DEPARTMENT OF TRANSPORTATION

Illicit Discharge Detection & Elimination (IDDE)

Field Pocket Guide

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CDOT has a permit from the Colorado Department of Public Health and the Environment (CDPHE) to discharge stormwater from our storm drain system to surface waters of the state. The permit states that only stormwater can be discharged from CDOT's storm drain system. Pollutants, such as sediment; fertilizers; pesticides; oil and grease, antifreeze; and other automotive fluids are strictly prohibited from being disposed of in CDOT's storm drain system.

As part of the permit, CDOT has several different programs to prevent pollutants from entering the storm drain system. The programs are:

- **Construction sites program**
- **New development and redevelopment program**
- **Illicit discharges program**
- **Industrial facilities program**
- **Public education and involvement program**
- **Pollution prevention and good housekeeping program**
- **Wet weather monitoring program**

The purpose of the Illicit Discharge Program is to identify and eliminate any discharge that is not composed entirely of stormwater (unless authorized by a separate permit from CDPHE). CDOT employees can help prevent these discharges from polluting stormwater and our streams and rivers.

Corrective Action for an Illicit Discharge

The CDOT Illicit Discharge Response Team, in conjunction with the CDOT Water Quality Program Manager, will take action to respond to suspected illicit discharges with the following steps:

Suspected Hazardous Discharge

Spills on highways, into waterways, or that may otherwise present and immediate danger to the public shall be reported by:

- **Call 911**
- **Immediately notify the CDOT illicit discharge hotline 303-512-4H20 (4426).**
- **Immediately Notify the CDOT Water Quality Program Manager 303-757-9343.**
- **Immediately Notify the CDPHE-EMP hotline (and follow up in writing within 5-days) 1-877-518-5608.**
- **Contact State Patrol Dispatch 303-239-4546**
- **Complete incident tracking forms**
- **Conduct follow-up inspections to ensure the discharge has been stopped and/or illicit connection has been removed**

Suspected Non-Hazardous Discharge

- **Immediately notify the CDOT illicit discharge hotline 303-512-4H20 (4426).**
- **Notify the CDOT Water Quality Program Manager 303-757-9343.**
- **Notify the CDPHE-EMP hotline (and follow up in writing within allowed time period) 1-877-518-5608.**
- **Notify the local MS4 municipality**
- **Dispatch the CDOT Illicit Discharge Response Team**
- **Perform sampling of any non-hazardous discharge to determine its nature**
- **Perform sampling and visual inspection upstream of the discharge to determine the location of its origin**
- **Once the source of an illicit discharge has been identified, steps should be taken to eliminate the discharge.**
- **Issue a letter of violation to the upstream offender**
- **Complete incident tracking forms**
- **Conduct follow-up inspections to ensure the discharge has been stopped and/or illicit connection has been removed**
- **If the offending party does not take corrective action, contact the CDPHE-Water Quality Control Division**

Outfall Field Screening

When screening outfalls for illicit discharge it is important to ensure that any dry weather discharges are not influenced by stormwater. Therefore, all outfall sampling and inspections should be conducted 48 hours or more after the end of a precipitation or snowmelt event.

To ensure safety, efficiency, proper documentation and testing, CDOT field inspection teams will consist of a minimum of two people,.one team leader and at least one sampler/technician.

<u>Precipitation Within Last 48 hours</u> - The exact time and date of previous precipitation is NOT required. Enter amount in inches based on knowledge of the area and physical evidence (i.e., rain, snow, etc.). http://www.wunderground.com/wundermap/ as well as many other on-line sources provide both current and historical precipitation data and are useful tools to determine the physical attributes of a precipitation event at a specific location.

Visit Procedure

- **Go to site**
- **Locate outfall using GPS coordinates (if known).**
- **Capture GPS coordinates location (if not known)**
- **Photograph outfall with "white board", document on field data sheet.**
- **Complete the Outfall Visit Field Data Sheet recording visual observations about the outfall, its condition, and the discharge (if any) flowing out of the outfall including color, odor, turbidity, and floatables.**

Collecting a water sample*

- **Transport sampling equipment to the outfall.**
- **Put on nitrile gloves.**
- **A 1-liter grab sample will be collected for field testing of total chlorine, color, total copper, turbidity, pH, phenols, and other parameters. Two, 1-liter grab samples will be collected at the same time for possible laboratory analysis of the same parameters.**
- **Preserve field and laboratory samples by placing samples in a cooler with ice, or for onsite testing.**
- **Rinse meters/equipment in the water to be tested.**
- **Complete water quality tests on sample.**

(Continued Next Page)

- **Measure the flow rate.**
- **Rinse probes with distilled water**
- **Complete all paper work.**
- **Gather all equipment.**
- **Label samples with indelible ink.**
- **Record sample number, analysis parameter, and collection time on COC and in field data sheet.**
- **Transport samples to lab.**

*Field testing is primarily for outfall reconnaissance investigations. Depending upon the potential regulatory implications, any additional samples obtained at a suspected ID site must be sent to an independent lab.

Outfall Visit Field Data Sheet

CDOT Outfall Field Visit Data Sheet

(1)Outfall ID No._____ (2)GPS Unit _____ (3)Date_____ (4)Time _____ AM/PM

(5) Investigation Team:

SECTION 1: Background Information

(6) Reason for Visit
- ❑ Complaint
- ❑ Outfall Screening
- ❑ Repeat/Follow-up Visit
- ❑ Illegal Connection/ Illicit Discharge
- ❑ Other _____

Camera Name:_____
Photo Numbers:_____
_____

(7) Location
Highway:_____
In CDOT ROW? ❑ Yes ❑ No
Address:_____
Milepost:_____
Latitude _____Deg _____Min_____Sec N
Longitude_____Deg_____Min_____Sec W
Distance from Outfall (if applicable): _____
Receiving Water:_____
Watershed:_____
Accessibility:_____

(8) Land Use
- ❑ Agricultural
- ❑ Commercial
- ❑ Designated Open Space
- ❑ Highway
- ❑ Industrial
- ❑ Institutional
- ❑ Residential
- ❑ Urban
- ❑ Undeveloped
- ❑ Other:_____

(9) Drains To
- ❑ Ditch
- ❑ Gulch
- ❑ Gore point
- ❑ Stream
- ❑ Other:

_____

(10) Rainfall _____ in.
- ❑ <48 hrs
- ❑ 48-72 hours
- ❑ >72 hours

(11)Notes (e.g. Origin of outfall, Permit No., Outfall owner, other outfall ID info):

SECTION 2: Outfall Description

(12) Outfall Type
- ❑ Closed Pipe
- ❑ Manhole
- ❑ Open Channel
- ❑ Other_____

(13) Outfall Dia./Dimensions
(Diameter/ Height/ Width)
_____
_____
_____

(14) Material
- ❑ Clay
- ❑ CMP
- ❑ DIP (Iron)
- ❑ Earthen
- ❑ Grass Lined
- ❑ HDPE
- ❑ PVC
- ❑ RCP (Concrete)
- ❑ Rip-rap
- ❑ Steel
- ❑ VCP
- ❑ Other: _____

(15) Shape
Closed Pipe
- ❑ Box
- ❑ Circular
- ❑ Elliptical
- ❑ Arch
- ❑ Other: _____

Open Channel
- ❑ Chute
- ❑ Trapezoidal
- ❑ Parabolic
- ❑ Other: _____

(16) Structure
- ❑ Good Condition
- ❑ Chipping
- ❑ Collapsed
- ❑ Corrosion
- ❑ Cracking
- ❑ Peeling Paint
- ❑ Spalling
- ❑ Other: _____

(17) Deposits
- ❑ None
- ❑ Oils
- ❑ Sediments
- ❑ Stains
- ❑ Paint
- ❑ Other: _____

Blocked?
❑ Yes ❑ No

Percent Blocked: _____%

(18) Vegetation
- ❑ None
- ❑ Light
- ❑ Medium
- ❑ Heavy
- ❑ Excessive

Blocked?
❑ Yes ❑ No

Percent Blocked: _____%

(19) Submerged In Water?
❑ No ❑ Partially ❑ Fully

(20) Notes/Sketches:

(21) Misc. Dumping
- ❑ Appliances
- ❑ Car Battery
- ❑ Motor oil
- ❑ Other car fluid
- ❑ Mattresses
- ❑ Trash
- ❑ Food Waste

Blocked?
❑ Yes ❑ No

❑ Yes ❑ No

Type:
- ❑ Brown
- ❑ Orange
- ❑ Green
- ❑ Other: _____

(22) Benthic Growth
❑ Yes ❑ No

Type:
- ❑ Brown
- ❑ Orange
- ❑ Green
- ❑ Other: _____

*(23) Pool Quality**
- ❑ Odor
- ❑ Color
- ❑ Floatables
- ❑ Oil Sheen
- ❑ Sewage
- ❑ Sanitary Sewage
- ❑ Illicit Dumping
- ❑ Suds
- ❑ Algae
- ❑ Other: _____

*If any of the pool quality parameters are checked, collect sample and complete Sections 3 and 4.

(24) Notes:

SECTION 3: Flow Measurement and Water Quality

(25) Flow Present?
❑ Yes ❑ No

Flow Description:
- ❑ Trickle
- ❑ Moderate
- ❑ Substantial

(26) Evidence of Illicit Discharge in Pool?
❑ Yes ❑ No
---If yes, skip to Section 4. If no, skip to Section 6---

****Complete water quality testing before flow measurement****

(27) Field Meter Measurements

Temperature	_____ °F
pH	_____ pH Units
Turbidity	_____ NTU
Conductivity	_____ S/m

(28) Stormwater Kit Measurements

Ammonia	_____ mg/L
Chlorine, Total Residual	_____ mg/L
Color, Apparent	_____ Color Units
Copper, Total	_____ mg/L
Detergent Surfactants	_____ mg/L
Phenols, Total	_____ mg/L
Dissolved Oxygen	_____ mg/L

(29) Flow Dimensions
Flow Width: _____ in _____ft
Flow Depth: _____ in _____ft
Flow Velocity _____ ft/sec

Flow Rate _____ ft³/sec
(Rate = Width*Depth*Velocity)

(30) Notes:

SECTION 4: Physical Characterization

(31) ODOR
❑ Yes ❑ No

Type:
- ❑ Chlorine
- ❑ Gasoline/Petroleum
- ❑ Musty
- ❑ Rancid
- ❑ Rotten Eggs
- ❑ Sewage
- ❑ Sour Milk
- ❑ Sulfide
- ❑ Other_____

_____

Severity Index:
- ❑ Faint
- ❑ Easily Detected
- ❑ Noticed from Distance

(32) COLOR
❑ Yes ❑ No

Type:
- ❑ Brown
- ❑ Gray
- ❑ Green
- ❑ Orange
- ❑ Red
- ❑ Yellow
- ❑ Other:_____

_____

Severity Index:
- ❑ Faint Colors in Sample Bottle
- ❑ Clearly Visible in Sample Bottle
- ❑ Clearly visible in Outfall Flow

(33) TURBIDITY/CLARITY
❑ Yes ❑ No

Severity Index:
- ❑ Slight Cloudiness
- ❑ Cloudy
- ❑ Opaque

(34) BIOLOGICAL WASTE
❑ Yes ❑ No

Type:
- ❑ Insects
- ❑ Algae
- ❑ Other Biological Matter:

_____
_____

(35) FLOATABLES
❑ Yes ❑ No

Type:
- ❑ Biological Growth
- ❑ Foam/Suds
- ❑ Garbage
- ❑ Oil Sheen
- ❑ Sewage
- ❑ Sanitary Sewage (toilet paper, coffee grounds, egg shells, corn)
- ❑ Other:_____

_____

Severity Index:
- ❑ Few/Slight, origin not obvious
- ❑ Some indications of origin
- ❑ Clear indications of origin

(36) Notes:

SECTION 5: Data Collection

(37)Sample Collected for Lab?
- ❑ Yes
- ❑ No

---If no, skip to Section 6---

(38) Collection Information
Location: _____
Date:_____
Time:_____
Sample ID:_____

(39) Collected From:
- ❑ Outfall
- ❑ Pool
- ❑ Upstream
- ❑ Other:_____

(40) Side of Stream
- ❑ River Right
- ❑ River Left
- ❑ Confluence River Right
- ❑ Confluence River Left
- ❑ Other:_____

SECTION 6: Overall Outfall Characterization

(41) Probability of Illicit Discharge
❑ Unlikely ❑ Potential ❑ Suspect ❑ Obvious

Notes: (Illicit Discharge Concerns? Non-illicit Discharge Concerns?)

Field Equipment Checklist

Safety Equipment

	First Aid Kit
	Sunscreen
	Bug Spray
	Nitrile Gloves
	Safety Goggles
	Leather / work gloves
	Orange Traffic Safety Vests
	Emergency Telephone Numbers
	Snake Gaiters / Chaps
	Cell phone or Communication Device
	Traffic Cones for Parking
	Mace (optional, for self defense only)
	Maps / Aerial Photos / previous visits

Sample Collection Equipment

	Sample Pole and Accessories
	Manhole Cover Pick (optional)
	Sample Bottles – 500 mL (plastic and glass)
	Sample Bottles – 1000 mL (plastic)
	Sample Bottles – 125 mL (plastic)
	Beakers – 50 mL (plastic)
	Sharpie Markers/Label Tags for Sample Labeling
	Blue Ice Packs or Ice Cubes -Care must be taken to ensure that sufficient ice is maintained in the cooler to keep samples cool during transport to the laboratory
	Cooler Chest(s)
	Filter Funnel
	Filter Paper – for turbid samples
	MSDS for all Chemicals / Reagents
	Labels for samples & lab Chain of Custody forms.

Flow Estimation Equipment

	Flow tape measure and floating object to measure velocity (i.e. cork)
	Stop Watch
	Spray Paint / Chalk / Nylon Marking Ribbon
	Flow Containers / Buckets – Graduated in L or Gal
	Calculator
	Velocity Meter (Optional)

Analytical Equipment

	Conductivity Probe, Meter, and Calibration Standards
	Turbidity Meter
	pH Probe, Meter, and Calibration Standards Thermometer
	Ammonia Test Kit
	Total Chlorine Test Kit and Reagents
	Copper Test Kit and Reagents
	Phenols Test Kit and Reagent
	Detergents Test Kit
	De-ionized Water – to rinse analytical equipment
	Wash Bottles
	Pipets and Other Measuring Devices
	Replacement Batteries
	Pipettes and Bulb
	Clipboard
	Bound Field Notebook
	Kimwipes
	Paper Towels
	Scissors

Other Equipment

	Digital camera & white board/marker
	GPS handheld with data dictionary
	Outfall Visit Field Data Sheets
	Dry Weather Screening Manual

Typical Outfall Materials

Clay & Brick 	**Corrugated Metal Pipe (CMP)**
High Density Polyethylene (HDPE) 	**HDPE** **Possible Illicit Laundry Connection**
Ductile Iron Pipe (DIP) 	**Polyvinyl Chloride (PVC)**
Reinforced Concrete Pipe (RCP) 	**Rip-rap**

Typical Outfall Types

Box
Measure both H & V

Chute
Measure both width and depth indicating shape (Trapezoidal or Parabolic)

Circular
Measure diameter

Culvert
May not record, look for internal connections & look upstream for other outfalls.

Elliptical
Measure both horizontal and vertical diameters

Weep Holes
Don't record weep holes

Bridge Drains
Measure diameter

Double Pipes
Mark as separate outfalls unless known to connect immediately up-pipe.

Characterizing Flow

Submerged: **More than ½ below water**

Partially Submerged: **Less than ½ below water**

Trickle Flow

Very narrow stream of water

Moderate Flow

Steady stream, but very shallow depth

Substantial Flow

Steady stream, with several inches of depth

Moderate Flow

Blocked: **More than ½ with vegetation**

Blocked: **More than ½ with sediment**

Outfall Structure Condition

Chipping

Collapsed

Collapsed 50% or more

Corrosion

Metal pipes or covers

Cracking

Spalling

Water entering concrete forcing the surface to peel, pop out or flake off.

Light Vegetation

Medium Vegetation:

Heavy Vegetation:

Measuring Flow

1. Channel Flow
2. Free Falling Flow

1. Procedure for Channel Flow (including partial flow in pipe):

1. Locate the hydraulic control for flow measurement. Do not enter any pipes in order to measure flow as that may pose a possible health hazard.
2. If possible, mark off a 10-ft longitudinal segment in the channel or pipe.
3. Clock the time required for a light-weight floatable object to travel the marked-off distance.
4. Place the floating object in the water upstream of the starting point and begin timing as it passes the upstream mark.
5. Repeat Step 4 three times and calculate the average velocity (v) of the floating object in feet per second (fps).
6. If a current meter is available, direct stream measurements should be taken at 60% depth at the point that the cross-sectional flow area is measured in lieu of steps 1-5.
7. Estimate cross-sectional flow area.

For rectangular sections:

Area(A) = Average Width (W) x Average Depth (D)

For a trapezoidal section:

$$Area(A) = \frac{(TopofWater\,Width + BottomWidth)}{2} \times AverageDep\,th(D)$$

Compute flow rate.

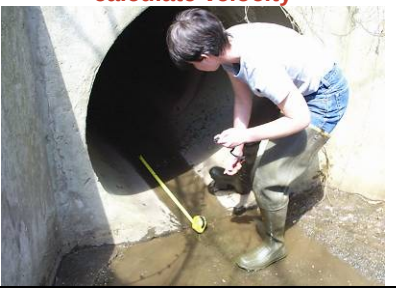
Flowrate(Q) = AverageVelocity(v) x Area(A)

Units:
Flow rate = cubic feet per second (cfs)
Velocity =feet per second (fps)
Area = square feet (ft^2)

Step 1: Measure flow depth

Step 2: Measure flow width

Step 3: Time the travel of a light object (e.g., cork) along a known distance to calculate velocity



2. Procedure for Free-Falling Flow:

1. Place a container of a specific volume directly beneath the free-falling discharge. NOTE: Carry several containers of different volumes and shapes so that you have one that is best suited to the site.
2. Use a stop watch to determine the time required to fill a known volume in the container.
3. Repeat Steps 1 and 2 two or three times. Calculate the average time required to fill the container.
4. Compute flow rate.

Flowrate(Q)=[Volume(V)] / [Time(t)]

Units:

Flow rate =gallons per minute (gpm)
Volume =gallons
Time = minutes

1. Convert gallons per minute to cubic feet per second. If the container is in other than gallon units, use an appropriate conversion factor (for example, 1-liter equals 0.2642 gallons): Flow in cubic feet per second = Flow in gallons per minute x 0.0022
2. Record the Calculated Flow on the Data sheet. Enter to the nearest two significant figures only. (Examples: 0.024 cfs, or 2.1 cfs, or 15 cfs).

Interpreting Color and Turbidity

Using a clear sample bottle to estimate color and turbidity

Color **Severity Index:** **Clearly Visible at Outfall** 	**Turbidity/Clarity** **Severity Index: Opaque** **Iron Floc**
Color **Severity Index:** **Clearly Visible** 	**Turbidity/Clarity** **Severity Index:** **Cloudy**
Color **Severity Index:** **Faintly Visible** 	**Turbidity/Clarity** **Severity Index:** **Slight Cloudiness**

Interpreting Color and Turbidity Examples

Color Clearly Visible
Turbidity/Clarity Cloudy

Sewage Discharge

Color Clearly Visible
Turbidity/Clarity
Slight cloudiness

Confirm with sample bottle

Color Clearly Visible
Turbidity/Clarity Cloudy

Sewage Discharge

Color Faintly Visible
Turbidity/Clarity Cloudy

Confirm with sample bottle

Color Blue-green
Severity Index:
Clearly Visible at Outfall

Color Red
Turbidity/Clarity Opaque

Blood

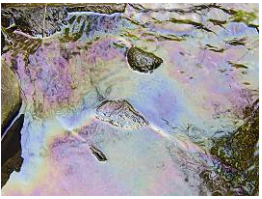
Color clearly visible
Turbidity/Clarity cloudy

Paint

Color clearly visible
Turbidity/Clarity cloudy

Construction site discharge

Suds and Oil Sheens

Suds **Natural Foam/Suds are only associated with high flows at the "drop off"** 	**Oil Sheens** **Low Severity, oil sheen**
Suds **Low Severity appear to travel; very thin foam layer** 	**Oil Sheens** **Moderate severity oil sheen**
Suds **High severity, sewage related** 	**Oil Sheens** **High severity oil film** 

Synthetic versus Natural Sheen

Sheen from bacteria such as iron floc forms a sheet-like film that cracks if disturbed

Synthetic oil forms a swirling pattern

Benthic & Biologic Indicators

Bacterial growth as this outfall indicates nutrient enrichment, a likely sewage source 	**This bright red bacterial growth often indicates high manganese & iron concentrations. Not typically associated with illicit discharges**
Sporalitis filamentous bacteria, also known as "sewage fungus" can be used to track down sanitary sewer leaks 	**Algal mats on lakes indicate eutrophication. Several sources can cause this problem. Investigate potential illicit sources**
Illicit discharges or excessive nutrient application can lead to extreme algal growth on stream beds 	**Potentially a high nutrient concentration. The cause may be an illicit discharge, but may be excessive use of lawn chemicals**
This brownish algae indicates an elevated nutrient level 	**This flow is from rusting rebar from the RCP**

Typical Findings at Outfalls

Reddish staining on the rocks below this outfall indicate high iron concentrations

Excessive vegetation may indicate enriched flows associated with sewage

Toilet paper directly below the storm drain outlet

Brownish stain of unclear origin. May be from degradation of the brick infrastructure

Trash is not a sole indicator of illicit discharges, but should be noted

Cracked rock below the outfall may indicate an intermittent discharge

Staining at the base of the outfall may indicate a persistent, intermittent discharge

Poor pool quality. Consider sampling from the pool to determine origin

Sample Collection

Holding Times

Parameter	Container[1]	Volume	Preservation	Maximum Holding Time
Ammonia	P		N/A (Field Analysis), H_2S0_4 to pH<2, Cool at 4°C	Analyze within 28 days[2]
Chlorine, Total Residual	P or G	500 mL	Analyze Immediately	Analyze within 15 min. [2]
Color, Apparent	P or G	500 mL	Cool at 4°C (39°F)	Analyze within 48 hours
Conductivity	P or G	500 mL	Refrigerate	Analyze within 28 days
Copper, Total	P or G	1000 mL	N/A (Field Analysis), Filter and add $HN0_3$ to pH<: 2 and Cool at 4°C (39°F) (Lab Analysis)	Analyze within 6 months[2]
Surfactants	P or G	250 mL	N/A (Field Analysis), Cool at 4°C (39°F) (Lab Analysis)	Analyze within 48 hours[2]
pH	P or G	50 mL	Analyze Immediately	Analyze within 15 min[2]
Phenol, Total	P or G (PTFE- lined cap)	500 mL	N/A (Field Analysis), Cool at 4°C (39°F)[3] and adjust pH < 2 with H_2S0_4 (Lab Analysis)	Analyze within 28 days[2]
Turbidity	P or G	100 mL	N/A (Field Analysis), Store in dark up to 24 h, refrigerate	Analyze within 48 hours[2]

Onsite Field Tests

Parameter	Method	Range	Detection Limit
Ammonia	Field Meter	0-6.0mg/L	
*Chlorine, Total Residual	DPD, Color Disc	0-3.5 mg/L	0.5 mg/L
Specific Conductance (Conductivity)	Field Meter	0-10,000 uS/cm	
Copper, Total	Bicinchoninate, Hydrosulfite, Color Disc	0-5 mg/L	0.5 mg/L
Detergents	Field Spectrophotometer	0-1 mg/L	0.05 mg/L
*pH	Platinum Electrode, Field Meter	0-14 pH	0.1 pH
Phenols, Total	Color Disc	0-0.200 mg/L	
Turbidity	Field Turbidimeter	0-1 000 NTU	0.01 NTU
*Temperature	Thermometer	NA	$0.1^{0}C$

* Test MUST be performed immediately at outfall site, upon sample collection (no allowable holding time).

TOTAL AMMONIA

Range 0-6.0 mg/L Total Ammonia

1. **Fill sample vial to top line with water.**
2. **Dip the strip into water sample, Vigorously move the strip up and down in water sample for 30 seconds, making sure both pads are always submerged.**
3. **Remove the test strip and shake off excess water.**
4. **Hold the test strip level, with pad side up, for 30 seconds.**
5. **To read result, turn test strip over so that both pads are facing away from you.**
6. **Compare the color of the small pad to the color change on bottle. Read the result through the clear plastic of the test strip.**
7. **Rinse sample vial with DI water after each use.**

TOTAL CHLORINE

Range: O-3.5 mg/L Total Chlorine (Cl_2)

To ensure accurate results please read carefully before proceeding.

Rinse viewing tubes thoroughly before conducting the test. The powder does not have to dissolve completely to obtain correct results.

PROCEDURE

1. Fill a color viewing tube to the lower edge of frosted area (5 mL) with clear water and place it in the left top opening of the comparator (untreated sample, Figure 1).

2. Fill the other viewing tube to the lower edge of frosted area (5 mL) with the water sample to be tested.

3. Open one DPD Total Chlorine Reagent Powder Pillow. Add the contents of the pillow to the test sample. Let stand for three minutes, but not more than six minutes, to let the color develop. Place the sample in the right top opening of the comparator (prepared sample, Figure 1).

4. Hold the comparator up to a light source such as a window the sky or a lamp and view through the openings in front. Rotate the disc until a color match is obtained. Read the mg/L total chlorine (Cl_2) through the scale window.

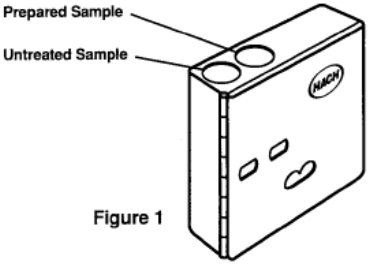


Figure 1

TOTAL COPPER

Range: 0-5 mg/L Total Copper (Cu)

To ensure accurate results please read carefully before proceeding.

This procedure tests for free or complexed copper. Free copper refers to any free or weakly chelated copper ion in solution. Complexed (chelated) copper is tightly bound, as in Cu (EDTA). Free copper plus complexed copper gives the total dissolved copper.

High concentrations of cyanide will inhibit color development. If the cyanide concentration is greater than 2 mg/L, add three drops of Formaldehyde Solution, Cat. 2059-36, to the prepared sample after completing Step 3. Wait three minutes before reading the mg/L free copper in Step 6. The Formaldehyde Solution is not part of this kit but may be ordered from Hach Company. See Replacements.

PROCEDURE

1. Rinse both color viewing tubes several times with the water to be tested. Fill both tubes to the 5-mL mark with the water sample.

2. Open one Free Copper Reagent Powder Pillow (red pillow). Add the contents of the pillow to one of the tubes.

3. Stopper the tube and invert several times to mix. If free copper is present, a purple color will develop. Allow at least two minutes before completing Steps 4 through 6.

4. Insert the prepared sample tube from Step 3 into the right top opening of the color comparator (prepared sample, Figure 1).

5. Insert the tube of untreated water sample into the left top opening of the color comparator (untreated sample, Figure 1).

6. Hold the comparator up to a light source such as the sky, a window or lamp and view through openings in front. Rotate disc to obtain a color match. Read the mg/L free copper through the scale window. Record the value obtained.

7. To determine the amount of total dissolved copper present in the sample add the contents of one Hydrosulfite Reagent Powder Pillow (clear pillow) to the sample tube prepared in Step 3. This is the sample tube in the right opening of the color comparator.

8. Stopper the tube and invert several times to mix. Allow at least two additional minutes before completing Step 9.

9. Replace the tube in the right top opening of the color comparator. Hold the comparator up to a light source and rotate the color disc to obtain a match. Read the mg/L total dissolved copper (free plus complexed copper) through the scale window.

10. The amount of complexed copper can be determined by subtracting the amount of free copper present in the sample (results from Step 6) from the amount of total copper present in the sample (results from Step 9).

DETERGENTS

Range: 0-1.3 mg/L Detergents

To ensure accurate results please read carefully before proceeding.

PROCEDURE

1. Fill one of the test tubes to the upper mark (20 mL) with the water to be tested.

2. Add 12 drops of Detergent Test Solution and shake to mix.

3. Add chloroform to the lowest mark (5 mL) on the test tube. (Chloroform is heavier than water and will sink.) Stopper, shake vigorously for 30 seconds and let stand for one minute to allow the chloroform to separate.

4. Using the draw-off pipet, remove the water from the tube and discard.

5. Refill the test tube to the upper mark with the Wash Water Buffer and, using the draw-off pipet, remove the Wash Water Buffer and discard. This step washes away the remaining water sample.

6. Refill the test tube to the upper mark with the Wash Water Buffer, stopper and shake vigorously for 30 seconds. See Notes for turbid samples.

Let stand for one minute to allow the chloroform to separate.

7. Insert the test tube containing the prepared sample in the right opening of the color comparator.

8. Fill the other test tube with demineralized water and place it in the left opening of the comparator.

9. Hold the comparator up to a light, such as the sky, a window or a lamp, and view through the two openings in the front. Rotate the Detergents Color Disc until a color match is obtained. Read the ppm Detergents (LAS and/or ABS) from the scale window.

10. If the color is darker than the highest reading on the color disc, dilute the original sample 20-to-1 by adding 1 mL of sample to the test tube (using the plastic dropper filled to the top, or 1-mL mark) and filling the test tube to the upper mark (20 mL) with demineralized water. Repeat Steps 2 through 9 and multiply the results by 20.

pH

USING POCKET PAL™ pH TESTER

Range: 0-14 pH units

To ensure accurate results please read carefully before proceeding.

PROCEDURE

1. Slide the on/off switch to on. The switch is located on top of the Pocket Pal.

2. Remove protective cap from the bottom.

3. Immerse the bottom of the Pocket Pal 1.0 to 1.5 inches (2.5-3.8 cm) into the sample. See Note A on how to calibrate and verify the accuracy of the Pocket Pal.

4. Using the Pocket Pal, gently stir the sample for several seconds. After stirring and when the digital display stabilizes, read the pH value. See Note B.

5. Rinse the bottom of the Pocket Pal and replace the protective cap. Follow Note C for longer life.

NOTES

A. Before using the Pocket Pal and for periodic calibration, prepare a pH 7.00 buffer solution. Use the Pocket Pal to read pH. If necessary adjust with a small screwdriver through the hole in the back to a 7.0 reading. The Pocket Pal is now calibrated (See Figure 1).

B. Large differences in pH readings may be caused by a dry electrode or run-down batteries. To improve performance, dip to immersion level in tap water for a few minutes at least once a week.

C. Place several drops of water in the protective cap to prevent the glass bulb from drying out. This will provide a faster response time and a longer Pocket Pal life.

PHENOLS

Range: 0-1 mg/L Phenols

To ensure accurate results please read carefully before proceeding.

PROCEDURE

1. Assemble the color comparator. If the anticipated concentration is between 0 and 1 mg/L, assemble with both the Long Path Viewing Adapter and the phenols color disc installed. See Figure 1. If the concentration is expected to require the 0-5 mg/L range, omit the adapter.

Note: *If the sample is turbid, it may be necessary to filter the sample as described in Steps a and b to accurately determine a color match in the comparator. Figure 2 illustrates how to assemble the filter assembly components. If filtering is not needed, proceed to Step 2.*

a. Install a 0.45 micron filter disc in the filter holder. Be sure the holder is well tightened after installation. Filter discs are packaged with blue papers separating them.

b. Fill the 30-cc syringe with the turbid sample and attach the filter holder to the syringe with a twisting motion. Use the filtered sample in Step 4.

2. Fill two plastic color viewing tubes to the line nearest the top with sample.

3. Add the contents of one EDTA Reagent Powder Pillow to each viewing tube. Cap each tube and mix until the powder is dissolved.

4. Add 15 drops of Hardness 1 Buffer Solution to each viewing tube. Cap the tubes and mix.

5. Place one of the tubes into the left opening in the top of the color comparator.

6. To the other tube, add the contents of one Phenol Reagent Powder Pillow (Nonextraction). Cap the tube and mix until powder is dissolved. Then add the contents of one Potassium Persulfate Powder Pillow for Phosphonate. Cap and mix until the powder is dissolved.

7. Place the sample tube treated in Step 6 into the right opening in the top of the comparator. Remove the caps from both tubes.

8. Hold the comparator so that light shines down through the tubes from the top if the adapter is installed or from the back if the adapter is not installed. See Figure 3. Rotate the disc to match the colors in the color matching windows. Read the mg/L phenols from the scale window. If measuring without the Long Path Viewing Adapter, multiply the reading by five.

Note: *If the color of the sample is too red to make a color match with the Long Path Viewing Adapter installed, repeat the procedure without the adapter.*

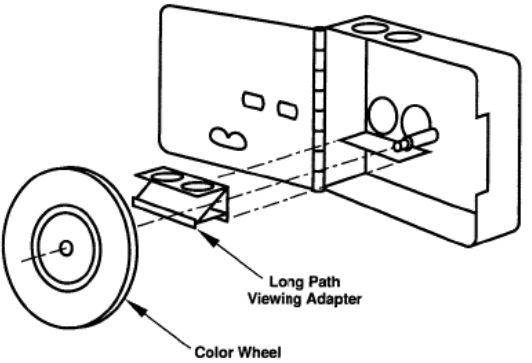


Figure 1

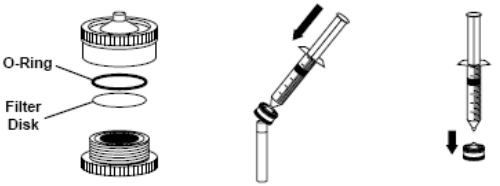


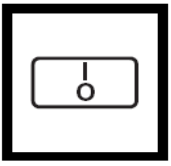
Figure 2 Optional Apparatus

TURBIDITY

1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL), taking care to handle the sample cell by the top. Cap the cell. (See *Section 2.3* on page *22* for more information about collecting a representative sample).

2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.

3. Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface.



4. Press: **I/O**.

The instrument will turn on. Place the instrument on a flat, sturdy surface. Do not hold the instrument while making measurements.

5. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment.
Close the lid.

6. Select manual or automatic range selection by pressing the **RANGE** key. The display will show **AUTO RNG** when the instrument is in automatic range selection.

7. Select signal averaging mode by pressing the **SIGNAL AVERAGE** key. The display will show **SIG AVG** when the instrument is using signal averaging. Use signal average mode if the sample causes a noisy signal (display changes constantly).

8. Press: **READ**

The display will show **- - - - NTU**, then the turbidity in NTU. Record the turbidity after the lamp symbol turns off.

Fingerprints of Major Sources

If testing kits aren't available in field, send samples to lab

Sewage

- **E. Coli**
- **Detergents (various)**
- **High Ammonia / Potassium Ratio**

Wash Water

- **Detergents (various)**

Shallow Groundwater

- **Hardness, pH**

Tap Water

- **Fluoride**
- **Sometimes Hardness**

Septage

- **E. Coli**
- **Fluorescence**
- **High Ammonia/Potassium**

Trigger Levels

Valuable time may be lost in locating the source of an illicit discharge if a second analysis is done every time a screening parameter level is exceeded. If the team leader feels the analytical value obtained is valid, an immediate attempt to find the source should be undertaken.

Parameter	Trigger Levels	Action
Odor	Suspicious or Strong	Attempt to locate source.
Clarity	Other than clear	Attempt to locate source if CDOT has not permitted any large dewatering activities upstream.
Floatables	Foaming or oily sheen	Attempt to locate source.
pH	< 6.0 or > 9.0	Reanalyze. If confirmed, attempt to locate source.
Conductivity	>1,000 uS/cm	Attempt to locate source.
Total Chlorine	> 0.1 mg/L	Reanalyze. If confirmed, attempt to locate source.
Total Copper	> 0.1 mg/L	Reanalyze. If confirmed, attempt to locate source. Lab analysis will be required.

Parameter	Trigger Levels	Action
Turbidity	> 100 NTU	Reanalyze. If confirmed, attempt to locate source if CDOT has not permitted any large dewatering activities upstream.
Total Phenols	> 0.5 mg1L	Reanalyze. If confirmed, attempt to locate source. Lab analysis will be required.
Detergents	> 0.5 mg/L	Reanalyze. If confirmed, attempt to locate source. Perform lab analysis unless residential car washing is found to be the source.

Probability of an Illicit Discharge

Unlikely Discharge	**Non-flowing outfalls with no physical indicators**
Potential Discharge	**Flowing or non-flowing with presence of two or more physical indicators.**
Suspect Discharge	**Flowing with one or more physical indicators above trigger levels.**
Obvious Discharge	**Outfalls where there is an illicit discharge that doesn't require sample collection for confirmation.**

Parameters	Method	Units	Sample Container	Sample Size
Phenol, Total	EPA 420.1	mg/L	Glass with Preservative	500 mL
*pH	EPA 150.1	SU	Plastic	50 mL
Color, Apparent	EPA 11 0.1 -3		Plastic	500 mL
Conductivity	EPA 120.1	uS/cm	Plastic	500 mL
*Chlorine. Total Residual	EPA 330.5	mg/L	Plastic	500 mL
Turbidity	EPA 180.1	NTU	Plastic	100 mL
Copper	EPA 220.1	mg/L	Plastic	500 mL
MBAS (Surfactants)	EPA 425.1	mg/L	Plastic	1000 mL

*Standard methods for these parameters require immediate analysis upon sample collection. This will be violated due to the time it takes to transport a sample from the outfall to the laboratory

Analysis QA/QC

The items listed below will help to ensure that the sample collection system is meeting project standards.

- **Duplicate samples (1 in 10 samples)**
- ***Split samples (1 in 10 samples - split sample sent to the laboratory)**
- **Distilled water blanks (1 per analytical event)**
- ***Spiked samples (1 in 10 samples - sample sent to laboratory for spiking and testing)**
- ***Sample preservative blanks (1 per sampling event - sent to laboratory for analysis)**
- **Control charts (Completed by CDOT database manager and laboratory)**
- **Calibration of field equipment each day prior to sampling event**
- **Record field sample results in field log or on field investigation form.**
- **Label lab samples with indelible ink.**
- **Record sample number, analysis parameter, and collection time on COC and in field book**
- **Record photo id numbers in field log.**

* Required only if litigation is anticipated. Sample analysis can be expensive.

Emergency Numbers:

Emergency Response
911

CDOT Illicit Discharge Hotline
303-512-4H20 (4426)

CDOT Water Quality Program Manager
303-757-9343

CDPHE-EMP Hotline
1-877-518-5608

State Patrol Dispatch
303-239-4546

Field Crew Contact Numbers:

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