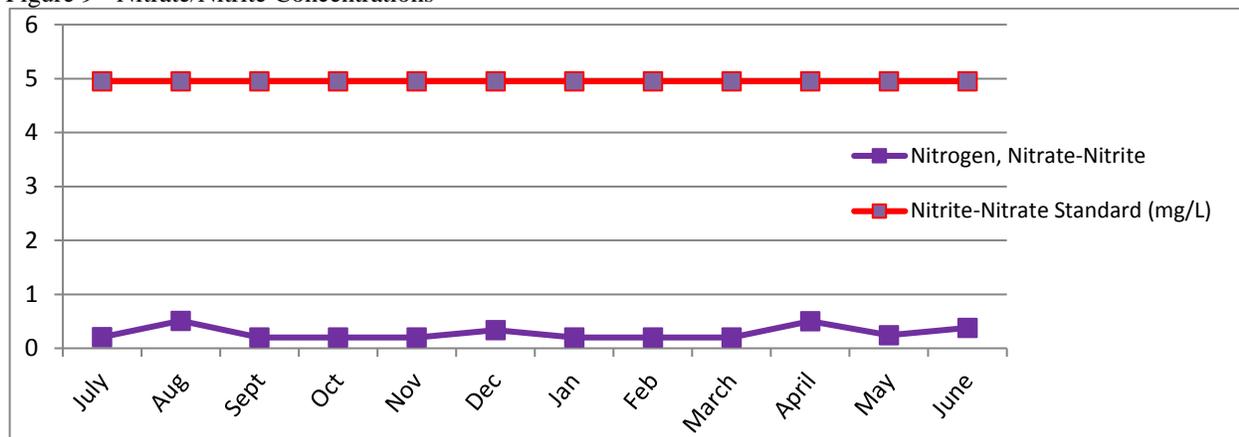


Figure 9 - Nitrate/Nitrite Concentrations



### 3.0 SUMMARY

Analytically, Harlow Creek reflects a few water quality impacts to the stream during the year of sampling including dissolved oxygen and *Enterococcus*. DNA testing was performed to help determine the cause of impairment in regards to *Enterococcus*; however, the results were inconclusive. Poor dissolved oxygen readings could be attributed to the poor flow of the stream. Fish collections reflected an impaired classification according to water quality standards which would show improvement with an increase in the number of intolerant species and lithophils as well as an increase in the diversity of fish. A disappointing benthic macroinvertebrate IBI score could be related to the lack of intolerant species which prevents support of the beneficial use as well as the poor flow of the stream.

Harlow						
Parameter	Sample Mean	Single Sample	Water Quality Standard	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Cadmium (µg/L)	0.50	0.50	Acute: 102.36, Chronic: 2.46	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper (µg/L)	1.38	3.30	Acute: 48.56, Chronic: 29.69	12	5	
Lead (µg/L)	0.69	1.49	Acute: 286.15, Chronic: 11.15	12	5	
Zinc (µg/L)	16.12	52.50	Acute: 269.64, Chronic: 244.23	12	5	
E. coli (MPN/100ml)	57	Na	126	12	5	Geometric mean not exceeding standard
Enterococcus (MPN/100ml)	90	Na	33	12	5	Geometric mean not exceeding standard
Oil and Grease (visual)	none	Na	No visible sheen	12	10	No more than 10% of observations with oil & grease
Total Phosphorus (mg/L)	0.06	Na	0.24	12	10	No more than 10% of samples outside range
Nitrite – Nitrate (mg/L)	0.29	Na	4.95	12	10	No more than 10% of samples outside range
Total Dissolved Solids (mg/L)	317	380	Sample: 1868, Yearly: 1496	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard
pH (s.u.)	7.2 – 7.8	Na	6.5-9.0	12	10	No more than 10% of samples outside range
Turbidity (NTU)	10.58	29.60	50	12	10	No more than 10% of samples outside of range
D.O. (mg/L)	2 samples below 5.0	na	April - June: 5.0	3	10 total	No more than 10% of samples outside range
	4 samples below 6.0	na	June - Mar: 6.0	9		
*Analytes in italics not required by permit Analytes in red exceed standards						

Table 14 – Oklahoma Water Quality Standards summary of collected data

Analyte	Result			Number of Samples	Number of Attempts
	Minimum	Mean	Maximum		
Cadmium, Total (µg/L) (DL 0.5 µg/L)	--	0.50	0.50	12	12
Copper, Total (µg/L) (DL 0.5 µg/L)	--	1.34	3.30	12	12
<i>E. coli</i> (MPN/100 mL) (DL 1 MPN/100 mL)	--	57	370	12	12
<i>Enterococcus</i> (MPN/100 mL)(DL 1 CFU/100 mL)	--	90	980	12	12
Hardness, Total (mg/L) (DL 3.6 mg/L)	95	173	210	12	12
Lead, Total (µg/L) (DL 0.5 µg/L)	--	0.69	1.49	12	12
Nitrogen, Nitrate-Nitrite (mg/L) (DL 0.2 mg/L)	--	0.26	0.51	12	12
Nitrogen, Total Kjeldahl (mg/L)(DL 0.50 mg/L)	--	0.66	1.10	12	12
Nitrogen, Total as Nitrogen (mg/L)(DL 0.50 mg/L)	--	0.75	1.20	12	12
Phosphorus, Dissolved (mg/L) (DL 0.010 mg/L)	--	0.03	0.05	12	12
Phosphorus, Total (mg/L) (DL 0.010 mg/L)	--	0.06	0.10	12	12
Solids, Total Dissolved (mg/L) (DL 10 mg/L)	--	317	380	12	12
Solids, Total Suspended (mg/L) (DL 2.0 mg/L)	--	5.59	11.00	12	12
Zinc, Total (µg/L) (DL 10 µg/L)	--	16.12	52.50	12	12
Water Temperature (°C)	6.32	17.74	29.00	12	12
pH (su)	7.18	--	7.81	12	12
Flow (cfs)	0.00	0.00	0.00	12	12
Turbidity (NTU)	--	10.58	29.60	12	12
Results found to be below the detection limit are reported as the detection limit					

Table 15 – MS4 permit required analytical sampling parameters result summaries

ANALYTE	Date Sampled											
	7/20/2016	8/1/2016	9/7/2016	10/10/2016	11/7/2016	12/7/2016	1/11/2017	2/13/2017	3/6/2017	4/19/2017	5/15/2017	6/12/2017
Cadmium, Total (BDL 0.5) µg/L	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Copper, Total (BDL 0.5) µg/L	1.03	1.28	0.89	1.60	2.05	0.70	0.50	0.62	0.72	3.30	2.11	1.30
Hardness, Total (BDL 3.6) mg/L	200	200	180	150	210	180	180	190	190	95	120	180
Lead, Total (BDL 0.5) µg/L	0.55	0.50	0.50	0.66	0.85	0.50	0.50	0.50	0.50	1.49	1.19	0.50
Nitrogen, Kjeldahl, Total (BDL 0.50) mg/L	0.92	0.51	0.51	0.50	0.50	0.85	0.62	0.50	0.51	1.10	0.78	0.66
Nitrogen, Nitrate-Nitrite (BDL 0.2) mg/L	0.21	0.51	0.20	0.20	0.20	0.34	0.20	0.20	0.20	0.20	0.24	0.38
Nitrogen, Total as N (BDL 0.5) mg/L	1.10	0.99	0.51	0.50	0.50	1.20	0.62	0.50	0.51	1.10	0.50	1.00
pH (s.u.)	7.20	7.70	7.38	7.30	7.60	7.44	7.51	7.24	7.39	7.81	7.51	7.18
Phosphorus, Total (BDL 0.010) mg/L	0.10	0.07	0.07	0.06	0.04	0.08	0.06	0.05	0.04	0.08	0.07	0.06
Phosphorus, Total Dissolved BDL (0.010) mg/L	0.05	0.04	0.03	0.02	0.02	0.03	0.02	0.02	0.01	0.04	0.03	0.03
Solids, Total Dissolved (BDL 10) mg/L	310	340	380	320	360	360	330	340	260	200	270	330
Solids, Total Suspended (BDL 2.0) mg/L	10.00	3.70	4.00	6.70	4.50	4.80	3.60	6.30	2.50	2.00	11.00	8.00
Temperature, Water °C	26.70	29.00	25.06	16.30	15.52	6.32	7.44	9.66	14.82	19.75	20.01	22.26
Turbidity (NTU)	8.47	6.75	5.50	9.04	5.79	9.07	6.56	8.86	9.73	29.60	21.40	495
Zinc, Total (BDL 10) µg/L	10.80	11.90	10.20	10.00	13.60	10.00	10.00	10.00	11.00	52.50	22.80	20.60
Flow CFS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Conductivity µS	551	616	653	485	525	377	367	400	462	251	341	495
Dissolved Oxygen mg/L	3.91	4.40	1.60	3.00	9.40	6.66	11.53	6.74	8.19	4.72	5.48	3.49
Results found to be below the detection limit are reported as the detection limit												

Table 16 – Complete analytical sampling results for all parameters

ANALYTE	Date Sampled											
	7/18/16	8/11/16	8/31/16	9/12/16	9/14/16	9/22/16	5/25/17	6/5/17	6/12/17	6/19/17	7/13/17	7/31/17
<i>E. coli</i> (BDL 1) MPN/100mL	59	30	31	19	39	79	190	120	26	370	64	24
<i>Enterococcus</i> (BDL 1) MPN/100 mL	20.7	8.5	29.1	110	160	190	980	210	62	250	110	49
Results found to be below the detection limit are reported as the detection limit												

Table 17 – Complete analytical results for bacteria samples

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## **CITY OF TULSA WATERSHED CHARACTERIZATION PROGRAM**

### **Comprehensive Watershed Characterization Assessment Year 1 (2016-2017):**

### **MOOSER CREEK**

City of Tulsa Streets and Stormwater  
Stormwater and Land Management Division  
4502 South Galveston  
Tulsa, OK 74107

Prepared by

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**September 19, 2017**

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## 1.0 INTRODUCTION

### 1.1 Objective

The purpose of this document is to serve as a comprehensive report of results from the biological, habitat, and analytical assessments of Mooser Creek. These assessments were performed in order to comply with requirements set forth in Part II(A)(13)(12)(b) and (13)(a) and (b) and Part IV(A)(1) and (2) of Oklahoma Pollutant Discharge Elimination System (OPDES) municipal stormwater (MS4) Permit No. OKS000201 for the City of Tulsa, Oklahoma (ODEQ, OPDES Permit OKS000201, 2011). In addition, assessment results are applied to Oklahoma Water Quality Standards. These standards are described in both (OWRB, 2013a) and (OWRB, 2013b). Where applicable, reference conditions will not be established until the conclusion of the current permit. Until such references are established, those standards will result in an “insufficient data” designation with regards to support within the Fish and Wildlife propagation beneficial use. While these implementations describe a multitude of surface water quality standards, this document will compare and describe only the standards applicable to the parameters required in the Watershed Characterization Program sub section of the Municipal Separate Storm Sewer System permit (ODEQ, OPDES Permit OKS000201, 2011). All remaining parameter results without applicable water quality standards will still be included in this report.

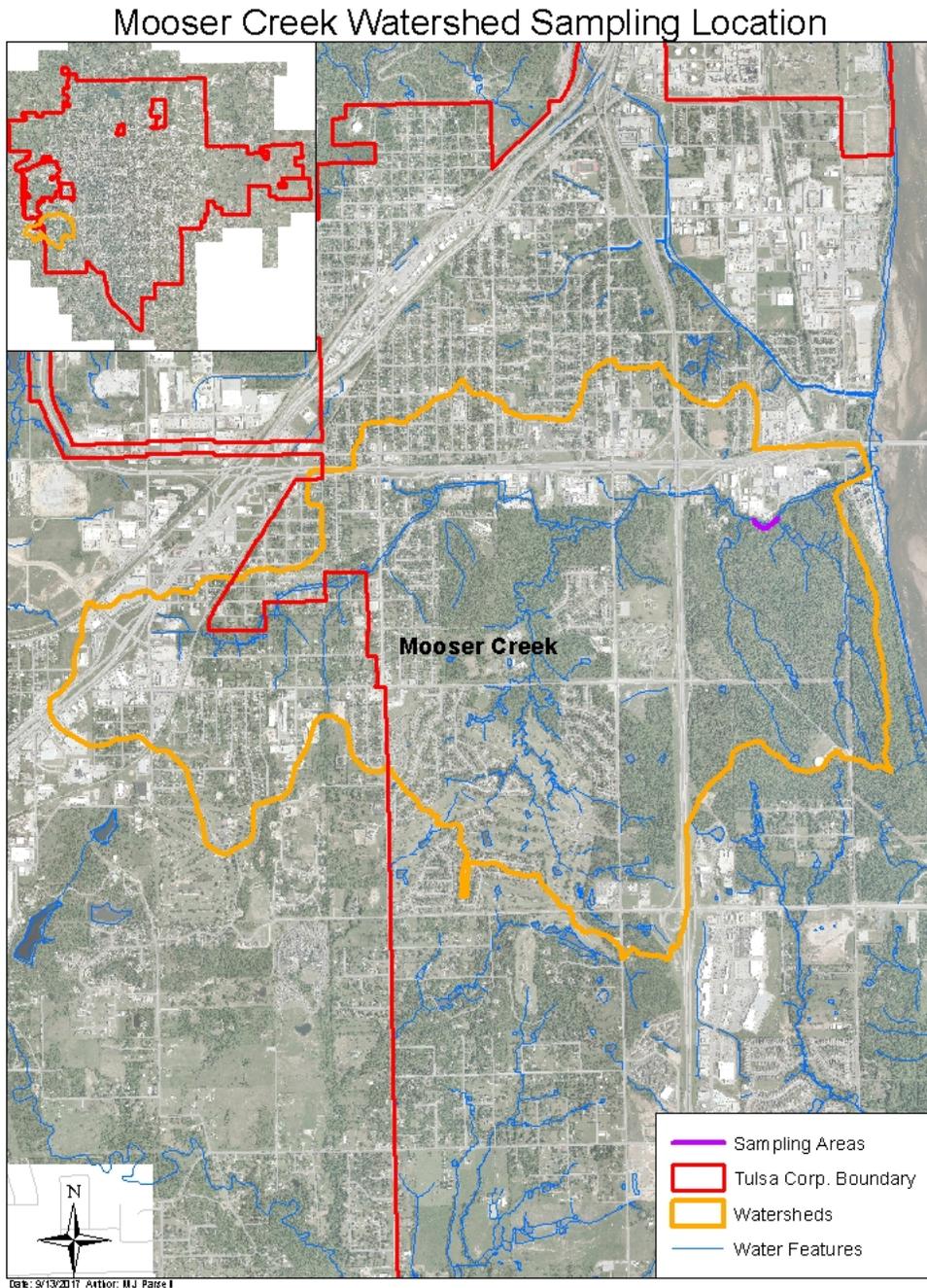
The data presented in this comprehensive report was collected over a one year period beginning in July of 2016 with completion in June of 2017. Field collection and assessment methodology followed project standard operating procedures (SOPs) as provided in the quality assurance project plans (QAPPs) for the biological component (CCRC & FTN, 2014) and the analytical component (CCRC & FTN, 2014). These QAPPs provide quality assurance and quality control procedures for all aspects of the watershed characterization program. They were submitted to and received approval from the Oklahoma Department of Environmental Quality as per MS4 permit requirements. All field data sheets were scanned electronically and archived at the City of Tulsa Stormwater and Land Management Division. All field measurements (in situ measurements, flows, observations), biological information (taxonomic identification, organism counts), and analytical results were compiled in Excel spreadsheets and verified (data entry, formula calculations) per project QA/QC procedures (CCRC & FTN, 2014) (CCRC & FTN, 2014). All raw data, SOPs, and QAPPs are available upon request.

**Mooser Creek**  
**WBID: OK120420010070\_00**

Figure 1 - Sampling location on Mooser Creek during Year 1

Waterbody	Sample Location		Watershed Area (mi <sup>2</sup> )*	Sampling/Evaluation Date			
	Latitude	Longitude		Fish	Benthic (Summer)	Benthic (Winter)	Habitat
Mooser Creek	36.085556	-95.998917	4.98	10/17/2016	07/06/2016	02/08/2017	09/27/2016

\* Collection area captured by sampling point



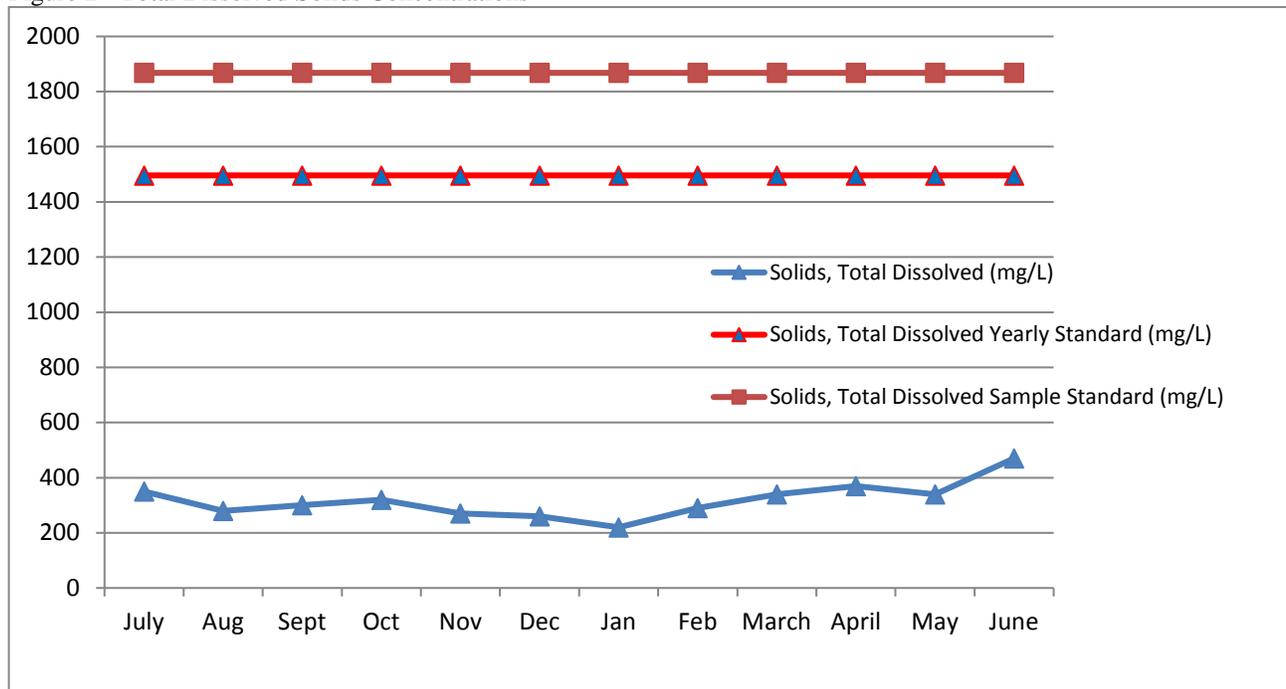
## 2.0 BENEFICIAL USES

**2.1 Agriculture** - Data collected on Total Dissolved Solids for Mooser Creek indicates attainment of the agricultural beneficial use. The number of samples collected exceeds the number of samples required. The sample mean does not exceed the yearly standard and none of the samples exceeded the sample standard.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Dissolved Solids	309	470	Sample: 1868, Yearly: 1496	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard

Table 1 – Agriculture standards for Mooser Creek

Figure 2 - Total Dissolved Solids Concentrations



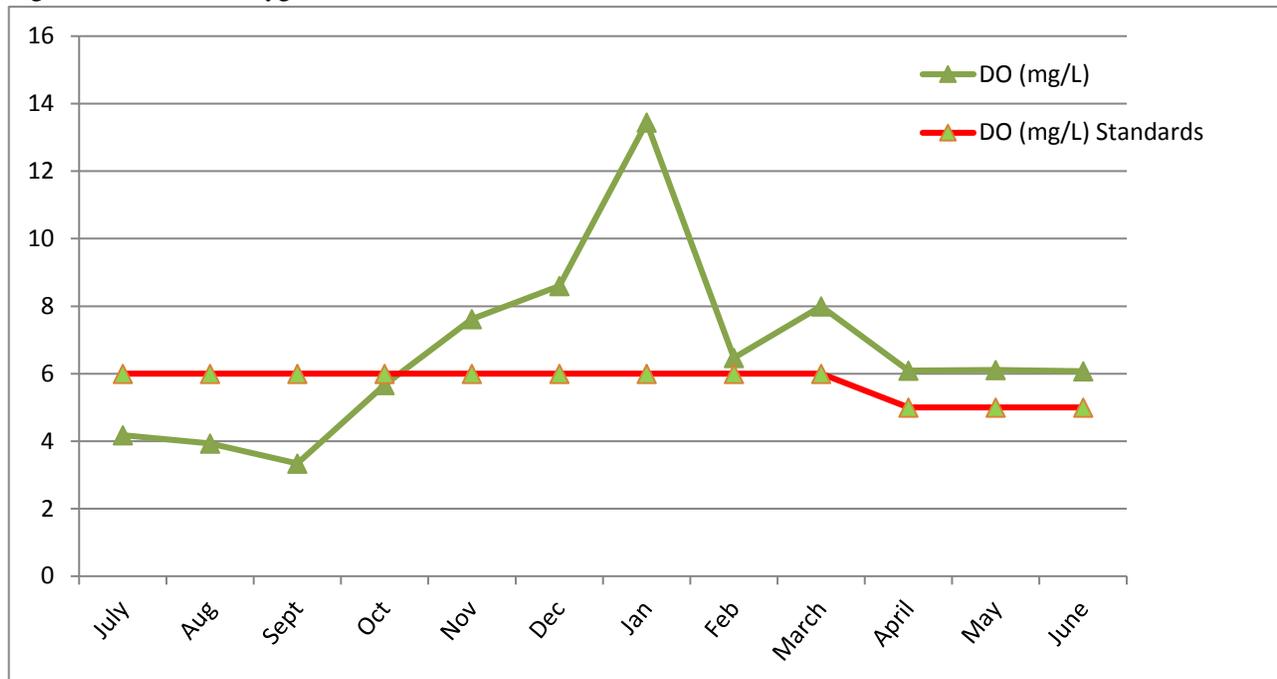
## 2.2 Fish and Wildlife Propagation: Warm Water Aquatic Community

**2.2.1 Dissolved Oxygen** - Data collected on Dissolved Oxygen concentrations shows the beneficial use is not supported. The number of samples collected exceeds the number of required samples. Out of 12 samples, there were 4 samples found to be below the standard.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
D.O.	0 samples below 5.0	na	April - June: 5.0	3	10 total	No more than 10% of samples outside range
	4 samples below 6.0	na	June – Mar: 6.0	9		

Table 2 – Dissolved Oxygen standards for Mooser Creek

Figure 3 - Dissolved Oxygen Concentrations



**2.2.2 Toxicants/Metals** - Data collected indicate full support of the beneficial use for Toxicants and Metals.

<u>Parameter</u>	<u>Sample Mean (µg/L)</u>	<u>Single Sample (µg/L)</u>	<u>Water Quality Standard (µg/L)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Cadmium	0.50	0.50	Acute: 102.36, Chronic: 2.46	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper	2.89	5.50	Acute: 48.56, Chronic: 29.69	12	5	
Lead	0.53	0.67	Acute: 286.15, Chronic: 11.15	12	5	
Zinc	15.43	48.80	Acute: 269.64, Chronic: 244.23	12	5	

Table 3 – Toxicants/Metals standards for Mooser Creek

**2.2.3 pH (Hydrogen Ion Activity)** - Data collected on pH readings Mooser Crow Creek show full support of the beneficial use. The number of pH measurements taken exceeds the number of required measurements. All pH measurements fell within the standard range.

<u>Parameter</u>	<u>Sample Range (s.u.)</u>	<u>Single Sample (s.u.)</u>	<u>Water Quality Standard Range (s.u.)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
pH	7.2 – 8.0	na	6.5-9.0	12	10	No more than 10% of samples outside range

Table 4 – pH standards for Mooser Creek

**2.2.4 Oil and Grease** – Oil and Grease is based on visual assessment. Visual observations do not indicate the presence of Oil and Grease pollution, supporting the beneficial use.

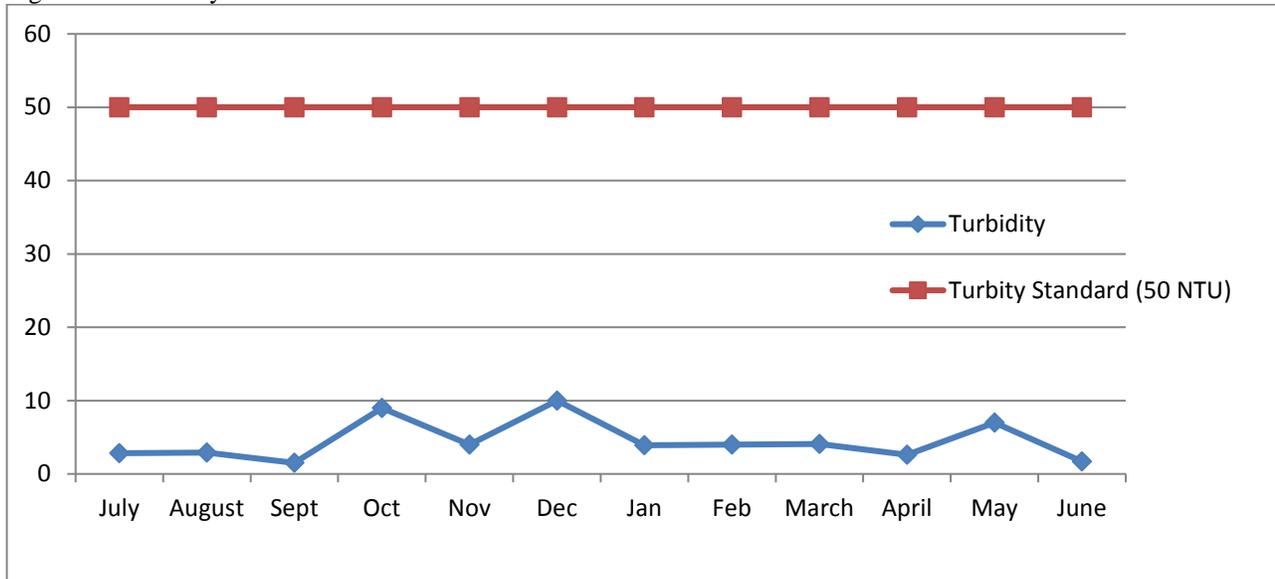
**2.2.5 Suspended and Bedded Sediments** – Using habitat assessment data to determine support of the beneficial use is conditional upon support of turbidity data and fish collection data.

**2.2.5.1 Turbidity** – Data collected on Turbidity readings for Mooser Creek show full support of the beneficial use.

<u>Parameter</u>	<u>Sample Mean (NTU)</u>	<u>Single Sample (NTU)</u>	<u>Water Quality Standard (NTU)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Turbidity	4.40	13.10	50	12	10	No more than 10% exceeding sample standard

Table 5 – Turbidity standards for Mooser Creek

Figure 4 – Turbidity Concentrations



**2.2.5.2 Habitat Assessment** – The resulting score of the habitat assessment on Mooser Creek can be compared to the average score of high quality sites within the same ecoregion provided by the Oklahoma Conservation Commission using a scoring workbook derived from OWRB (OWRB, 2001). The results of the habitat assessment produced a score above average for the cross timbers ecoregion.

Metric	Score
Instream habitat	19.4
Pool bottom substrate	10.7
Pool variability	19.0
Canopy cover	15.5
Presence of rocky runs and riffles	7.5
Flow (at representative low flow)	2.0
Channel alteration	4.2
Channel sinuosity	1.1
Bank stability	4.9
Bank vegetation stability	4.7
Stream side Cover	7.8
<b>Total Score</b>	<b>96.80</b>
<b>Cross Timbers Mean Score</b>	<b>93.58</b>

Table 6 – Habitat assessment metric and total results with ecoregion mean score

**2.2.6 Biological**

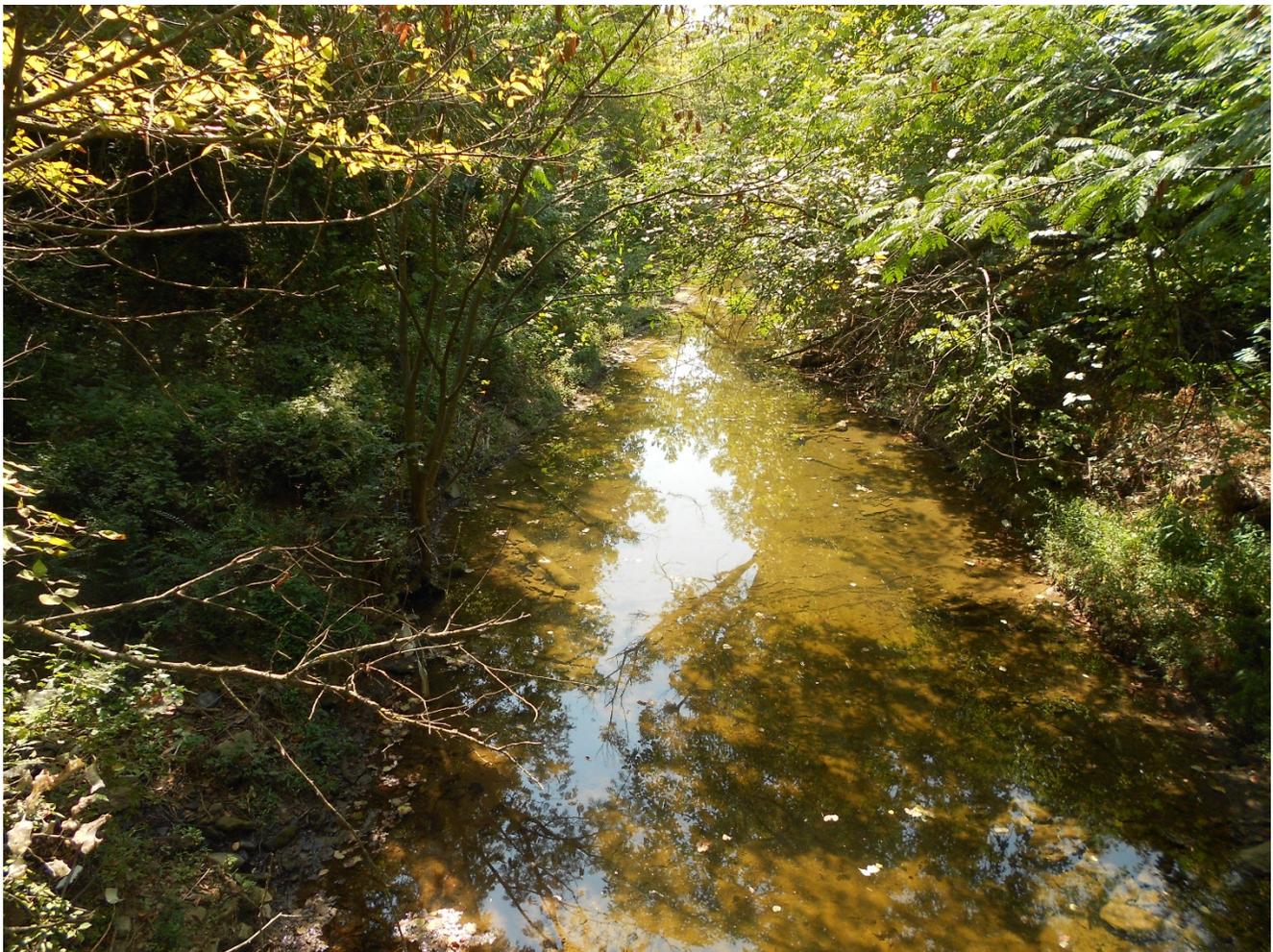
**2.2.6.1 Fish Collections** - Data recorded from Fish collections performed on Mooser Creek show that the beneficial use is undetermined. A lack of intolerant species prevents full support, however a small increase in species diversity would also be beneficial. Downstream water quality impacts may prevent repopulations.

Index of Biotic Integrity		5	3	1	Score
Sample Composition	Total no. of species	See Figure 1, OAC 785: CH. 46			3
	Shannon's diversity	> 2.50	2.49 - 1.50	< 1.50	3
	No. of sunfish sp.	>3	2 - 3	< 2	3
	No. of sp. Comprising 75% of sample	>5	4 - 3	< 3	1
	No. of intolerant species	>5	3 - 5	< 3	1
	Percentage of tolerant species	See Figure 3, OAC 785: CH. 46			3
Fish Condition	Percentage of lithophils	> 36	18 - 36	< 18	5
	Percentage of DELT anomalies	< 0.1	0.1 - 1.3	> 1.3	3
	Fish Numbers (total individuals)	> 200	200 - 75	< 75	5
Score Key: 30 + Beneficial Use Supported : 23 - 29 Undetermined : < 22 Impaired				Total	27

Table 7 – Fish IBI score for Mooser Creek

Family	Species Name	Common Name	Number of Fish	Percentage
Ictaluridae	<i>Ameiurus natalis</i>	Yellow bullhead catfish	18	5.9%
Centrarchidae	<i>Lepomis cyanellus</i>	Green sunfish	32	10.5%
	<i>Lepomis macrochirus</i>	Bluegill sunfish	11	3.6%
	<i>Lepomis megalotis</i>	Longear sunfish	86	28.1%
	<i>Micropterus salmoides</i>	Largemouth bass	13	4.2%
Cyprinidae	<i>Campostoma anomalum</i>	Central stoneroller	132	43.1%
Percidae	<i>Etheostoma spectabile</i>	Orangethroat darter	9	2.9%
Poeciliidae	<i>Gambusia affinis</i>	Mosquitofish	5	1.6%
<b>Total Number:</b>			306	100.0%
<b>Total Number of Taxa:</b>			8	

Table 8 – Fish collection counts for Mooser Creek



^Photograph taken of the Mooser Creek sample site

**2.2.6.2 Benthic Macroinvertebrate Collections** – Data recorded from benthic macroinvertebrate collection during the summer and winter index periods collections shows undetermined for the summer index period and impairment for the winter index period (ODEQ, Continuing Planning Process, 2012). Scores were above average in the richness of taxa for the summer index period, but low in percent dominance of any two families for both the summer and winter index periods.

Sampling protocol to determine attainment of water quality standards, (ODEQ, Water Quality in Oklahoma Integrated Report, 2014) requires a minimum of four sampling events within a two year period. Further sampling will be implemented to determine support.

Metric	6	4	2	0	Score
Taxa Richness	87%				6
Modified HBI	105%				6
EPT/Total	63%				6
EPT Taxa			75%		2
% Dominant 2 Taxa				42%	0
Shannon - Weaver			2.1		2
Mooser - Summer (Cross Timbers): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				69%

Metric	6	4	2	0	Score
Taxa Richness			50%		2
Modified HBI	92%				6
EPT/Total		26%			4
EPT Taxa				54%	0
% Dominant 2 Taxa				85%	0
Shannon - Weaver				1.2	0
Mooser - Winter (Cross Timbers): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				39%

Table 9 – Benthic macroinvertebrate metrics for summer and winter index periods at Mooser Creek

Phylum	Class	Order	Family	Genus	Common Class	7/6/2016		
						Count	%	
Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Baetis intercalaris</i>	Minnow Mayfly	11	8.3%	
				<i>Fallceon quilleri</i>	Minnow Mayfly	27	20.5%	
		Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	Netspinner Caddisfly	28	21.2%	
				Philopotamidae	<i>Chimarra</i> sp.	Fingernet Caddisfly	16	12.1%
					Hydroptilidae	<i>Hydroptila</i> sp.	Micro Caddisfly	1
		Odonata	Coenagrionidae	<i>Argia</i> sp.	Narrowwinged Damselfly	3	2.3%	
		Coleoptera	Elmidae	<i>Stenelmis</i> sp.	Riffle Beetle	23	17.4%	
		Diptera	Chironomidae	<i>Cricotopus</i> sp.	Midge	1	0.8%	
				<i>Pentaneura</i> sp.		2	1.5%	
				<i>Polypedilum flavum</i>		5	3.8%	
				<i>Thienemannimyia</i> gr. sp.		10	7.6%	
	Ceratopogonidae	<i>Atrichopogon</i> sp.	Biting Midge	2	1.5%			
Mollusca	Bivalvia	Veneroida	Corbiculidae	<i>Corbicula</i> sp.	Asian Freshwater Clam	1	0.8%	
Crustacea	Malacostraca	Decapoda	Cambaridae	<i>Cambaridae</i>	Crayfish	1	0.8%	
Platyhelminthes			Tubellaria			1	0.8%	
<b>Mooser Creek Summer Index Period</b>						Total	132	100.0%
						Total Number of Taxa	15	

Phylum	Class	Order	Family	Genus	Common Class	2/8/2017		
						Count	%	
Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Callibaetis</i> sp.	Minnow Mayfly	1	1.0%	
				<i>Fallceon quilleri</i>	Minnow Mayfly	3	2.9%	
		Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	Netspinner Caddisfly	3	2.9%	
				Philopotamidae	<i>Chimarra</i> sp.	Fingernet Caddisfly	20	19.2%
		Coleoptera	Elmidae	<i>Stenelmis</i> sp.	Riffle Beetle	2	1.9%	
		Diptera	Chironomidae	<i>Polypedilum flavum</i>	Midge	68	65.4%	
				<i>Polypedilum scalaenum</i> gr.		3	2.9%	
				<i>Rheotanytarsus exiguus</i> gr.		2	1.9%	
<i>Thienemannimyia</i> gr. sp.	2			1.9%				
<b>Mooser Creek Winter Index Period</b>						Total	104	100.0%
						Total Number of Taxa	9	

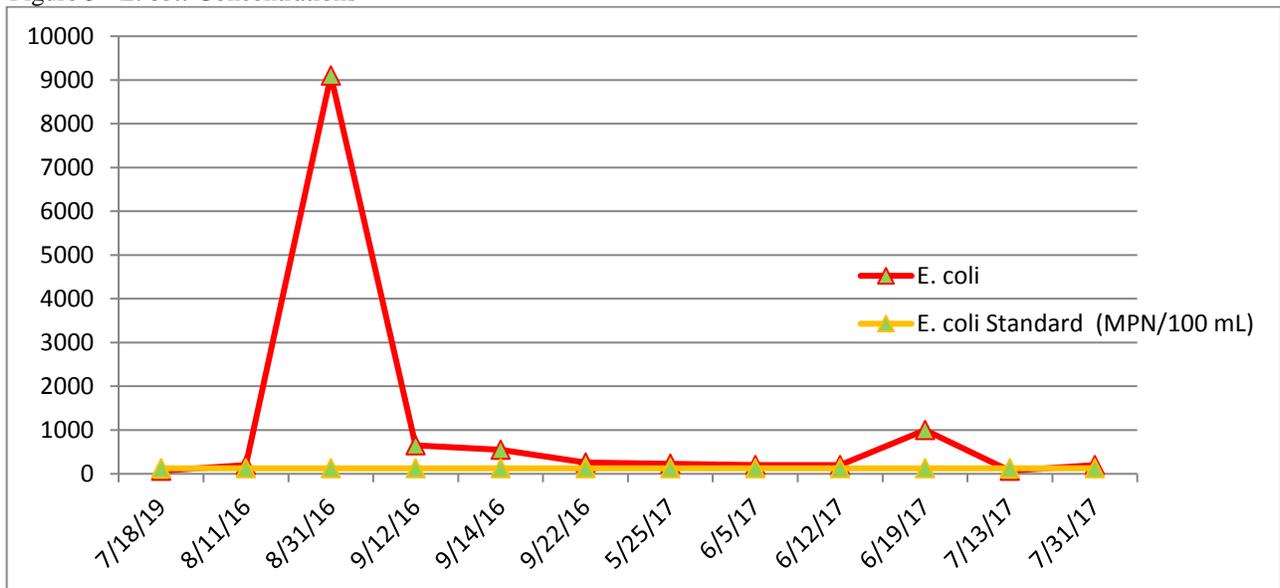
Table 10 – Benthic macroinvertebrate counts for Mooser Creek summer and winter index periods

**2.3 Primary Body Contact** - The data collected on *E. coli* and *Enterococcus* concentrations show that Mooser Creek is impaired for both *E. coli* and *Enterococcus*. The number of samples collected exceeds the number of samples required. Due to high bacteria results, 3 DNA samples were taken at minimum 7 days apart to help further illustrate the source of impairment. The results of the DNA testing indicates that the primary problem could be caused by pet waste not being picked up and properly disposed of.

<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>E. coli</i>	328	na	126	12	5	Geometric mean not exceeding standard

Table 11 – *E. coli* totals for Mooser Creek

Figure 5 - *E. coli* Concentrations



<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>Enterococcus</i>	285	na	33	12	5	Geometric mean not exceeding standard

Table 12 – *Enterococcus* totals for Mooser Creek

Figure 6 – *Enterococcus* Concentrations

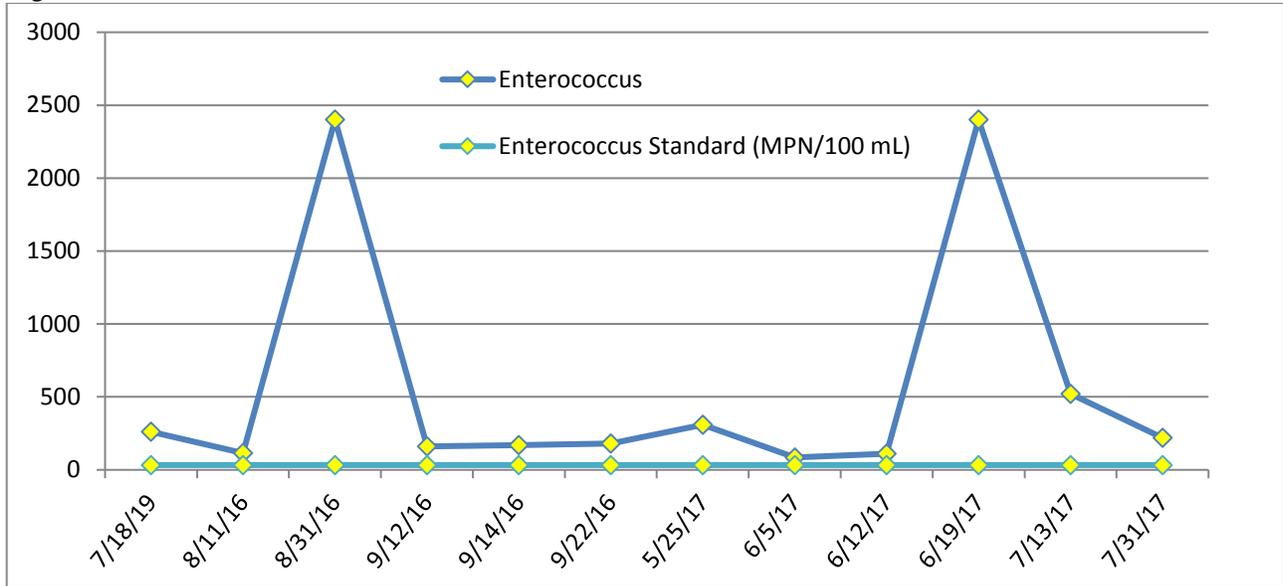
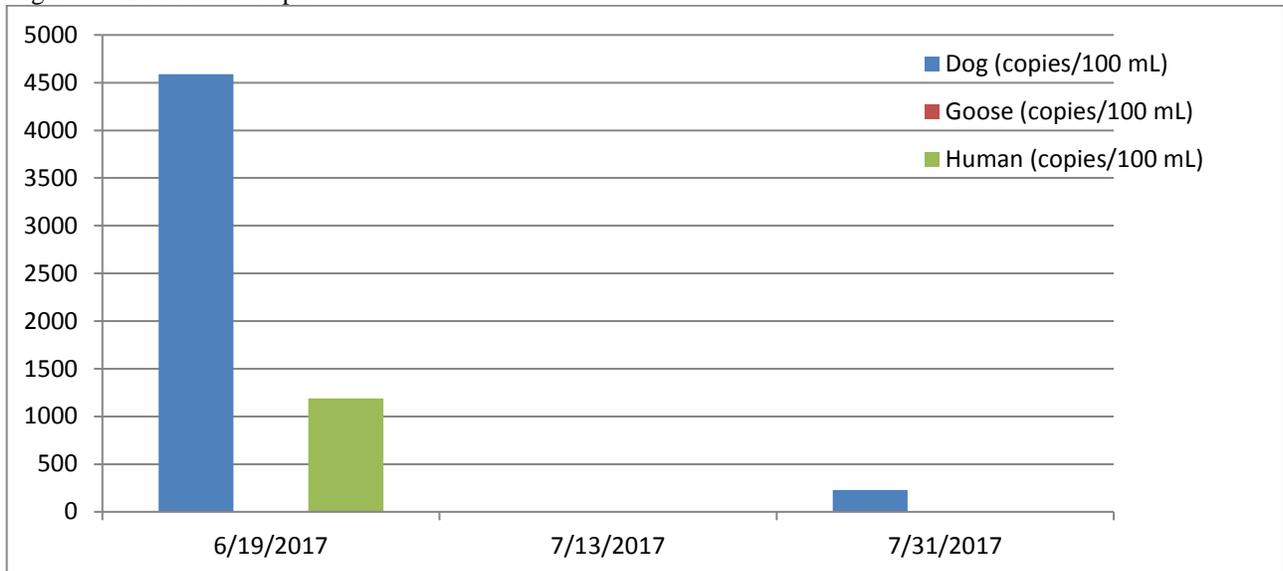


Figure 7 – DNA Gene Copies



## 2.4 Anti-Degradation Policy

2.4.1 Nutrients - Analytical results for Total Phosphorus and Nitrate/Nitrite show no need for further investigation to show support of the beneficial use. The number of samples collected exceeds the number of required samples, and less than 10% of samples exceeded the threshold for further sampling. While Nitrate/Nitrite concentrations have an action level, it is not a required parameter within the MS4 permit (ODEQ, OPDES Permit OKS000201, 2011).

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Threshold (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Phosphorus	0.03	na	0.24	12	10	No more than 10% of samples outside range
Nitrite - Nitrate	0.29	na	4.95	12	10	No more than 10% of samples outside range

Table 13 – Nutrient totals for Mooser Creek

Figure 8 - Total Phosphorus Concentrations

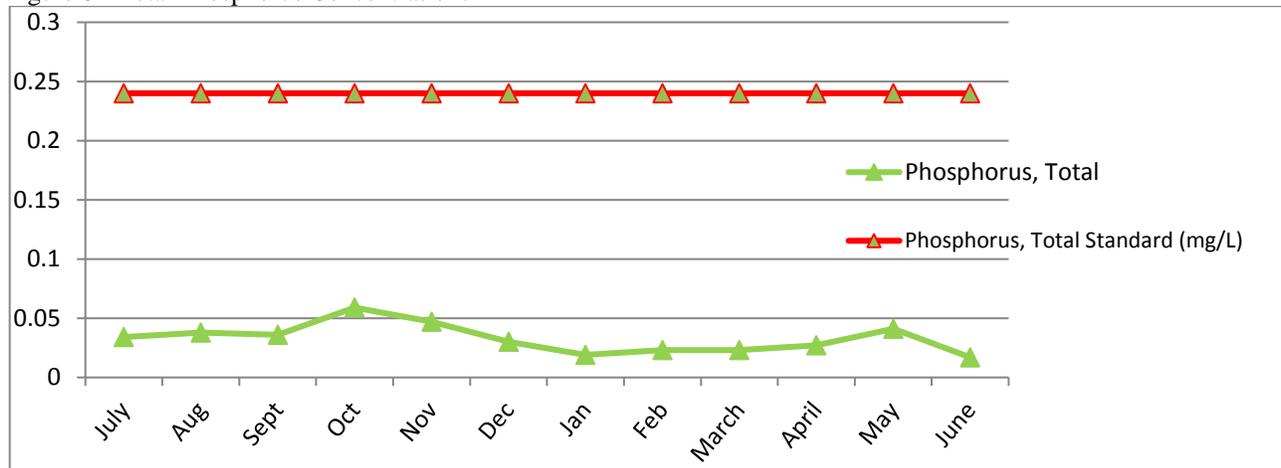
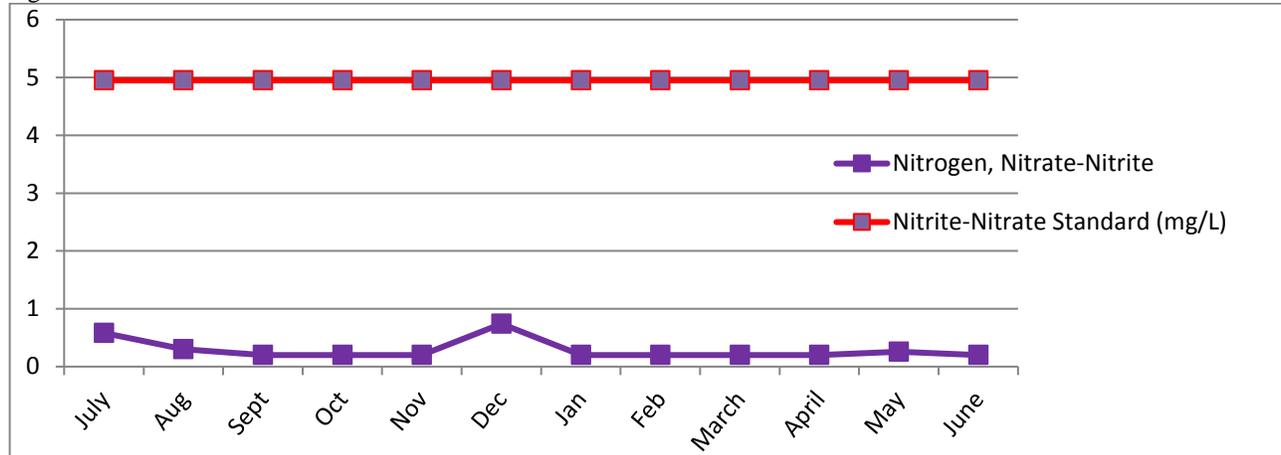


Figure 9 - Nitrate/Nitrite Concentrations



### 3.0 SUMMARY

Analytically, Mooser Creek does not reflect any water quality impacts to the stream during the year of sampling with the exception of dissolved oxygen and bacteria. DNA testing was performed to help determine the cause of impairment in regards to bacteria. The results showed that a continued push in public education addressing proper disposal of pet waste could be beneficial. Low dissolved oxygen values could be attributed to poor flow in the months that showed decreased dissolved oxygen. Fish collections reflected an undetermined classification according to water quality standards despite being close to supporting. A disappointing benthic macroinvertebrate IBI score could be related to the lack of intolerant species which prevents support of the beneficial use. Overall, with a slight increase in flow and dissolved oxygen, it is possible Mooser Creek could support a thriving biological community.

<b>Mooser</b>						
<b>Parameter</b>	<b>Sample Mean</b>	<b>Single Sample</b>	<b>Water Quality Standard</b>	<b>No. of Samples</b>	<b>No. of Samples Required (WQS)</b>	<b>How Standard is Violated</b>
Cadmium (µg/L)	0.50	0.50	Acute: 102.36, Chronic: 2.46	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper (µg/L)	2.89	5.50	Acute: 48.56, Chronic: 29.69	12	5	
Lead (µg/L)	0.53	0.67	Acute: 286.15, Chronic: 11.15	12	5	
Zinc (µg/L)	15.43	48.80	Acute: 269.64, Chronic: 244.23	12	5	
E. coli (MPN/100ml)	328	Na	126	12	5	Geometric mean not exceeding standard
Enterococcus (MPN/100ml)	285	Na	33	12	5	Geometric mean not exceeding standard
Oil and Grease (visual)	none	Na	No visible sheen	12	10	No more than 10% of observations with oil & grease
Total Phosphorus (mg/L)	0.03	Na	0.24	12	10	No more than 10% of samples outside range
Nitrite – Nitrate (mg/L)	0.29	Na	4.95	12	10	No more than 10% of samples outside range
Total Dissolved Solids (mg/L)	309	470	Sample: 1868, Yearly: 1496	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard
pH (s.u.)	7.2 – 8.0	Na	6.5-9.0	12	10	No more than 10% of samples outside range
Turbidity (NTU)	4.40	13.10	50	12	10	No more than 10% of samples outside of range
D.O. (mg/L)	0 samples below 5.0	na	April - June: 5.0	3	10 total	No more than 10% of samples outside range
	4 samples below 6.0	na	June – Mar: 6.0	9		
*Analytes in italics not required by permit Analytes in red exceed standards						

Table 14 – Oklahoma Water Quality Standards summary of collected data

Analyte	Result			Number of Samples	Number of Attempts
	Minimum	Mean	Maximum		
Cadmium, Total (µg/L) (DL 0.5 µg/L)	--	0.50	0.50	12	12
Copper, Total (µg/L) (DL 0.5 µg/L)	--	2.89	5.50	12	12
<i>E. coli</i> (MPN/100 mL) (DL 1 MPN/100 mL)	--	328	9100	12	12
<i>Enterococcus</i> (MPN/100 mL)(DL 1 CFU/100 mL)	--	285	2400	12	12
Hardness, Total (mg/L) (DL 3.6 mg/L)	150	191	260	12	12
Lead, Total (µg/L) (DL 0.5 µg/L)	--	0.53	0.67	12	12
Nitrogen, Nitrate-Nitrite (mg/L) (DL 0.2 mg/L)	--	0.29	0.74	12	12
Nitrogen, Total Kjeldahl (mg/L)(DL 0.50 mg/L)	--	0.58	0.75	12	12
Nitrogen, Total as Nitrogen (mg/L)(DL 0.50 mg/L)	--	0.63	1.04	12	12
Phosphorus, Dissolved (mg/L) (DL 0.010 mg/L)	--	0.02	0.04	12	12
Phosphorus, Total (mg/L) (DL 0.010 mg/L)	--	0.03	0.05	12	12
Solids, Total Dissolved (mg/L) (DL 10 mg/L)	--	309	470	12	12
Solids, Total Suspended (mg/L) (DL 2.0 mg/L)	--	4.06	8.20	12	12
Zinc, Total (µg/L) (DL 10 µg/L)	--	15.43	48.80	12	12
Water Temperature (°C)	3.50	16.06	27.10	12	12
pH (su)	7.20	--	8.03	12	12
Flow (cfs)	0.06	0.39	1.42	12	12
Turbidity (NTU)	--	4.40	13.10	12	12
Results found to be below the detection limit are reported as the detection limit					

Table 15 – MS4 permit required analytical sampling parameters result summaries

ANALYTE	Date Sampled											
	7/12/16	8/4/16	9/8/16	10/11/16	11/6/16	12/6/16	1/10/17	2/13/17	3/16/17	4/12/17	5/15/17	6/7/17
Cadmium, Total (BDL 0.5) µg/L	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Copper, Total (BDL 0.5) µg/L	4.21	5.50	2.86	3.25	5.28	2.74	1.42	1.46	1.75	1.56	2.56	2.10
Hardness, Total (BDL 3.6) mg/L	210	170	190	150	170	190	150	180	190	220	210	260
Lead, Total (BDL 0.5) µg/L	0.50	0.50	0.50	0.50	0.67	0.50	0.50	0.50	0.50	0.50	0.66	0.50
Nitrogen, Kjeldahl, Total (BDL 0.50) mg/L	0.75	0.74	0.50	0.50	0.68	0.50	0.50	0.50	0.50	0.64	0.62	0.50
Nitrogen, Nitrate-Nitrite (BDL 0.2) mg/L	0.58	0.30	0.20	0.20	0.20	0.74	0.20	0.20	0.20	0.20	0.26	0.20
Nitrogen, Total as N (BDL 0.5) mg/L	0.58	1.04	0.50	0.50	0.68	0.72	0.50	0.50	0.50	0.64	0.86	0.50
pH (s.u.)	7.60	7.20	7.37	8.03	7.51	7.43	7.48	7.48	7.58	7.47	7.44	7.42
Phosphorus, Total (BDL 0.010) mg/L	0.03	0.04	0.04	0.04	0.05	0.03	0.02	0.02	0.02	0.03	0.04	0.02
Phosphorus, Total Dissolved BDL (0.010) mg/L	0.02	0.04	0.03	0.03	0.03	0.02	0.01	0.01	0.01	0.02	0.02	0.01
Solids, Total Dissolved (BDL 10) mg/L	350	280	300	220	270	260	220	290	340	370	340	470
Solids, Total Suspended (BDL 2.0) mg/L	2.8	2.0	2.7	5.7	5.0	8.2	5.0	4.0	6.0	3.3	2.0	2.0
Temperature, Water °C	26.50	27.10	25.60	16.70	11.30	7.81	3.50	8.40	8.24	16.24	19.86	21.51
Turbidity (NTU)	2.81	2.91	1.46	5.28	3.99	13.10	3.92	4.03	4.06	2.61	6.96	1.67
Zinc, Total (BDL 10) µg/L	10.0	10.3	10.0	10.0	15.5	10.0	10.2	10.0	10.3	18.3	48.8	21.8
Flow CFS	0.13	0.11	0.09	0.24	0.38	0.54	0.50	0.06	0.41	0.40	1.42	0.45
Conductivity µS	595	494	527	333	345	292	220	336	356	530	473	607
Dissolved Oxygen mg/L	4.18	3.93	3.34	5.67	7.62	8.6	13.44	6.47	8.00	6.09	6.11	6.07
Results found to be below the detection limit are reported as the detection limit												

Table 16 – Complete analytical sampling results for all parameters

ANALYTE	Date Sampled											
	7/18/16	8/11/16	8/31/16	9/12/16	9/14/16	9/22/16	5/25/17	6/5/17	6/12/17	6/19/17	7/13/17	7/31/17
<i>E. coli</i> (BDL 1) MPN/100mL	70	200	9100	650	550	260	230	200	200	1000	70	200
<i>Enterococcus</i> (BDL 1) MPN/100 mL	261	116	2400	160	170	180	310	85	110	2400	520	220
Results found to be below the detection limit are reported as the detection limit												

Table 17 – Complete analytical results for bacteria samples

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**Save  
Our  
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## **CITY OF TULSA WATERSHED CHARACTERIZATION PROGRAM**

### **Comprehensive Watershed Characterization Assessment Year 1 (2016-2017):**

#### **NICKEL CREEK**

City of Tulsa Streets and Stormwater  
Stormwater and Land Management Division  
4502 South Galveston  
Tulsa, OK 74107

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**September 19, 2017**

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## 1.0 INTRODUCTION

### 1.1 Objective

The purpose of this document is to serve as a comprehensive report of results from the biological, habitat, and analytical assessments of Nickel Creek. These assessments were performed in order to comply with requirements set forth in Part II(A)(13)(12)(b) and (13)(a) and (b) and Part IV(A)(1) and (2) of Oklahoma Pollutant Discharge Elimination System (OPDES) municipal stormwater (MS4) Permit No. OKS000201 for the City of Tulsa, Oklahoma (ODEQ, OPDES Permit OKS000201, 2011). In addition, assessment results are applied to Oklahoma Water Quality Standards. These standards are described in both (OWRB, 2013a) and (OWRB, 2013b). Where applicable, reference conditions will not be established until the conclusion of the current permit. Until such references are established, those standards will result in an “insufficient data” designation with regards to support within the Fish and Wildlife propagation beneficial use. While these implementations describe a multitude of surface water quality standards, this document will compare and describe only the standards applicable to the parameters required in the Watershed Characterization Program sub section of the Municipal Separate Storm Sewer System permit (ODEQ, OPDES Permit OKS000201, 2011). All remaining parameter results without applicable water quality standards will still be included in this report.

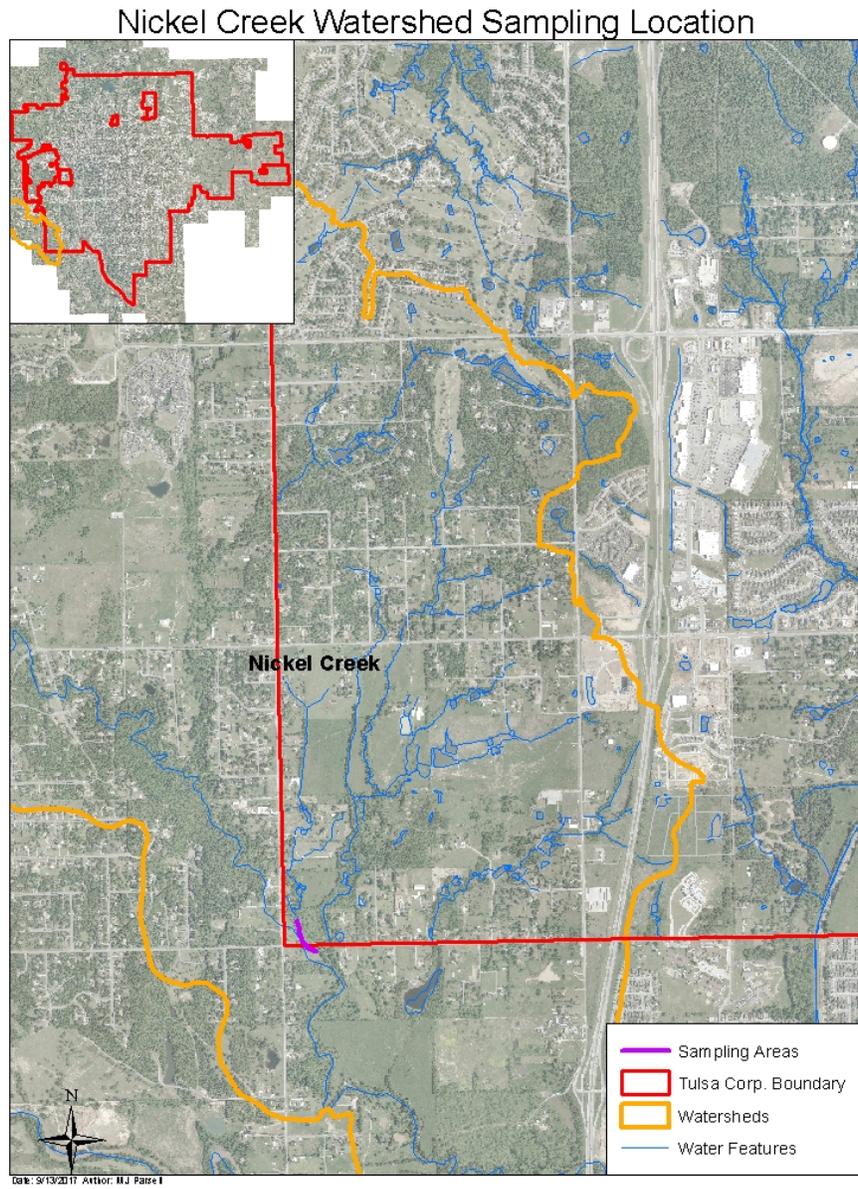
The data presented in this comprehensive report was collected over a one year period beginning in July of 2016 with completion in June of 2017. Field collection and assessment methodology followed project standard operating procedures (SOPs) as provided in the quality assurance project plans (QAPPs) for the biological component (CCRC & FTN, 2014) and the analytical component (CCRC & FTN, 2014). These QAPPs provide quality assurance and quality control procedures for all aspects of the watershed characterization program. They were submitted to and received approval from the Oklahoma Department of Environmental Quality as per MS4 permit requirements. All field data sheets were scanned electronically and archived at the City of Tulsa Stormwater and Land Management Division. All field measurements (in situ measurements, flows, observations), biological information (taxonomic identification, organism counts), and analytical results were compiled in Excel spreadsheets and verified (data entry, formula calculations) per project QA/QC procedures (CCRC & FTN, 2014) (CCRC & FTN, 2014). All raw data, SOPs, and QAPPs are available upon request.

**Nickel Creek**  
**WBID: OK120420020040\_00**

Figure 1 - Sampling location on Nickel Creek during Year 1

Waterbody	Sample Location		Watershed Area (mi <sup>2</sup> )*	Sampling/Evaluation Date			
	Latitude	Longitude		Fish	Benthic (Summer)	Benthic (Winter)	Habitat
Nickel Creek	36.031944	-96.028056	11.64	10/17/2016	06/21/2016	02/03/2017	10/20/2016

\* Collection area captured by sampling point



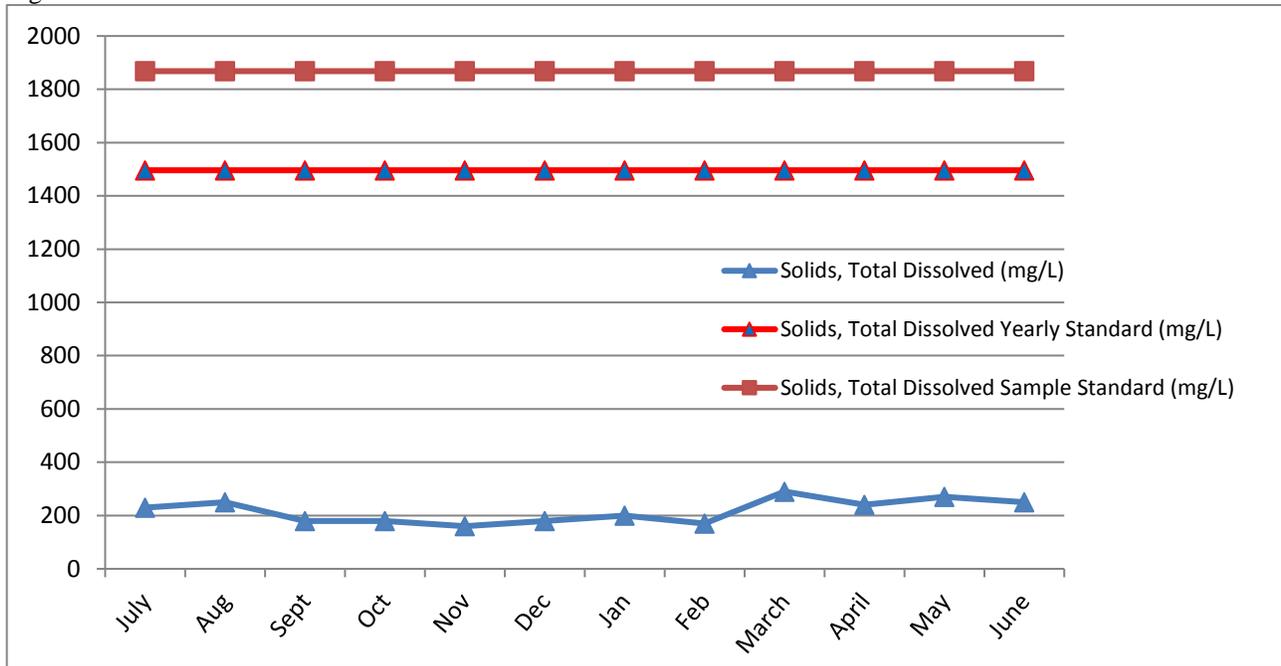
## 2.0 BENEFICIAL USES

**2.1 Agriculture** - Data collected on Total Dissolved Solids for Nickel Creek indicates attainment of the agricultural beneficial use. The number of samples collected exceeds the number of samples required. The sample mean does not exceed the yearly standard and none of the samples exceeded the sample standard.

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Standard (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Dissolved Solids	217	290	Sample: 1868, Yearly: 1496	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard

Table 1 – Agriculture standards for Nickel Creek

Figure 2 - Total Dissolved Solids Concentrations



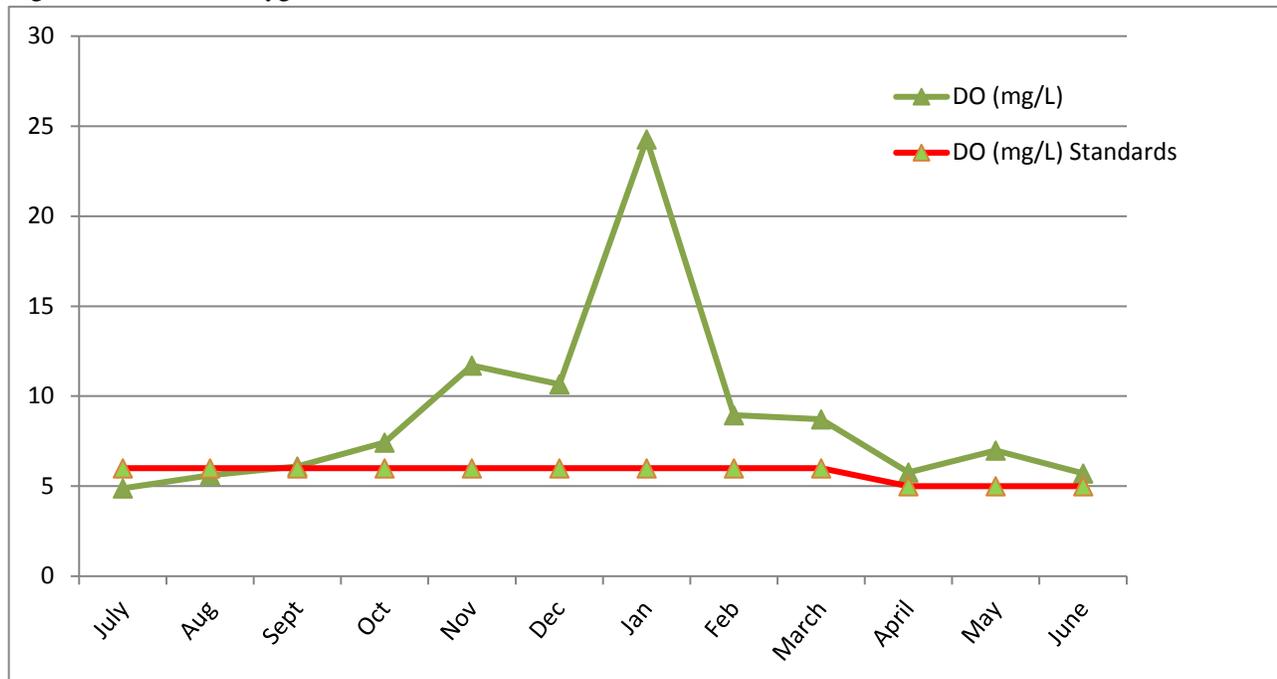
**2.2 Fish and Wildlife Propagation: Warm Water Aquatic Community**

**2.2.1 Dissolved Oxygen** - Data collected on Dissolved Oxygen concentrations shows the beneficial use is not supported. The number of samples collected exceeds the number of required samples. Out of 12 samples, there were 2 samples found to be below the standard.

<u>Parameter</u>	<u>Sample Mean (mg/L)</u>	<u>Single Sample (mg/L)</u>	<u>Water Quality Standard (mg/L)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
D.O.	0 samples below 5.0	na	April - June: 5.0	3	10 total	No more than 10% of samples outside range
	2 samples below 6.0	na	June - Mar: 6.0	9		

Table 2 – Dissolved Oxygen standards for Nickel Creek

Figure 3 - Dissolved Oxygen Concentrations



**2.2.2 Toxicants/Metals** - Data collected indicate full support of the beneficial use for Toxicants and Metals.

<u>Parameter</u>	<u>Sample Mean</u> ( $\mu\text{g/L}$ )	<u>Single Sample</u> ( $\mu\text{g/L}$ )	<u>Water Quality Standard</u> ( $\mu\text{g/L}$ )	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Cadmium	0.50	0.50	Acute: 102.36, Chronic: 2.46	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper	1.69	3.91	Acute: 48.56, Chronic: 29.69	12	5	
Lead	0.62	1.06	Acute: 286.15, Chronic: 11.15	12	5	
Zinc	14.03	28.00	Acute: 269.64, Chronic: 244.23	12	5	

Table 3 – Toxicants/Metals standards for Nickel Creek

**2.2.3 pH (Hydrogen Ion Activity)** - Data collected on pH readings for Nickel Creek show full support of the beneficial use. The number of pH measurements taken exceeds the number of required measurements. All pH measurements fell within the standard range.

<u>Parameter</u>	<u>Sample Range</u> (s.u.)	<u>Single Sample</u> (s.u.)	<u>Water Quality Standard Range</u> (s.u.)	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
pH	7.4 – 8.0	na	6.5-9.0	12	10	No more than 10% of samples outside range

Table 4 – pH standards for Nickel Creek

**2.2.4 Oil and Grease** – Oil and Grease is based on visual assessment. Visual observations do not indicate the presence of Oil and Grease pollution, supporting the beneficial use.

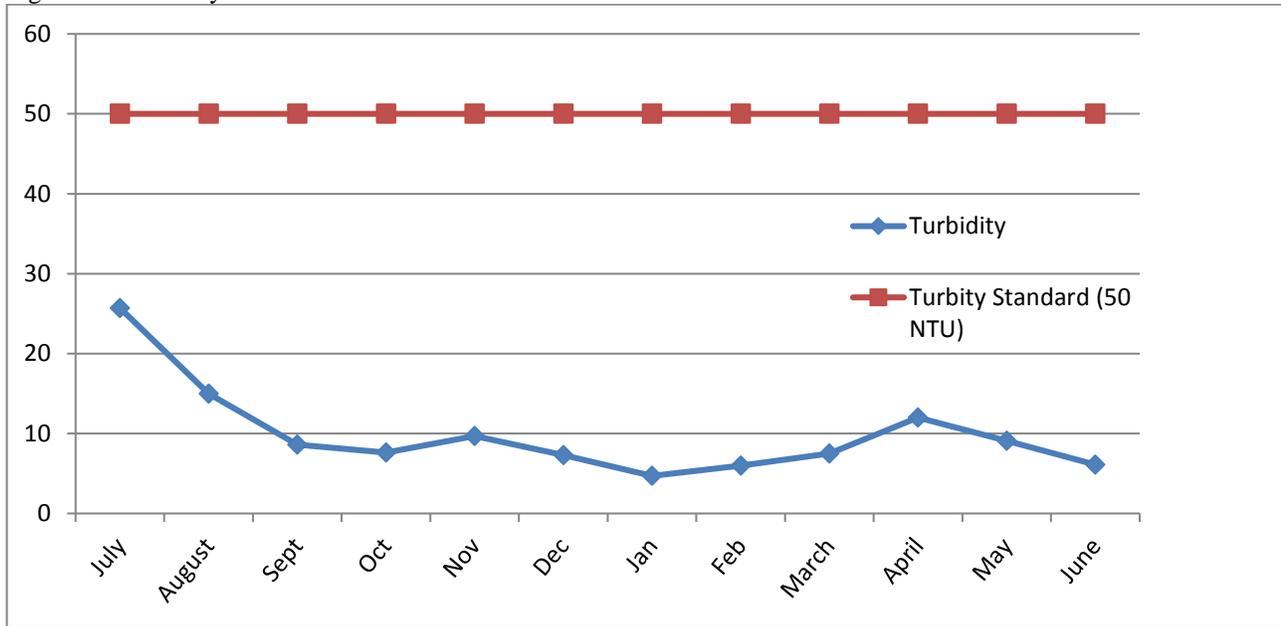
**2.2.5 Suspended and Bedded Sediments** – Using habitat assessment data to determine support of the beneficial use is conditional upon the support of turbidity data and fish collection data.

**2.2.5.1 Turbidity** – Data collected on Turbidity readings for Nickel Creek show full support of the beneficial use.

<u>Parameter</u>	<u>Sample Mean (NTU)</u>	<u>Single Sample (NTU)</u>	<u>Water Quality Standard (NTU)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
Turbidity	9.89	25.70	50	12	10	No more than 10% exceeding sample standard

Table 5 – Turbidity standards for Nickel Creek

Figure 4 – Turbidity Concentrations



**2.2.5.2 Habitat Assessment** - The resulting score of the habitat assessment on Nickel Creek can be compared to the average score of high quality sites within the same ecoregion provided by the Oklahoma Conservation Commission using a scoring workbook derived from OWRB (OWRB, 2001). The results of the habitat assessment produced a score above average for the cross timbers ecoregion.

Metric	Score
Instream habitat	19.10
Pool bottom substrate	2.70
Pool variability	13.70
Canopy cover	18.50
Presence of rocky runs and riffles	13.30
Flow (at representative low flow)	15.70
Channel alteration	11.10
Channel sinuosity	1.10
Bank stability	6.10
Bank vegetation stability	3.00
Stream side Cover	6.20
<b>Total Score</b>	<b>110.50</b>
<b>Cross Timbers Mean Score</b>	<b>93.58</b>

Table 6 – Habitat assessment metric and total results with ecoregion mean score

## 2.2.6 Biological

**2.2.6.1 Fish Collections** - Data recorded from Fish collections performed on Nickel Creek show that the beneficial use is supported.

Index of Biotic Integrity		5	3	1	Score
Sample Composition	Total no. of species	See Figure 1, OAC 785: CH. 46			3
	Shannon's diversity	> 2.50	2.49 - 1.50	< 1.50	3
	No. of sunfish sp.	>3	2 - 3	< 2	3
	No. of sp. Comprising 75% of sample	>5	4 - 3	< 3	5
	No. of intolerant species	>5	3 - 5	< 3	3
	Percentage of tolerant species	See Figure 3, OAC 785: CH. 46			1
Fish Condition	Percentage of lithophils	> 36	18 - 36	< 18	5
	Percentage of DELT anomalies	< 0.1	0.1 - 1.3	> 1.3	5
	Fish Numbers (total individuals)	> 200	200 - 75	< 75	5
Score Key: 30 + Beneficial Use Supported : 23 - 29 Undetermined : < 22 Impaired				Total	33

Table 7 – Fish IBI score for Nickel Creek

Family	Species Name	Common Name	Number of	Percentage
Ictaluridae	<i>Ameiurus natalis</i>	Yellow bullhead catfish	2	0.7%
	<i>Ameiurus melas</i>	Black bullhead catfish	2	0.7%
Centrarchidae	<i>Lepomis cyanellus</i>	Green sunfish	42	14.5%
	<i>Lepomis macrochirus</i>	Bluegill sunfish	33	11.4%
	<i>Lepomis megalotis</i>	Longear sunfish	20	6.9%
Cyprinidae	<i>Campostoma anomalum</i>	Central stoneroller	67	23.2%
	<i>Pimephalus notatus</i>	Bluntnose minnow	13	4.5%
	<i>Cyprinella lutrensis</i>	Red shiner	53	18.3%
	<i>Cyprinella</i> sp.	Shiner sp.	22	7.6%
Percidae	<i>Etheostoma whipplei</i>	Redfin darter	34	11.8%
Catostomidae	<i>Minytrema melanops</i>	Spotted sucker	1	0.3%
<b>Total Number:</b>			289	100.0%
<b>Total Number of Taxa:</b>			11	

Table 8 – Fish collection counts for Nickel Creek



^Photograph taken of Nickel Creek sample site

**2.2.6.2 Benthic Macroinvertebrate Collections** – Data recorded from benthic macroinvertebrate collection during the summer and winter index periods collections shows undetermined for the summer index period and impairment for the winter index period (ODEQ, Continuing Planning Process, 2012). Scores were low in percent dominance of any two families for both the summer and winter index periods. Analytical data and habitat assessments do not reflect any water quality impacts with the exception of dissolved oxygen. Further sampling may show improvements.

Sampling protocol to determine attainment of water quality standards, (ODEQ, Water Quality in Oklahoma Integrated Report, 2014) requires a minimum of four sampling events within a two year period. Further sampling will be implemented to determine support.

Metric	6	4	2	0	Score
Taxa Richness		69%			4
Modified HBI	100%				6
EPT/Total	31%				6
EPT Taxa				30%	0
% Dominant 2 Taxa				57%	0
Shannon - Weaver			1.7		2
Nickel - Summer (Cross Timbers): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				56%

Metric	6	4	2	0	Score
Taxa Richness		78%			4
Modified HBI	89%				6
EPT/Total			17%		2
EPT Taxa				27%	0
% Dominant 2 Taxa				59%	0
Shannon - Weaver			1.9		2
Nickel - Winter (Cross Timbers): > 80% Attaining : 80 - 50% Undetermined : < 50% Impaired	Total				45%

Table 9 – Benthic macroinvertebrate metrics for summer and winter index periods at Nickel Creek

Phylum	Class	Order	Family	Genus	Common Class	6/21/2016			
						Count	%		
Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Baetis intercalaris</i>	Minnow Mayfly	1	0.9%		
		Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	Netspinner Caddisfly	35	30.4%		
		Coleoptera	Elmidae	<i>Dubiraphia</i> sp.	Riffle Beetle	3	2.6%		
				<i>Stenelmis</i> sp.		27	23.5%		
		Diptera	Chironomidae	<i>Polypedium flavum</i>	Midge	31	27.0%		
				<i>Tanytarsus</i> sp.		1	0.9%		
				<i>Thienemannimyia</i> gr. sp.		1	0.9%		
			Ceratopogonidae	<i>Bezzia/Palpomyia</i> sp.	Biting Midge	2	1.7%		
		Empididae	<i>Hemerodromia</i> sp.	Dance Fly	1	0.9%			
		Arachnida	Acari	<i>Atractides</i> sp.	Water Mite	1	0.9%		
<i>Testudacarus</i> sp.	11			9.6%					
Mollusca	Bivalvia			Clam	1	0.9%			
<b>Nickel Creek Summer Index Period</b>						Total		115	100.0%
						Total Number of Taxa			

Phylum	Class	Order	Family	Genus	Common Class	2/3/2017			
						Count	%		
Arthropoda	Insecta	Ephemeroptera	Caenidae	<i>Caenis</i> sp.	Squaregilled Mayfly	4	3.8%		
		Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	Netspinner Caddisfly	13	12.4%		
		Odonata	Coenagrionidae	<i>Argia</i> sp.	Narrowwinged Damselfly	4	3.8%		
		Coleoptera	Elmidae	<i>Stenelmis</i> sp.	Riffle Beetle	8	7.6%		
		Diptera	Chironomidae	<i>Cricotopus</i> sp.	Midge	1	1.0%		
				<i>Parakiefferiella</i> sp.		1	1.0%		
				<i>Polypedium flavum</i>		48	45.7%		
				<i>Rheotanytarsus exiguus</i> gr.		4	3.8%		
				<i>Tanytarsus</i> sp.		1	1.0%		
		<i>Thienemannimyia</i> gr. sp.	14	13.3%					
Ceratopogonidae	<i>Bezzia/Palpomyia</i> sp.	Biting Midge	2	1.9%					
Tabanidae	Tabanidae	Horse Fly	1	1.0%					
Arachnida	Acari	<i>Torrenticola</i> sp.	Water Mite	1	1.0%				
Mollusca	Bivalvia	Veneroida	Corbiculidae	<i>Corbicula</i> sp.	Asian Freshwater Clam	3	2.9%		
<b>Nickel Creek Winter Index Period</b>						Total		105	100.0%
						Total Number of Taxa			

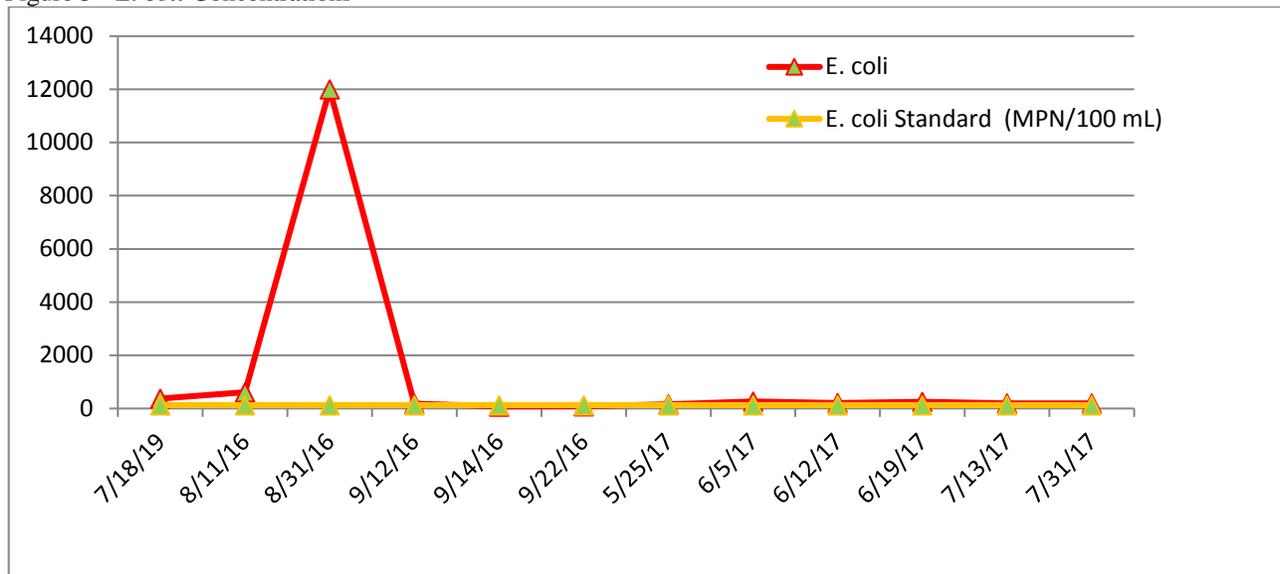
Table 9 – Benthic macroinvertebrate counts for Nickel Creek summer and winter index periods

**2.3 Primary Body Contact** - The data collected on *E. coli* and *Enterococcus* concentrations show that Nickel Creek is impaired for both *E. coli* and *Enterococcus*. The number of samples collected exceeds the number of samples required. Due to high bacteria results, 3 DNA samples were taken at minimum 7 days apart to help further illustrate the source of impairment. The results of the DNA testing indicate that the primary problem could be caused by pet waste not being picked up and properly disposed of.

<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>E. coli</i>	282	na	126	12	5	Geometric mean not exceeding standard

Table 11 – *E. coli* totals for Nickel Creek

Figure 5 - *E. coli* Concentrations



<u>Parameter</u>	<u>Sample Geometric Mean (MPN/100mL)</u>	<u>Single Sample (MPN/100mL)</u>	<u>Water Quality Standard (MPN/100mL)</u>	<u>No. of Samples</u>	<u>No. of Samples Required (WQS)</u>	<u>How Standard is Violated</u>
<i>Enterococcus</i>	269	na	33	12	5	Geometric mean not exceeding standard

Table 12 – *Enterococcus* totals for Nickel Creek

Figure 6 – *Enterococcus* Concentrations

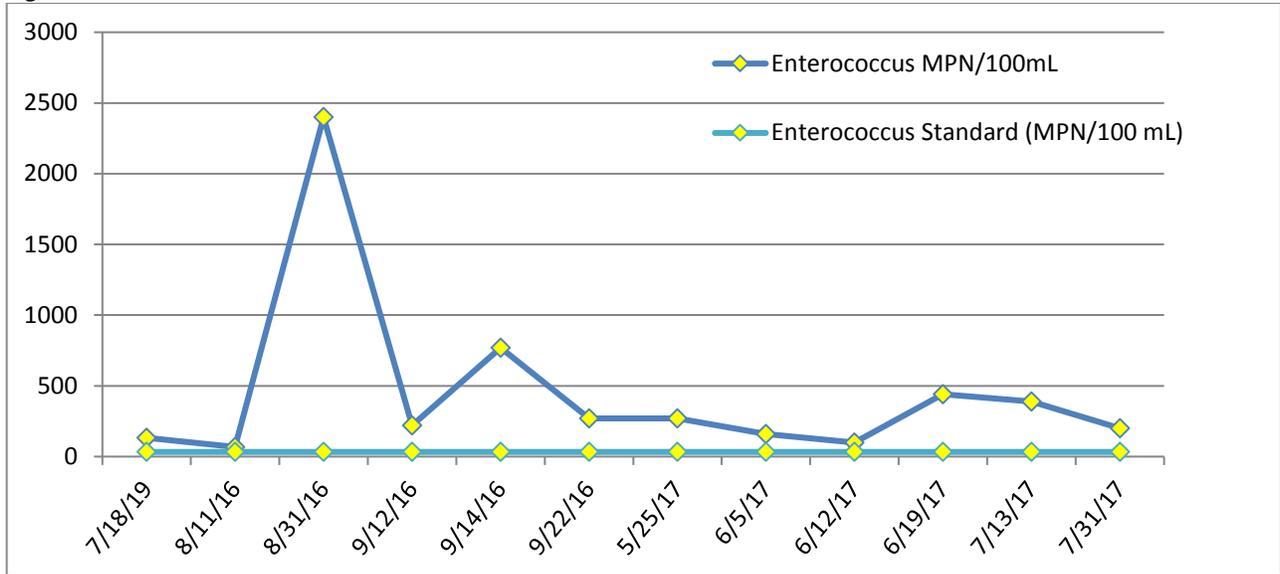
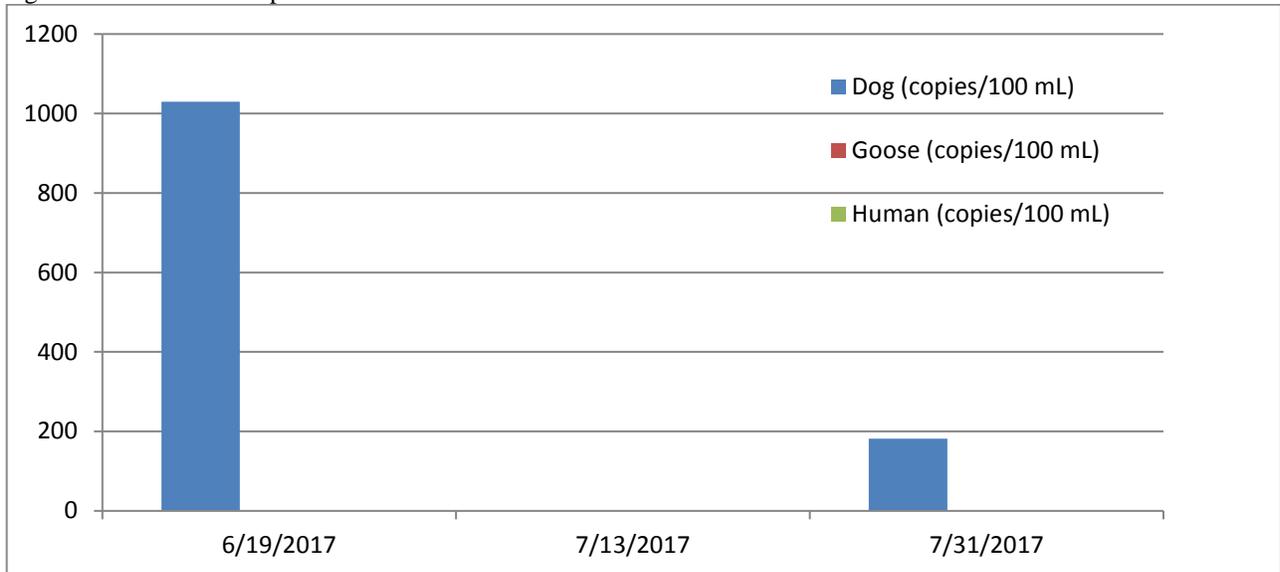


Figure 7 – DNA Gene copies



## 2.4 Anti-Degradation Policy

2.4.1 Nutrients - Analytical results for Total Phosphorus and Nitrate/Nitrite show no need for further investigation to show support of the beneficial use. The number of samples collected exceeds the number of required samples, and less than 10% of samples exceeded the threshold for further sampling. While Nitrate/Nitrite concentrations have an action level, it is not a required parameter within the MS4 permit (ODEQ, OPDES Permit OKS000201, 2011).

Parameter	Sample Mean (mg/L)	Single Sample (mg/L)	Water Quality Threshold (mg/L)	No. of Samples	No. of Samples Required (WQS)	How Standard is Violated
Total Phosphorus	0.03	na	0.24	12	10	No more than 10% of samples outside range
Nitrite - Nitrate	0.46	na	4.95	12	10	No more than 10% of samples outside range

Table 13 – Nutrient totals for Nickel Creek

Figure 8 - Total Phosphorus Concentrations

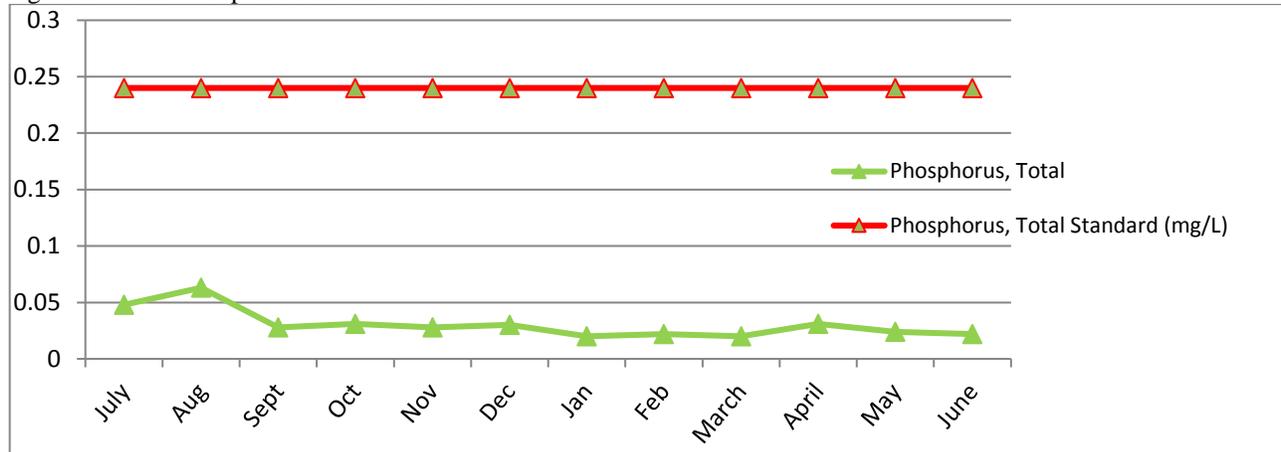
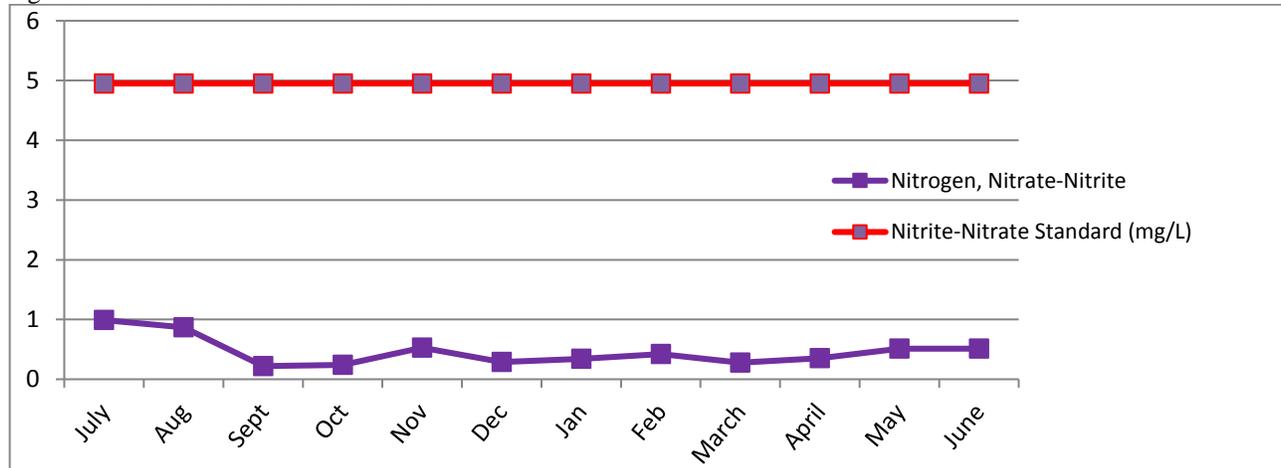


Figure 9 - Nitrate/Nitrite Concentrations



### 3.0 SUMMARY

Analytically, Nickel Creek does not reflect any water quality impacts to the stream during the year of sampling with the exception of dissolved oxygen and bacteria. DNA testing was performed to help determine the cause of impairment in regards to bacteria. The results showed that a continued push in public education addressing proper disposal of pet waste could be beneficial. Fish collections reflected a supporting classification according to water quality standards. A disappointing benthic macroinvertebrate IBI score could be related to the lack of intolerant species which prevents support of the beneficial use. However, analytical data does not reflect any water quality impacts to the stream during the year of sampling with the exception of dissolved oxygen and bacteria. Overall, Nickel Creek possesses all of the ingredients to support a thriving biological community, but the benthic populations were not up to the expected standard.

<b>Nickel</b>						
<b>Parameter</b>	<b>Sample Mean</b>	<b>Single Sample</b>	<b>Water Quality Standard</b>	<b>No. of Samples</b>	<b>No. of Samples Required (WQS)</b>	<b>How Standard is Violated</b>
Cadmium (µg/L)	0.50	0.50	Acute: 102.36, Chronic: 2.46	12	5	Acute: No more than one sample concentration exceeding WQS Chronic: No more than one sample or 10% exceeding
Copper (µg/L)	1.69	3.91	Acute: 48.56, Chronic: 29.69	12	5	
Lead (µg/L)	0.62	1.06	Acute: 286.15, Chronic: 11.15	12	5	
Zinc (µg/L)	14.03	28.00	Acute: 269.64, Chronic: 244.23	12	5	
E. coli (MPN/100ml)	282	Na	126	12	5	Geometric mean not exceeding standard
Enterococcus (MPN/100ml)	269	Na	33	12	5	Geometric mean not exceeding standard
Oil and Grease (visual)	none	Na	No visible sheen	12	10	No more than 10% of observations with oil & grease
Total Phosphorus (mg/L)	0.03	Na	0.24	12	10	No more than 10% of samples outside range
<i>Nitrite – Nitrate (mg/L)</i>	0.46	<i>Na</i>	4.95	12	10	<i>No more than 10% of samples outside range</i>
Total Dissolved Solids (mg/L)	217	290	Sample: 1868, Yearly: 1496	12	10	Mean of samples not exceeding yearly standard & no more than 10% exceeding sample standard
pH (s.u.)	7.4 – 8.0	Na	6.5-9.0	12	10	No more than 10% of samples outside range
Turbidity (NTU)	9.89	25.70	50	12	10	No more than 10% of samples outside of range
<i>D.O. (mg/L)</i>	0 samples below 5.0	na	April - June: 5.0	3	10 total	<i>No more than 10% of samples outside range</i>
	2 samples below 6.0	na	June - Mar: 6.0	9		
*Analytes in italics not required by permit Analytes in red exceed standards						

Table 14 – Oklahoma Water Quality Standards summary of collected data

Analyte	Result			Number of Samples	Number of Attempts
	Minimum	Mean	Maximum		
Cadmium, Total (µg/L) (DL 0.5 µg/L)	--	0.50	0.50	12	12
Copper, Total (µg/L) (DL 0.5 µg/L)	--	1.69	3.91	12	12
<i>E. coli</i> (MPN/100 mL) (DL 1 MPN/100 mL)	--	282	12000	12	12
<i>Enterococcus</i> (MPN/100 mL)(DL 1 CFU/100 mL)	--	269	2400	12	12
Hardness, Total (mg/L) (DL 3.6 mg/L)	98	126	150	12	12
Lead, Total (µg/L) (DL 0.5 µg/L)	--	0.62	1.06	12	12
Nitrogen, Nitrate-Nitrite (mg/L) (DL 0.2 mg/L)	--	0.46	0.99	12	12
Nitrogen, Total Kjeldahl (mg/L)(DL 0.50 mg/L)	--	0.62	0.94	12	12
Nitrogen, Total as Nitrogen (mg/L)(DL 0.50 mg/L)	--	0.77	1.80	12	12
Phosphorus, Dissolved (mg/L) (DL 0.010 mg/L)	--	0.02	0.04	12	12
Phosphorus, Total (mg/L) (DL 0.010 mg/L)	--	0.03	0.06	12	12
Solids, Total Dissolved (mg/L) (DL 10 mg/L)	--	217	290	12	12
Solids, Total Suspended (mg/L) (DL 2.0 mg/L)	--	5.96	16.00	12	12
Zinc, Total (µg/L) (DL 10 µg/L)	--	14.03	28.00	12	12
Water Temperature (°C)	0.85	16.39	28.90	12	12
pH (su)	7.41	--	7.95	12	12
Flow (cfs)	5.84	7.07	8.30	12	12
Turbidity (NTU)	--	9.89	25.70	12	12
Results found to be below the detection limit are reported as the detection limit					

Table 15 – MS4 permit required analytical sampling parameters result summaries

ANALYTE	Date Sampled											
	7/20/16	8/9/16	9/6/16	10/11/16	11/15/16	12/12/16	1/9/17	2/9/17	3/14/17	4/10/17	5/8/17	6/8/17
Cadmium, Total (BDL 0.5) µg/L	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Copper, Total (BDL 0.5) µg/L	2.14	3.91	1.68	2.04	1.19	1.49	1.25	1.03	1.42	1.25	1.52	1.34
Hardness, Total (BDL 3.6) mg/L	140	140	120	130	98	130	110	100	130	130	150	130
Lead, Total (BDL 0.5) µg/L	1.06	0.86	0.50	0.98	0.50	0.50	0.50	0.50	0.05	0.50	0.50	0.50
Nitrogen, Kjeldahl, Total (BDL 0.50) mg/L	0.75	0.94	0.50	0.50	0.50	0.75	0.60	0.50	0.50	0.50	0.50	0.92
Nitrogen, Nitrate-Nitrite (BDL 0.2) mg/L	0.99	0.87	0.22	0.24	0.53	0.29	0.34	0.42	0.28	0.35	0.51	0.51
Nitrogen, Total as N (BDL 0.5) mg/L	0.99	1.80	0.50	0.24	0.50	1.00	0.92	0.50	0.50	0.35	0.50	1.40
pH (s.u.)	7.50	7.76	7.68	7.95	7.53	7.62	7.61	7.72	7.74	7.52	7.50	7.41
Phosphorus, Total (BDL 0.010) mg/L	0.05	0.06	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.02	0.02
Phosphorus, Total Dissolved BDL (0.010) mg/L	0.02	0.04	0.02	0.02	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01
Solids, Total Dissolved (BDL 10) mg/L	230	250	180	180	160	180	200	170	290	240	270	250
Solids, Total Suspended (BDL 2.0) mg/L	16.0	10.0	5.0	4.0	6.6	7.5	2.4	3.7	2.0	7.0	5.3	2.0
Temperature, Water °C	28.90	26.50	25.50	17.90	13.22	6.90	0.85	7.08	9.14	19.44	19.18	22.01
Turbidity (NTU)	25.70	14.60	8.47	7.64	9.73	7.27	4.70	5.96	7.45	12.00	9.10	6.10
Zinc, Total (BDL 10) µg/L	18.5	11.9	11.1	10.5	10.0	11.6	11.0	10.0	11.0	13.8	28.0	20.9
Flow CFS	7.97	7.95	5.89	8.30	7.01	7.75	5.84	6.91	7.35	7.51	6.44	5.91
Conductivity µS	444	440	347	291	201	165	151	180	265	340	374	320
Dissolved Oxygen mg/L	4.88	5.60	6.10	7.43	11.70	10.67	24.27	8.95	8.71	5.77	6.99	5.72
Results found to be below the detection limit are reported as the detection limit												

Table 16 – Complete analytical sampling results for all parameters

ANALYTE	Date Sampled											
	7/18/16	8/11/16	8/31/16	9/12/16	9/14/16	9/22/16	5/25/17	6/5/17	6/12/17	6/19/17	7/13/17	7/31/17
<i>E. coli</i> (BDL 1) MPN/100mL	370	610	12000	180	79	88	160	260	200	250	190	190
<i>Enterococcus</i> (BDL 1) MPN/100 mL	132	68	2400	220	770	270	270	160	100	440	390	200
Results found to be below the detection limit are reported as the detection limit												

Table 17 – Complete analytical results for bacteria samples

## REFERENCES

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- OWRB. (2013b). *Chapter 46 Oklahoma Water Quality Standards*. Oklahoma City, OK: Oklahoma Administrative Code Title 785.

**Section 5**

**Annual Expenditures for the Reporting Period/Budget for the Year Following Each Annual Report**

* FY 2011/2012 reflects an extensive department reorganization	<b>FY 2016/2017 Actual</b>	<b>FY 2017/2018 Budget</b>
Alert System	44,320	76,565
Asset Management Admin	-	9,962
Building Maintenance	80,087	34,418
Building Operations – Administration	1,610	1,690
Building Operations – Contracts	2,752	2,712
Building Plans Review	-	-
Call OKIE – Encroachments	50,102	60,127
Channel Maintenance and Ditching	1,516,844	1,820,676
Combined Residential Inspections	-	-
Commercial Building Inspections	-	-
Construction Inspection	451,187	492,967
Cost Accounting	-	-
Custodial Services	10,404	9,857
Customer Care	195,069	157,265
Design	618,378	675,682
Design Services – Administration	31,132	32,381
Engr Serv- Design- Right of Way	-	-
Detention, Ditch, Concrete Channel	1,520,266	2,004,842
Development Plans Review	-	-
Development Serv. Adm (Dev Dept to indirect cost)	-	-
Distribution Systems - Administration	11,021	14,122
Engineering Administration – Stormwater	357,788	510,145
Engineering Services Administration	89,242	94,897
Field Cust. Serv. Rep. I (Meter Reading)	86,277	60,506
Field Cust. Serv. Rep. II (Meter Turn On/Off)	5,130	5,091
Field Engineering – Administration	41,017	43,479
Field Surveys	114,327	154,731
Financial Planning (to Finance Dept)	-	-
Fiscal Services	-	-
Floodplain Management	1,443,785	1,973,177
Forestry and Horticulture Management changed to Horticulture	44,093	58,446
Graphics / CADDs	154,567	240,636
Engineering Graphics	47,134	58,424
Hydrology and Hydraulics	-	46,188
Infrastructure Management	69,148	71,416
Inspection Services – Administration	-	-
Inventory Control	-	-
IT Administration	41,002	18,045
IT Information Services Application	60,287	141,667
IT Operations and Infrastructure	70,067	159,560
IT Capital Direct Charges	32,969	36,000
Laboratories	112,543	78,033
Lift and Pump Stations	248,498	286,422
Operation Support	-	-
Paving Cut Administration	29,093	17,563

## Annual Report FY 2016-2017

### Section 5 – Annual Expenditures

Permitting Services – Administration	-	-
Personnel	-	-
Planning and Project Management Administration	35,620	61,713
Planning	116	-
Planning Stormwater/General	128,305	132,557
Project Management	22,511	30,844
Public Land Management changed to General Site Services	119,796	127,125
Quality Assurance – Administration	5,343	4,518
Reproduction changed to Central Services	193,784	223,072
Right of Way	103,500	114,562
Security for One Technology Center	160,917	192,469
Sewer O & M – Admin	67,863	60,394
Sewer O & M – Support Services	5,284	4,903
Sign and Site Inspections	-	-
SS – Stormwater Fund	3,525,924	3,690,907
SS Payroll & Accts Payable	41,502	15,811
Storm Sewer Maintenance	2,149,919	3,281,812
Stormwater & Land Management Admin	750,527	969,469
Stormwater Quality	1,174,040	1,247,212
Stormwater Quality (moved)	-	-
Stormwater Roadside Mowing	463,488	544,295
Stormwater Vegetation	2,098,316	2,844,955
Street Sweeping	1,040,321	1,544,283
Streets & Stormwater – Administration	107,615	128,225
Street Maint & Inspections- Admin	112,133	136,113
Street Maintenance -- Patching	726,923	814,668
Training	-	-
Utilities Administration	426,609	518,482
Warehouse	17,813	21,933
Water & Sewer Dept. – Stormwater	50,246	127,154
Water and Sewer Admin.	17,340	18,241
Asset Management - Direct charge	33,404	49,000
Security (Direct charge fund 7010)	68,278	62,837
Household Pollutant Collection	6,117	44,460
Quality Assurance – Operations Support	1,516	1,755
Total	21,235,210	26,461,459

## Section 6

### A Summary of Enforcement Actions, Inspections, and Public Education

#### A. Enforcement Actions

It is the philosophy of the City of Tulsa to bring responsible parties into compliance through education prior to initiating any enforcement action. Enforcement actions are taken only when deemed necessary to ensure permit compliance.

During this reporting period 302 investigations were conducted identifying 10 illicit discharges to the storm sewers. Title 11-A Chapter 5 (Pollution Ordinance) was adopted November 1995 and continues to be utilized for the removal of non-storm water discharges (see Section 6). This Ordinance allows the City of Tulsa to recover cleanup cost from the responsible party.

A summary of the investigations conducted by the Stormwater and Land Management Division are as follows:

Number of Investigations	Description of Investigations
14	Construction (relating to construction site potential violations)
16	Hazmat (relating to potential discharges of pollutants from fire department responses involving the hazardous materials unit)
302	Stormwater (relating to potential releases of pollutants to the storm sewer or violations of the pollution ordinance)
19	Drug Labs (relating to the potential release of pollutants from drug lab remediation to the storm sewer or violations of the pollution ordinance)
351	Total number of investigations for this reporting year

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Section 6 – A Summary of Enforcement Actions, Inspections and Public Education

- Construction Site – Erosion Control
  - The Stormwater and Land Management Division conducted 1,463 construction site inspections resulting in 29 enforcement actions. These actions consisted of issuing a notice of violation that may involve fines and cost recovery. The total amount of fines and penalties collected was \$2,600.
- Industrial, Commercial and Residential Sites
  - Tulsa continued to use the Industrial and High Risk Runoff program to identify, monitor and control pollutants from municipal landfills; treatment, storage and disposal facilities for municipal waste; facilities subject to EPCRA Title III, Section 313 reporting requirements; and any other industrial or commercial discharge the City determined had the potential to contribute substantial pollutant loading to the City's storm sewer system. This program contains procedures for inspecting, monitoring and controlling pollution from the aforementioned sources. A database of industrial storm water sources discharging to the City's storm sewer continues to be maintained. During this reporting period, 286 industrial stormwater inspections were conducted. Ten enforcement actions were taken against industries or facilities in order to eliminate illegal or illicit discharges. No fines were levied during this fiscal year.

## **B. Inspections**

The following is a summary of inspections that were conducted during this reporting period. These inspections were previously mentioned in other sections of this report.

Sewer Operations Maintenance and SLM conducted the following:

- Sanitary sewer lines TV inspected – 169.22 miles

SLM conducted the following inspections:

- Storm sewer lines inspected – 2.25 miles
- Industrial and commercial storm water runoff inspections – 286
- Construction site erosion control inspections – 1,463

Development Services conducted the following number of inspections:

- 806 construction site inspections were conducted with attention on erosion controls measures.

Section 6 – A Summary of Enforcement Actions, Inspections and Public Education

Engineering Services conducted the following inspections:

- Daily inspections at construction projects (91 city and privately funded Infrastructure Development Process (IDP) projects).

### **C. Public Education Programs**

The public education programs utilized by the City of Tulsa have been described in Section 1 of this report. The City of Tulsa understands that public education plays a major role in reducing non-point source pollution and improving stormwater runoff quality. Tulsa believes that it is better to prevent non-point source pollution at the source through education than to control it after it is generated. Many educational programs used by the City of Tulsa to meet permit requirements are completed through the cooperative efforts of other groups, such as The M.e.t. and the Tulsa County Conservation District, as well as various City of Tulsa departments. Through activities such as educational events, presentations, school visits, summer day camps, conferences, television/radio commercials, billboards etc. education material was viewed approximately 72,435,779 times during this reporting period (the significant increase from last year is due to the implementation of the Stormwater Quality media campaign). See below for more information on Tulsa's Public Education Program's.

Attachment A "Public Education 2016-2017" lists the educational material distributed during this reporting period by the City of Tulsa.

Attachment B "Education Events 2016-2017" lists the educational activities performed during this period by the City of Tulsa.

Attachment C "Children's Education Activities 2016-2017" lists various educational activities performed for children's groups.



Attachment B: Education Events FY 16/17

Date	Event Name	Attended	Decription
7/1/2016	Cap Dragongly Program	48	Dragonfly Magnet to teach about water quality
7/6/2016	Drillers Game	3000	Bark in the Park
7/7/2016	Sustainable Tulsa First Thrusday	67	Meeting supporting sustainability thourgh networking
7/8/2016	Life Bracelets Hicks Park	46	Program for kids to teache need for clean water
7/9/2016	Facebook Post	6049	Post of new leaves Sgt Red Commercial
7/11/2016	LID PDM Aim High	12	Meeting with developers to encourage LID
7/11/2016	LID PDM KOTV	12	Meeting with developers to encourage LID
7/18/2016	LID PDM Ronald McDonald House	12	Meeting with developers to encourage LID
7/19/2016	HBA Developers Council	24	HBA committee with developers to encourage BMP's
7/19/2016	Drillers Game	3000	Focus on the Four
7/20/2016	Drillers Game	3000	Bark in the Park
7/20/2016	Enviroscape Hicks Park	46	Demonstration of pollution run off
7/20/2016	Groggs Dragonfly program	15	Dragonfly Magnet to teach about water quality
7/26/2016	News Clip mentioning clogged drain	50,000	Keep debirs out of drains
7/26/2016	Drillers Game	3000	Focus on the Four
7/26/2016	RMC Facebook post	6049	Facebook post about upcoming RMC event
7/27/2016	Drillers Game	3000	Bark in the Park
7/27/2016	HBA RMC announcment		HBA Newsletter telling of RMC
7/29/2016	Cap Dragongly Program	24	Dragonfly Magnet to teach about water quality
7/29/2016	HHPCF Facebook Post	6049	Post about the HHPCF on Facebook
8/1/2016	RMC Planning Meeting	6	Planning the RMC Event with HBA
8/2/2016	Monarch on the Mountain Planning Meeting	7	Turkey Mt event plannin
8/4/2016	Sustainable Tulsa First Thrusday	57	Meeting supporting sustainability thourgh networking
8/4/2016	Monarch on the Mountain Planning Meeting	4	Turkey Mt event plannin
8/9/2016	RMC Planning Meeting	6	Planning the RMC Event with HBA
8/9/2016	Drillers Game	4235	Focus on the Four
8/10/2016	Drillers Game	3513	Bark in the Park
8/10/2016	Dog Days Plannin Meeting	10	Meeting encourging pet waste pick up
8/11/2016	Sustainable Tulsa B2B	68	Meeting over enviornmental issues with local companies
8/12/2016	Green Stem Planning Meeting	15	Meeting combining Green Schools with TPS and MET
8/12/2016	EEC Meeting	4	Meeting on env events in the tulsa area
8/16/2016	Typors School Supply Drive	8	Meeting to give school supplies to pencil box

Date	Event Name	Attended	Description
8/17/2016	Internal Training SWQ	10	Webinar over erosion control options
8/19/2016	RMC Event	69	RMC over erosion control and compliance
8/23/2016	Drillers Game	4985	Focus on the Four
8/24/2016	Drillers Game	3978	Bark in the Park
8/24/2016	Internal Training Water distribution Mainline	35	Basic Stormwater Training
8/25/2016	Mayors Breakfast	25	Typros event with Mayor where LID was discussed
8/30/2016	Internal Training	30	Internal Training with Solid Waste on HAZMAT
9/1/2016	City Life	140,000	Illicit Discharges
9/2/2016	EPA Planning Call	20	Conference Call to plan EPA Region 6 conference
9/7/2016	Internal Training	23	SWQ Training with Water Distribution
9/7/2016	Monarch on the Mountain Planning Meeting	7	Turkey Mt event planning
9/7/2016	TLG Tour Meeting	6	Meeting to schedule tours for TLG Conference
9/9/2016	TLG Steering Committee	12	Meeting to plan TLG Conference
9/12/2016	LID Workgroup	7	group working on barriers to LID
9/12/2016	Monarch on the Mountain Planning Meeting	7	Turkey Mt Event Planning
9/12/2016	RMC Debriefing	6	Meeting to discuss the RMC Conference
9/14/2016	Internal Training	50	SWQ Training with Water Distribution
9/15/2016	Heat & Air BMP mtg	4	Mtg to go over heat and air BMP
9/19/2016	LID PDM	12	Meeting with developers to encourage LID
9/20/2016	HBA Developers Council	25	Meeting to educate construction site operators
9/22/2016	STEM Alliance Event	1200	Event encouraging STEM among middle schoolers
9/24/2016	Monarch on the Mountain Event	1500	Event education about monarch conservation
9/27/2016	MET Newsletter	500	MET Newsletter promoting the HHPCF
9/29/2016	Tulsa State Fair	300,000	Tulsa State Fair
9/30/2016	Typros Dog Day Event	50	Event with a temporary dog park plus 50 dogs
9/30/2016	WIN Neighborhood News	888	Storm Drains are for Rain
10/11/2016	News clip letter to the editor publication not known	300,000	References the stormwater webpage
10/12/2016	KTUL Digital Media Meeting	5	Meeting to discuss digital media
10/17/2016	LID Workgroup	10	Meeting to work on LID issues
10/17/2016	LID PDM	10	103rd & Memorial
10/19/2016	Guthrie Green	500	Event with planning department for city education
10/21/2016	WIN Neighborhood News	470	Storm Drains are for Rain
10/22/2016	Crow Creek Work Day	8	Work on Crow Creek garden, volunteers used

Date	Event Name	Attended	Description
10/24/2016	LID PDM	10	21st & Jamestown
10/27/2016	Water Policy Summit	50	Chamber meeting on preserving our water
10/29/2016	BooHaHa	5000	Event where materials were handed out trick or treating
10/31/2016	LID PDM	10	31st & 193rd & Sheridan Subdivision
10/31/2016	LID PDM	10	2800 E. Skelly Dr Offices
11/1/2016	LID PDM Workgroup	6	Meeting on LID issues
11/3/2016	Sustainable Tulsa First Thursday	54	Meeting supporting sustainability through networking
11/4/2016	WIN Neighborhood News	888	Storm Drains are for Rain
11/5/2016	WIN Neighborhood News	470	Storm Drains are for Rain
11/5/2016	Crow Creek Work Day	6	Work on Crow Creek garden, volunteers used
11/14/2016	LID PDM	12	South Peoria Commercial Center
11/14/2016	LID PDM	14	St Joseph Vietnamese Church
11/17/2016	Union Community Night	1000	Set up booth with enviroscape
11/21/2016	Enviroscape Grissiom	24	Enviroscape for P-k students
11/21/2016	LID PDM	10	Data Center
11/21/2016	LID PDM	10	Skye Properties Airport Industrial Park Bldg
11/23/2016	Internal COT training	7	Training on Edu sheets for SWQ new employees
11/28/2016	LID PDM	10	Charles Paige Dollar General
11/28/2016	LID PDM	11	Kaiser Property
11/30/2016	LID Workgroup	8	Meeting to work on LID issues
12/15/2016	LID Workgroup	10	Meeting on LID issues
12/19/2016	LID PDM	14	Leinbach Apts
1/1/2017	City Life	140000	Article on stormwater quality
1/9/2017	LID PDM	14	Potter Multi Family
1/9/2017	LID PDM	15	Stome Creek Commercial
1/25/2017	Internal Training	20	Stormwater Certification East Yard
1/30/2017	LID PDM	15	Kum & Go #868
1/30/2017	LID PDM	13	Tate Boys Tire and Service
2/2/2017	Sustainable Tulsa First Thursday	36	Meeting on sustainable issues
2/3/2017	OKAEE Conference	1	Ok Association of Env Educators conference
2/4/2017	Crow Creek Work Day	9	Planting seeds for the Crow Creek Project
2/21/2017	Stormwater Hazard Mitigation Board meeting	19	Stormwater board meeting
2/21/2017	City wide edu	6	Handed out edu materials in field

Date	Event Name	Attended	Decription
2/22/2017	TPS Earth Day Planning Meeting	16	Planning meeting for Earth Day event Total of 8 meetings
2/22/2017	LID Workgroup	10	Meeting on LID issues
2/23/2017	Sustainable Tulsa B2B	57	B2B on environmental issues DEQ and Carla Grogg spoke
2/28/2017	Creek Ckean up Planning Meeting	4	Meeting on details for the Creek Clean up at dirty butter
3/1/2017	Swap Shop news clips	300,000	KTUL Channel 8 news clip
3/2/2017	City wide edu	2	Handed out edu materials in field
3/2/2017	Sustainable Tulsa First Thrusday	33	Meeting on sustainable issues
3/6/2017	LID PDM	12	Discount Tire 41st St
3/6/2017	LID PDM	12	Amos Baker Apts
3/7/2017	Home and Garden Show training meeting	12	Meeting to let employees know what's up for the show
3/9/2017	Home and Garden Show	30,000	Large show with booth for public interaction
3/13/2017	LID PDM	11	Whataburger 31st & 169
3/16/2017	Crow Creek Meeting	3	Meeting to discuss Crow Creek Project
3/18/2017	Woodland Hills Mall Weather Event	1000	Event at the mall for public information
3/20/2017	LID PDM	13	Raining Canes #270
3/20/2017	Oxley Nature Center Training	11	Trained Volunteers for Oxley Nature Center tours
3/22/2017	LID Workgroup	6	Meeting on LID issues
3/25/2017	TCC Ecofest	1500	Event with Eco concious vendors
3/27/2017	City wide edu	10	Handed out edu materials in field
3/30/2017	ORU Education	40	Presented what SWQ does
3/30/2017	Creek Ckean up Planning Meeting	4	Meeting to plan for Creek Clean up
4/3/2017	LID PDM	15	Micinley Elementary
4/3/2017	LID PDM	12	Warlic Bldg
4/6/2017	Spoke at OFMA Conference	40	Spoke on education program
4/10/2017	LID PDM	12	St. Francis 51st & Garnett
4/10/2017	City wide edu	8	SS Landscaping 6, car washing 2
4/10/2017	Chanel 6 rain barrel event info	300,000	Internet and TV clips promotion of Rain barrel and LID
4/10/2017	Grissiom Elem	22	Dragonfly Magnet to teach about water quality
4/13/2017	STEM Allience Event	15	Spoke at Mark Twain Enviroscape
4/17/2017	LID PDM	11	QT 46th St N. & Highway 169
4/19/2017	MET Enviro Expw	1000	Downtown Event with Sustainable Vendors
4/21/2017	TPS Earth Day Event at TU	1600	Huge event for earth day with TPS indoors b/c of the rain
4/22/2017	HHPCF New Clips and Earthday	300,000	Earth Day mentinoed, HHPCF, Johnson Park and TPS event

Date	Event Name	Attended	Decription
4/22/2017	Carrie Dickenson Foundation Earth Day	1000	March for Science
4/22/2017	EIS Life Lab work day and Earth day celebration	150	EIS Earth Day where we had given a rain barrel
4/24/2017	LID PDM	12	91st & Elwood
4/25/2017	News Clips HHPCF	50,000	Journal Record not sure if it's internet print or TV
4/27/2017	The MET Drillers Green Night	4200	ONEOK
4/27/2017	Typros sustainabilty crew meeting	8	Meeting for creek clean up
4/28/2017	Roy Clark Communitny night	1400	STEM community night
4/29/2017	Tulsa World News Clips May 20th Event HHPCF	300,000	Tulsa World coverage for May 20th event
5/3/2017	Grissiom Elem	44	Life Braclets
5/4/2017	Sustainable Tulsa	72	First Thursday
5/6/2017	Creek Clean Up	32	Dirty Butter
5/6/2017	Materials to other City Depts	100	Materials for cinco De Mayo & another Creek Clean up
5/9/2017	Grissiom Elem	22	Dragonfly Magnet to teach about water quality
5/11/2017	Sustainable Tulsa	101	B2B on environmental issues DEQ and Carla Grogg spoke
5/11/2017	PPI Committee Meeting	12	PPI meeting and LID was discussed
5/11/2017	Roughnecks Games Drillers	3100	Soccer games
5/14/2017	Stormwater Operator Certification	14	Class for basic stormwater understanding
5/16/2017	Power of partical improvments	4	Meeting to help with clean up efforts with new orginization
5/22/2017	Meeting to plan for Monarch on the Mountain	6	Planning meeting for Monarch on the mountain
5/27/2017	Construction BMP update meeting	6	Make construction BMP up to date
5/31/2017	Bark in the Park	3000	Event to educate on pet waste
6/13/2017	Hutcherson YMCA Day Camp	77	Enviroscape for P-k students
6/14/2017	Bark in the Park	3000	Event to educate on pet waste
6/15/2017	Hutcherson YMCA Day Camp	77	Life Braclets
6/21/2017	Hutcherson YMCA Day Camp	77	Dragonfly Magnet to teach about water quality

Attachment C: Tulsa Daycamps Education FY 16/17

<b>Date</b>	<b>Event</b>	<b>Attended</b>	<b>Description</b>
7/1/2016	Community Action Project p-k Eastgate	48	Dragonfly Program
7/8/2016	Tulsa Parks Day Camp Hicks	46	Life Bracelets
7/20/2016	Grogg's Green Barn Day Camp	16	Dragonfly Program
9/22/2016	STEM Allience Flight Night Middle School	1200	Enviroscape
11/7/2016	Union Community Night 7th Grade Center	1000	Enviroscape
11/21/2016	Grissiom Elementary TPS	24	Enviroscape
4/10/2017	Grissiom Elementary TPS	22	Dragonfly Program
4/13/2017	Mark Twain Science Club TPS	15	Enviroscape
4/21/2017	TPS Community Earth Day at TU	1600	Fish Prints Elementary
4/28/2017	Roy Clark Elementary UPS Stem Night	1000	Enviroscape
5/3/2017	Grissiom Elementary TPS	44	Life Bracelets
5/9/2017	Grissiom Elementary TPS	22	Dragonfly Program
6/13/2017	Hutcherson YMCA Elementary Day Camp	77	Enviroscape
6/15/2017	Hutcherson YMCA Elementary Day Camp	77	Life Bracelets
6/21/2017	Hutcherson YMCA Elementary Day Camp	77	Dragonfly Program
<b>Total</b>		<b>5268</b>	

## **Section 7**

### **Identification of Water Quality Improvements or Degradation**

No water quality improvements or degradation were noted during this reporting period. The City of Tulsa has preliminarily identified some factors that appear to be negatively influencing the health of Tulsa's streams. We are also developing a baseline condition which will allow us to better determine improvements or degradation in water quality. Additional personnel recently added have begun to give further insight into the precise reasons behind water quality degradation and will be reported on in the future.

## **Section 8**

### **Watershed Characterization Program**

In accordance with MS4 Permit #OKS000201 requirement Part IV(C)(8) the City of Tulsa submitted the Comprehensive Assessment of the Watershed Characterization Project in the FY 2014-2015 Annual Report.

**Section 9**  
**Co-permittee Reports**

# **Appendix A**

Oklahoma Department of Transportation

Annual Report

For Reporting Period:  
July 1, 2016 through June 30, 2017



September 12, 2017

Roy Teeters, Storm Water & Land Management Division Manager  
Department of Streets and Storm Water  
City of Tulsa  
4502 S. Galveston Ave.  
Tulsa, OK 74107

Attention: Jacob Hagen

Dear Mr. Hagen:

Enclosed is the Oklahoma Department of Transportation portion of the Fiscal Year 2017 Annual Report to be submitted to the Oklahoma Department of Environmental Quality in accordance with the Tulsa Municipal Separate Storm Sewer System (MS4) Permit Number OKS000201. This report covers the period from July 1, 2016 through June 30, 2017.

Please provide this office with one copy of the Annual Report as it is submitted. If you have any questions or require further information, please contact Ms. Michele Dolan at (405)521-6771.

Sincerely,

Casey Shell  
Chief Engineer

Enclosure

Oklahoma Department of Transportation

Annual Report

For

July 1, 2016 through June 30, 2017



CERTIFICATION STATEMENT

NPDES Permit No. OKS000201  
Review of Storm Water Annual Report

I certify under penalty that this document and all attachments were prepared under my direction or supervision, in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations.

Casey Shell  
Chief Engineer

Date

FISCAL YEAR  
2017  
ANNUAL REPORT  
BY THE  
OKLAHOMA DEPARTMENT OF TRANSPORTATION (ODOT)  
ON  
TULSA MS4 PERMIT # OKS000201

August 1, 2017

Status

The Oklahoma Department of Transportation (ODOT) has implemented and is in compliance with the Storm Water Management Plan. The following items demonstrate activities undertaken for this annual report period.

Expenditures

As part of ODOT's Storm Water Management Program, the Tulsa metro area highway system shoulders are swept to remove sediment and debris. This sweeping program for the annual report period covered two thousand, five hundred and forty lane miles at a cost of approximately \$769,000. Two inmate crews and one private contractor pick up litter from the highways in the city at an annual cost of \$874,000. The estimated total expenditure for ODOT in anti-litter efforts statewide is approximately \$4,500,000.

Erosion and Sediment Control

ODOT's "Storm Water Management Guidelines for Design and Construction Activities" is used by ODOT design, construction and maintenance personnel, consulting engineers and contractors to select, design and maintain appropriate erosion control measures for our construction and maintenance activities. Currently, ODOT is working with a consultant to create manuals for Design, Implementation and Inspection of erosion and sediment control devices for construction projects. An internal Erosion and Sediment Control task force was formed in January 2003 to improve and standardize best management practices for ODOT and entities acting on their behalf.

The Department formed four Storm Water Advisory Teams (SWAT) for the development of Design, Construction, Maintenance and Public Education/ Public Involvement Best Management Practices for the agency in 2009. Currently, these teams are in the process of developing and conducting training and materials for educating ODOT personnel on Storm Water regulations.

The American Association of State Highway and Transportation Officials (AASHTO) collected Best Management Practices from all fifty DOT's and developed guideline manuals for Construction and Maintenance personnel. ODOT's Environmental Program Division gave a presentation at six of the eight Field Division Supervisors meetings about the MS4 Storm Water Program and handed out a manual for every construction and maintenance employee for public education.

ODOT has developed a Construction Site Storm Water Performance Review Guideline process to ensure that Storm Water requirements are incorporated throughout the Design, Construction and Document Retention phases. This oversight review is being implemented, initially, in the regulated areas of the State.

ODOT/ DEQ Enforcement staff has conducted multiple inspections on nine construction site road projects across the state. Any project with compliance issues was given fourteen days to remedy prior to a second inspection. Four Contractors were given non-compliance assessments from DEQ. These inspections will be ongoing for the foreseeable future. The goal is to inspect all road construction contractors with every ODOT construction office at least one time.

ODOT adopted a non-compliance assessment specification for construction contractors. The specification gives ODOT a mechanism to assess per day monetary fees for failure to comply with effective and timely measures, as requested by the construction inspections. ODOT has withheld \$315,000 from Contractors for non-compliance assessments this past year.

ODOT participated with the ODEQ's OKR10 Working Group to review the updated construction regulations due out in September 2017.

### Phase II MS4 Program

As of February 2005, ODOT was required to obtain a Phase II MS4 permit from DEQ. During this process, ODOT has been reviewing all aspects of our operations to comply with these additional requirements. ODOT has hired a consultant to advise the agency on the six Minimum Control Measures; Public Education and Outreach, Public Participation and Involvement, Illicit Discharge Detection and Elimination, Construction, Post Construction and Good Housekeeping / Pollution Prevention programs. ODOT has delivered to DEQ an application for a statewide Non-Traditional MS4 permit that is currently being reviewed by DEQ.

### Illicit Discharge Detection and Elimination Program (IDDE)

ODOT continues to conduct Outfall Mapping in the regulated areas of the State. This effort is being done by Consultants. This data (pictures, inspection results) is being built into ODOT's Geographical Resource Intranet Portal system that contains multiple databases with many facets of highway information. Ongoing training for the IDDE Program continues. This includes information gathered during the Outfall Inspections and how to identify and report an Illicit Discharge. This training was developed from meetings with the Maintenance SWAT team and a Consultant. Discussion on tracking Highway Spills from accidents is ongoing between DEQ, ODOT Risk Managers, Maintenance personnel and the Highway Patrol.

### Good Housekeeping / Pollution Prevention Plans (GHPPP)

ODOT has completed an inventory survey of facilities statewide to develop training on Good Housekeeping and Pollution Prevention. Funding for facility upgrades and/ or relocation is being pursued by the Agency. ODOT has built new maintenance facilities for Okmulgee County, Ellis County, Roger Mills County, Cotton County, Custer County, Kingfisher County, Cleveland County, Atoka County, Oklahoma County and McIntosh County. Currently, each of the eight Field Divisions are evaluating location, condition and need to determine which County facility will be moved or rebuilt on site. These upgrades will further the Good Housekeeping /Pollution Prevention Minimum Control Measure. In addition, ODOT has developed a Good Housekeeping Pollution Prevention Plan Facility template. The templates are being completed for facilities in the regulated areas to satisfy DEQ requirements. Currently, all the facilities located in the regulated areas have been inspected for pollution prevention opportunities, procedures have been reviewed with their Maintenance Supervisors. GHPPP's and training are being developed.

ODOT has incorporated a "Clean Sweep" program at all of the facilities throughout the State. This program is intended to remove old materials that may be potential pollutants. This program is ongoing and is being conducted with the assistance of the Department of Central Services on the sale of the material that can be repurposed. This undertaking is being done for the Good Housekeeping/ Pollution Prevention MCM, as well as evaluating which facilities will require Spill Prevention, Control and Countermeasure (SPCC) plans. It has been determined that many facilities will not meet the required capacity for SPCC plans, after the Clean Sweep operation has been conducted.

Additionally, ODOT has hired a Consultant to map all the maintenance facilities in the regulated areas for possible water quality impacts, e.g., sensitive waters, aquatic resources of concern, endangered and threatened species. This information will be incorporated into the mapping database mentioned in the IDDE section.

## Herbicide Application

The application of herbicides is performed by Oklahoma Department of Transportation employees. ODOT closely follows the procedures, rules, and regulations contained in the Oklahoma Pesticide Applicators Law. ODOT requires all its applicators to be licensed and are subject to the implementing regulations of this law. ODOT partners with the Oklahoma Department of Agriculture to offer the Pesticide Applicators test required for a license during our annual workshops.

ODOT has a contract with the Oklahoma State University/ Oklahoma Cooperative Extension Service to provide annual herbicide applicator workshops. Fifteen continuing education workshops were held across the state in each of the eight field divisions. Approximately six hundred people attended the workshops statewide, which includes seventy two employees from the Tulsa area. A large portion of this workshop covered the various issues concerning environmentally safe usage of herbicides. Calibration/ Equipment Assessment Workshops were held statewide in April/ May 2016. Twenty five Tulsa area employees were in attendance. Four Certification Workshops were held statewide with sixty six employees attending. ODOT has scheduled the continuation of this training / certification for the coming year.

On October 31<sup>st</sup>, 2011, new EPA regulations were promulgated that brought Pesticide Application under the Clean Water Act, if applicable. ODOT has adopted a thirty foot buffer zone from all USGS “Blue Line” streams to meet EPA’s Pesticide General Permit requirements. By applying “terrestrial only” applications, ODOT will not be required to obtain Pesticide Application permits under the Clean Water Act. ODOT Environmental Programs Division attended the Field Division workshops, explained the buffer zone requirements, demonstrated how this process of shutting off the spray in the correct areas and the importance of complying with this regulation. USGS “Blue Line” maps were provided for their prospective roadways.

## Public Education/ Litter Program

ODOT has continued the statewide anti-litter campaign, “Oklahoma, Keep Our Land Grand”. The litter hot-line (1-888-5-LITTER), is available to report littering anywhere across the state. Callers can report the offenders tag number. The people observed littering were sent a postcard requesting them to help “Keep Our Land Grand”. Littering is against the law and offenders can be fined from \$200 to \$2000.

School-age children are invited annually to enter a poster contest, sponsored by ODOT; Oklahoma Department of Environmental Quality, Oklahoma State Department of Education, Keep Oklahoma Beautiful, Oklahoma Environmental Management Authority, Oklahoma Rural Water Association, Oklahoma Chapter of the Sierra Club, Solid Waste Institute of NE Oklahoma, Waste Research, Inc., Oklahoma Arts Council, Oklahoma Employees Credit Union, OGE Energy Corporation, Veolia Water, Oklahoma Tourism & Recreation Department (Oklahoma State Parks), Wal-Mart, AEP-Public Service Company of Oklahoma, Oklahoma

Turnpike Authority and the Oklahoma Highway Safety Office. Nearly fourteen thousand students, grade Kindergarten through 12<sup>th</sup> participated in 2016/ 2017 contest. The winning posters are printed for distribution to schools, businesses, and chambers of commerce. A quantity of forty five thousand calendars, featuring the winning posters, will be printed and distributed statewide to schools, libraries city, county, state and federal offices. One of the twelve winning posters will be featured on fourteen thousand color reprints distributed for promotional display purposes to spread the anti-litter message to Oklahoma citizens of all ages.

The 25th Annual State poster contest winners were honored at an April awards luncheon at ODOT's office in Oklahoma City. Luncheon speaker was Mr. Scott Thompson, DEQ's Director. Guests were treated to lunch. Each state poster winner received a monetary award of \$250, \$150 or \$100 for first, second or third place. Winners also received a mounted reprint of their poster, placemats and t-shirts bearing their design. The twelve winners were then presented to the Oklahoma State House of Representatives at the Capitol. Each of the 12 students had the opportunity to get their photos taken with their respective representative.

As a component of ODOT's continuing education efforts, monthly "Spotlight on Storm Water" email bulletins began being developed and distributed in August 2013. The bulletins can be discussed at safety meetings, posted on bulletin boards or at the construction site field offices. They are intended to inform ODOT personnel about common problem areas on the construction site, new regulations and also highlight examples of effective erosion and sediment control.

#### Adopt-a-Highway/ TRASH-OFF

ODOT'S anti-litter efforts are still on-going and include one hundred thirty eight separate "Adopt-a-Highway" groups who remove litter from their two mile section of state highways at an interval of four times a year, and the "TRASH-OFF", an annual volunteer spring roadside cleaning sponsored by ODOT. Tulsa has sixty three "Adopt-a-Highway" groups covering one hundred twenty six miles at a minimum of four times a year.

The Twenty-ninth Annual TRASH-OFF was held on Saturday, April 22, 2017. This year's event involved one hundred and thirty eight cities, eighteen counties, twenty five groups/ organizations, two Corps of Engineers lakes, sixty one "Adopt-a-Highway" groups and twenty State parks in the clean up effort. Many groups have expanded TRASH-OFF day to TRASH-OFF week or month. ODOT distributes trash bags for the annual TRASH-OFF. Last year, this effort resulted in one million five hundred thousand pounds of litter and debris collected from Oklahoma roadsides and public areas by 50,000 volunteers. This saved taxpayers an estimated five million dollars. In addition, Keep Oklahoma Beautiful sponsors a banquet in the fall where awards are given to participants for "Best First Effort" and "Best Overall Effort".

ODOT is a member of the newly formed Central Oklahoma Storm Water Alliance (COWSA). ODOT created a Storm Water contact link to the Website to receive questions or concerns regarding our processes and/or construction projects.

### Wildflowers

Wildflower planting was ODOT's first landscaping program which started in 1976, but went into full scale planting in 1987. There are more than two thousand, two hundred acres in five hundred eighty six sites planted statewide. The Oklahoma Legislature passed a bill in May 2006 creating a new Oklahoma wildflower car tag. Every wildflower tag will donate twenty dollars toward the planting of wildflowers on Oklahoma roadsides.

Citizen donations of \$280,086 have purchased wildflower seed for planting along highways during the last 24 years. To date, ODOT has planted approximately two thousand three hundred acres on roadside sites statewide.

Three drill seeders, specifically designed for wildflower seed, are used by ODOT for planting on highway roadsides. These drills are available for use by Oklahoma communities and organizations.

In the spring of 2016 a memorandum of agreement was signed in partnership with the Federal Highway Administration and the Missouri, Texas, Iowa, Kansas and Minnesota DOTs designating Interstate 35 as the Monarch Highway. The goal is to protect more of the Monarch Butterfly's natural habitat by allowing milkweed and native flowers to grow in the right-of-way where possible. In anticipation of the collaboration, ODOT began refraining from mowing highway rights-of-way statewide, except where necessary, until July when the flowers are primed for seed dispersal. Mowing was continued in urban areas and safety zones, which includes medians and rights-of-way up to 30 feet from the pavement's edge. A pollinator garden was also planted by ODOT staff at the Oklahoma City Welcome Center. The garden, a registered Monarch Waystation, is a 20 foot by 40 foot plot containing five types of milkweed, Black-eyed Susans, purple coneflower and other types of wildflowers. The garden will serve as educational tool for the public to help them recognize and protect milkweed and other native wildflowers.

### Collection and Recycling

ODOT's Maintenance personnel recycled approximately six hundred gallons of oil this past year. The oil is picked up by a private contractor six times a year. Additionally, ODOT recycled approximately nine barrels of oil filters this past year. Approximately, two hundred gallons of antifreeze was recycled. One hundred forty batteries were returned to the manufacturer for reuse. Approximately, one hundred and eighty tires were recycled.

### Mowing

ODOT's maintenance activities are being performed by private contractors that mow just over forty seven hundred acres per year in the Tulsa metropolitan area. This is done five times a year at a cost of approximately \$2,200,000.

# **Appendix B**

Oklahoma Turnpike Authority

Annual Report

For Reporting Period:  
July 1, 2016 through June 30, 2017



August 1, 2017

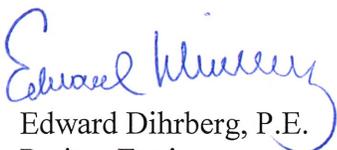
Mr. Scott Van Loo  
Operations Manager, Stormwater and Land Management  
Streets and Stormwater Department, City of Tulsa  
4502 S. Galveston Ave.  
Tulsa, Oklahoma 74107

Dear Mr. Van Loo,

Enclosed is the Oklahoma Turnpike Authority's portion of the Annual Report to be submitted to the Oklahoma Department of Environmental Quality (DEQ) in accordance with the City of Tulsa Municipal Separate Storm Sewer System (MS4) Permit Number OKS000201. This report covers the period from July 1, 2016 through June 30, 2017.

Please provide this office with one copy of the Annual Report as it is submitted to DEQ.

Sincerely,

  
Edward Dührberg, P.E.  
Project Engineer



NPDES Permit No. OKS000201  
July 1, 2016 through June 30, 2017  
Annual Report for  
Oklahoma Turnpike Authority (OTA)

### Overview

This report summarizes the OTA stormwater management activities for Turnpike areas in the City of Tulsa Municipal Separate Storm Sewer System (MS4) area. The Creek Turnpike Maintenance yard and approximately 29% of the Creek Turnpike roadway are within Tulsa's MS4 boundary. The roadway areas include 5.7 miles of roadway in the south Tulsa area that crosses parts of the Vensel Creek, Fry Ditch, and Haikey Creek watersheds. The roadway areas also include 4 miles in the east Tulsa area that crosses parts of the Spunky Creek and Adams Creek watersheds. The Creek Turnpike statistics shown in the remainder of this report refer to the entire Creek Turnpike, not just the portions that are in the Tulsa MS4 area.

#### 1. Status of the Implementation of the Storm Water Management Program.

Responsibilities of OTA outlined in the NPDES Part 2 Application have been met.

##### *Structural Controls and Storm Water Collection System Operations:*

OTA's commitment to a superior functioning storm water system is demonstrated by its regular inspections all of the below ground storm water carrying structures. All of the drainage structures on the Creek Turnpike are inspected every other year. This year there were approximately 660 inspections.

Above ground storm water controls are monitored daily by the maintenance staff who are equipped to handle any flow problems that could potentially arise. Examples of such controls would be detention areas, roadside ditches, and culverts. To ensure the storm water is flowing efficiently, OTA mows 4 to 7 cycles per season. Approximately 2022 acres are mowed per cycle.

*Areas of New Development and significant redevelopment:*

A five (5) year capital plan has been developed by the Turnpike Authority to identify future construction projects. This Capitol Plan is updated yearly to incorporate priority areas and any lessons learned are incorporated into future projects. OTA shall continue to look for opportunities to use low impact development and adopt Best Management Practices to minimize the impact that runoff discharges have to receiving streams.

*Roadways:*

For 2016 – 2017, all storm drains on the bridges, roadways, and at the Creek Turnpike maintenance yard were cleaned.

OTA requires a storm water management plan for all construction projects. The OTA requires contractors to obtain necessary permits for placement of dredge or fill material (from the US Army Corps of Engineers) as well as floodplain and watershed permits (from relevant municipalities).

Approximately 5600 cubic yards of litter were collected and properly disposed by providing 33 trash containers along the Creek Turnpike. In addition, a private contractor collected litter from 1598 acres of turnpike right of way on a two-week frequency. Maintenance staff, as part of their regular duties, also picked up approximately 1988 cubic yard of trash.

OTA Maintenance also cleaned debris and fixed erosion on the Creek Turnpike at the Riverside westbound off ramp.

Finally, OTA Maintenance covered sand piles at Creek Turnpike Maintenance yards with tarps to prevent sand from washing off in the rain.

*Pesticide, Herbicide, and Fertilizer Application:*

The OTA requires all turnpike herbicide applicators as well as all contract applicators to be licensed and subject to all of the regulations under the Oklahoma Herbicide Applicators Law including re-certification. Applicators receive yearly training on pesticides, herbicides, and fertilizer chemicals from the Oklahoma Vegetation Management Association (OKVMA). The OTA has 4 certified applicators on the Creek Turnpike. Approximately 219 gallons of herbicide were applied around sign footings, fences, and at various other locations within the limits of the right of way.

*Illicit Discharge and Improper Disposal:*

The bridges and culverts on the Creek Turnpike are inspected annually. No illicit discharges were detected during the 2016-2017 inspections.

OTA's maintenance staff collected and recycled 250 gallons of oil. The oil is routinely picked up at the maintenance yard by a private contractor (Safety Kleen). In addition to the oil, OTA recycled 128 filters. Batteries and tires were returned to the location where new ones were purchased.

*Construction Site Runoff:*

The OTA understands the significance of construction site runoff and the adverse effects it can cause. As a result, strict guidelines are set forth to ensure that each construction site has adequate controls for reducing pollutants. As stated previously, all construction plans that are produced by or for the OTA have a mandatory Storm Water Management Plan and Erosion Control Plan. These sheets provide information such as location/description of project, sequence of erosion control activities, area disturbed, name of receiving waters, soil stabilization practices, structural practices, offsite vehicle tracking, layout showing exactly where soil stabilization and structural practices should be placed, and references to the OTA Standard Specification for all Storm Water Guidelines. The most optimal approach and recommendations are discussed and agreed upon prior to project implementation to ensure the best option be undertaken for the project.

During construction, the approved storm water management plan is monitored and enforced regularly by the OTA's on-site representative.

Upon project completion, OTA conducts a final inspection and assures that the work areas are restored to compliance level.

*Public Education:*

The OTA dedicates space on its website to the subject of Storm Water Management. On the site there are links to the Phase I Annual Reports. The site includes a phone number to allow the public to contact OTA with suggestions, comments, or questions about OTA's stormwater program.

A stormwater pollution prevention bookmark was produced which included 10 suggestions for preventing stormwater pollution. This bookmark was distributed to members of the public at OTA headquarters and other locations. The bookmark can also be seen by going to OTA's website.

The OTA is also part of the anti-litter campaign, "Oklahoma Keep Our Land Grand." As part of this campaign, the OTA offers a toll free number to call to report littering as well as a place to report it on the website. Individuals who are reported littering are sent a postcard to remind them that littering is a punishable offense and that the goal is to keep Oklahoma land looking grand. For the period July 2016 – June 2017, the OTA received 517 littering report calls for the whole turnpike system. This was approximately 19% less than the number of calls received during the same period the previous year.

*Employee Education:*

In order to keep up to date with herbicide management practices, OTA Maintenance employees will attend an OKVMA Conferences this upcoming fall. Stormwater topics are discussed during weekly Maintenance meetings at the Creek Turnpike.

*Landscape:*

OTA partners with the organization “Up With Trees” to landscape areas in and around the major interchanges in the Tulsa and Broken Arrow communities. OTA also partners with “Color Oklahoma” and maintains two wildflower plots on the right of way adjacent to the Creek Turnpike.

2. Proposed Storm Water Management Program Changes.

The OTA does not propose any changes to the Storm Water Management Program.

3. Revision to the Assessment of Controls and the Fiscal Analysis.

OTA proposes no revision to the assessments of controls. The Fiscal Analysis is as shown on the City of Tulsa’s Report.

4. Monitoring Data Accumulated Throughout the Reporting Year.

Refer to the Regional Storm Monitoring Report.

5. Annual Expenditures for the Reporting Period with a Breakdown for the Major Elements of the Storm Water Management Program.

Description	Cost
Structural Controls Inspections	17,750.00
Mowing	199,296.13
Sweeping	37,391.77
Trash Collection and Disposal	122,630.92
Herbicide	5,570.66
Total	\$ 382,639.48

6. A Summary Describing the Number and Nature of Enforcement Actions, Inspection and Public Education Program.

All enforcement actions in OTA’s watershed are issued by the City of Tulsa in concurrence with the OTA. None occurred during the year covered by this report.

7. Identification of Water Quality Improvements or Degradation.

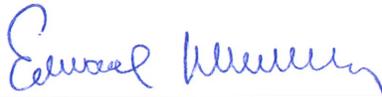
OTA was not able to identify any water quality improvements or degradations during this report period.

8. Regional Monitoring Report.

Please see the City of Tulsa's report.

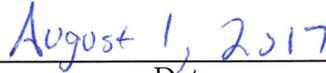
## CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.



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Edward Dührberg, P. E.  
Oklahoma Turnpike Authority



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Date