ILLICIT DISCHARGE DETECTION AND ELIMINATION PLAN

ENVIRONMENTAL QUALITY MANAGEMENT
UNIVERSITY OF KENTUCKY
LEXINGTON, FAYETTE COUNTY, KENTUCKY

Prepared for:

University of Kentucky

Prepared by:

Strand Associates Inc.®
651 Perimeter Drive
Suite 220
Lexington, KY 40515

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1.0 Introduction

In 2003, the United States Environmental Protection Agency (USEPA) initiated efforts to improve surface water quality by implementing the Phase II Stormwater Program. This plan targets communities designated as "Urbanized Areas" that have Municipal Separate Storm Sewer Systems (MS4) and residential populations of at least 50,000 with a population density equal to or greater than 1,000 persons per square mile. The Phase II stormwater program addresses six minimum control measures focusing on improving water quality in the community. These are:

1. Public Education and Outreach
2. Public Involvement and Participation
3. Illicit Discharge Detection and Elimination (IDDE)
4. Construction Site Stormwater Runoff Control
5. Post-Construction Stormwater Management in New Development and Redevelopment
6. Pollution Prevention/Good Housekeeping for Municipal Operations

The University of Kentucky (University) is regulated as a Phase II community through the MS4 Phase II permit (Permit Number KYG200000) developed and adopted by Kentucky Division of Water (KDOW) through the Kentucky Pollutant Discharge Elimination System (KPDES) program. The University has developed a Stormwater Quality Management Plan (SWQMP) that was updated in 2018 and defines the tasks associated with maintaining compliance with the MS4 Phase II permit.

The MS4 permit boundary was established between the University and KDOW and, as of 2021, encompasses approximately 824 acres of the main campus but does not include extended campus facilities such as Coldstream Research Park or other research farms. The permitted area includes 386 acres of impervious areas including classroom and administrative buildings, residence halls, all on-campus hospitals and health care facilities, athletic facilities, parking areas, research laboratories, an arboretum, and support facilities such as the Physical Plant's heating and cooling facilities. Although fully encompassed within the Lexington-Fayette Urban County Government's (LFUCG) Phase I MS4 boundary because the University is a regulated Phase II entity, it is not included in the coverage of the LFUCG Permit. However, because both the University and LFUCG have a shared boundary, integrated coordination efforts are integral to the success of both programs.

The University's MS4 Permit boundary is shown on the University's MS4 boundary map included in **Appendix A** and drains to Town Branch, Wolf Run, and West Hickman Creek as well as to on-campus sinkholes. All these streams are within the Kentucky River Basin (HUC 5100205). The permitted area has been divided into six primary subwatersheds: two drain to West Hickman, two drain to Wolf Run, and two drain to campus sinkholes or Town Branch. There are only two streams located within the MS4 boundary: Big Elm Fork (sometimes referred to as an unnamed tributary to Vaughn's Branch), which is a tributary to Wolf Run, and an unnamed tributary to West Hickman.

Based on the KDOW 2018/2020 303(d) list, segments of all three of the above-mentioned streams, along with many of their tributaries, are impaired by various pollutants. None of these impaired stream segments or tributaries are within the University's boundary with the exception of Big Elm Fork, which is listed as an unnamed tributary to Vaughn's Branch.

Based on the KDOW 2016 303(d) list, segments of all three of the above-mentioned streams, along with many of their tributaries, are impaired by various pollutants. None of these impaired stream segments or tributaries are within the University's boundary except for Big Elm Fork, which is listed as an unnamed tributary to Vaughn's Branch.

Initially listed in 2016, the section of Big Elm Fork, which begins at the outlet of the Greg Page underground detention basin and continues to the WR-1 Outfall at the corner of Alumni Drive and Nicholasville Road, does not support aquatic life and partially supports swimming, fishing, wading, and boating because of specific conductance, *E.coli*, and fecal coliform impairments. The data used to make this determination was collected in 2011 and 2012. It is important to note that, since that time, the entire watershed has undergone a major redesign due to the efforts of the FEMA Flood Mitigation Project as well as the rerouting and redesign of Alumni Drive. For more information on impaired streams and the most current 303(d) list, please visit the Integrated Reports on the Kentucky Division of Water website or the Kentucky Energy and Environment Cabinet's Water Health Portal.

1.1 Purpose

The 2018 MS4 Phase II permit requires MS4 permittees to develop and implement a written Illicit Discharge Detection and Elimination (IDDE) plan and program to meet the requirements of that minimum control measure. Specifically, Section 2.2.3.3. of the permit states: "*The permittee shall develop and implement a written plan to address illicit discharges including illegal dumping*" (KDOW, 2018a). An illicit discharge is defined as "any discharge to the municipal separate storm sewer that is not composed entirely of stormwater except discharges pursuant to a KPDES permit (other than the KPDES permit for discharges from the municipal separate storm sewer and discharges resulting from firefighting activities or other *de minimis* activities allowable under the MS4 regulations) and other discharges referenced in 40 CFS 122.26(d) (2) (iv) (B) (1)."

The University has previously initiated an illicit discharge program to meet previous regulatory permit requirements, including the preparation of the previous version of this manual, as well as mapping and dry-weather screening of major outfalls from the MS4 area.

1.2 Scope

To meet the MS4 permit requirement for a written plan to address illicit discharges, this IDDE Plan summarizes the University's protocols and procedures for the following items as required by Section 2.2.3.3 of the permit:

a. Locating priority areas.
b. Implementing field assessment activities.
c. Providing public reporting opportunities.
d. Investigating complaints or reports related to illicit discharges.
e. Developing time frames for the investigation and removal of illicit discharges.
f. Tracing the source of an illicit discharge.
g. Removing the source of the illicit discharge.
h. Adopting procedures for evaluation and assessment.

1.3 Administrative Regulations

Generally, municipalities develop ordinances as the regulatory mechanism that prohibits illicit discharges to the MS4. The IDDE program procedures will then implement and enforce this regulatory mechanism. However, an ordinance is not applicable for other types of MS4 permittees, such as universities. Instead, the University uses "Administrative Regulations" (ARs) that provide interpretation and implementation of university-wide policies set forth by the Board of Trustees in the Governing Regulations and the Minutes of the Board of Trustees. The ARs promote the responsible and efficient administration of the university and the accomplishment of its goals. The ARs, which include the Human Resources Policy and Procedure Administrative Regulations and the Business Procedures Manual, are official university rules or directives that:

1. Mandate requirements of, or provisions for, members of the university community, and may also provide procedures for implementation.
2. Provide interpretation and implementation of university-wide polices set forth in the *Governing Regulations* and the *Minutes of the Board of Trustees.*
3. Have broad application throughout the university.
4. Enhance the university's mission, reduce institutional risk, and/or promote operational efficiency.
5. Ensure the consistent, equitable application of the university's policies and procedures.
6. Help achieve compliance with applicable federal or state law, local ordinance, or accrediting bodies.
7. Have been reviewed and approved by the President or the Board of Trustees.

The Board of Trustees has full legal authority and responsibility for the governance of the university. The President is the chief executive officer of the university with broad authority delegated from the Board.

Administrative Regulation (AR) 6:3, effective August 24, 2016, and delegated to the Executive Vice President for Finance and Administration as the Responsible Office, specifically mandates compliance and assigns specific responsibilities associated with the implementation of the university's health, safety and environmental protection programs. Through AR 6:3 the university has established broad, yet comprehensive authority over its population of faculty, staff and students regarding compliance with local, state and federal environmental regulations including MS4 Permit requirements. This environmental, health, and safety AR states the following:

> *The University of Kentucky (the University) endeavors to maintain a safe and healthy environment for its students, employees, and visitors through effective environmental health and safety programs. The University positions itself as a leader within the Commonwealth in environmental stewardship, health protection, and safety standards and expects all students, employees, and members of the community to comply with applicable environmental, health, and safety laws and regulations. This regulation mandates compliance and assigns specific responsibilities associated with implementation and maintenance of the University's environmental health and safety programs.*

2.0 Locating Priority Areas

Section 2.2.3.3.a of the MS4 permit requires the following:

> *"Procedures for locating priority areas likely to have illicit discharges."*

2.1 Priority Area Identification

Priority areas can generally be considered as locations that have a higher probably of illicit discharges. The following list, taken from *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments* (CWP and Pitt, 2004), describes several screening factors that should be considered when determining the potential for priority areas of illicit discharges.

1. History of discharge complaints and reports.
2. Poor dry weather water quality.
3. Density of generating sites or industrial National Pollutant Discharge Elimination System (NPDES) stormwater permits.
4. Stormwater outfall density.
5. Age of subwatershed development.
6. Sewer conversion.
7. Historic combined sewer systems.
8. Presence of older industrial operations.
9. Aging or failing sewer infrastructure.
10. Density of aging septic systems.

Because of the small number of major outfalls located within the University's MS4 boundary and the nature of the campus development, a list of priority areas is anticipated to be based on only a few of the categories listed above. The identification of priority areas is anticipated to be an adaptive or evolving process throughout the life of the program. Based on the history of previous drainage complaints, very few illicit discharges have been documented in recent years. If additional illicit discharges are documented in the future, the University will evaluate the need for dry-weather screening based on the locations of the illicit discharges.

2.2 Outfall Inventory

The permit requires the development of mapping to identify the location of all known major outfalls, which are defined as follows:

> *"Major outfall means a municipal separate storm sewer outfall that discharges from a single pipe with an inside diameter of 36 inches or more or its equivalent (discharge from a single conveyance other than a circular pipe which is associated with a drainage area of more than 50 acres); or for municipal separate storm sewers that receive stormwater from lands zoned for industrial activity (based on comprehensive zoning plans or the equivalent), an outfall that discharges from a single pipe with an inside diameter of 12 inches or more or from its equivalent (discharge from other than a circular pipe associated with a drainage of 2 acres or more)."*

Should a new major outfall be identified, the University's inventory of major outfalls will be updated and amended as necessary to include these new locations that are consistent with KDOW's definition of major outfalls.

The Phase II MS4 Permit only requires that all major outfalls must be screened at least once during the 5-year MS4 permit cycle, with a goal to screen at least 20 percent of major outfalls each year. Because of the low number of major outfalls currently included in the outfall inventory, the University has committed throughout its SWQMP to complete screenings at locations on an annual basis. There are five outfalls that have been identified and noted as WR-1, WR-2, WR-3, WH-1, and WH-2 shown on the MS4 Boundary Map (Appendix A) and in Table 2.1 following.

Table 2.1 - Major Outfalls

Outfall	Location Description	Receiving Waters
WR-1	Approximately 185 feet south of the intersection of Nicholasville Road and Alumni Drive	Vaughns Branch via Dantzler Drive
WR-2	At the outlet of the Pond in front of Gluck Equine Research Building along Nicholasville Road	Vaughns Branch via Westwood Drive
WR-3	South side of Cooper Drive at the Outlet of the BCTC Campus Pond approximately 425 feet south of Sports Center Drive	Vaughns Branch via Simpson Avenue/ Press Avenue
WH-1	On the south side of Alumni Drive approximately 750 feet west of the intersection with Tates Creek Road	West Hickman via Tates Creek Road
WH-2	Outlet of the pond in the arboretum approximately 1,400 feet south of the Visitor Center near Glendover Road	West Hickman via Zandale Drive

These outfalls only account for about 47 percent of the drainage area for campus. The other 53 percent of the campus area, including central campus, is conveyed to LFUCG-owned culverts that are routed through campus. It was determined that since the outfalls of these culverts into natural channels is not on University-owned property, they are not outfalls under the

University's Phase II permit and are not required to be formally inspected. However, the University works closely with LFUCG to monitor and address any illicit discharge into these culverts from campus.

3.0 Implementing Field Assessment Activities

Section 2.2.3.3.b of the MS4 permit requires the following:

> *"Procedures for field assessment activities, including dry-weather screening of representative outfalls. The recommended level of effort is twenty percent (20%) of the major outfalls per year, with all of the major outfalls being address this permit term. Screening shall include, at a minimum, the visual inspection of the discharge for indicators of pollutants. Indicators shall include odor, oil sheen, discoloration, and high degree of siltation or aquatic plant growth. Alternatively, the permittee shall develop an approach based on screening factors determined to be more applicable to the area than dry-weather screening of representative outfalls. This approach shall be submitted with the SWQMP to the Division of Water for review and approval before implementing. The illicit discharge detection and elimination plan may require follow-up field water-quality sampling and/or analysis or laboratory analyses to determine the pollutant source and most effective plan of action."*

The following is an overview of the field assessment activities associated with outfall screening, sampling, and IDDE identification including the procedures, work instructions, and forms necessary for task completion.

3.1 Health and Safety

Health and safety considerations should be evaluated and addressed before field crews begin outfall field screening. Hazards such as vehicle traffic, weather, confined spaces, water contact, and wildlife should be included in this planning process. If the risks associated with the hazard cannot be eliminated, field personnel will need to acquire equipment or develop procedures to reduce the hazard risk.

3.2 Screening Timing

Outfall screening field work timing is an important factor. The field work is best performed during dry months when outfalls are not affected by stormwater runoff. The typical dry months are July through October. However, the summer months can also present challenges (such as overgrown vegetation) that can make field data collection difficult. The best conditions for outfall screening work are prolonged dry periods during the nongrowing season with low groundwater levels. Outfall screening should be conducted after at least 72 hours with less than 0.1 inches of precipitation (consistent with LFUCG's outfall screening criteria).

3.3 Preparation for Field Assessment

Before implementing field activities associated with dry-weather screening of major outfalls, field personnel should complete a thorough inspection of equipment and perform equipment calibration for any devices to be used. Traffic control planning, if required, should be coordinated with the Water Quality Compliance Manager, Transportation Services, and the University police, as needed. Finally, the subsequent procedures and reference material below should be reviewed before completion of field activities.

3.4 Authority to Enter Private Property

Outfall monitoring efforts are anticipated to be within the University's MS4 area. Where feasible, accessing privately owned property should be avoided. However, there is the potential for University personnel to need to enter private property for outfall screening or illicit discharge tracking purposes. If private property access is needed, property owner permission should be secured before conducting the field work. If efforts to obtain private property owner permission are unsuccessful, the University's MS4 staff may need to coordinate with the LFUCG MS4 staff to assist with obtaining property access.

3.5 Screening Protocols

Field crews will be completing Data Sheets to help document outfall conditions on the screening date. These Data Sheets also address follow-up actions if any follow-up is required as a result of the outfall screening process. The procedures, work instructions, and forms are included in Appendix 1 of this Field Protocol Plan. The following sections discuss how to assess conditions and to complete each section of the Data Sheets.

3.5.1 Background Data

The Background Data section is used to record basic outfall information such as time, field crew members, and current and past weather conditions. Field personnel should take a digital photograph of each outfall and record the photograph numbers on the field sheet, if necessary. The spatial location of each outfall should be confirmed on the field maps.

Data such as receiving stream watershed, outfall ID, latitude and longitude may be pre-printed or pre-completed on the data sheet in advance of the outfall screening field work. The pre-completed information should be checked using the field maps and GPS unit to verify that no errors were made in the pre-completed information.

3.5.2 Outfall Description

The outfall description includes the outfall's location, material, shape and dimensions, as well as whether the outfall is submerged. The presence of flow is also indicated in this section of the Data Sheet. Portions of Section 2 (location, material, shape, and dimensions) can be completed in advance for outfalls that were previously included in the outfall inventory. However, any pre-completed data should be checked for accuracy based on observed field conditions, and any incorrect or incomplete information should be addressed. All outfalls will be checked for whether the outfall is submerged, whether or not sediment obstructs the outfall, and whether or not flow is observed at the outfall. If no flow is observed at the outfall, the field crew can skip down to Section 5 to continue the outfall screening. Otherwise, all sections of the Data Sheet should be completed.

3.5.3 Field Water Quality Characterization

For flowing outfalls, field water quality parameters may be tested to help with the IDDE screening process. It will be the discretion of the University's Water Quality Compliance Manager or the Director of the Environmental Management Department as to whether sampling will be necessary. If necessary, the descriptions associated with this section will be applicable. Based on Center for Watershed Protection guidance, these water quality parameters should be tested by using a sample bottle to collect outfall flow. For test strip use, some interpolation may be required, but avoid interpolating further than the mid-range between two color points.

Section 3 includes guidance for field crews to help with the determination of whether dry-weather outfall discharges have elevated levels of the test parameters–Chlorine, water temperature, pH, ammonia, specific conductance, and total dissolved solids (TDS). Field crews need to have basic knowledge regarding each of the indicator parameters to understand what the parameter can mean and whether there are other factors (such as background environmental levels) that also need to be considered.

1. Chlorine –The presence of chlorine in stormwater discharges may indicate discharge sources from treated drinking water that is disinfected with chlorine. Chlorine is not a conservative indicator parameter because chlorine will dissipate from water over time. The USEPA's Stormwater Menu of BMPs for Chlorinated Water Discharge Options recommends not discharging swimming pool water until the chlorine levels have dropped below 0.1 mg/L. This concentration will be used as a value for identifying potential illicit discharges. However, it is also important to note that 40 CFR 122.26 (d) (2) (iv) (B) (1) lists discharges from firefighting activities and other *de minimis* activities that are not considered illicit discharges under KYG200000.
2. Water temperature – For water temperatures that exceed the air temperature, field crews should consider whether this outfall has a potential illicit discharge. Field crews should further investigate the outfall vicinity to consider whether non-contact cooling water or solar radiation (i.e., sunlight warms a metal outfall pipe) could be causing the water temperature differences that may be falsely flagged as a potential illicit discharge. Because of this potential for "false positives" related to other environmental conditions, temperature should always be used along with other parameters to flag potential illicit discharges.
3. pH – The pH indicator can be helpful for flagging outfalls that may need further testing using other parameters. Often, pH is used in combination with other water quality parameters because pH alone is not often useful for conclusively determining an illicit discharge's source. Industrial wastes can have very high or very low pH values, and residential wash water can have an elevated pH (pH between 8 and 9) based on Center for Watershed Protection research (CWP and Pitt, 2004). The Data Sheets include information for the field crews to flag pH values that are elevated or low.

4. Ammonia – Elevated ammonia levels can indicate illicit discharges for sewage, wash water, and industrial or commercial wastes. Ammonia is a very good indicator for sewage, and less reliable for other discharge types (CWP and Pitt, 2004). Two challenges with using ammonia as an indicator parameter are (1) ammonia can change into other forms of nitrogen as flow moves toward the outfall (i.e., ammonia levels are not conservative, and ammonia can also volatilize) and (2) there can be background levels of ammonia due to wildlife presence. The LFUCG Manual indicates that ammonia levels over 0.5 mg/L can indicate a potential illicit discharge.

5. Specific Conductance – The specific conductance indicator measures the level of electrical conductivity in water, which is directly related to the levels of total dissolved solids (TDS) in the water. Specific conductance is the conductivity of a liquid at a fixed temperature of 25°C. Specific conductance can also be helpful for identifying a few industrial discharges as well as sewage and wastewater. KDOW indicates that streams with conductivity between 150 and 500 micromhos (μmhos) per centimeter are in the best range for allowing fish and other aquatic life in streams (Kentucky Waterways Alliance and KDOW, 2010). The Kentucky standard for specific conductance requires that specific conductance not be changed to the point that the indigenous aquatic community is adversely affected (KLRC, 2017). LFUCG has defined a specific conductance with a limit of 1,000 microohms/cm (LFUCG, 2015). However, high background conductance levels may also be present in a karst environment because of the presence of dissolved $CaCO_3$ ions. Therefore, field crews should also carefully assess other potential background sources that could cause elevated specific conductance other than illicit discharges.

6. Total Dissolved Solids (TDS) - A TDS measurement is related to the specific conductance. The Kentucky standard for TDS also requires that TDS not be changed to the point that the indigenous aquatic community is adversely affected. For Kentucky, a water quality criterion for TDS has been established only for the mainstem of the Ohio River, with a limit of 500 mg/L TDS (KRWW, 2009).

3.5.4 Physical Indicators for Flowing Outfalls Only

This section records sensory indicator information for the flowing outfalls – odor, color, turbidity, and floatables. No measurement equipment is required for this part of the assessment. Even though sensory indicators are not always reliable for detecting illicit discharges, these indicators can be important for severe and obvious discharges. These items are rated based on a scale between one and three, with one being the least severe and three being the most severe.

1. Odor – For odor assessment, the whole field crew should be involved in odor assessment because different noses have different sensitivities. The crew should reach consensus regarding whether there is an odor present and the odor's severity. A faint odor or an odor where the crew cannot agree on its

presence or origin is scored as a one. A severity score of three indicates that the odor is so strong that all crew members can smell the odor at a distance from the outfall. Crews should be careful not to confuse odors from other sources (i.e., shrubs, trash, spray paint used to mark outfalls) with odors at the outfalls.

2. Color – For color assessment, the best approach is to collect flow from the outfall in a sample bottle and hold the sample bottle up to the light. The field crews should also look for downstream colored plumes that may be connected with the outfall.

3. Turbidity – Turbidity is a measure of the cloudiness of the water or how easily light can penetrate through water. Turbidity can also be visually assessed by observing outfall flow in a clear sample bottle held up to the light. Field crews should also look for turbidity or turbidity plumes in any plunge pools or downstream flow below the outfall. Keep in mind that color and turbidity are related, but these two parameters are NOT the same.

4. Floatables – This indicator is checked by looking for any floatable materials in the discharge or in the plunge pool below the outfall. The Center for Watershed Protection's guidance typically excludes trash and debris from outfall screening procedures; however, LFUCG's outfall screening procedures include assessing presence of trash at outfalls. The University's MS4 outfall assessments will include checking for trash consistent with the LFUCG procedures.

   For floatables severity index scoring, the field crews need to carefully assess the outfall conditions. If sewage is observed at the outfall, the severity score should be three. The severity index for surface oil sheens is based on the sheen's thickness and coverage. However, surface sheens can also be created by in-stream processes. If field crews observe a thick or swirling sheen with a heavy petroleum-like odor, the outfall could have an oil discharge.

5. Suds – The suds indicator can also have both a natural origin or could be linked with an illicit discharge. Field crews should consider not only whether suds are present at an outfall but also how quickly suds break up downstream of the outfall. Suds caused by outfall turbulence often break up quickly, but suds associated with illicit discharges often continue well downstream of the outfall. The suds thickness should also be considered because the thickness can be linked with the severity. The odor associated with the suds should also be considered (e.g., a strong organic or sewage-like odor may indicate a sewage leak or connection, fragrant odors may indicate the presence of laundry water).

3.5.5 Physical Indicators for Both Flowing and Non-flowing Outfalls

Other physical indicators can affect both flowing and non-flowing outfalls. These indicators can help assess the impact of past discharges as well as current discharges. There is no severity ranking for these indicators because the indicators can be subtle and can reflect other sources. The outfall is first checked for signs of damage such as spalling (splintering or fragmenting of outfall material), cracking, chipping, peeling paint, corrosion, or settlement (signs that the outfall has moved due to ground settling effects). Another indicator is looking for the presence of deposits and stains. For vegetation below the outfall, field crews should look for large algal or bacterial growths as these can often be linked with high nutrient concentrations. The field crews should also look for signs of inhibited vegetation growth where vegetation growth would be expected to occur. Some industrial discharges can actually inhibit vegetation growth, and missing vegetation growth may indicate an illicit discharge. Additional comments may be added to further describe the outfall damage items. The plunge pool below the outfall is also assessed for the presence of odors, colors, and floatables. Finally, the pipe at the outfall is also assessed for benthic growth color.

3.5.6 Overall Outfall Characterization

The overall outfall characterization is based on the outfall screening results from Sections 3, 4, and 5 of the Data Sheet. If two or more indicators were flagged, the outfall has a potential illicit discharge. If one or more indicators has a severity of three, the outfall is suspected of having an illicit discharge. The most ranking is for an obvious illicit discharge. It is important to note that this outfall survey designation is an initial review of discharge potential. However, this review helps with understanding illicit discharge distribution and problems within a watershed.

Field crews may encounter outfall conditions or other concerns that were not addressed elsewhere on the Data Sheet. Examples are noting where infrastructure repairs may be needed or noting any safety or field conditions that may affect future outfall surveys or testing.

3.5.7 Recommended Actions/Actions Taken

The Action(s) section helps track what step(s) have been taken and what step(s) are pending to follow up on dry-weather outfall discharges. Multiple action items may be needed to fully address an illicit discharge situation. There are several potential action steps to move toward eliminating any illicit discharges found during the outfall survey. In addition to those listed, other recommendations or actions could include:

1. Waiting on Lab Results – This temporary action item is used pending receiving lab results for an outfall's dry-weather discharge.
2. Investigate Further – Further investigation may be required where investigation and testing results are unclear, and other actions cannot be identified at present. Once the illicit discharge source is confirmed, no further field work or testing is needed.

3. Notified Other MS4 – If an illicit discharge's source is traced to portions of the University's MS4 that interconnect with other MS4s, the connected MS4 should be notified. This notification can allow joint investigation of the illicit discharge's source.

4. Dye Test – A dye test can be used to confirm the presence of an illicit connection. KDOW, LFUCG MS4, and local emergency first responders such as health, fire, and police departments should be notified before starting dye testing. If dye testing results are inconclusive, additional testing and investigation may be needed to find the illicit discharge source.

5. Illicit Connection – This action item is selected if an illicit connection is confirmed.

6. Illicit Removed – If an illicit discharge or an illicit connection is removed from the University's MS4, this action item is marked.

7. Televise – For areas where property access may not be readily available, a good alternate approach may be using closed-circuit cameras to televise the storm sewer lines and to look for illicit discharges or illicit connections. The LFUCG Manual includes this method, and there may be potential for the LFUCG and the University MS4s to use this method for joint illicit discharge investigations.

8. Targeted Education Efforts or Spill Prevention Controls - These can help prevent future illicit discharges. This action may be applicable if the illicit discharges could easily be eliminated by behavioral changes or enacting spill prevention control measures near drains.

3.6 Indicator Parameters to Identify Illicit Discharges

The Center for Watershed Protection identifies at least 15 potential indicator parameters for illicit discharge identification. These parameters are listed below and those identified in italics are also frequently used by the LFUCG MS4 based on the LFUCG Manual.

- *Ammonia*
- Boron
- *Chlorine*
- *Conductivity/Specific Conductance*
- Detergents
- *E. coli,* enterococci & total coliform
- Fluorescence
- *Fluoride*
- Hardness
- *pH*
- Potassium
- Surface Tension
- Surfactants
- Temperature
- *Turbidity*

(CWP and Pitt, 2004; LFUCG, 2015)

However, most cases typically use a smaller subset of indicator parameters depending on what is needed to identify an illicit discharge's makeup (CWP and Pitt, 2004). Ideally, an indicator parameter would have each of the following characteristics:

- Function well for separating illicit discharges from clean water sources.
- Provide clues about the illicit discharge's source.

- Link the parameter's concentration with discharge type and major flow (i.e., higher or lower parameter concentrations can help distinguish the discharge extent and source).
- Show smaller concentration variations for similar flow and discharge types.
- Be conservative in the flow (i.e., parameter concentrations will not be affected over time by physical, chemical or biological processes).
- Be measured easily with acceptable detection limits, accuracy, safety, and repeatability.

Each indicator parameter has limitations for its use and applicability, so there is no single "perfect" indicator parameter. Indicator parameters are typically selected based on local condition and discharge types. Table 3.1 summarizes the illicit discharges that can be detected well as well as challenges associated with each of the indicator parameters.

Table 3.1 - Center for Watershed Protection Indicator Parameters

Parameter	Discharge Types It Can Detect				Laboratory/Analytical Challenges
	Sewage	Wash-water	Tap Water	Industrial or Commercial Liquid	
Ammonia	●	◖	○	◖	Can change into other nitrogen forms as the flow travels to the outfall.
Boron	◖	◖	○	N/A	
Chlorine	○	○	○	◖	High chlorine demand in natural waters limits utility to flows with very high chlorine.
Color	◖	◖	○	◖	
Conductivity	◖	◖	○	◖	Ineffective in saline waters
Detergents –	●	●	○	◖	Reagent is a hazardous waste
E. coli ,Enterococci & Total Coliform	◖	○	○	○	24-hour wait for results. Need to modify standard monitoring protocols to measure high bacteria.
Fluoride*	○	○	●	◖	Reagent is a hazardous waste Exception for communities that do not fluoridate their tap water.
Hardness	◖	◖	◖	◖	
pH	○	◖	○	◖	
Potassium	◖	○	○	●	May need to use two separate techniques, depending on the concentration.
Turbidity	◖	◖	○	◖	

● Can typically (>80% of samples) distinguish this discharge from clean flow types (e.g., tap water or natural water). For tap water, can distinguish from natural water.

◖ Can sometimes (>50% of samples) distinguish this discharge from clean flow types depending on regional characteristics, or can be helpful in combination with another parameter.

○ Poor indicator. Cannot reliably detect illicit discharges, or cannot detect tap water.

N/A: Data are not available to assess the utility of this parameter for this purpose.

Sources: CWP and Pitt, 2004

*Fluoride is a poor indicator when used as a single parameter, but when combined with additional parameters (such as detergents, ammonia and potassium), it can almost always distinguish between sewage and wash water.

3.7 Sample Collection

Proper water quality sample collection is critical for a successful IDDE program. This section gives an overview of sample collection considerations and procedures to encourage sample collection consistency between field crews. The related procedures, work instructions, and forms are included in the Appendix.

The items for field sampling are also included in the overall field equipment checklist in the Appendix. Equipment list items that are applicable to sample collection include the following: a cooler, ice or ice packs, permanent marker to label samples, labeling tape or pre-printed labels, several dozen one-liter polyethylene plastic sample bottles, a "dipper," a measuring cup at the end of a long pole (to collect samples from outfalls that are hard to reach), sterile disposable syringes, and bacteria analysis sample bottles (typically pre-cleaned 120 mL sample bottles to ensure against contamination). Prepared sample bottles are obtained from the commercial laboratory performing the lab analysis.

3.8 Tips for Illicit Discharge Sample Collection

The following tips can help to improve the IDDE monitoring program quality if followed by field crews.

1. Complete a Data Sheet for each outfall location where samples are collected.
2. This form documents other outfall information and helps link the outfall to the samples, and aids in interpreting the indicator monitoring data.
3. Sample in batches where feasible to cut down on field and mobilization time.
4. Avoid sampling lagged storm events by sampling at least 48 to 72 hours after a storm event.

3.9 Interpreting Indicator Data

After water quality samples are collected and analyzed, the data must be read or interpreted. Each of the tested indicator parameters has associated levels that help indicate whether or not the dry-weather discharge is an illicit discharge or is due to a natural water source (such as groundwater infiltration). **Table 3.2** lists the indicator parameters tested by the University's MS4 along with the parameter levels that may indicate a potential illicit discharge.

Table 3.2 - Indicator Parameters with Levels That May Indicate a Potential Illicit Discharge

Parameter	Potential Illicit Discharge Values	Source
Specific Conductance	>1,000 µS/cm	LFUCG IDDE Manual
Dissolved Oxygen	> 4.0 mg/L	LFUCG IDDE Manual
pH	pH < 6.0 or pH > 9.0	LFUCG IDDE Manual KDOW WQ Standards
Ammonia	Ammonia >0.5 mg/L	LFUCG IDDE Manual
Chlorine	>0.5 mg/L	LFUCG IDDE Manual
Detergents	0.25 mg/L	LFUCG IDDE Manual
Fluoride	>0.65 mg/L	LFUCG IDDE Manual
Phosphorus	1.0 mg/L	LFUCG IDDE Manual
E. coli	>2,400 CFU/100 mL > 130 colonies/100 mL (primary contact recreation)	LFUCG IDDE Manual KDOW WQ Standards
Nitrate	3 mg/L	LFUCG IDDE Manual
Total Dissolved Solids (TDS)	>500 mg/L	Kentucky River Watershed Watch
Hardness (as CaCO3)	> 60 mg/L for moderately hard to hard water	USGS

4.0 Providing Public Reporting Opportunities

Section 2.2.3.3.c of the MS4 permit requires the following:

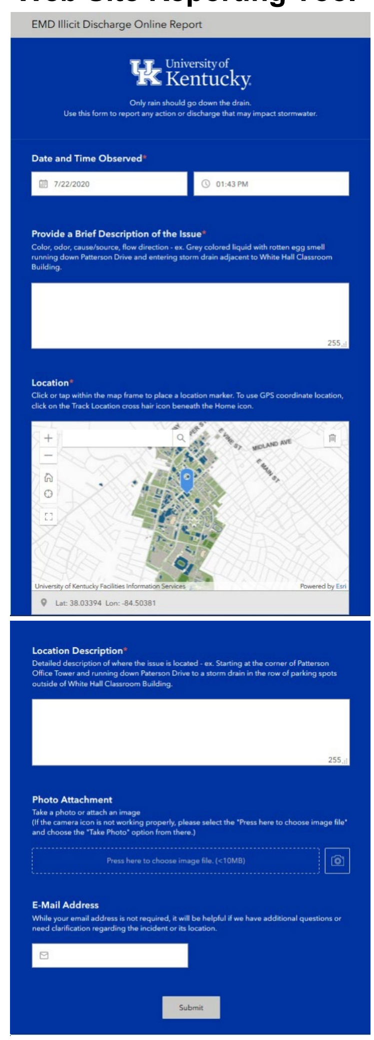
> *"A mechanism and protocols in place that provides for the public reporting of spills and other discharges."*

Public observation and reporting have proven invaluable in many IDDE programs around the country. A large majority of illicit discharges are "intermittent" or "transitory" in nature (i.e., they occur over a very short period of time or rarely at all). It is not feasible to have staff on-site to examine all outfalls all the time. For this reason, public observation can be a valuable asset in detecting illicit discharges. Using this resource will most likely allow the detection of more illicit discharges and increase the public's knowledge of illegal discharges and substances that may flow into the storm drainage network.

4.1 Stormwater Website

The Environmental Quality Management Stormwater Quality Website is used to support the public education and outreach minimum control measure and can also be used as a reporting mechanism for complaints and illicit discharges. The website includes a "Report an Illicit Stormwater Discharge" button that links users to a GIS-based reporting tool shown in Figure 4.1. This tool allows the collection of location, description, and photographic documentation. Once submitted, the information is sent to the University's Water Quality Compliance Manager to evaluate, document, and respond to any complaints received (as noted in Section 5 of this document) for review in accordance with this document. Additionally, contact information is provided on the website for individuals who do not want to use the online application.

Figure 4.1 - IDDE Web Site Reporting Tool



5.0 Investigating Illicit Discharge Complaints or Reports

Section 2.2.3.3.d of the MS4 permit requires the following:

> *"Procedures to provide for the investigation of any complaints, reports, or monitoring information that indicates a potential illicit discharge, spill, or illegal dumping. The permittee shall immediately investigate problems and violations determined to be emergencies or otherwise judged urgent or severe. Where water quality impairments are deemed severe or urgent, the permittee shall promptly refer the incidents to the Department for Environmental Protection's Environmental Emergency 24-hour hotline at (502) 564-2380 or (800) 928-2380."*

As previously discussed, public complaints will be received through the University's MS4 "Illicit Discharge Website Reporting Tool" or through reports received at its normal business address or phone system. These complaints and the subsequent follow-up will be tracked through a database.

Upon receipt of a complaint, report, or monitoring information that indicates a potential illicit discharge, spill, or illegal dumping, the University's Water Quality Compliance Manager will evaluate whether a site visit is required to investigate the report. The following questions shall be considered before completing a visual screening on-site in response to an IDDE complaint.

- Does the site have any active permits on it?
- Is the site located within the University's MS4, or is it within another MS4?
- Is there a need to notify other agencies (i.e., LFUCG MS4, and KDOW)?
- Within which stream watershed is the complaint located?
- Has the area been screened for outfalls previously? If so, gather any existing data on outfalls screened (such as photographs and data sheets), before visiting the site if time is available.
- Have other similar complaints (i.e., same location or same type of complaint) been received by the University's MS4?

All reports of suspected illicit discharges will be documented by completing an illicit discharge report through the active online database reporting mechanism. This will include a description of the reported discharge, correspondence with the individual reporting, and action items recommended or completed.

If necessary, the site visit will be completed within a 24-hour period following receipt of the complaint. If an illicit discharge is suspected, the University's Water Quality Compliance Manager may be required to complete the following tasks:

1. Conduct a visual screening of the site.
2. Identify the severity of the illicit discharge.

3. Notify the property owner via certified mail if needed.
4. Contact KDOW in severe or urgent water quality impairment issues.
5. Implement legal action under local, state, or federal laws as warranted.

If a site visit is not required, the University's Water Quality Compliance Manager will contact the appropriate staff and coordinate cleanup, maintenance, or repair work, if needed. As the complaint is investigated, any required action items or follow-up will also be included in the illicit discharge report for future reference.

6.0 Time Frames for Illicit Discharge Investigation and Removal

Section 2.2.3.3.e of the MS4 permit requires the following:

> *"Timeframes for the investigation and removal of illicit discharges."*

The University will attempt to begin investigating substantiated complaints within 24 hours of receipt. This will include a site visit, if identified as necessary through the processes previously identified in this document.

After a potential illicit discharge is observed or reported, the University's MS4 will attempt to trace the source of the illicit discharge to confirm the location of the source. Once the location of the illicit discharge source is identified, the University's MS4 will notify the facility manager and work to develop a response plan.

Typically, discharges should be stopped within seven days of illicit discharge identification, and illicit connections should be repaired within 30 days of notification. However, the time frame for eliminating the illegal connection and discharge will depend on the type of connection and the complexity of removing the connection or discharge. As needed, the University intends to establish appropriate time frames on a case-by-case basis.

The University will provide follow-up with the complainant when possible or if deemed necessary after the investigation is completed. This should include findings and corrective actions, if available. This correspondence should be included in the illicit discharge report.

7.0 Tracing the Source of an Illicit Discharge

Section 2.2.3.3.f of the MS4 permit requires the following:

> *"Procedures for tracing the source of an illicit discharge; including visual inspections, and when necessary, collecting and analyzing water samples, and other detailed inspection procedures."*

The University's MS4 IDDE program will combine multiple methods to work toward identifying and eliminating illicit discharges in the MS4 area. These illicit discharges can include one-time/intermittent releases or can be linked to a continuous source (such as an illicit connection). The following highlights appropriate approaches for tracing a suspected illicit discharge.

7.1 Methods for Source Tracing

If the University has confirmed the presence of an illicit discharge, attempts will be made to trace the source and a combination of methods may be used to isolate the specific source of the illicit discharge. The procedures used to trace the source will be documented to allow for future decisions on appropriate procedures for specific types of illicit discharges.

7.1.1 Storm Drain Network Investigations

The three investigation approach options include working incrementally up the main sewer trunk, splitting the network into segments for investigation, or beginning at the headwaters and working downstream in the system. These approaches are further described procedures and work instructions in the Appendix.

Because shared boundaries exist with the LFUCG MS4, there may be potential for the University's MS4 to partner with LFUCG to jointly investigate storm sewer system areas where the MS4s are interconnected.

7.1.2 Drainage Area Investigations

Where drainage areas to an outfall are large and complex and where a flow type in the outfall dry-weather discharge would be linked with a land use or a particular generating site in the watershed, a drainage area investigation may be a more appropriate approach for illicit discharge investigation. These investigations are most effective when the outfall discharge has unique characteristics that allow the field crews to quickly discover the probable operation or site that is generating the discharge. An example of this approach that may be more relevant for the University's MS4 might be suspecting a link between sediment-laden outfall discharge and an upstream construction site. Field crews could then investigate further at the construction site to determine whether or not the construction site is contributing to the sediment-laden flow to the outfall. However, it is important to note that these types of investigations are not always helpful in tracing sewage discharges. Examples of these investigation techniques that could be used for the University's MS4 might include the following items:

- Land use investigations.
- Construction site review.
- Project as-built plan review.
- LFUCG MS4 projects and permits.
- Aerial photography analysis.

7.1.3 Building or Structure Investigations

On-site investigations are typically performed on the plumbing systems of buildings within a target area to determine whether any connections to the storm sewer system exist. These investigations occur after the illicit discharge is pinpointed to a specific section of the drainage network. Dye testing is typically used within buildings in order to pinpoint the on-site connection to the storm sewer that may be contributing to the illicit discharge. KDOW, LFUCG MS4, and local emergency first responders such as health, fire and police departments should be notified before starting dye testing.

7.1.4 Unconfirmed or Unverified Discharge Source

In all cases, if the discharge is not visible upon arrival, screen the surrounding catch basins, ditches, upstream bridges, junctions, and similar to verify the discharge cannot be found and has likely ceased or did not occur. The investigation will be documented for future reference through the active online database reporting mechanism.

8.0 Steps to Remove Illicit Discharges

Section 2.2.3.3.g of the MS4 permit requires the following:

> *"Procedures for removing the source of the discharge; including notification of appropriate authorities, notification of property owners; follow-up inspections; and enforcement if the discharge is not eliminated."*

Following the procedures described in the section above related to tracing the source of an illicit discharge, the University will take appropriate actions to remove the source of the illicit discharge once it is identified. According to the *Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments* (CWP and Pitt, 2004), there are four questions that should be answered for each illicit discharge to determine appropriate procedure for corrective action, as follows:

1. Who is responsible?
2. What methods will be used to fix it?
3. How long will it take?
4. How will removal be confirmed?

The source of the discharge will be needed in order to appropriately answer these questions. Typical sources of illicit discharges include internal plumbing connections, service lateral cross-connections, infrastructure failure within the sanitary sewer system or MS4, and indirect discharges resulting from leaks, spills, or overflows.

The majority of illicit discharge corrective actions involve modifying or repairing part of the infrastructure. These structural repairs are used to eliminate a wide variety of direct discharges such as sewage and other cross connections. The range of repairs is broad and covers simple plumbing projects to sewer line replacements. Most transitory discharges are corrected simply with spill containment and clean-up procedures.

8.1 Illicit Discharge Sources

The illicit discharge's source must be identified before determining who is responsible, what methods can be used to fix it, how long it will take, and how to confirm removal. Illicit discharges generally originate from one of the following four sources:

1. Internal Plumbing

An example of an internal plumbing connection is the discharge from a washing machine that is directed to the building's storm lateral. The responsibility for correcting an internal plumbing connection on campus is the responsibility of the Facilities Management. Any source from off campus locations is the responsibility of the building owner and may require coordinating efforts with LFUCG to ensure elimination of the discharge.

2. Service Lateral

There are instances where a building's sanitary service or other non-stormwater drain lateral is connected directly to the stormwater conveyance system. The responsibility for correcting a problem within a service lateral will need to be coordinated between UK Facilities Management and Utilities and Energy Management. Note that the cost of correcting a service lateral problem can be significantly higher than that of fixing an internal plumbing problem. Keep this in mind when determining a deadline for corrective actions to be taken as interim steps may need to be outlined.

3. Infrastructure Failure Within the Sanitary Sewer or MS4

Infrastructure failure such as sewer line collapses or breaks can contribute illicit discharges to the MS4. Illicit discharges related to some sort of infrastructure failure within the sanitary sewer or MS4 must be corrected by UK Utility and Energy Management.

4. Transitory Discharges

Leaks, spills, and overflows are common sources for transitory discharges. On-campus leaks and spills are the responsibility of the department in charge of the campus area/activity where the discharge originates. Such discharges are also covered under UK's Groundwater Management Plan and/or a Spill Prevention Control, and Countermeasures Plan. In the event that such a discharge is caused by a contractor on campus, the contractor will be held responsible for the elimination of the discharge and any associated clean-up.

Table 8.1 provides examples of the three main types of illicit discharges, the potential sources, and possible ways to remove the illicit discharges.

Table 8.1 - Methods to Fix Illicit Discharges

Discharge Type	Source	Removal Action
Sewage	Break in line in right of way	Repair by UEM or LFUCG, depending on right of way ownership
	Commercial or industrial direct connection	Repair by UEM, Facilities, or enforcement with LFUCG MS4
	Infrequent discharge	Spill response, Repair by UEM or Facilities if University-owned or Enforcement with LFUCG MS4
Wash Water	Commercial or industrial direct connection	Repair by UEM, Facilities, or enforcement with LFUCG MS4
	Residential direct connection	Repair by UEM, Facilities, or enforcement with LFUCG MS4
	Power wash and car wash (commercial)	Repair, Elimination, BMP Installation, or Halting of activity by UEM, Facilities, responsible contractor, or enforcement with LFUCG MS4
	Commercial wash down	Repair, Elimination, BMP Installation, or Halting of activity by UEM, Facilities, responsible contractor, or enforcement with LFUCG MS4
	Residential car wash or household maintenance related activities	Education (with LFUCG MS4 if property not University-owned MS4)
Liquid Wastes	Professional oil change and car maintenance	Spill Response, Halting of Activity, Installation of BMPs, and/or Training of Personnel if action being performed by UK staff or UK Contractor
	Heating and oil solvent pumping	Spill response, Repair by UEM or Facilities if University-owned or Enforcement with LFUCG MS4
	Resident oil change and other liquid waste disposal (e.g., paint)	Warning, education, and enforce administrative policy by the University's MS4
	Spill (trucking)	Spill response
	Other industrial wastes	Spill response, Repair by UEM or Facilities if University-owned or Enforcement with LFUCG MS4

Table 8.2 gives more detail for particular methods used to eliminate illicit discharges from the previously mentioned sources. Each technique can be targeted toward a discharge type (e.g., the last six techniques are used for sanitary sewer line repair and rehabilitation).

Table 8.2 - Methods to Eliminate Discharges

Technique	Application	Description
Service lateral disconnection, reconnection	Lateral is connected to wrong line	Lateral is disconnected and reconnected to appropriate line
Cleaning	Line is blocked or capacity is diminished	Flushing (sending high pressure water jet through line); pigging (dragging a large rubber plug through the lines); or rodding
Excavation and replacement	Line is collapsed, severely blocked, significantly misaligned, or undersized	Existing pipe is removed, new pipe abandoned in place, replaced by new pipe in parallel alignment
Manhole repair	Decrease ponding; prevent flow of surface water into manhole, prevent groundwater infiltration	Raise frame and grid above grade; install lid inserts, grout, mortar or apply shot-crete inside the walls; install new pre-cast
Corrosion control coating	Improve resistance to corrosion	Spray or brush on coating applied to interior of pipe
Grouting	Seal leaking joints and small cracks	Seals leaking joints and small cracks
Pipe bursting	Line is collapsed, severely blocked, or undersized	Existing pipe used as guide for inserting expansion head; expansion head increases area available for new pipe by pushing existing pipe out radially until existing pipe cracks; bursting device pulls
Slip lining	Pipe has numerous cracks, leaking joints, but is continuous with no significant joint offsets	Pulling of a new pipe through an old one
Fold and formed pipe	Pipe has numerous cracks and leaking joints	Similar to slip lining but is easier to install, uses existing manholes for insertion; a folded thermoplastic pipe is pulled into place
Inversion lining	Pipe has numerous cracks, leaking joints; can be used where there are misalignments	Similar to slip lining but is easier to install, uses existing manholes for insertion; a soft resin impregnated felt tube is inserted into the pipe, inverted by filling it with air or water at one end, and cured-in-place

8.2 Illicit Discharge Prevention

The most effective way to manage illicit discharges is to encourage the staff, students, and visitors to follow pollution prevention practices that ***prevent*** the illicit discharges from occurring. In the case of University staff, it is a requirement that these "good housekeeping" practices be incorporated into their work. Supervisors also have opportunities to provide one-on-one or group education to the staff during regular meetings, trainings, and field work observations. Supervisors should be prepared to identify, correct, and educate staff.

Other potential education and outreach tools targeted at staff, students, and visitors that have been incorporated into the University's MS4 IDDE program to affect changes in behaviors include:

- Illicit Discharge section on the University's Environmental Quality Management website that include detailed information, training resources, and reporting tools.
- Storm drain marking or labeling.
- Illicit discharge education efforts tailored to specific situations and targeted toward the affected staff, students, and visitors.
- Distribution of the University of Kentucky Environmental Management "What you need to know about MS4" pamphlet. (UK, 2013b)
- Spill Prevention Control and Countermeasures Plan training for staff.

Staff should consistently be identifying additional opportunities to engage and educate others on campus about illicit discharge identification and prevention.

8.3 Enforcement

The University's MS4's IDDE program goal is to protect the storm water system and receiving waters. These efforts include enforcing the University's Administrative Regulation (See Section 1.3 of this document), Design Standards/General Conditions of the Contract for Construction, and cooperating with LFUCG MS4's enforcement efforts in interconnected areas. This cooperative effort between the MS4s will be critical if there is a need to pursue corrective actions for any private properties that are connected to the University's MS4 system.

Contractors for construction projects are governed by University Design Standards as well as the General Conditions of the Contract for Construction. To encourage compliance with all projects, University Design Standards and Contract Language require the submittal and approval of stormwater information as well as the approval of the SWPPP and obtainment of KYR10 permit coverage before sitework can begin. Should a construction site be found non-compliant with requirements, enforcement measures may be taken as outlined in these documents.

9.0 Evaluation and Assessment

Section 2.2.3.3.h of the MS4 permit requires the following:

> *"Procedures for Illicit Discharge Program evaluation and assessment, including tracking the number and type of spills of illicit discharges identified, inspections made; and any feedback received from public education efforts."*

Implementing an accurate and user-friendly system for tracking illicit discharge reports, dry-weather outfall screenings and responses to illicit discharge problems is critical for effective IDDE program. The University's MS4 currently uses an online database to track and store this data. The MS4 Phase II permit requires permittees to keep records related to this general permit for at least 3 years following the general permit's termination. Key records and supporting records that help demonstrate permit compliance will be maintained as required by the permit. This information is available to focus future illicit discharge investigations, public education and outreach efforts, or other University efforts.

The University can revise any data collection efforts to allow for its most efficient data collection throughout the MS4 boundary area. The IDDE program will involve consistent evaluation procedures and record keeping as outlined in this document. Through the implementation process, field staff will learn how to evaluate, document, and mitigate illicit discharge locations. Several objectives can be achieved through the implementation of the IDDE program:

1. Initiate efforts to meet requirements set forth in the MS4 Phase II permit.
2. Better understand the condition of a segment of the stormwater drainage network.
3. Expose and train staff on the appropriate procedures associated with IDDE.
4. Analyze and modify the data collection techniques used to allow for the most efficient data collection in other parts of the stormwater drainage network.

The University's illicit discharge program will continue to adapt and evolve over the permit term based on the tasks outlined in the SWQMP. The KDOW's latest definition of major outfalls, including the reference to industrial land uses, may result in the identification of additional outfalls within the MS4. Also, as dry-weather screening continues on an annual basis, the database of information related to the screening and illicit discharges will continue to grow, offering a larger dataset that can be evaluated over time to allow the MS4 program to make adjustments moving forward.

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