WORKING COPY

VERIF. DATE: _____

INTIALS: _____

CP3-ES-2203 FRev. 1	**TITLE**: Surface Water Sampling	Page 1 of 43

DOCUMENT CATEGORY: Technical	
LEVEL OF USE: ☒ Reference Level ☐ Continuous Use	
FUNCTIONAL AREA: Characterization-Sampling **SUBJECT MATTER AREA:** Sampling	**SUBJECT MATTER EXPERT**: Chris Skinner, Characterization Sampling Lead
NUCLEAR SAFETY REVIEW DOCUMENTATION: FRNP-23-0257-D	**APPROVED BY/DATE** (Signature on file): Kelly Layne, Laboratory/Characterization Manager 4/17/2023
REQUIRED REVIEW DATE (or expiration date for temporary change) 4/17/2026	**EFFECTIVE DATE**: 4/17/2023

REVISION/CHANGE LOG

Revision/Change Letter	Description of Changes	Pages Affected	Date of Revision/Change
FR0	Revision -Procedure was originally CP4-ES-2203 but is used by multifunctional areas so is being revised to a CP3 procedure. Added 3710 Portable Sampler and 5800 Refrigerated Sampler Manuals to Source References. Incorporated the use of Portable Samplers and Refrigerated Samplers to step 6.1.18. Addition of Acute and Chronic Toxicity Sampling Section 6.6 and NOTEs concerning K017 Acute Toxicity Sampling time requirements and Chronic Toxicity Sampling for all outfalls EXCEPT K001 and K010. Revised forms CP4-ES-2203-F01 to CP3-ES-2203-F01 and CP4-2203-F02 to CP3-ES-2203-F02 and added as attachments.	All	10/22/2022
FC1	Change to address RADCON requirements for off-site shipment.	16	02/27/2023
FR0A	Intent change to incorporate Field Change 1	16	03/07/2023
FR0B	Change to add the use reference for PFAS sampling guidance and to consult the guidance as a prerequisite step	3, 6	03/16/2023
FR1	General Revision to address multiple comments	All	4/17/2023

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE

1.1 Purpose

This procedure describes the standard process used to collect surface water samples using manual grab sampling methods, sampling devices or automated samplers.

1.2 Scope

This procedure shall be used by the Deactivation and Remediation (D&R) Contractor personnel, and subcontractor personnel that perform sampling to support U.S. Department of Energy (DOE) environmental monitoring at and near the DOE-owned Paducah Site.

2.0 REFERENCES

2.1 Use References

- CP2-ES-0006, *Environmental Monitoring Plan Fiscal Year 2023 Paducah Gaseous Diffusion Plant, Paducah, Kentucky*
- CP2-HS-2000, *Worker Safety and Health Program for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*
- CP3-ES-0003, *Environmental Incident Reporting*
- CP3-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*
- CP3-HS-2010*, Instructions for Lockout/Tagout*
- CP3-HS-2017, *Safe Work Practices Around Water*
- CP3-SM-0019*, Electrical Safety Guidelines*
- CP3-WM-1037, *Generation and Temporary Storage of Waste Materials*
- CP3-WM-9503, *Off-Site Shipments by Air Transport*
- CP4-ES-0109, *Calibration and Preventative Maintenance of Laboratory Equipment*
- CP4-ES-2700, *Logbooks and Data Forms*
- CP4-ES-2702, *Decontamination of Sampling Equipment and Devices*
- CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation*
- CP5-TS-1000, *Per- and Polyfluoroalkyl Substances Sampling Guidelines*
- EPA/540/P-87/001, December 1987. *A Compendium of Superfund Field Operations Methods,* U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-14.

2.2 Source References

- CP2-SM-1000, *Activity Level Work Planning and Control Program*
- Isco Open Channel Flow Measurement Handbook, 7th edition
- Instrument-specific instructions provided by manufacturer

- JHA-10438, *Environmental Monitoring Inspections and Sampling of KPDES Outfalls and Streams*
- Kentucky Pollutant Discharge Elimination System (KPDES) Permit KY0004049
- U.S. Environmental Protection Agency 1992, *NPDES Storm Water Sampling Guidance Document*, EPA-833-B-92-001 Office of Water, July.
- U.S. Geological Survey, Office of Surface Water Technical Memorandum No. 93-07, December 1992.
- 40 CFR Part 136, *Guidelines Establishing Test Procedures for the Analysis of Pollutants*. U.S. Environmental Protection Agency 2001, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. Region 4, Environmental Compliance Branch, Athens, GA, November.
- 3710 Portable Sampler User Manual
- 5800 Refrigerated Sampler User Manual

3.0 COMMITMENTS

None

4.0 PRECAUTIONS AND LIMITATIONS

4.1 Precautions

4.1.1 The sampling personnel performing the task of surface water sampling shall comply with the requirements of CP2-HS-2000, *Worker Safety and Health Program for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*.

4.1.2 The sampling personnel shall comply with additional requirements in the Job Hazard Analysis (JHA) and applicable Industrial Hygiene Work Permit(s) (IHWP) and the radiation works permit (RWP).

4.1.3 Requirements of the RWP shall be followed during sampling activities.

4.1.4 Wear approved safety glasses shall be worn when sampling activities are being performed.

4.1.5 Approved eye wash station will be available for employees when chemicals are being used that have the potential to come in contact with the employees eyes.

4.1.6 Nitrile rubber gloves shall be worn when using sample bottles with prepackaged acid present.

4.1.7 **If** any Hydrochloric Acid, Nitric Acid or Sulfuric Acid comes in contact with nitrile gloves **then** remove and dispose of gloves and obtain an new pair.

4.1.8 A two-way radio and/or cell phone shall be kept at the sampling site during any sampling event for communication purposes.

4.1.9 The buddy system must always be used when sampling Outfalls and Streams.

4.1.10 Water depth must be checked before entering.

4.1.11 **DO NOT** enter water that presents a drowning hazard unless approved methods have been discussed with Safety and Health and controls are implemented from CP3-HS-2017, *Safe Work Practices Around Water*.

4.1.12 Adhere to electrical safety requirements for maintaining safe distance from energized components.

4.1.13 The requirements established in the company CP3-SM-0019,*Electrical Safety Guidelines* and CP3- HS-2010, *Instructions for Lockout Tagout,* implementation guidance/program documents shall be followed.

4.1.14 If guards must be removed or systems opened that could contain hazardous energy (pressure, electrical, etc), lock and tag.

4.1.15 Where sources of hazardous energy may be encountered during sampling, coordinate Lockout/Tagout with the facility manager, system owner, and issuing authority.

4.1.16 Follow requirements of any issued Lockout/Tagout permit to de-energize sources and for verification of de-energization.

4.1.17 **If** an unplanned event, accident, and/or injury occurs during off-shift hours **then** PSS and next line management shall be notified immediately.

4.2 Limitations

4.2.1 Be aware of changing weather and stream conditions.

4.2.2 Stream flow measurements during storm flow events could present weather related hazards.

4.2.3 **If** ambient conditions prevent sample collection, for example if there is insufficient flow to submerge the sampling device; **then** it should be documented in the field records that there is **NOT** enough flow to take a sample.

4.2.4 Any spills and/or releases shall be reported according to CP3-ES-0003, *Environmental Incident Reporting.*

5.0 PREREQUISITES

5.1 Contact RADCON to request access to radiological areas.

5.2 Read and sign off on the RWP and IHWP, if required, and review task-specific requirements prior to beginning work.

5.3 Obtain chain-of-custody forms (COC), sample data forms, and sample labels from Sample Management Office (SMO).

5.4 Prepare quality control samples according to CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation.*

5.5 Limit preparation and collection of samples to those individuals who have the necessary training and are knowledgeable of field procedures applicable to the collection of samples.

NOTE:

The items listed may be used as a guide, but may **NOT** be a complete list.

5.6 Refer to specific tasks, SAP (Sampling and Analysis Plan) and TI (Task Instructions), and the RWP (if one is required) to determine what instruments, supplies, materials, and equipment are needed to safely execute the activities comprising the surface water sampling or surface water measurement event.

- PPE as specified by the RWP, if required
- Task-specific sampling apparatus
- Filter apparatus and filters, when required
- Peristaltic pump, when required
- Silicone tubing or approved equivalent when using peristaltic pump
- COCs generated from Project Environmental Measurements System (PEMS) database
- Sample labels generated from PEMS database including extra labels
- Sample data forms generated form PEMS database
- Sample containers appropriate for the samples to be collected
- Cooler chest(s) with ice or blue ice
- Silicone, Teflon®, or similar inert sealing tape
- Black indelible ink pens
- Custody seals

5.7 Assemble the necessary equipment, tools, and supplies to ensure that sufficient materials and equipment are available for the field activity so as **NOT** to interrupt the water sampling event.

5.8 Calibrate the water quality meter and perform a check prior to collecting field measurements according to CP4-ES-0109, *Calibration and Preventative Maintenance of Laboratory Equipment*.

5.9 **If** collecting samples for PFAS parameters, **then** consult sampling guidelines discussed in CP5-TS-1000, *Per- and Polyfluoroalkyl Substances Sampling Guidelines*.

6.0 INSTRUCTIONS

6.1 General Requirements

Sampler

6.1.1 Perform sampling procedure steps in any order as long as the intent of the procedure is met.

NOTE:

PSS is contacted when sampling is performed outside of normal business hours.

6.1.2 Perform sampling of the storm water dependent KPDES outfalls (e.g. K015) after a significant rainfall event as directed by Environmental Field Compliance.

6.1.3 **If NOT** pre-preserved, **then** preserve sample bottles before going to the field as per the requirements of the COC.

6.1.4 Collect the number and types of Quality Control (QC) samples (for example, field duplicate, equipment rinsate blank, trip blank, split sample, and matrix spike, if necessary) as specified on the COC and/or from the SMO.

NOTE:

Rinsate blanks are **NOT** required when disposable sampling equipment is used.

6.1.5 Prepare equipment rinsate and trip blanks according to CP4-ES-2704.

6.1.6 Document any deviations or difficulties encountered in the field concerning sample collection or related activities on the sample data form.

6.1.7 Collect **and** preserve all samples according to the requirements of the COC.

6.1.8 **If** discrepancies exist between sample collection and the COC **then** contact SMO.

NOTES:

The PEMS database is the preferred approach for generating sample labels, COCs , and sample data forms. The PEMS database will be used to pre-populate the forms according to the project-specific Data Management and Implementation Plan.

Specific sampling instructions apply for KPDES samples that are collected in conjunction with the KPDES permit. These instructions are provided in Appendix B, *KPDES Sampling Instructions*.

KPDES Permit KY0004049

6.1.9 **If** the outfall has sufficient flow, **then** collect samples at the following KPDES outfalls: K001, K002, K004, K006, K008, K009, K010, K011, K012, K013, K015, K016, K017, K019, and K020.

6.1.10 Collect KPDES outfall samples at the sample location and frequency as specified in CP2-ES-0006, *Environmental Monitoring Plan Fiscal Year 2023 Paducah Gaseous Diffusion Plant, Paducah, Kentucky*.

6.1.11 **If** the outfall has sufficient flow, **then** collect Environmental Radiation Protection Program (ERPP) samples at the following KPDES outfalls: K001, K002, K004, K008, K009, K010, K011, K012, K013, K015, K016, K017, K019, and K020.

6.1.12 Collect ERPP samples at the sample location and frequency as specified in CP2-ES-0006.

6.1.13 Prepare **and** gather all needed PEMS generated forms, instruments, equipment, tools, and supplies to safely and successfully complete the water sampling event.

NOTE:

The sampling method often depends on environmental conditions encountered at the time of sampling, the parameters that will need to be sampled, and the amount of sample needed.

Sampling Lead and Sampler

6.1.14 Ensure the sampling data objectives and sampling design address the collection of surface water samples under the following conditions to obtain the most representative sample to meet the needs of the project.

- Potential contamination of surface-water samples
- Physical condition during sampling
- Groundwater interaction at sampling location
- Mixing zone influence
- Flow conditions
- Seasonal influences
- Limnologic conditions in deep water bodies

6.1.15 Refer to EPA/540/P-87/001, USEPA, OSWER Directive 9355.0-14. December 1987, *EPA Compendium of Superfund Field Operations Methods,* for further information.

WARNING:

Be aware of changing weather and stream conditions to avoid injury or death.

Stream flow measurements during storm flow events could present weather related hazards resulting in injury or death.

6.1.16 Unless new, verify that all reusable sampling equipment has been decontaminated prior to use.

6.1.17 **If** prior decontamination of sampling equipment **CANNOT** be verified, **then** decontaminate the equipment according to CP4-ES-2702, *Decontamination of Sampling Equipment and Devices*, prior to use.

NOTE:

Devices with disposable containers are preferred.

6.1.18 **When** surface water and sediment samples are collected from the same location, **then** collect water samples first.

NOTE:

Sample depths and access may warrant the use of special grab sampling devices and are summarized in Step **6.1.19**.

6.1.19 Determine the sampling device required to be used from the following device descriptions:

- Bacon Bomb Sampling Device may be used in most cases where site access is from a boat or structure such as a bridge or pier and where samples at depth are required.
- Kemmerer Bottle Sampling Device can be used in most cases where the Bacon Bomb Sampler is used; however the Kemmerer is useful for collecting volatile organics.
- Portable Sampler is a programmable liquid sampler designed for the collection of samples. The portable sampler is programmable for extensive sampling capabilities, flexible programming, and adjustable sampling volumes.
- Refrigerated Sampler is an automated sampler that can collect liquid samples from a variety of sources. The refrigerated sampler is permanently installed at the desired location and plugged into an alternating current (AC) power source. The Refrigerated Sampler is programmable for extensive sampling capabilities, flexible programming, and adjustable sampling volumes.
- Teflon® Bailer is used for depth-integrated sampling in deep water bodies.
- Wheaton Grab Sampling Device may be used as a subsurface-water sampling tool designed to obtain samples from spillways, boats, docks, etc., without physical entry into the water.

- Weighted Bottle Sampling Device is a primitive form of sampling device where a bottle closure is jerked out of the bottle at the selected depth. Such sampling devices allow some mixing as they are drawn out of the water.

6.2 Manual Surface Water Sampling

NOTE:

Generally sample bottles come from the laboratory with preservative already added and proper preservation will be verified by the laboratory during sample receipt.

Sampler

6.2.1 Complete surface water sampling based upon one of the following methods selected:

- Submergence Method
- Dipper Method
- Peristaltic Pump Sampling

6.3 Submergence Method

NOTES:

This is the preferred method of collecting grab samples, unless a vertical profile is required through the water column. This method is commonly used to collect samples from shallow streams and outfall pipes. For hard-to-reach locations, an extendable pole can be useful to hold the container. This method has the potential for spreading contamination because of residuals on the outside of the container when the water has high concentrations of hazardous constituents.

Container submergence may **NOT** be suitable for pre-preserved containers. When container submergence is **NOT** appropriate, a dip sampling device with an extension handle may be used.

6.3.1 **If NOT** previously labeled, **then** obtain the appropriate sample container **and** affix the appropriate label as required by the COC.

NOTE:

In flowing bodies of water, the opening of the container should face upstream away from sampling personnel.

6.3.2 Collect Field Sample Measurements according to section **6.7**, **and** record parameters required on the sample data form and/or COC.

6.3.3 Submerge the sample container below the water surface preventing surface scum and other floating debris from entering the container unless prescribed in the task-specific task instruction.

6.3.4 **If** collection of surface scum **CANNOT** be avoided, **then** note as a comment on the appropriate sample data form according to CP3-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*.

6.3.5 Allow the sample container to fill to the desired volume, allowing some volume for expansion and mixing.

6.3.6 **If** sampling for VOCs, **then** ensure that a meniscus is raised above the lip of the container before capping, ensuring NO headspace.

A. After closing VOC vial, then invert and tap lightly to check for air bubbles.

B. **If** air bubbles are present, **then** re-open container and add additional sample.

6.3.7 Remove the container from the water, and replace the lid securely.

NOTE:

The best technique is to hold the lid in hand without touching the inside of the lid while filling the container.

6.3.8 Do **NOT** allow the lid to be in contact with any potentially contaminated surfaces.

6.3.9 Document sample collection on the COC, sample data form and sample container label according to CP3-ES-2708.

6.3.10 Place the sample container in a cooler with ice or blue ice to chill the samples until samples are refrigerated.

6.3.11 Refrigerate samples requiring preservation of less than six degrees Celsius until the samples can be shipped to the laboratory for analysis.

6.4 Dipper Method

6.4.1 Use a plastic sheet as a ground cover for staging equipment and/or materials, as necessary, to prevent equipment from contacting potentially contaminated surfaces.

6.4.2 **If NOT** previously labeled, **then** obtain the appropriate sample container **and** affix the appropriate label as required by the COC.

6.4.3 Submerge a clean dipper (or pond sampler) slowly into the water to avoid splashing or mixing, **and** fill completely.

6.4.4 Do **NOT** disturb bottom sediments.

6.4.5 Point the open end of the container upstream in undisturbed, gently flowing water.

6.4.6 Slowly lift the dipper from the water surface.

6.4.7 Collect Field Sample Measurements according to section 6.7, and record parameters as required on the sample data form and/or COC.

6.4.8 Remove the cap from the sample container **and** tilt slightly.

6.4.9 Avoid splashing the sample **and** pour the sample slowly from the dipper down the inside of the sample container.

6.4.10 Ensure that any suspended matter in the sample is transferred quantitatively to the sample bottle.

6.4.11 Allow space in each bottle for expansion and mixing.

6.4.12 **If** sampling for VOCs, **then** ensure that a meniscus is raised above the lip of the container before capping, ensuring **NO** headspace.

C. **After** closing VOC vial, **then** invert **and** tap lightly to check for air bubbles.

D. **If** air bubbles are present, **then** re-open container **and** add additional sample.

6.4.13 Document sample collection on the COC, sample data form **and** sample container label according to CP3-ES-2708.

6.4.14 Place the sample container in a cooler with ice or blue ice to chill the samples until samples are refrigerated.

6.4.15 Refrigerate samples requiring preservation of less than six degrees Celsius until the samples can be shipped to the laboratory for analysis.

6.5 Peristaltic Pump Sampling

NOTE:

This method is **NOT** recommended for collecting VOC samples. VOCs should be collected by the manual grab (dipper) method.

6.5.1 As needed, use a plastic sheet as a ground cover for staging equipment and/or materials, as necessary, to prevent equipment from contacting potentially contaminated surfaces.

6.5.2 **If NOT** previously labeled, **then** obtain the appropriate sample container prescribed in the task-specific WP **and** affix the appropriate label.

6.5.3 Ensure that an AC power source is available in the field or that there is an adequately charged battery, sized for the peristaltic pump.

6.5.4 As needed, cut clean, unused tubing **and** attach to the intake and discharge of the pump. Tubing shall be an inert material [such as, Teflon® or high-density polyethylene (HDPE)].

6.5.5 Insert the intake end of the tubing to the desired sample depth.

NOTE:

The peristaltic pump can pull a column of water up to approximately 6 meters (less than 20 feet) through the tube above the water surface.

6.5.6 Start the pump **and** allow approximately 100 milliliters of water to purge back to the water body, **and** then stop the pump.

6.5.7 Collect Field Sample Measurements according to section 6.7, and record parameters as required on the sample data form and/or COC.

6.5.8 Move the discharge tubing to the sample containers and/or collection container.

6.5.9 Place the outlet end of the tubing at the mouth of the sample container and/or collection container without touching the sides of the container.

6.5.10 Start the pump to fill each sample container.

6.5.11 Stop the pump.

6.5.12 **If** collection container is used, **then** fill sample container from the collection container.

6.5.13 Document sample collection on the COC, sample data form **and** sample container label according to CP3-ES-2708.

6.5.14 Place the sample container in a cooler with ice or blue ice to chill the samples until samples are refrigerated.

6.5.15 Refrigerate samples requiring preservation of less than six degrees Celsius until the samples can be shipped to the laboratory for analysis.

6.6 Acute and Chronic Toxicity Sampling

NOTE:

Chronic Toxicity Sampling for All Outfalls should be collected following steps **6.6.1 A** through **I, EXCEPT** K001 and K010**.**

Chronic Toxicity Sampling for Outfall K011 is required if the C-617-B lagoon is discharged through Outfall K011.

6.6.1 Perform the following for Chronic Toxicity Sampling:

A. Gather necessary equipment:

- portable sampler
- tubing
- strainer
- battery
- jug
- ice

B. Place portable sampler at the desired location.

C. Install tubing into the portable sampler **and** attach strainer to the influent end of the tubing.

D. Install a charged battery, clean jug, and ice into the portable sampler.

E. Program the portable sampler with the desired settings (i.e. time, volume, sequence) for the sampling event.

F. Upon return to the sampling location, remove the jug from the portable sampler and fill sample containers.

G. Document sample collection on the COC, sample data form and sample container label according to CP3-ES-2708.

H. Place the sample containers in a cooler with ice or blue ice to chill the samples until they can be delivered to the lab.

I. Refrigerate samples requiring preservation of less than six degrees Celsius until the samples can be shipped to the laboratory for analysis.

6.6.2 Perform the following for **Acute Toxicity Sampling**:

NOTE:
The KPDES Permit requires acute toxicity samples for outfall K017 to be collected by 2 discrete grab samples collected approximately 12 hours apart. To meet this requirement, the first grab sample should be collected using the portable autosampler and the second sample collected manually approximately 12 hours later.

A. Gather necessary equipment:

- portable sampler
- tubing
- strainer
- battery
- jug
- ice

B. Place portable sampler at the desired location.

C. Install tubing into the portable sampler **and** attach strainer to the influent end of the tubing.

D. Install a charged battery, clean jug, and ice into the portable sampler.

E. Program the portable sampler with the desired settings (i.e. time, volume, sequence) for the sampling event.

F. Upon return to the sampling location, remove the jug from the portable sampler and fill sample containers.

G. Document sample collection on the COC, sample data form and sample container label according to CP3-ES-2708.

H. The second discrete grab sample should be collected approximately 12 hours after the first discrete grab sample was collected. Refer to section 6.2 for instructions on manually collecting the second discrete grab sample.

I. Document sample collection on the COC, sample data form and sample container label according to CP3-ES-2708.

J. Place the sample containers in a cooler with ice or blue ice to chill the samples until they can be delivered to the lab.

K. Refrigerate samples requiring preservation of less than six degrees Celsius until the samples can be shipped to the laboratory for analysis.

6.6.3 Perform the following for **Chronic Toxicity Sampling** of Outfalls equipped with a refrigerated sampler (K001 and K010):

A. **If** an event should arise in which the refrigerated sampler **cannot** be used, **then** follow the steps in **6.6.1** for collection of Chronic Toxicity samples.

B. Ensure that the AC power source is powering the refrigerated sampler unit.

C. As needed, install new ISCO head tubing (with the blue alignment collars) into the peristaltic pump following the refrigerated sampler's manufacturer instructions.

D. Insert the intake end of the tubing to the desired sample depth.

E. Place a clean jug inside the refrigerated sampler.

F. Program the refrigerated sampler with the desired settings (i.e. time, volume, sequence) for the sampling event.

G. Upon return to the sampling location, remove the jug from the refrigerated sampler **and** fill sample containers.

H. Document sample collection on the COC, sample data form and sample container label according to CP3-ES-2708.

I. Place the sample containers in a cooler with ice or blue ice to chill the samples until they can be delivered to the lab.

J. Refrigerate samples requiring preservation of less than six degrees Celsius until the samples can be shipped to the laboratory for analysis.

6.7 Field Sample Measurements

6.7.1 Calibrate and check the Water Quality Meter prior to collecting field measurements according to CP3-ES-0109, *Calibration and Preventative Maintenance of Laboratory Equipment*.

6.7.2 Collect a representative sample to perform field analyses.

6.7.3 Record results from field analyses onto the sample data form and/or COC in the spaces provided.

6.7.4 **If** temperature or pH exceeds the KPDES permit field limits listed in Appendix B, **then** immediately contact the Regulatory Compliance Manager and/or Environmental Field Compliance Manager while still in the field so that an evaluation of the equipment can be performed to ensure the result is accurate.

6.7.5 **If** Total Residual Chlorine (TRC) exceeds the KPDES permit field limits listed in Appendix B, **then** immediately contact the Regulatory Compliance Manager and/or Environmental Field Compliance Manager .

6.8 Stream Flow Measurement

6.8.1 Collect surface water flow measurements from streams and outfalls using volumetric flow rate methods, flow meters, or control structure devices.

NOTE:

The following are the methods for measuring surface water flow beginning with the most accurate method:

- Volumetric Flow Measurements
- Flow Measurement with Control Structures
- Weir Flow Measurements
- Flume Flow Measurements
- Open-Channel Flow Measurements

6.8.2 Select the method dependent upon the field conditions and the desired accuracy.

6.9 Volumetric Flow Measurements with a Container of Known Volume

NOTE:

For low-flow conditions in a pipe or orifice where a container easily can collect all of the flow, an instant flow measurement can be collected using a container of known volume. Equipment needed includes a container of known volume and a stop watch able to measure in seconds.

6.9.1 Identify marks on the container that represent known volumes.

6.9.2 Measure the amount of time required to fill the container from flowing outlet.

6.9.3 Record the time on the sample data form.

6.9.4 Calculate the flow [volume divided by time (such as, gallons per minute, for example; a 5-gallon bucket that requires 2 minutes to fill would be calculated as 2.5 gallons per minute)].

NOTE:

This task is best performed by two persons where one person holds the container and the other person is the timekeeper.

6.9.5 Repeat this process at least 3 times **and** average the results using CP3-ES-2203-F01, *Flow Rate Calculation Form.*

6.10 Flow Measurements with Control Structures

NOTES:

Surface water flow measurements are measures of the height of the water surface in relation to a fixed control structure that constrains the flow through a designed opening. Control structures can be installed in open channels or pipes to measure flow. Flume Flow Measurement definition is provided in Appendix A.

To obtain outfall flow measurements, the height of the water on the flume staff gage should be read to the nearest hundredths of a foot. Given the outfall flume type and the staff gage measurement, the respective flume Discharge Table can be referenced to obtain the outfall flow measurements in million gallons per day (mgd).

A staff gage may be fixed within the stilling well correlating to the bottom depth of the flume. An outside staff gage should be affixed to the constriction wall of the weir or flume for quality control purposes in comparison to the staff gage inside the stilling well. Measurements on the staff gage indirectly represent a correlating flow discharge within the weir or flume. The staff gage should be incremented in tenths and hundredths of a foot.

6.10.1 For outfall K001 record the value of the flow from the flowmeter associated with the outfall.

6.10.2 **If** the flowmeter at outfall K001 is not operational, **then** record the height of water on the staff gage on the sample data form to the nearest 1/100th (0.01) of a foot.

A. Document the flowmeter is inoperable on the sample data form.

B. Tag outfall K001 flowmeter out of service and include a description of the out-of-tolerance condition on the tag.

C. Contact the Contract Technical Representative and evaluate the impact of the out-of-tolerance condition.

Compliance

6.10.3 **If** the flowmeter at outfall K001 is **NOT** operational and the height of the water on the staff gage has **NOT** been read, **then** the daily flow measurement is based on average flows under similar conditions while taking into account any rainfall events.

6.10.4 Provide flow data to the SMO for entry to PEMS.

Sampler

6.10.5 For outfall K004 record the value of the flow from the flowmeter located at C-615.

6.10.6 For outfall K002, K006, K008, K009, K010, K011, K012, K013, K015, K016, K017, K019, and K020, record the height of water on the staff gage in the head feet space provided on the sample data form.

6.10.7 Record measurements from the staff gage to the nearest 1/100th (0.01) of a foot.

6.10.8 On the sample data form, note any obstructions to direct flow approaching the weir or flume that may cause turbulence that makes the flow over the weir or flume look rippled rather than smooth.

6.11 Open Channel Flow Measurements with a Current-Rate Meter

NOTES:

Current-rate meters measure the velocity or speed that the water is moving at the measurement location. The discharge is a result of the flow velocity times the cross sectional area of the stream. The current rate meter either will be electronic or mechanical (having rotating cups or a propeller) with digital readout. The readout window should read out in feet per second.

Equipment as needed for this type of measurement includes the following:

- A measuring rod able to measure in feet and 1/100 (0.01) of a foot increments
- Measuring tape at least as long as the width of the channel
- A top-setting rod
- Current-rate meter (manufacturer **NOT** specified)

6.11.1 **If** possible, **then** select a reach of stream that is straight, free of obstructions with a stable stream bed, and uniform bottom profile.

6.11.2 Determine the width of the channel.

6.11.3 Record the width of the stream or channel on the sample data form.

6.11.4 Determine the spacing between vertical partial sections or segments across the channel **and** measure the depth of each section as determined and record data on sample data form.

6.11.5 **After** the meter is placed at the proper depth, **then** allow the meter to adjust to the flow according to manufacturer's instructions for a stable meter reading.

6.11.6 Measure stream flow.

6.11.7 Document the measured stream flow on the sample data form.

NOTE:

Eddies may exist in the channel where the flow is **NOT** parallel to the channel. This sometimes can be observed by noting the detritus saltating along the streambed. **If** this happens, **then** an attempt must be made to measure the stream flow with the meter pointed in the direction of flow. The reading will be greatest when the probe points in the direction of flow.

Automated Flow Measurement:

Surface water flow measurements routinely are measured to support environmental monitoring of Paducah Site streams. Automated flow measurements also may be performed during a characterization effort to determine variations in the flow over time.

6.11.8 **If** wading in the stream with the meter, **then** stand downstream and to the side of the meter to avoid disruptions in the velocity vectors around the meter.

6.12 Continuous Surface Water Flow Measurements

NOTE:

Surface water flow measurements may need to be collected on a routine or continuous basis to determine seasonal trends in flow characteristics.

6.12.1 Use specific instructions for set up of the automated recording device according to the instrument requirements.

6.12.2 **If** continuous measurements are necessary, **then** install an automated recording device in conjunction with a primary measuring device (weir or flume).

6.13 C001 Flow Measurement

NOTE:

The effluent flow rate from C-765 and C-765A is in units of gallons per minute (gpm).

6.13.1 Document effluent flow rate from C-765A on the sample data form.

6.13.2 Document effluent flow rate from C-765 on the sample data form.

6.14 Post-Sampling Activities

Sampling Lead or Sampler

6.14.1 Complete the COCs and sample labels according to CP3-ES-2708.

6.14.2 Ensure sample information is documented according to CP4-ES-2700, *Logbooks and Data Forms* on sample data forms.

6.14.3 Inspect reusable sampling equipment to ensure gross quantities of sample material have been removed.

6.14.4 **If** gross quantities of sample material can **NOT** be removed from the reusable sampling equipment, **then** handle the reusable sampling equipment as non-fissile waste according to CP3-WM-1037, Generation and Temporary Storage of Waste Materials.

6.14.5 Decontaminate sampling equipment according to CP4-ES-2702 **and** record the decontamination event in the logbook or CP4-ES-2702-F01, *Decontamination Log Sheet*.

6.14.6 Dispose of all waste generated from sampling activities in accordance with CP3-WM-1037.

7.0 ACCEPTANCE CRITERIA

None

8.0 POST PERFORMANCE WORK ACTIVITIES

Sampling Lead and Sampler

8.1.1 Maintain custody of the samples according to CP3-ES-2708 until samples are transferred to the designated laboratory for analysis as soon as possible.

8.1.2 Ensure that the temperature of the sample(s) is maintained according to CP3-ES-0043, *Temperature Control for Sample Storage*.

8.1.3 **If** samples contain radiological material, **then** coordinate with RADCON, and handle according to CP3-WM-9503, *Off-Site Shipments by Air Transport*.

8.1.4 Prepare samples for shipment off-site and ship according to CP3-WM-9503.

8.1.5 Submit a copy of the COCs, logbook pages and/or sample data forms to the SMO for entry into PEMS.

8.1.6 **When** required, **then** place unused or excess sample material into the original waste container according to CP3-WM-1037.

Sample Management Office

8.1.7 Determination of flow from Open Channel Flow Measurements with a Current-Rate Meter

A. Enter distance from edge of stream, depth of water, and flow velocity values from the sample data form into the Flow Rate Calculation Microsoft Excel spreadsheet to calculate flow rate in mgd.

B. Print CP3-ES-2203-F01, *Flow Rate Calculation Form* used to calculate flow and place in project data assessment package.

C. Enter the calculated flow rate in mgd on the sample data form.

8.1.8 Determination of flow from Flow Measurements with Control Structures (e.g. flumes and weirs located at outfalls)

A. Determine the flow at the outfall using the outfall number, measured height of water at the outfall flume or weir (i.e. Head Feet), and the appropriate Flume Discharge Table with Head in Feet conversion table as found in Appendix C.

B. Record the flow in mgd on the sample data form.

NOTE:

Flume Discharge Table with Head in Feet values in italics indicates the flow at the outfall is below the recommended range of this particular primary device (flume or weir).

C. **If** the flow value from the Flume Discharge Table with Head in Feet is shaded and in italics, **then**:

1. Record the flow listed in italics on the sample data form.

2. Place an "E" qualifier by the flow result to indicate this is an estimated value.

D. **If** the Head (feet) value from the Flume Discharge Table with Head in Feet is greater than the maximum Head (feet) value listed in the table, **then**:

1. Record the flow related to the greatest Head (feet) on the sample data form.

2. Place a ”>” qualifier by the flow result to indicate this value exceeds the maximum head reading provided in the flume Discharge Table.

E. **If** the flow value on the Flume Discharge Table with Head in Feet table is blank, **then**:

1. Proceed to the next value in the flow column (MGD) where there is a numerical value.

2. Record the flow in mgd on the sample data form.

3. Place an “<” qualifier by the flow result to indicate this value is below the flow value recorded.

8.1.9 Determination of Flow Measurement from C001

A. Sum the C-765 and C-765A effluent flow rates.

B. Convert flow rate from gpm to mgd using formula:

flow rate (gpm) * 0.00144 = flow rate (mgd)

C. Record the calculated flow rate on the sample data form.

8.1.10 Enter sample date, time, and other information related to sample collection (e.g. field parameters) into PEMS.

9.0 RECORDS

9.1 Records Generated

The following records may be generated by this procedure:

- CP3-ES-2203-F01*, Flow Rate Calculation Form*

Forms are to be completed according to CP3-OP-0024, *Forms Control*.

9.2 Records Disposition

The records are to be maintained according to CP3-RD-0010, *Records Management Process*.

Appendix A – Acronyms/Definitions

ACRONYMS

AC – Alternating Current

***CFR* –** Code of Federal Regulations

COA – Certificate of Analysis

COC – chain-of-custody

D&R – Deactivation & Remediation

DOE – U.S. Department of Energy

EM – environmental monitoring

EPA – U.S. Environmental Protection Agency

ERPP – Environmental Radiation Protection Plan

gpm – gallons per minute

HDPE – high-density polyethylene

JHA – job hazard analysis

KPDES – Kentucky Pollutant Discharge Elimination System

mgd – million gallons per day

OSWER – Office of Solid Waste and Emergency Management

PEMS – Project Environmental Measurements System

PPE – Personal Protective Equipment

QC – Quality Control

RADCON – Radiological Control

RWP – Radiological Work Permit

SAP – Sampling and Analysis Plan

TI – Task Instructions

VOC – Volatile Organic Compound

WP – Work package

Appendix A – Acronyms/Definitions (continued)

Detritus – Loose material (such as rock fragments or organic particles) that results directly from disintegration.

Flume Flow Measurement – A control structure that constricts flow within an opening of known area. Flumes can be designed to fit channels and pipes. Each flume is designed with its own rating curve. Flume measurements are best collected from a stilling well. The stilling well is hydraulically connected to the opening of the flume upstream of the constriction. The following flumes are associated with the KPDES outfalls that are sampled:

- K001 9” Parshall flume
- K002 4.0’ HL flume
- K006 2’ H flume
- K008 9” Parshall flume
- K009 1.5’ H flume
- K010 9” Parshall flume
- K011 4.5’ H flume
- K012 9” Parshall flume
- K013 2’ Parshall flume
- K015 3’ H flume
- K016 90° V Notch Weir
- K017 4.5’ H flume
- K019 2’ Parshall flume
- K020 2’ Parshall flume

Grab Sample – An individual sample collected within a short period of time at a particular location.

Head Space – Void space above the liquid in a sample container.

PEMS Generated Forms – Forms can include COCs, labels, and sample data forms.

Peristaltic Pump – A small positive displacement pump with a capacity of 1 to 3L / minute.

Saltate – To move by jumps or leaps.

Sediment – Material in the bottom of a water body that has been eroded and transported to the stream.

Appendix B – KPDES Sampling Instructions

When conducting KPDES sampling, the following actions shall be taken for all KPDES Outfalls:

- Contact the Regulatory Compliance Manager and/or Environmental Field Compliance Manager immediately while still in the field if Suspended Solids appear to be higher than expected, floating oil is present, a color change is noted, unusual odor is detected, or anything unusual is seen.
- Contact the Regulatory Compliance Manager and/or Environmental Field Compliance Manager immediately while still in the field if pH falls outside the limits of 6.0 to 9.0.

When collecting KPDES field measurements for temperature, contact the Regulatory Compliance Manager and/or Environmental Field Compliance Manager immediately if temperature exceeds 89° Fahrenheit at Outfalls 001, 002, or 008.

When collecting KPDES field measurements for Total Residual Chlorine (TRC), contact the Regulatory Compliance Manger and/or Environmental Field Compliance Manager Compliance Manager immediately if TRC exceeds 11 µg/L at Outfalls 001, 006, or 008.

Appendix C – Flume Discharge Table with Head in Feet

Outfalls K001, K008, K010, K012

ISCO Table 13-5: 9 in. Parshall Flume Discharge Table with Head in Feet

Formula: MGD = 1.984 $H^{1.530}$, *where:* H = head in feet

Values in italics indicate flow below the recommended range of this particular primary device.

Table 13-5	
Head (feet)	MGD
0.01	*0.0017*
0.02	*0.005*
0.03	*0.0093*
0.04	*0.0144*
0.05	*0.0203*
0.06	*0.0268*
0.07	*0.0339*
0.08	*0.0416*
0.09	*0.0498*
0.1	0.0586
0.11	0.0677
0.12	0.0774
0.13	0.0875
0.14	0.098
0.15	0.1089
0.16	0.1202
0.17	0.1319
0.18	0.1439
0.19	0.1563
0.2	0.1691
0.21	0.1822
0.22	0.1956
0.23	0.2094
0.24	0.2235
0.25	0.2379
0.26	0.2526
0.27	0.2676
0.28	0.2829
0.29	0.2985
0.3	0.3144
0.31	0.3306
0.32	0.3471
0.33	0.3638
0.34	0.3808
0.35	0.3981
0.36	0.4156
0.37	0.4334
0.38	0.4515

Table 13-5	
Head (feet)	MGD
0.39	0.4698
0.4	0.4883
0.41	0.5071
0.42	0.5262
0.43	0.5454
0.44	0.565
0.45	0.5847
0.46	0.6047
0.47	0.625
0.48	0.6454
0.49	0.6661
0.5	0.687
0.51	0.7081
0.52	0.7295
0.53	0.7511
0.54	0.7729
0.55	0.7949
0.56	0.8171
0.57	0.8395
0.58	0.8622
0.59	0.885
0.6	0.9081
0.61	0.9313
0.62	0.9548
0.63	0.9784
0.64	1.002
0.65	1.026
0.66	1.051
0.67	1.075
0.68	1.1
0.69	1.125
0.7	1.15
0.71	1.175
0.72	1.2
0.73	1.226
0.74	1.252
0.75	1.278
0.76	1.304

Table 13-5	
Head (feet)	MGD
0.77	1.33
0.78	1.357
0.79	1.383
0.8	1.41
0.81	1.437
0.82	1.464
0.83	1.492
0.84	1.519
0.85	1.547
0.86	1.575
0.87	1.603
0.88	1.632
0.89	1.66
0.9	1.689
0.91	1.717
0.92	1.746
0.93	1.775
0.94	1.805
0.95	1.834
0.96	1.864
0.97	1.894
0.98	1.924
0.99	1.954
1	1.984
1.01	2.014
1.02	2.045
1.03	2.076
1.04	2.107
1.05	2.138
1.06	2.169
1.07	2.200
1.08	2.232
1.09	2.264
1.10	2.295
1.11	2.327
1.12	2.360
1.13	2.392
1.14	2.424

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfalls K001, K008, K010, K012

ISCO Table 13-5: 9 in. Parshall Flume Discharge Table with Head in Feet

Formula: MGD = 1.984 $H^{1.530}$, *where:* H = head in feet

Values in italics indicate flow below the recommended range of this particular primary device.

Table 13-5	
Head (feet)	MGD
1.15	2.457
1.16	2.490
1.17	2.523
1.18	2.556
1.19	2.589
1.20	2.622
1.21	2.656
1.22	2.690
1.23	2.723
1.24	2.757
1.25	2.791
1.26	2.826
1.27	2.860
1.28	2.894
1.29	2.929
1.30	2.964
1.31	2.999
1.32	3.034
1.33	3.069
1.34	3.105
1.35	3.140
1.36	3.176
1.37	3.212
1.38	3.248
1.39	3.284
1.4	3.32
1.41	3.356
1.42	3.393
1.43	3.429
1.44	3.466
1.45	3.503
1.46	3.54
1.47	3.577
1.48	3.614
1.49	3.652
1.5	3.689
1.51	3.727
1.52	3.765

Table 13-5	
Head (feet)	MGD
1.53	3.803
1.54	3.841
1.55	3.879
1.56	3.918
1.57	3.956
1.58	3.995
1.59	4.033
1.6	4.072
1.61	4.111
1.62	4.15
1.63	4.19
1.64	4.229
1.65	4.269
1.66	4.308
1.67	4.348
1.68	4.388
1.69	4.428
1.7	4.468
1.71	4.508
1.72	4.549
1.73	4.589
1.74	4.63
1.75	4.671
1.76	4.712
1.77	4.753
1.78	4.794
1.79	4.835
1.8	4.877
1.81	4.918
1.82	4.96
1.83	5.001
1.84	5.043
1.85	5.085
1.86	5.127
1.87	5.17
1.88	5.212
1.89	5.254
1.9	5.297

Table 13-5	
Head (feet)	MGD
1.91	5.34
1.92	5.383
1.93	5.426
1.94	5.469
1.95	5.512
1.96	5.555
1.97	5.599
1.98	5.642
1.99	5.686
2	5.73

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfall K002

ISCO Table 16-13: 4.0 ft. HL Flume Discharge Table with Head in Feet

Source: U.S.D.A. Handbook No. 224

Table 16-13	
Head (feet)	MGD
0.01	
0.02	0.0032
0.03	0.0078
0.04	0.0129
0.05	0.0187
0.06	0.0252
0.07	0.0323
0.08	0.0401
0.09	0.0485
0.1	0.0575
0.11	0.0666
0.12	0.0769
0.13	0.0873
0.14	0.0982
0.15	0.1099
0.16	0.1228
0.17	0.1364
0.18	0.1499
0.19	0.1648
0.2	0.1797
0.21	0.1952
0.22	0.2113
0.23	0.2275
0.24	0.2443
0.25	0.2618
0.26	0.2805
0.27	0.3005
0.28	0.3212
0.29	0.3425
0.3	0.3652
0.31	0.3878
0.32	0.4104
0.33	0.433
0.34	0.4556
0.35	0.4783
0.36	0.5041
0.37	0.53
0.38	0.5558

Table 16-13	
Head (feet)	MGD
0.39	0.5817
0.4	0.6075
0.41	0.6347
0.42	0.6657
0.43	0.698
0.44	0.7239
0.45	0.7562
0.46	0.7885
0.47	0.8208
0.48	0.8531
0.49	0.8854
0.5	0.9177
0.51	0.9565
0.52	0.9888
0.53	1.028
0.54	1.06
0.55	1.099
0.56	1.137
0.57	1.176
0.58	1.215
0.59	1.254
0.6	1.299
0.61	1.338
0.62	1.383
0.63	1.428
0.64	1.474
0.65	1.519
0.66	1.564
0.67	1.609
0.68	1.655
0.69	1.706
0.7	1.751
0.71	1.803
0.72	1.855
0.73	1.907
0.74	1.958
0.75	2.01
0.76	2.062

Table 16-13	
Head (feet)	MGD
0.77	2.12
0.78	2.172
0.79	2.223
0.8	2.281
0.81	2.333
0.82	2.391
0.83	2.449
0.84	2.508
0.85	2.572
0.86	2.637
0.87	2.702
0.88	2.766
0.89	2.831
0.9	2.895
0.91	2.96
0.92	3.025
0.93	3.096
0.94	3.167
0.95	3.238
0.96	3.309
0.97	3.38
0.98	3.451
0.99	3.522
1	3.593
1.01	3.671
1.02	3.749
1.03	3.826
1.04	3.904
1.05	3.981
1.06	4.059
1.07	4.136
1.08	4.214
1.09	4.291
1.10	4.369
1.11	4.453
1.12	4.537
1.13	4.621
1.14	4.705

Table 16-13	
Head (feet)	MGD
1.15	4.789
1.16	4.873
1.17	4.957
1.18	5.041
1.19	5.125
1.20	5.209
1.21	5.300
1.22	5.397
1.23	5.494
1.24	5.590
1.25	5.687
1.26	5.784
1.27	5.881
1.28	5.978
1.29	6.075
1.30	6.172
1.31	6.269
1.32	6.398
1.33	6.528
1.34	6.592
1.35	6.722
1.36	6.786
1.37	6.915
1.38	6.98
1.39	7.109
1.4	7.239
1.41	7.368
1.42	7.497
1.43	7.562
1.44	7.691
1.45	7.82
1.46	7.949
1.47	8.014
1.48	8.143
1.49	8.273
1.5	8.402
1.51	8.531
1.52	8.596

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfall K002

ISCO Table 16-13: 4.0 ft. HL Flume Discharge Table with Head in Feet

Source: U.S.D.A. Handbook No. 224

Table 16-13	
Head (feet)	MGD
1.53	8.725
1.54	8.854
1.55	8.984
1.56	9.113
1.57	9.242
1.58	9.371
1.59	9.501
1.6	9.63
1.61	9.759
1.62	9.888
1.63	10.02
1.64	10.15
1.65	10.28
1.66	10.47
1.67	10.6
1.68	10.73
1.69	10.86
1.7	10.99
1.71	11.12
1.72	11.25
1.73	11.37
1.74	11.5
1.75	11.7
1.76	11.83
1.77	11.96
1.78	12.09
1.79	12.28
1.8	12.41
1.81	12.54
1.82	12.73
1.83	12.86
1.84	13.06
1.85	13.18
1.86	13.31
1.87	13.51
1.88	13.7
1.89	13.83
1.9	14.02

Table 16-13	
Head (feet)	MGD
1.91	14.15
1.92	14.28
1.93	14.48
1.94	14.67
1.95	14.86
1.96	14.99
1.97	15.12
1.98	15.32
1.99	15.51
2	15.71
2.01	15.83
2.02	16.03
2.03	16.16
2.04	16.35
2.05	16.55
2.06	16.67
2.07	16.87
2.08	17.06
2.09	17.26
2.1	17.45
2.11	17.64
2.12	17.84
2.13	18.03
2.14	18.23
2.15	18.42
2.16	18.61
2.17	18.81
2.18	19
2.19	19.2
2.2	19.39
2.21	19.58
2.22	19.78
2.23	19.97
2.24	20.16
2.25	20.36
2.26	20.62
2.27	20.81
2.28	21

Table 16-13	
Head (feet)	MGD
2.29	21.2
2.3	21.39
2.31	21.65
2.32	21.84
2.33	22.04
2.34	22.3
2.35	22.49
2.36	22.69
2.37	22.88
2.38	23.14
2.39	23.33
2.4	23.59
2.41	23.78
2.42	23.98
2.43	24.17
2.44	24.43
2.45	24.69
2.46	24.88
2.47	25.08
2.48	25.27
2.49	25.53
2.5	25.79
2.51	26.05
2.52	26.24
2.53	26.5
2.54	26.76
2.55	26.95
2.56	27.21
2.57	27.4
2.58	27.66
2.59	27.92
2.6	28.18
2.61	28.37
2.62	28.63
2.63	28.89
2.64	29.15
2.65	29.41
2.66	29.6

Table 16-13	
Head (feet)	MGD
2.67	29.86
2.68	30.12
2.69	30.44
2.7	30.7
2.71	30.96
2.72	31.15
2.73	31.41
2.74	31.67
2.75	31.93
2.76	32.19
2.77	32.44
2.78	32.77
2.79	33.03
2.8	33.35
2.81	33.61
2.82	33.87
2.83	34.12
2.84	34.45
2.85	34.71
2.86	34.96
2.87	35.22
2.88	35.48
2.89	35.81
2.9	36.13
2.91	36.39
2.92	36.65
2.93	36.97
2.94	37.23
2.95	37.55
2.96	37.87
2.97	38.2
2.98	38.45
2.99	38.71
3	38.97
3.01	39.3
3.02	39.62
3.03	39.94
3.04	40.26

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfall K002

ISCO Table 16-13: 4.0 ft. HL Flume Discharge Table with Head in Feet

Source: U.S.D.A. Handbook No. 224

Table 16-13	
Head (feet)	MGD
3.05	40.59
3.06	40.85
3.07	41.17
3.08	41.43
3.09	41.75
3.1	42.07
3.11	42.4
3.12	42.72
3.13	43.04
3.14	43.37
3.15	43.63
3.16	43.95
3.17	44.27
3.18	44.59
3.19	44.92
3.2	45.24
3.21	45.56
3.22	45.89
3.23	46.21
3.24	46.53
3.25	46.86
3.26	47.18
3.27	47.5
3.28	47.83
3.29	48.15
3.3	48.47
3.31	48.8
3.32	49.12
3.33	49.44
3.34	49.77
3.35	50.15
3.36	50.54
3.37	50.86
3.38	51.25
3.39	51.64
3.4	52.03
3.41	52.29
3.42	52.67

Table 16-13	
Head (feet)	MGD
3.43	53
3.44	53.38
3.45	53.71
3.46	54.03
3.47	54.42
3.48	54.81
3.49	55.13
3.5	55.52
3.51	55.9
3.52	56.29
3.53	56.68
3.54	57.07
3.55	57.46
3.56	57.84
3.57	58.23
3.58	58.62
3.59	59.01
3.6	59.39
3.61	59.78
3.62	60.17
3.63	60.56
3.64	60.95
3.65	61.33
3.66	61.72
3.67	62.11
3.68	62.5
3.69	62.95
3.7	63.34
3.71	63.73
3.72	64.11
3.73	64.5
3.74	64.91
3.75	65.33
3.76	65.74
3.77	66.16
3.78	66.57
3.79	66.98
3.8	67.4

Table 16-13	
Head (feet)	MGD
3.81	67.81
3.82	68.22
3.83	68.64
3.84	69.05
3.85	69.46
3.86	69.88
3.87	70.29
3.88	70.71
3.89	71.12
3.9	71.53
3.91	71.95
3.92	72.36
3.93	72.77
3.94	73.19
3.95	73.6
3.96	74.01
3.97	74.43
3.98	74.84
3.99	75.26
4	75.67

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfall K006

Table 16-9: 2.0 ft. H Flume Discharge Table with Head in Feet

Formula: MGD = 1.44 $H^{2.31}$, where: H = head in feet

Table 16-9	
Head (feet)	MGD
0.01	
0.02	0.0009
0.03	0.002
0.04	0.0032
0.05	0.0047
0.06	0.0065
0.07	0.0084
0.08	0.0107
0.09	0.0132
0.1	0.016
0.11	0.0189
0.12	0.022
0.13	0.0253
0.14	0.0289
0.15	0.0326
0.16	0.0366
0.17	0.0408
0.18	0.0453
0.19	0.05
0.2	0.0549
0.21	0.0601
0.22	0.0656
0.23	0.0713
0.24	0.0772
0.25	0.0834
0.26	0.0898
0.27	0.0966
0.28	0.1035
0.29	0.1108
0.3	0.1183
0.31	0.126
0.32	0.1338
0.33	0.1422
0.34	0.1512
0.35	0.1603
0.36	0.1693
0.37	0.1784
0.38	0.1881

Table 16-9	
Head (feet)	MGD
0.39	0.1984
0.4	0.2088
0.41	0.2191
0.42	0.2301
0.43	0.2417
0.44	0.2533
0.45	0.265
0.46	0.2773
0.47	0.2895
0.48	0.3025
0.49	0.3154
0.5	0.329
0.51	0.3425
0.52	0.3568
0.53	0.371
0.54	0.3858
0.55	0.4007
0.56	0.4162
0.57	0.4317
0.58	0.4479
0.59	0.4647
0.6	0.4815
0.61	0.4983
0.62	0.5157
0.63	0.5338
0.64	0.5519
0.65	0.57
0.66	0.5888
0.67	0.6082
0.68	0.6276
0.69	0.6476
0.7	0.6657
0.71	0.6915
0.72	0.7109
0.73	0.7303
0.74	0.7497
0.75	0.7756
0.76	0.7949

Table 16-9	
Head (feet)	MGD
0.77	0.8208
0.78	0.8402
0.79	0.866
0.8	0.8919
0.81	0.9177
0.82	0.9436
0.83	0.963
0.84	0.9888
0.85	1.015
0.86	1.047
0.87	1.073
0.88	1.099
0.89	1.125
0.9	1.15
0.91	1.183
0.92	1.209
0.93	1.241
0.94	1.267
0.95	1.299
0.96	1.331
0.97	1.357
0.98	1.39
0.99	1.422
1	1.454
1.01	1.486
1.02	1.519
1.03	1.551
1.04	1.583
1.05	1.622
1.06	1.655
1.07	1.693
1.08	1.726
1.09	1.764
1.10	1.797
1.11	1.835
1.12	1.874
1.13	1.913
1.14	1.952

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfall K006

Table 16-9: 2.0 ft. H Flume Discharge Table with Head in Feet

Formula: MGD = 1.44 $H^{2.31}$, where: H = head in feet

Table 16-9	
Head (feet)	MGD
1.15	1.991
1.16	2.029
1.17	2.068
1.18	2.107
1.19	2.146
1.20	2.184
1.21	2.230
1.22	2.269
1.23	2.314
1.24	2.359
1.25	2.398
1.26	2.443
1.27	2.488
1.28	2.533
1.29	2.579
1.30	2.624
1.31	2.669
1.32	2.714
1.33	2.766
1.34	2.811
1.35	2.863
1.36	2.908
1.37	2.96
1.38	3.012
1.39	3.063
1.4	3.115
1.41	3.167
1.42	3.219
1.43	3.27
1.44	3.322
1.45	3.38
1.46	3.432
1.47	3.49
1.48	3.542
1.49	3.6
1.5	3.652
1.51	3.71
1.52	3.768

Table 16-9	
Head (feet)	MGD
1.53	3.826
1.54	3.884
1.55	3.949
1.56	4.007
1.57	4.065
1.58	4.123
1.59	4.188
1.6	4.253
1.61	4.311
1.62	4.375
1.63	4.44
1.64	4.505
1.65	4.569
1.66	4.634
1.67	4.699
1.68	4.763
1.69	4.828
1.7	4.899
1.71	4.964
1.72	5.035
1.73	5.106
1.74	5.17
1.75	5.241
1.76	5.313
1.77	5.384
1.78	5.455
1.79	5.532
1.8	5.603
1.81	5.675
1.82	5.752
1.83	5.823
1.84	5.901
1.85	5.972
1.86	6.049
1.87	6.127
1.88	6.204
1.89	6.282
1.9	6.366

Table 16-9	
Head (feet)	MGD
1.91	6.444
1.92	6.521
1.93	6.599
1.94	6.683
1.95	6.767
1.96	6.851
1.97	6.928
1.98	7.012
1.99	7.096
2	7.174

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfall K009

ISCO Table 16-8: 1.5 ft. H Flume Discharge Table with Head in Feet

Formula: MGD = 1.36 $H^{2.31}$, where: H = head in feet

Table 16-8	
Head (feet)	MGD
0.01	
0.02	0.0007
0.03	0.0015
0.04	0.0025
0.05	0.0037
0.06	0.005
0.07	0.0067
0.08	0.0085
0.09	0.0106
0.1	0.0129
0.11	0.0153
0.12	0.0178
0.13	0.0206
0.14	0.0236
0.15	0.0268
0.16	0.0302
0.17	0.0338
0.18	0.0376
0.19	0.0417
0.2	0.046
0.21	0.0504
0.22	0.0552
0.23	0.0602
0.24	0.0653
0.25	0.0708
0.26	0.0765
0.27	0.0824
0.28	0.0886
0.29	0.095
0.3	0.1015
0.31	0.1086
0.32	0.1157
0.33	0.1234
0.34	0.1312
0.35	0.139
0.36	0.1474
0.37	0.1558
0.38	0.1648

Table 16-8	
Head (feet)	MGD
0.39	0.1739
0.4	0.1829
0.41	0.1926
0.42	0.2029
0.43	0.2133
0.44	0.2236
0.45	0.2346
0.46	0.2456
0.47	0.2572
0.48	0.2689
0.49	0.2811
0.5	0.2934
0.51	0.3057
0.52	0.3186
0.53	0.3322
0.54	0.3458
0.55	0.36
0.56	0.3742
0.57	0.3884
0.58	0.4033
0.59	0.4188
0.6	0.4343
0.61	0.4505
0.62	0.4666
0.63	0.4828
0.64	0.4996
0.65	0.517
0.66	0.5345
0.67	0.5526
0.68	0.5707
0.69	0.5894
0.7	0.6088
0.71	0.6282
0.72	0.6476
0.73	0.6676
0.74	0.6883
0.75	0.709
0.76	0.7303

Table 16-8	
Head (feet)	MGD
0.77	0.7516
0.78	0.7736
0.79	0.7956
0.8	0.8208
0.81	0.8402
0.82	0.866
0.83	0.8919
0.84	0.9113
0.85	0.9371
0.86	0.963
0.87	0.9888
0.88	1.015
0.89	1.041
0.9	1.066
0.91	1.092
0.92	1.118
0.93	1.15
0.94	1.176
0.95	1.202
0.96	1.234
0.97	1.26
0.98	1.293
0.99	1.325
1	1.351
1.01	1.383
1.02	1.415
1.03	1.448
1.04	1.486
1.05	1.519
1.06	1.551
1.07	1.583
1.08	1.616
1.09	1.655
1.10	1.687
1.11	1.726
1.12	1.764
1.13	1.797
1.14	1.835

Table 16-8	
Head (feet)	MGD
1.15	1.874
1.16	1.913
1.17	1.952
1.18	1.991
1.19	2.029
1.20	2.068
1.21	2.113
1.22	2.152
1.23	2.191
1.24	2.236
1.25	2.275
1.26	2.320
1.27	2.365
1.28	2.411
1.29	2.456
1.30	2.501
1.31	2.546
1.32	2.592
1.33	2.637
1.34	2.682
1.35	2.727
1.36	2.779
1.37	2.824
1.38	2.876
1.39	2.921
1.4	2.973
1.41	3.025
1.42	3.076
1.43	3.128
1.44	3.18
1.45	3.232
1.46	3.283
1.47	3.335
1.48	3.387
1.49	3.445
1.5	3.503

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfalls K011 & K017

ISCO Table 16-12: 4.5 ft. H Flume Discharge Table with Head in Feet

Formula: MGD = 1.68 $H^{2.31}$, where: H = head in feet

Table 16-12	
Head (feet)	MGD
0.01	
0.02	0.002
0.03	0.0043
0.04	0.0069
0.05	0.01
0.06	0.0134
0.07	0.0174
0.08	0.0218
0.09	0.0267
0.1	0.0321
0.11	0.0374
0.12	0.043
0.13	0.049
0.14	0.0553
0.15	0.062
0.16	0.069
0.17	0.0763
0.18	0.0839
0.19	0.0918
0.2	0.1002
0.21	0.1086
0.22	0.1176
0.23	0.1267
0.24	0.1364
0.25	0.1461
0.26	0.1564
0.27	0.1674
0.28	0.1784
0.29	0.1894
0.3	0.201
0.31	0.2133
0.32	0.2256
0.33	0.2378
0.34	0.2508
0.35	0.2643
0.36	0.2779
0.37	0.2921
0.38	0.3063

Table 16-12	
Head (feet)	MGD
0.39	0.3212
0.4	0.3361
0.41	0.3516
0.42	0.3677
0.43	0.3839
0.44	0.4007
0.45	0.4175
0.46	0.435
0.47	0.4524
0.48	0.4705
0.49	0.4886
0.5	0.5073
0.51	0.5267
0.52	0.5461
0.53	0.5662
0.54	0.5862
0.55	0.6069
0.56	0.6282
0.57	0.6495
0.58	0.6715
0.59	0.6935
0.6	0.7174
0.61	0.7368
0.62	0.7626
0.63	0.7251
0.64	0.8079
0.65	0.8337
0.66	0.8596
0.67	0.8919
0.68	0.9113
0.69	0.9371
0.7	0.963
0.71	0.9888
0.72	1.021
0.73	1.047
0.74	1.073
0.75	1.105
0.76	1.131

Table 16-12	
Head (feet)	MGD
0.77	1.163
0.78	1.189
0.79	1.222
0.8	1.254
0.81	1.286
0.82	1.318
0.83	1.351
0.84	1.383
0.85	1.415
0.86	1.448
0.87	1.48
0.88	1.519
0.89	1.551
0.9	1.583
0.91	1.622
0.92	1.655
0.93	1.693
0.94	1.732
0.95	1.771
0.96	1.803
0.97	1.842
0.98	1.881
0.99	1.926
1	1.965
1.01	2.004
1.02	2.042
1.03	2.081
1.04	2.126
1.05	2.165
1.06	2.210
1.07	2.256
1.08	2.294
1.09	2.340
1.10	2.385
1.11	2.430
1.12	2.475
1.13	2.521
1.14	2.566

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfalls K011 & K017

ISCO Table 16-12: 4.5 ft. H Flume Discharge Table with Head in Feet

Formula: MGD = 1.68 $H^{2.31}$, where: H = head in feet

Table 16-12	
Head (feet)	MGD
1.15	2.611
1.16	2.663
1.17	2.708
1.18	2.760
1.19	2.805
1.20	2.857
1.21	2.908
1.22	2.960
1.23	3.005
1.24	3.057
1.25	3.109
1.26	3.160
1.27	3.219
1.28	3.270
1.29	3.322
1.30	3.374
1.31	3.432
1.32	3.484
1.33	3.542
1.34	3.600
1.35	3.658
1.36	3.710
1.37	3.768
1.38	3.826
1.39	3.891
1.4	3.949
1.41	4.007
1.42	4.065
1.43	4.13
1.44	4.188
1.45	4.253
1.46	4.317
1.47	4.375
1.48	4.44
1.49	4.505
1.5	4.569
1.51	4.634
1.52	4.699

Table 16-12	
Head (feet)	MGD
1.53	4.763
1.54	4.834
1.55	4.905
1.56	4.97
1.57	5.041
1.58	5.106
1.59	5.177
1.6	5.248
1.61	5.319
1.62	5.39
1.63	5.461
1.64	5.532
1.65	5.61
1.66	5.681
1.67	5.752
1.68	5.83
1.69	5.907
1.7	5.978
1.71	6.056
1.72	6.133
1.73	6.211
1.74	6.288
1.75	6.366
1.76	6.45
1.77	6.528
1.78	6.605
1.79	6.689
1.8	6.786
1.81	6.851
1.82	6.915
1.83	6.98
1.84	7.109
1.85	7.174
1.86	7.239
1.87	7.368
1.88	7.432
1.89	7.497
1.9	7.626

Table 16-12	
Head (feet)	MGD
1.91	7.691
1.92	7.756
1.93	7.885
1.94	7.949
1.95	8.079
1.96	8.143
1.97	8.273
1.98	8.337
1.99	8.402
2	8.531
2.01	8.596
2.02	8.725
2.03	8.79
2.04	8.854
2.05	8.984
2.06	9.113
2.07	9.177
2.08	9.307
2.09	9.371
2.1	9.501
2.11	9.565
2.12	9.695
2.13	9.824
2.14	9.888
2.15	10.02
2.16	10.08
2.17	10.21
2.18	10.28
2.19	10.41
2.2	10.53
2.21	10.6
2.22	10.73
2.23	10.86
2.24	10.92
2.25	11.05
2.26	11.18
2.27	11.25
2.28	11.37

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfalls K011 & K017

ISCO Table 16-12: 4.5 ft. H Flume Discharge Table with Head in Feet

Formula: MGD = 1.68 $H^{2.31}$, where: H = head in feet

Table 16-12	
Head (feet)	MGD
2.29	11.5
2.3	11.63
2.31	11.7
2.32	11.83
2.33	11.96
2.34	12.09
2.35	12.15
2.36	12.28
2.37	12.41
2.38	12.54
2.39	12.67
2.4	12.73
2.41	12.86
2.42	12.99
2.43	13.12
2.44	13.25
2.45	13.38
2.46	13.51
2.47	13.57
2.48	13.7
2.49	13.83
2.5	13.96
2.51	14.09
2.52	14.22
2.53	14.35
2.54	14.48
2.55	14.61
2.56	14.74
2.57	14.86
2.58	14.99
2.59	15.12
2.6	15.25
2.61	15.38
2.62	15.51
2.63	15.64
2.64	15.77
2.65	15.9
2.66	16.09

Table 16-12	
Head (feet)	MGD
2.67	16.22
2.68	16.35
2.69	16.48
2.7	16.61
2.71	16.74
2.72	16.87
2.73	17.06
2.74	17.19
2.75	17.32
2.76	17.45
2.77	17.58
2.78	17.71
2.79	17.9
2.8	18.03
2.81	18.16
2.82	18.35
2.83	18.48
2.84	18.61
2.85	18.74
2.86	18.94
2.87	19.07
2.88	19.2
2.89	19.39
2.9	19.52
2.91	19.65
2.92	19.84
2.93	19.97
2.94	20.16
2.95	20.29
2.96	20.49
2.97	20.62
2.98	20.81
2.99	20.94
3	21.13
3.01	21.26
3.02	21.46
3.03	21.59
3.04	21.78

Table 16-12	
Head (feet)	MGD
3.05	21.91
3.06	22.1
3.07	22.23
3.08	22.43
3.09	22.62
3.1	22.75
3.11	22.94
3.12	23.14
3.13	23.27
3.14	23.46
3.15	23.65
3.16	23.78
3.17	23.98
3.18	24.17
3.19	24.37
3.2	24.49
3.21	24.69
3.22	24.88
3.23	25.08
3.24	25.21
3.25	25.4
3.26	25.59
3.27	25.79
3.28	25.98
3.29	26.18
3.3	26.37
3.31	26.63
3.32	26.69
3.33	26.89
3.34	27.08
3.35	27.27
3.36	27.47
3.37	27.66
3.38	27.86
3.39	28.05
3.4	28.24
3.41	28.44
3.42	28.63

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfalls K011 & K017

ISCO Table 16-12: 4.5 ft. H Flume Discharge Table with Head in Feet

Formula: MGD = 1.68 $H^{2.31}$, where: H = head in feet

Table 16-12	
Head (feet)	MGD
3.43	28.82
3.44	29.02
3.45	29.21
3.46	29.41
3.47	29.6
3.48	29.79
3.49	29.99
3.5	30.25
3.51	30.44
3.52	30.63
3.53	30.83
3.54	31.02
3.55	31.22
3.56	31.41
3.57	31.67
3.58	31.86
3.59	32.06
3.6	32.25
3.61	32.51
3.62	32.7
3.63	32.9
3.64	33.09
3.65	33.35
3.66	33.54
3.67	33.74
3.68	34
3.69	34.19
3.7	34.38
3.71	34.64
3.72	34.84
3.73	35.09
3.74	35.29
3.75	35.48
3.76	35.74
3.77	35.93
3.78	36.19
3.79	36.39
3.8	36.65

Table 16-12	
Head (feet)	MGD
3.81	36.84
3.82	37.1
3.83	37.29
3.84	37.55
3.85	37.74
3.86	38
3.87	38.26
3.88	38.45
3.89	38.71
3.9	38.91
3.91	39.17
3.92	39.42
3.93	39.62
3.94	39.88
3.95	40.14
3.96	40.33
3.97	40.59
3.98	40.85
3.99	41.1
4	41.3
4.01	41.56
4.02	41.82
4.03	42.07
4.04	42.27
4.05	42.53
4.06	42.79
4.07	43.04
4.08	43.3
4.09	43.56
4.1	43.82
4.11	44.08
4.12	44.27
4.13	44.53
4.14	44.79
4.15	45.05
4.16	45.31
4.17	45.56
4.18	45.82

Table 16-12	
Head (feet)	MGD
4.19	46.08
4.2	46.34
4.21	46.6
4.22	46.86
4.23	47.12
4.24	47.37
4.25	47.7
4.26	47.96
4.27	48.21
4.28	48.47
4.29	48.73
4.3	48.99
4.31	49.25
4.32	49.51
4.33	49.83
4.34	50.09
4.35	50.35
4.36	50.61
4.37	50.93
4.38	51.19
4.39	51.45
4.4	51.7
4.41	52.03
4.42	52.29
4.43	52.54
4.44	52.87
4.45	53.13
4.46	53.38
4.47	53.71
4.48	53.97
4.49	54.29
4.5	54.61

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfalls K013, K019, & K020

ISCO Table 13-8: 2 ft. Parshall Flume Discharge Table with Head in Feet

Formula: MGD = 5.170 $H^{1.550}$, where: H = head in feet

Values in italics indicate flow below the recommended range of this particular primary device.

Table 13-8	
Head (feet)	MGD
0.01	*0.0041*
0.02	*0.012*
0.03	*0.0225*
0.04	*0.0352*
0.05	*0.0498*
0.06	*0.066*
0.07	*0.0838*
0.08	*0.1031*
0.09	*0.1238*
0.1	*0.1457*
0.11	*0.1689*
0.12	*0.1933*
0.13	*0.2189*
0.14	*0.2455*
0.15	0.2732
0.16	0.3019
0.17	0.3317
0.18	0.3624
0.19	0.3941
0.2	0.4267
0.21	0.4602
0.22	0.4946
0.23	0.5299
0.24	0.566
0.25	0.603
0.26	0.6408
0.27	0.6794
0.28	0.7188
0.29	0.7589
0.3	0.7999
0.31	0.8416
0.32	0.884
0.33	0.9272
0.34	0.9711
0.35	1.016
0.36	1.061
0.37	1.107
0.38	1.154

Table 13-8	
Head (feet)	MGD
0.39	1.201
0.4	1.249
0.41	1.298
0.42	1.347
0.43	1.398
0.44	1.448
0.45	1.5
0.46	1.552
0.47	1.604
0.48	1.657
0.49	1.711
0.5	1.766
0.51	1.821
0.52	1.876
0.53	1.932
0.54	1.989
0.55	2.047
0.56	2.105
0.57	2.163
0.58	2.222
0.59	2.282
0.6	2.342
0.61	2.403
0.62	2.464
0.63	2.526
0.64	2.589
0.65	2.652
0.66	2.715
0.67	2.779
0.68	2.844
0.69	2.909
0.7	2.974
0.71	3.04
0.72	3.107
0.73	3.174
0.74	3.242
0.75	3.31
0.76	3.379

Table 13-8	
Head (feet)	MGD
0.77	3.448
0.78	3.518
0.79	3.588
0.8	3.658
0.81	3.729
0.82	3.801
0.83	3.873
0.84	3.946
0.85	4.019
0.86	4.092
0.87	4.166
0.88	4.241
0.89	4.316
0.9	4.391
0.91	4.467
0.92	4.543
0.93	4.62
0.94	4.697
0.95	4.775
0.96	4.853
0.97	4.932
0.98	5.011
0.99	5.09
1	5.17
1.01	5.25
1.02	5.331
1.03	5.412
1.04	5.494
1.05	5.576
1.06	5.659
1.07	5.742
1.08	5.825
1.09	5.909
1.10	5.993
1.11	6.078
1.12	6.163
1.13	6.248
1.14	6.334

Table 13-8	
Head (feet)	MGD
1.15	6.421
1.16	6.507
1.17	6.594
1.18	6.682
1.19	6.770
1.20	6.858
1.21	6.947
1.22	7.036
1.23	7.126
1.24	7.216
1.25	7.306
1.26	7.397
1.27	7.488
1.28	7.580
1.29	7.672
1.30	7.764
1.31	7.857
1.32	7.950
1.33	8.044
1.34	8.138
1.35	8.232
1.36	8.327
1.37	8.422
1.38	8.517
1.39	8.613
1.4	8.709
1.41	8.806
1.42	8.903
1.43	9
1.44	9.098
1.45	9.196
1.46	9.295
1.47	9.394
1.48	9.493
1.49	9.592
1.5	9.692
1.51	9.793
1.52	9.893

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfalls K013, K019, & K020

ISCO Table 13-8: 2 ft. Parshall Flume Discharge Table with Head in Feet

Formula: MGD = 5.170 $H^{1.550}$, where: H = head in feet

Values in italics indicate flow below the recommended range of this particular primary device.

Table 13-8	
Head (feet)	MGD
1.53	9.995
1.54	10.1
1.55	10.2
1.56	10.3
1.57	10.4
1.58	10.51
1.59	10.61
1.6	10.71
1.61	10.82
1.62	10.92
1.63	11.03
1.64	11.13
1.65	11.24
1.66	11.34
1.67	11.45
1.68	11.55
1.69	11.66
1.7	11.77
1.71	11.88
1.72	11.98
1.73	12.09
1.74	12.2
1.75	12.31
1.76	12.42
1.77	12.53
1.78	12.64
1.79	12.75
1.8	12.86
1.81	12.97
1.82	13.08
1.83	13.19
1.84	13.3
1.85	13.42
1.86	13.53
1.87	13.64
1.88	13.75
1.89	13.87
1.9	13.98

Table 13-8	
Head (feet)	MGD
1.91	14.1
1.92	14.21
1.93	14.33
1.94	14.44
1.95	14.56
1.96	14.67
1.97	14.79
1.98	14.9
1.99	15.02
2	15.14
2.01	15.26
2.02	15.37
2.03	15.49
2.04	15.61
2.05	15.73
2.06	15.85
2.07	15.97
2.08	16.09
2.09	16.21
2.1	16.33
2.11	16.45
2.12	16.57
2.13	16.69
2.14	16.81
2.15	16.93
2.16	17.06
2.17	17.18
2.18	17.3
2.19	17.43
2.2	17.55
2.21	17.67
2.22	17.8
2.23	17.92
2.24	18.05
2.25	18.17
2.26	18.3
2.27	18.42
2.28	18.55

Table 13-8	
Head (feet)	MGD
2.29	18.67
2.3	18.8
2.31	18.93
2.32	19.05
2.33	19.18
2.34	19.31
2.35	19.44
2.36	19.57
2.37	19.69
2.38	19.82
2.39	19.95
2.4	20.08
2.41	20.21
2.42	20.34
2.43	20.47
2.44	20.6
2.45	20.73
2.46	20.87
2.47	21
2.48	21.13
2.49	21.26
2.5	21.39

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfall K015

ISCO Table 16-11: 3.0 ft. H Flume Discharge Table with Head in Feet

Formula: MGD = 1.56 $H^{2.31}$, where: H = head in feet

Table 16-11	
Head (feet)	MGD
0.01	
0.02	0.0014
0.03	0.0029
0.04	0.0047
0.05	0.0068
0.06	0.0092
0.07	0.012
0.08	0.0151
0.09	0.0186
0.1	0.0224
0.11	0.0263
0.12	0.0304
0.13	0.0348
0.14	0.0394
0.15	0.0443
0.16	0.0495
0.17	0.055
0.18	0.0607
0.19	0.0667
0.2	0.073
0.21	0.0795
0.22	0.0866
0.23	0.0937
0.24	0.1008
0.25	0.1086
0.26	0.1163
0.27	0.1247
0.28	0.1338
0.29	0.1422
0.3	0.1512
0.31	0.1609
0.32	0.1706
0.33	0.181
0.34	0.1913
0.35	0.2016
0.36	0.2126
0.37	0.2243
0.38	0.2359

Table 16-11	
Head (feet)	MGD
0.39	0.2475
0.4	0.2598
0.41	0.2721
0.42	0.285
0.43	0.2986
0.44	0.3122
0.45	0.3257
0.46	0.34
0.47	0.3548
0.48	0.3697
0.49	0.3852
0.5	0.4007
0.51	0.4162
0.52	0.4324
0.53	0.4492
0.54	0.466
0.55	0.4834
0.56	0.5009
0.57	0.519
0.58	0.5377
0.59	0.5565
0.6	0.5752
0.61	0.5946
0.62	0.6146
0.63	0.6347
0.64	0.6553
0.65	0.6767
0.66	0.698
0.67	0.7193
0.68	0.7413
0.69	0.7639
0.7	0.7885
0.71	0.8079
0.72	0.8337
0.73	0.8596
0.74	0.879
0.75	0.9048
0.76	0.9307

Table 16-11	
Head (feet)	MGD
0.77	0.9565
0.78	0.9824
0.79	1.008
0.8	1.034
0.81	1.066
0.82	1.092
0.83	1.118
0.84	1.15
0.85	1.176
0.86	1.202
0.87	1.234
0.88	1.267
0.89	1.293
0.9	1.325
0.91	1.357
0.92	1.39
0.93	1.422
0.94	1.454
0.95	1.486
0.96	1.519
0.97	1.558
0.98	1.59
0.99	1.622
1	1.661
1.01	1.693
1.02	1.732
1.03	1.764
1.04	1.803
1.05	1.842
1.06	1.881
1.07	1.920
1.08	1.958
1.09	1.997
1.10	2.036
1.11	2.075
1.12	2.113
1.13	2.159
1.14	2.197

Table 16-11	
Head (feet)	MGD
1.15	2.236
1.16	2.281
1.17	2.327
1.18	2.365
1.19	2.411
1.20	2.456
1.21	2.501
1.22	2.546
1.23	2.592
1.24	2.637
1.25	2.682
1.26	2.734
1.27	2.779
1.28	2.824
1.29	2.876
1.30	2.928
1.31	2.973
1.32	3.025
1.33	3.076
1.34	3.128
1.35	3.180
1.36	3.232
1.37	3.283
1.38	3.335
1.39	3.387
1.4	3.445
1.41	3.496
1.42	3.555
1.43	3.606
1.44	3.665
1.45	3.723
1.46	3.774
1.47	3.833
1.48	3.891
1.49	3.949
1.5	4.007
1.51	4.072
1.52	4.13

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfall K015

ISCO Table 16-11: 3.0 ft. H Flume Discharge Table with Head in Feet

Formula: MGD = 1.56 $H^{2.31}$, where: H = head in feet

Table 16-11	
Head (feet)	MGD
1.53	4.188
1.54	4.253
1.55	4.311
1.56	4.375
1.57	4.44
1.58	4.498
1.59	4.563
1.6	4.628
1.61	4.692
1.62	4.757
1.63	4.828
1.64	4.892
1.65	4.957
1.66	5.028
1.67	5.093
1.68	5.164
1.69	5.235
1.7	5.3
1.71	5.371
1.72	5.442
1.73	5.513
1.74	5.584
1.75	5.655
1.76	5.733
1.77	5.804
1.78	5.881
1.79	5.952
1.8	6.03
1.81	6.108
1.82	6.179
1.83	6.256
1.84	6.334
1.85	6.411
1.86	6.495
1.87	6.573
1.88	6.65
1.89	6.728
1.9	6.786

Table 16-11	
Head (feet)	MGD
1.91	6.915
1.92	6.98
1.93	7.045
1.94	7.109
1.95	7.239
1.96	7.303
1.97	7.368
1.98	7.497
1.99	7.562
2	7.691
2.01	7.756
2.02	7.82
2.03	7.949
2.04	8.014
2.05	8.143
2.06	8.208
2.07	8.273
2.08	8.402
2.09	8.467
2.1	8.596
2.11	8.66
2.12	8.79
2.13	8.854
2.14	8.984
2.15	9.048
2.16	9.177
2.17	9.242
2.18	9.371
2.19	9.436
2.2	9.565
2.21	9.63
2.22	9.759
2.23	9.888
2.24	9.953
2.25	10.08
2.26	10.15
2.27	10.28
2.28	10.41

Table 16-11	
Head (feet)	MGD
2.29	10.47
2.3	10.6
2.31	10.73
2.32	10.79
2.33	10.92
2.34	11.05
2.35	11.12
2.36	11.25
2.37	11.37
2.38	11.5
2.39	11.57
2.4	11.7
2.41	11.83
2.42	11.96
2.43	12.09
2.44	12.15
2.45	12.28
2.46	12.41
2.47	12.54
2.48	12.67
2.49	12.8
2.5	12.86
2.51	12.99
2.52	13.12
2.53	13.25
2.54	13.38
2.55	13.51
2.56	13.64
2.57	13.77
2.58	13.9
2.59	14.02
2.6	14.15
2.61	14.28
2.62	14.41
2.63	14.54
2.64	14.67
2.65	14.8
2.66	14.93

Table 16-11	
Head (feet)	MGD
2.67	15.06
2.68	15.19
2.69	15.32
2.7	15.45
2.71	15.58
2.72	15.71
2.73	15.83
2.74	15.96
2.75	16.09
2.76	16.29
2.77	16.42
2.78	16.55
2.79	16.67
2.8	16.8
2.81	16.93
2.82	17.13
2.83	17.26
2.84	17.39
2.85	17.51
2.86	17.71
2.87	17.84
2.88	17.97
2.89	18.1
2.9	18.29
2.91	18.42
2.92	18.55
2.93	18.68
2.94	18.87
2.95	19
2.96	19.2
2.97	19.32
2.98	19.45
2.99	19.65
3	19.84

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfall K016

ISCO Table 9-5: 90° V-notch Weir Discharge Table with Head in Feet

Formula: MGD = 1.616 $H^{2.5}$, where: H = head in feet

Values in italics indicate flow below the recommended range of this particular primary device.

Table 9-5	
Head (feet)	MGD
0.01	*0*
0.02	*0.0001*
0.03	*0.0003*
0.04	*0.0005*
0.05	*0.0009*
0.06	*0.0014*
0.07	*0.0021*
0.08	*0.0029*
0.09	*0.0039*
0.1	*0.0051*
0.11	*0.0065*
0.12	*0.0081*
0.13	*0.0098*
0.14	*0.0118*
0.15	*0.0141*
0.16	*0.0165*
0.17	*0.0193*
0.18	*0.0222*
0.19	*0.0254*
0.2	0.0289
0.21	0.0327
0.22	0.0367
0.23	0.041
0.24	0.0456
0.25	0.0505
0.26	0.0557
0.27	0.0612
0.28	0.067
0.29	0.0732
0.3	0.0797
0.31	0.0865
0.32	0.0936
0.33	0.1011
0.34	0.1089
0.35	0.1171
0.36	0.1257
0.37	0.1346
0.38	0.1438

Table 9-5	
Head (feet)	MGD
0.39	0.1535
0.4	0.1635
0.41	0.1739
0.42	0.1847
0.43	0.1959
0.44	0.2075
0.45	0.2195
0.46	0.2319
0.47	0.2447
0.48	0.258
0.49	0.2716
0.5	0.2857
0.51	0.3002
0.52	0.3151
0.53	0.3305
0.54	0.3463
0.55	0.3625
0.56	0.3792
0.57	0.3964
0.58	0.414
0.59	0.4321
0.6	0.4506
0.61	0.4696
0.62	0.4891
0.63	0.5091
0.64	0.5295
0.65	0.5505
0.66	0.5719
0.67	0.5938
0.68	0.6162
0.69	0.6391
0.7	0.6625
0.71	0.6864
0.72	0.7108
0.73	0.7358
0.74	0.7612
0.75	0.7872
0.76	0.8137

Table 9-5	
Head (feet)	MGD
0.77	0.8408
0.78	0.8683
0.79	0.8964
0.8	0.9251
0.81	0.9542
0.82	0.984
0.83	1.014
0.84	1.045
0.85	1.076
0.86	1.108
0.87	1.141
0.88	1.174
0.89	1.208
0.9	1.242
0.91	1.277
0.92	1.312
0.93	1.348
0.94	1.384
0.95	1.422
0.96	1.459
0.97	1.498
0.98	1.536
0.99	1.576
1	1.616
1.01	1.657
1.02	1.698
1.03	1.740
1.04	1.782
1.05	1.826
1.06	1.869
1.07	1.914
1.08	1.959
1.09	2.005
1.10	2.051
1.11	2.098
1.12	2.145
1.13	2.193
1.14	2.242

Appendix C – Flume Discharge Table with Head in Feet (continued)

Outfall K016

ISCO Table 9-5: 90° V-notch Weir Discharge Table with Head in Feet

Formula: MGD = 1.616 $H^{2.5}$, where: H = head in feet

Values in italics indicate flow below the recommended range of this particular primary device.

Table 9-5	
Head (feet)	MGD
1.15	2.292
1.16	2.342
1.17	2.393
1.18	2.444
1.19	2.496
1.20	2.549
1.21	2.603
1.22	2.657
1.23	2.711
1.24	2.767
1.25	2.823
1.26	2.880
1.27	2.937
1.28	2.995
1.29	3.054
1.30	3.114
1.31	3.174
1.32	3.235
1.33	3.297
1.34	3.359
1.35	3.422
1.36	3.486
1.37	3.55
1.38	3.615
1.39	3.681
1.4	3.748
1.41	3.815
1.42	3.883
1.43	3.952
1.44	4.021
1.45	4.091
1.46	4.162
1.47	4.234
1.48	4.306
1.49	4.379
1.5	4.453
1.51	4.528
1.52	4.603

Table 9-5	
Head (feet)	MGD
1.53	4.679
1.54	4.756
1.55	4.834
1.56	4.912
1.57	4.991
1.58	5.071
1.59	5.152
1.6	5.233
1.61	5.315
1.62	5.398
1.63	5.482
1.64	5.566
1.65	5.651
1.66	5.737
1.67	5.824
1.68	5.912
1.69	6
1.7	6.089
1.71	6.179
1.72	6.27
1.73	6.361
1.74	6.454
1.75	6.547
1.76	6.641
1.77	6.736
1.78	6.831
1.79	6.927
1.8	7.025
1.81	7.123
1.82	7.221
1.83	7.321
1.84	7.421
1.85	7.523
1.86	7.625
1.87	7.728
1.88	7.831
1.89	7.936
1.9	8.041

Table 9-5	
Head (feet)	MGD
1.91	8.148
1.92	8.255
1.93	8.362
1.94	8.471
1.95	8.581
1.96	8.691
1.97	8.803
1.98	8.915
1.99	9.028
2	9.141

CP3-ES-2203-F01 – Flow Rate Calculation Form

FLOW RATE CALCULATION

Sample ID:

Project ID: **Station:**

Date Collected: **Time Collected:**

Stream Width (ft)[A]	Avg. Stream Depth (in)[A]	Flow (Ft/Sec)[A]

Stream Width(in) [Stream Width (ft) * 12]	Total Average Stream Depth (in)

Square Inches [Stream Width(in) * Avg. Stream Depth (in)]	Square Ft of Water (sq ft) [sq in / 144 sq in/sq ft]

Cubic(cu) ft Water/Sec [sq ft of Water * Flow ft/sec]	Gal/Sec [Water cu ft /sec * 7.48 gal water/cu ft]

Gal/Day [Gal/Sec * 86400 Sec/Day]	Million Gallons per Day (mgd) [Gal/Day * 10e-6]

NOTE:

[A] Values entered from Sample Data Form.

Completed By: _____ Date: _____

Verified By: _____ Date: _____

CP3-ES-2203-F01 FR1