Stormwater Coalition of Albany County
Outfall Reconnaissance Inventory (ORI) Training
Information Package

Background: This packet was prepared for an In-House ORI Training conducted on September 12, 2017 at the University at Albany – Uptown Campus by D. Kubek, Albany County DPW for various Coalition members. The items listed here are also located in ORI Training Binders distributed to Coalition members over multiple years.

List of Items

A. Stormwater Coalition of Albany County ORI Test Kit and Data Collection Information

1) ORI Field Testing Kits – Check In/Out and Lab Test Procedures
2) ORI Kit Inventory List
3) ORI/Sample Collection Field Sheet
4) Optical Brightener Field Sheet
5) How to complete Section 1 and 1a of the ORI Field Sheet
6) SPDES Permit ID Numbers (some Albany County MS4s)
7) National Weather Service Climate Data Sample Sheet
8) ORI Water Sampling Field Tips
9) Memo on ORI Preparation, Personnel, Procedures and Paperwork
10) How to use the Optical Brighteners
11) How to calibrate the pH probe
12) ORI Training Notes from May 6, 2015 Session

B. Regulatory and Guidance Materials

13) New York State Department of Environmental Conservation – Outfall and System Mapping for Illicit Discharge Detection and Elimination in New York
14) Chapter 11 of Center for Watershed Protection Illicit Discharge Detection and Elimination Guidance Manual
15) Interpreting Water Analysis Test Results by Alken-Murray Corporation
16) Interpreting Water Chemistry Test Strips – North Central Texas IDDE Program
17) Eight Towns and the Bay Optical Brightener Handbook

SWMPv5 (2015 to 2018) BMP 3-5 Dry Weather Outfall Screening (ORI)
ORI Field Testing Kits-Check In/Out & Lab Test Procedures (Sort of MG1)

Background:

1. Kits owned by the Stormwater Coalition; managed by the Albany County Sewer District
2. 6 kits available for borrowing, located at North Plant, see check out/in procedures
3. Kit supplies match data gathering items included in ORI Field Sheet
4. Purchase of original kit materials funded with a NYSDEC Stormwater Implementation grant
5. Kit maintenance/lab tests funded with Coalition dues
   -Typically $1000 contract with ACSD; ~$700 materials
6. Location of Kits
   Albany County Sewer District
   North Wastewater Treatment Plant
   1 Canal Road South, Menands, NY 12204

7. ACSD Staff (ORI Kits and Lab Tests)
   a. Sally Rushford, Lab Technician, 447-1620, Sally.Rushford@albanycountyny.gov
      Others who work in lab: Mei Chen and Jaron Ferguson.

8. Coalition Staff
   a. Nancy Heinzen, Coalition Program Coordinator, 447-5645, Nancy.Heinzen@albanycountyny.gov

ORI Kit Check Out/Check In and Replenish Procedures:

1. To pick up/drop off ORI Kit, if you do not know Sally Rushford, first contact Nancy Heinzen. Nancy will explain to Sally who you are, from which MS4, and make introductions.

2. If you do know Sally and have done this before, arrange a drop off/pick up with Sally directly, or Craig if Sally is not available.

3. If you need to drop off the kit and Sally is not available, LEAVE A NOTE, explaining who dropped off the kit, on what date, from which municipality, note any missing items. Also contact Nancy Heinzen to let her know that a kit was dropped off.

4. If you need to pick up a kit, be sure to contact Sally directly. She will need to check it out to you.

5. If you borrow a kit and critical items missing, contact Nancy Heinzen and/or Sally Rushford.

6. If you need a lab sample, contact Sally Rushford. You'll need directions and may need collection bottles. ACSD will follow up with you regarding lab results; follow up on your own as needed.

7. Periodically Sally checks the kits for missing/broken items, items to purchase are discussed with Nancy, purchased by the Coalition and then repacked by Sally. Coordination of kit drop off/pick up is generally arranged at Working Group meetings, or as needed.

BOX CHECK LIST File Name: 2017_9-1_BoxCkList_BasicFullKit_1BlackLites_FINAL.xlsx

Community Using Box (Name):	**Item Present**	**Item Missing**	**Community Using Box & Other Equipment**	**Item Present**	**Item Missing**
Inventory By (ACSD? MS4?):	*Circle box #*	*Circle box #*		*Circle box #*	*Circle box #*
Box Inventory Check List	Box 1 2 3	Box 1 2 3	Box Inventory Check List	Box 4 5 6	Box 4 5 6
TOP TRAY			**TOP TRAY**		
Hach Dr/890					
GPS					
Multi-Parameter Tester					
Checker Portable pH meter					
HACH 890 sample adapter					
6 HACH Sample cells (round)					
2 HACH Sample cells (square)					
10 ml pipet			" " "		
1 ml pipet			" " "		
Pipet Bulb			" " "		
Pen			" " "		
Sharpie			" " "		
Tape Measure			" " "		
Hach pH test strips			" " "		
Thermometer			" " "		
Funnel			" " "		
Small screw driver			" " "		
Stop Watch			" " "		
Clip Board			" " "		
Scissors			" " "		
2 Ping Pong Balls			" " "		
Dr890 Laminated Instructions					
GPS Laminated Instructions			" " "		
Field Work Laminated Instructions			" " "		
LOWER BOX			**LOWER BOX**		
10 Ammonia Tubes					
Graduated Cylinder					
HACH Chemical Packet Box			" " "		
1 Phosphate test strip bottle (50ea)			" " "		
1 Nitrite/Nitrate test strip bottles (25ea)			" " "		
1 Hach Ammonia test strip bottles (25ea)			" " "		
1 HACH pH Test Strip bottle (50ea)			" " "		
Squirt Bottle			" " "		
1 Waste Bottle					
3 Small Plastic Tubes					
Disposable gloves			" " "		
Kim Wipes			" " "		
Lab Soap			" " "		
Nalgene sample bottles (6)			" " "		
Fishing line (1 rolls)			" " "		
Hammer			" " "		
10 Light intensity cages			" " "		
10 Light intensity yellow nets			" " "		
Rag			" " "		
Large Ziploc Bag for Garbage			" " "		
Distilled Water			" " "		
1 Gallon Pail			" " "		
Optical Pads			" " "		
10 Ziplock Bags			" " "		
pH Buffer 4			" " "		
pH Buffer 7			" " "		
pH Buffer 10			" " "		
7 Nails			" " "		
10 popsicle sticks			" " "		
10 Zip ties			" " "		
Wire clippers			" " "		
Pieces of cardboard			" " "		
OTHER EQUIPMENT			**OTHER EQUIPMENT**		
1 Black Light					
~~1 Turbidity Meter~~ (HACH 2100P Ordered 3/18/09 Grant Contract #C303129 #258,000)					
~~Waders~~					
~~Micrology Lab Eqpmt-Bacteria~~					

Inventory completed by (name): ____ Date ________________

OUTFALL RECONNAISSANCE INVENTORY/SAMPLE COLLECTION FIELD SHEET
Adapted for use by the Stormwater Coalition of Albany County (July 10, 2009)

Section 1: Background Data

Subwatershed:			Outfall ID:
Today's date:			Time:
Investigators:			Form completed by:
Temperature (°C)	Rainfall (in.): Last 24 hours:		Last 48 hours:
Latitude:	Longitude:		GPS Unit:
Camera:			Photo #s:

Land Use in Drainage Area (Check all that apply):

- ☐ Industrial
- ☐ Ultra-Urban Residential
- ☐ Suburban Residential
- ☐ Commercial
- ☐ Open Space
- ☐ Institutional
- Other: ______________________
- Known Industries: ______________________

Notes

Section 1a: Additional Background Data
(Recommended by NYSDEC and incorporated into the Albany Internet Mapping System)

AIMS Field Name	Write or Check Off	Explanation
MS4Permit	Permit No: NYR________	Enter the MS4 Permit number of the regulated MS4 for which this outfall information is being collected
Outfall_ID	Already recorded in Section 1	Outfall_ID (When creating AIMS each outfall made available to the system by participating MS4s was assigned a unique id number. The first two digits are coded for each municipality, and the remaining four digits describe all of the outfalls within that MS4. New outfalls can be added, but to benefit from the AIMS system, they need to conform to the AIMS labeling protocol.
XY_Source		Method of data collection used to locate utfall (Enter GPS unit, hard copy of map, CAD derived)
HUC_No		Hydrologic Unit Code number, use most recent HUC available (Enter 11 digits)
Water_Name		Waters of NY name; Stream name, From NHD Dataset, if not available reference local names or note as, unnamed stream
Water_ID		Waters of NY ID; NHD rch-code (Enter best guess of stream segment(s) receiving stormwater discharge at outfall location.) This info is from the Waterbody Inventory/Priority Waterbodies List. Also known as Waterbody Index Number or WIN
Rec_MS4	o None	Rec_MS4 (Receiving MS4) None=Outfall discharges within the MS4
	o Permit No: NYR________	Outfall Discharges to another regulated MS4 (Enter Permit No of receiving MS4)
	o SWIS code no: ________	Outfall discharges to a non-regulated MS4 (Enter SWIS code of non-regulated MS4-5 digits)
OF_Type		OF_Type =Outfall Type (Enter Open Drainage, Closed Pipe, Culvert, Catch Basin, Manhole, Swale)
MOE	o Direct	MOE (Mode of Entry) Check off one. Direct=Discharge to identified NY water
	o MS4	MS4=Discharge to another regulaterd MS4
	o Indirect	Indirect=Discharge via overland flow, intermittent/unidentified stream (no WIN), no obvious hydraulic connection such as wetlands
Confidence	o Verified	Confidence-Describes degree of confidence in outfall location info. Verified=Verified with field observation
	o Calculated	Calculated= Educated guess or desk calculated
	o Historical data	Historical data=Existing records or previous knowledge
	o None	None=No records of outfall
Photo		Record the location of photo file (if possible) and photo number(s). Attached print of photo to data sheets
Owner		Owner of MS4 (Enter owner name listed on MS4 Permit)
Owner_ID		Each Stormwater Coalition member has been assigned a unique number (Enter 1st two digits of outfall id)

Outfall ID: ________________ **Date:** ______________

Section 2: Outfall Description

LOCATION	MATERIAL		SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ Closed Pipe	☐ RCP ☐ PVC ☐ Steel ☐ Other: ________	☐ CMP ☐ HDPE	☐ Circular ☐ Eliptical ☐ Box ☐ Other: _____	☐ Single ☐ Double ☐ Triple ☐ Other: _____	Diameter/Dimensions: ____________________	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ Open drainage	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: _____		☐ Trapezoid ☐ Parabolic ☐ Other: _____		Depth: _____ Top Width: _____ Bottom Width: _____	
☐ In-Stream	(applicable when collecting samples)					
Flow Present?	☐ Yes	☐ No	*If No, Skip to Section 5*			
Flow Description (If present)	☐ Trickle	☐ Moderate	☐ Substantial			

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		RESULT	UNIT	EQUIPMENT
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐Flow #2	Flow depth		In	Tape measure
	Flow width	____' ____"	Ft, In	Tape measure
	Measured length	____' ____"	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer

Section 3a: Additional Quantitative Characterization
BOXES 1, 2, and 3: Contain DR890 Calorimeter and Multi-Parameter Tester

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		RESULT	UNIT	EQUIPMENT
pH	1 to 14		pH Units	Probe
pH	7.5 to 14.0		pH Units	Test strip (Dispenser)
pH	4, 5, 6, 7, 8, 9		pH Units	Test strip (pH bottle)
Total Ammonia	0, 0.25, 0.5, 1.0, 3.0, 6.0		ppm (NH3-N)	Test strip (Ammonia bottle)
Nitrate	0, 1, 2, 5, 10, 20, 50		ppm Nitrate Nitrogen	Test strip (Nitrate bottle)
Nitrite	0, 0.15, 0.3, 1.0, 1.5, 3.0		ppm Nitrite Nitrogen	Test strip (Nitrate bottle)
Phosphate	0, 5, 15, 30, 50		ppm PO_4^-	Test strip (Phosphate bottle)
Nitrogen, Ammonia	0 to .50 mg/L NH3-N		mg/L NH3-N	DR 890 (Method 8155)
Nitrogen, Ammonia	0 to 2.50 mg/L NH3-N		mg/L NH3-N	DR 890 (Method 10023)
Nitrate, Low Range	0 to .50 mg/L NO_3^--N		mg/L NO_3^--N	DR 890 (Method 8192)
Nitrate, Mid Range	0 to 5.0 mg/L NO_3^--N		mg/L NO_3^--N	DR 890 (Method 8171)
Phosphorus, Reactive	0 to 2.50 mg/L PO_4^{3-}		mg/L PO_4^{3-}	DR 890 (Method 8048)
Conductivity			µS/cm	Multi-Parameter Tester
Salinity			ppt	Multi-Parameter Tester
Total Dissolved Solids (TDS)			mg/L	Multi-Parameter Tester
Turbidity			NTU	2100P Portable Turbidity Meter

Outfall ID: ______________ Date: ______________

Outfall Reconnaissance Inventory Field Sheet

Section 4: Physical Indicators for Flowing Outfalls Only
Are Any Physical Indicators Present in the flow? ☐ Yes ☐ No *(If No, Skip to Section 5)*

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX (1-3)		
Odor	☐	☐ Sewage ☐ Rancid/sour ☐ Petroleum/gas ☐ Sulfide ☐ Other:	☐ 1 – Faint	☐ 2 – Easily detected	☐ 3 – Noticeable from a distance
Color	☐	☐ Clear ☐ Brown ☐ Gray ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐Other:	☐ 1 – Faint colors in sample bottle	☐ 2 – Clearly visible in sample bottle	☐ 3 – Clearly visible in outfall flow
Turbidity	☐	See severity	☐ 1 – Slight cloudiness	☐ 2 – Cloudy	☐ 3 – Opaque
Floatables -Does Not Include Trash!!	☐	☐ Sewage (Toilet Paper, etc.) ☐ Suds ☐ Petroleum (oil sheen) ☐ Other:	☐ 1 – Few/slight; origin not obvious	☐ 2 – Some; indications of origin (e.g., possible suds or oil sheen)	☐ 3 - Some; origin clear (e.g., obvious oil sheen, suds, or floating sanitary materials)

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls
Are physical indicators that are not related to flow present? ☐ Yes ☐ No *(If No, Skip to Section 6)*

INDICATOR	CHECK if Present	DESCRIPTION	COMMENTS
Outfall Damage	☐	☐ Spalling, Cracking or Chipping ☐ Peeling Paint ☐ Corrosion	
Deposits/Stains	☐	☐ Oily ☐ Flow Line ☐ Paint ☐ Other:	
Abnormal Vegetation	☐	☐ Excessive ☐ Inhibited	
Poor pool quality	☐	☐ Odors ☐ Colors ☐ Floatables ☐ Oil Sheen ☐ Suds ☐ Excessive Algae ☐ Other:	
Pipe benthic growth	☐	☐ Brown ☐ Orange ☐ Green ☐ Other:	

Section 6: Overall Outfall Characterization

☐ Unlikely ☐ Potential (presence of two or more indicators) ☐ Suspect (one or more indicators with a severity of 3) ☐ Obvious

Section 7: Data Collection

1. Sample for the lab?	☐ Yes	☐ No		
2. If yes, collected from:	☐ Flow	☐ Pool		
3. Intermittent flow trap set?	☐ Yes	☐ No	If Yes, type: ☐ OBM	☐ Caulk dam

Section 8: Any Non-Illicit Discharge Concerns (e.g., trash or needed infrastructure repairs)?

Outfall ID: ______________ **Date of Photo(s):** ______________________________

Attach photo #1

Attach photo #2

Optical Brightener
Field Sheet
(From Eight Towns and The Bay Water Quality Sampling An Optical Brightener Handbook)

Sub Watershed (Drainage Area and/or Stream Name):		**Collected By:**
Sewershed Name (If available):		**Page ___ of ___**
Remarks:		

Location	Date Placed	Date Pulled	No days	Flow Volume (liters/sec)	O.B. +/-	Total Rain

How to complete Section 1 and 1a of the ORI Field Sheet:

1. Sign into AIMS

2. Use the magnifying glass to Zoom into the area with your municipality.

3. On the left-hand side, Under Map Contents, Layers, turn on the following layers:

    a. Stormwater Management – make sure "Other Stormwater Systems" is on under Stormwater Management.
    b. Watersheds – Then click "Watersheds (HUC12)" on under Watersheds. Also, click "Local Watersheds (StreamStats)" on under Watersheds.
    c. Natural Features – Open Natural Features (click it on) and then open Hydrography (click it on). Make sure "Priority Waters" is checked on.
    d. 2007 Aerial Photography

HINT: If there is a "+" next to one of the layers, that means that there are more layers (that you cannot see yet) which can be turned on. Click on the "+" to reveal them.

HINT: If there is a box next to a layer that does not have a check-mark in it, that means that the layer is not turned on. If the layer is not turned on, then you cannot get the information for that layer later when you use the "Identify" tool. Also, the layer has to be turned on and so do each of the larger groupings before it in order for it to turn on completely. For example, even though you have clicked on "Watersheds (HUC 12)," You must also have the larger heading called "Watersheds" clicked on.

4. Zoom into the street or outfall you are looking for.

HINT: Some layers (i.e. the orthoimagery and the topography layers) are scale sensitive. This means you may have to zoom in pretty close before some layers can be clicked on and appear on the map. These particular layers will remain gray in the Map Contents panel until you are zoomed in enough on the map to then click them on.

<u>Completing Section 1:</u>

1. **Outfall ID** – The outfall number according to AIMS. Some MS4s have their own system, but please include the AIMS number here.

2. **Date** – The day you completed the ORI for the particular outfall.

3. **Time** – The time you completed the ORI for the particular outfall.

4. **Investigators** – The names of the people who went to do the ORI. Initials are fine.

5. **Form completed by** – The name of the person filling out the field sheet. Initials are fine.

6. **Temperature** – The daily temperature can be gotten from the NOAA website after the inventories have been completed for the day. If you can get the temperature throughout the day, that works too. The sheet asks for the temperature in Celcius so you will need to convert it from Fahrenheit. You can look up a converter easily using Google.

7. **Rainfall** – This can be collected from the NOAA website after the inventories have been completed for the day. Be sure that it had been relatively dry for two days prior to ORI work before going into the field for the day. Actual stormwater in the outfalls will make detecting an illicit discharge difficult.

8. **Latitude and Longitude**

    a. On the tool bar on the top right of the map, click the "i" in the gray circle, "Map Identify". You should have a little hand now for a cursor.

    b. Click on the blue point identifying the outfall in question.

    c. You will know if you have clicked on the point successfully when the AIMS # of the outfall appears along with the name of your municipality next to it in parentheses. Then, click the down arrow near the "x" to get the information on the outfall.

        i. **Latitude and Longitude** – This can be found by scrolling down in the box which just opened and going to "GISLatitude" and "GIS Longitude". Enter these values onto your field sheet.

9. **GPS Unit** – The tool used to get the coordinates (i.e. AIMS or Garmin or Trimble)

10. **Camera** – The name (brand) of camera that was used to take pictures that day. This is important especially if more than one camera is used within a municipality.

11. **Photo #s** – On your camera, review the picture you just took of the outfall in question by pushing either a button which says review or a button which looks like a "play" button on a VCR. All of the photos are numbered sequentially. Try to take a few pictures at each outfall including pictures of damage, litter, questionable discharge, and the surrounding area (these pictures will prove useful for anyone who will be completing the ORI in the future).

12. **Land Use in Drainage Area** – This is self-explanatory. Everywhere upstream/up the stormwater drainage system from this outfall needs to be considered. Therefore, if an area is mostly houses and a park, check off "Suburban Residential" and "Open Space."

13. **Notes** – Include any information here regarding location of or damage to the outfall. Any and all information could prove useful. Also, this is a good method of creating a maintenance list.

14. **Subwatershed**

    a. A second dark down arrow will show up next to your outfall number and the name of municipality. Click on this down arrow and a list of the layers that are turned on and present at the point you clicked on the map (here, that point is your outfall) will appear. Each one of these pieces in the list can now be clicked to get additional information. When you are done getting information from one, simply click on that same dark down arrow to select another layer to get information from.

        i. **Subwatershed** – click on the dark down arrow. There will be a layer in bold followed by the same name in parentheses with the word watershed (i.e. "**Shaker Creek** (Shaker Creek Watershed)"). This is the subwatershed. Enter it on your field sheet.

<u>Completing Section 1a:</u>

1. **MS4Permit** – This number is available in the black notebook which was created by the Stormwater Coalition in a table along with all the other permit numbers for all MS4s in the Coalition. It is also on your individual permit.

2. **XY Source** – AIMS or the GPS that you used (i.e. Garmin, Trimble).

3. **HUC No.** – A second dark down arrow will show up next to your outfall number and the name of municipality. Click on this down arrow and a list of the layers that are turned on and present at the point you clicked on the map (here, that point is your outfall) will appear. Each one of these pieces in the list can now be clicked to get additional information. When you are done getting information from one, simply click on that same dark down arrow to select another layer to get information from.

    a. Click on the dark down arrow and select the layer which has Watersheds (HUC 12) in parentheses after it. The third item in the list is "HU_12". This is the HUC No. Enter it on your field sheet.

4. **Water Name** – Click on the small blue stream line near the outfall. Make sure this is the stream that the outfall is flowing to by turning on the topography (this is not always necessary). Click on the dark down arrow next to the outfall ID number. A layer will appear in the list with "Streams (WIPWL)" in parentheses next to it. Click on that layer. A new list will show up with a line called "Name." Enter this in the "Water Name" section of the field sheet.

5. **Water ID** – If you keep the list where you found water name open, you will also find the Water ID. It is called "PWL_ID." Enter this 8 digit number into your field sheet.

HINT: If the “Streams (WIPWL)” layer does not appear in the list when you click on the dark down arrow, try clicking on the stream again. You might have missed it slightly. Try zooming in also.

6. **Rec MS4** – This stands for Receiving MS4. Read the options and their definitions thoroughly and choose ONE. (i.e. Choose “None” if the outfall discharges into a section of the stream which runs through your MS4 designated area).
7. **OF Type** – This stands for Outfall Type. Read the options and their definitions thoroughly and choose ONE. (i.e. Choose “Closed Pipe” if there is a pipe discharging into the stream).
8. **MOE** – This stands for mode of entry. Read the options and their definitions thoroughly and choose ONE. (i.e. Choose “Indirect” if the outfall discharges into a man-made detention pond with no obvious hydraulic connection to a stream).
9. **Confidence** – This is the way in which you determined there was an outfall present at the given location. Read the options and their definitions thoroughly and choose ONE. (i.e. Choose “Verified” if you went into the field and located the outfall).
10. **Photo** – Write in the name of the person who has the pictures. Likely, the Stormwater Coalition representative.
11. **Owner** – Write in the name of your MS4.
12. **Owner ID** – This is the number which preceeds your outfall ID number on AIMS. It is the first two digits of the ID. It is also the number associated with your AIMS username.

SPDES Permit ID Numbers (Coalition members):

Each of the regulated MS4s within the Stormwater Coalition has its own SPDES Permit. The following is a list of the regulated entities along with their SPDES Permit ID numbers:

Municipality	SPDES Permit ID Number
Albany County	NYR20A359
City of Albany	NYR20A464
Town of Bethlehem	NYR20A208
City of Cohoes	NYR20A243
Town of Colonie	NYR20A190
Village of Colonie	NYR20A076
Village of Green Island	NYR20A377
Town of Guilderland	NYR20A211
Village of Menands	NYR20A144
Town of New Scotland	NYR20A463
~~Village of Voorheesville~~	~~NYR20A210~~
City of Watervliet	NYR20A087
University at Albany-SUNY	NYR20A234

SAMPLE SHEET

Explanation of the Preliminary Monthly Climate Data (F6) Product

These data are preliminary and have not undergone final quality control by the National Climatic Data Center (NCDC). Therefore, these data are subject to revision. Final and certified climate data can be accessed at the NCDC - http://www.ncdc.noaa.gov.

Example: If you did ORI on July 7th, it was dry because it did not rain 24 hours (the 6th) or 48 hours (the 5th) before.

WFO Monthly/Daily Climate Data

```
000
CXUS55 KALY 160800
CF6ALB
PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6)

                                  STATION:   ALBANY NY
                                  MONTH:     JULY
                                  YEAR:      2010
                                  LATITUDE:   42 45 N
                                  LONGITUDE:  73 48 W
```

See back of sheet for directions to get this information

Temperature Needs to be converted to °C (Google converter)

Precipitation (Rain, snow, etc)

Day of the month

Check for precip.

Day of ORI

TEMPERATURE IN F:							:PCPN:	SNOW:		WIND			:SUNSHINE:		SKY		:PK WND	
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17	18
									12Z	AVG	MX	2MIN						
DY	MAX	MIN	AVG	DEP	HDD	CDD	WTR	SNW	DPTH	SPD	SPD	DIR	MIN	PSBL	S-S	WX	SPD	DR
1	70	49	60	-10	5	0	T	0.0	0	8.6	20	290	M	M	6		25	290
2	80	48	64	-6	1	0	0.00	0.0	0	4.9	14	330	M	M	4		18	320
3	87	53	70	0	0	5	0.00	0.0	0	3.4	13	260	M	M	4		16	230
4	89	61	75	5	0	10	0.00	0.0	0	5.6	21	280	M	M	5		26	300
5	94	60	77	7	0	12	0.00	0.0	0	4.3	17	290	M	M	2	18	22	300
6	96	76	86	16	0	21	0.00	0.0	0	6.5	15	300	M	M	3	8	21	270
$\boxed{7}$	95	71	83	12	0	18	0.00	0.0	0	2.3	8	30	M	M	1	18	16	60
8	93	73	83	12	0	18	0.00	0.0	0	6.2	18	170	M	M	3	18	24	160
9	91	73	82	11	0	17	T	0.0	0	11.8	21	180	M	M	6		29	180
10	82	70	76	5	0	11	0.30	0.0	0	3.3	13	200	M	M	8	1	16	200
11	88	70	79	8	0	14	0.00	0.0	0	3.3	20	340	M	M	7		25	340
12	91	66	79	8	0	14	0.00	0.0	0	6.9	18	170	M	M	7		25	170
13	86	70	78	7	0	13	0.54	0.0	0	7.0	18	190	M	M	8	1	24	190
14	83	71	77	6	0	12	0.02	0.0	0	4.4	12	10	M	M	8	1	14	10
15	89	67	78	7	0	13	0.00	0.0	0	3.4	12	170	M	M	6	18	16	170
SM	1314	978			6	178	0.86		0.0	81.9			M		78			
AV	87.6	65.2								5.5	FASTST		M	M	5		MAX (MPH)	
								MISC ---->			# 21	280					# 29	180

```
NOTES:
# LAST OF SEVERAL OCCURRENCES

COLUMN 17 PEAK WIND IN M.P.H.

PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6) , PAGE 2

                                  STATION:   ALBANY NY
                                  MONTH:     JULY
```

YEAR: 2010
LATITUDE: 42 45 N
LONGITUDE: 73 48 W

```
[TEMPERATURE DATA]          [PRECIPITATION DATA]          SYMBOLS USED IN COLUMN 16

AVERAGE MONTHLY: 76.4       TOTAL FOR MONTH:   0.86       1 = FOG OR MIST
DPTR FM NORMAL:   5.8       DPTR FM NORMAL:   -0.86       2 = FOG REDUCING VISIBILITY
HIGHEST:     96 ON  6       GRTST 24HR  0.56 ON 13-14         TO 1/4 MILE OR LESS
LOWEST:      48 ON  2                                     3 = THUNDER
                            SNOW, ICE PELLETS, HAIL       4 = ICE PELLETS
                            TOTAL MONTH:    0.0 INCH      5 = HAIL
                            GRTST 24HR      0.0           6 = FREEZING RAIN OR DRIZZLE
                            GRTST DEPTH:    0             7 = DUSTSTORM OR SANDSTORM:
                                                              VSBY 1/2 MILE OR LESS
                                                          8 = SMOKE OR HAZE
[NO. OF DAYS WITH]          [WEATHER - DAYS WITH]         9 = BLOWING SNOW
                                                          X = TORNADO
MAX 32 OR BELOW:    0       0.01 INCH OR MORE:    3
MAX 90 OR ABOVE:    6       0.10 INCH OR MORE:    2
MIN 32 OR BELOW:    0       0.50 INCH OR MORE:    1
MIN  0 OR BELOW:    0       1.00 INCH OR MORE:    0

[HDD (BASE 65) ]
TOTAL THIS MO.      6       CLEAR  (SCALE 0-3)    4
DPTR FM NORMAL     -4       PTCLDY (SCALE 4-7)    8
TOTAL FM JUL 1      6       CLOUDY (SCALE 8-10)   3
DPTR FM NORMAL     -4

[CDD (BASE 65) ]
TOTAL THIS MO.    178
DPTR FM NORMAL     84       [PRESSURE DATA]
TOTAL FM JAN 1    382       HIGHEST SLP M ON M
DPTR FM NORMAL    155       LOWEST  SLP 29.78 ON  9
```

[REMARKS]

SNOWFALL AND SNOW DEPTH MEASUREMENTS ARE TAKEN AT THE NATIONAL WEATHER SERVICE OFFICE LOCATED AT THE CESTM BUILDING ON THE UNIVERSITY AT ALBANY CAMPUS IN ALBANY NY.

SNOW DEPTH IS MEASURED AT 700 AM.

How to get this information:
1) Go to www.weather.gov/climate/index.php?wfo=aly
2) Under "observed weather" tab, click the following
1 - Product = Preliminary Monthly Climate Data
2 - Location = Your city (i.e. Albany)
3 - Archived Data for the Timeframe
4 - View

ORI Water Sampling Field Tips

1. SAFETY FIRST:
    a. Although the water sometimes seems clean and clear, there can be bacteria in/around flowing outfalls.
    b. Whenever doing water tests, gloves should be worn at all times to protect yourself from potential hazards and disease.

2. Using the plastic bottle to take water samples:
    a. Once a plastic bottle is used for sampling, it CANNOT be reused in the field again. It has to be cleaned out using phosphate free soap. It cannot simply be washed out using distilled water, so plan accordingly. If you are doing a lot of outfalls one day, you may need to pick up extra sampling bottles.
    b. The smaller glass and very small plastic vials that are in the kits can be rinsed out using distilled water. This waste water should also go in the waste disposal container.

3. Water tests in the field vs. water tests in the sewer district:
    a. There is no problem doing the water chemistry tests in the field. The strips do not take a long time (they are less accurate) and the chemical testing is not very difficult as long as you follow the directions (although it can be time consuming).
    b. If you find that you are going to be doing a lot of water tests, it might be a good idea to bring a cooler with an ice pack in it into the field. In this way, you can fill up sample bottles (be sure to label them properly and cross-reference the sample bottle on the ORI field sheet), keep them cool, and bring them back to the Sewer District to do full tests simultaneously. So, instead of 4 chemical tests for one outfall taking 1 hour in the field, it may only take 20 minutes in the laboratory.
    c. **NOTE: pH testing MUST be done in the field**.

4. What to do with unused water samples:
    a. Water samples are taken from locations with flowing/stagnant water. This water is then divided into smaller vials so testing can be done on it (this is the same for the full and basic kits and also for test strips and chemical testing). The water that was taken from the outfall, even if it was not used for testing directly, CANNOT be returned to the stream/outfall location. All water that is taken for sampling has to be put in the waste disposal container.

5. What to do with used test strip/samples that were tested using chemicals:
    a. After a test strip has been used, it should be placed in the disposal container along with all the water that was not used.
    b. All waste water from chemical testing should also be poured into the waste disposal container.

6. What to do with used gloves/OB pads:
    a. Used gloves and OB pads can be placed into a plastic bag and returned to the Sewer district for proper disposal.

Write a memo-style message regarding what it actually takes to complete ORI. Preparation. Personnel. Procedure. Post-ORI Paper work. Time frame. Mind set. What helps and what doesn't?

Preparation:
Before going out and doing the inventory, it is important that everything is in order. This includes the following:

1. What will the focus of the inventory be?
    a. Although it might seem a bit like over-kill to really focus on one area to complete at a time, it is actually very helpful. Trying to take on the entire ORI project and can be overwhelming. Instead, choosing one watershed at a time can organize ORI efforts better and also make the upcoming tasks seem less daunting. Watersheds can span multiple municipalities, so a joint effort and understanding between municipalities regarding a time frame of when ORI in a particular watershed will be completed my also be helpful. In this way, an entire watershed can be inventoried in a relatively short amount of time. This will also allow time for the municipality to get permission to go onto private property (as needed) prior to going into the field.
2. Paperwork
    a. A majority of the time, the ORI field sheets are not filed out until after the inventory has been completed. The field sheets do not *have* to be filed out prior to the inventory; however, it is really useful to have some of the information. For example, there is information on the sheet regarding the GPS coordinate location of the outfalls. This information proves to be extremely useful in the field especially if the people in the field are not familiar with the infrastructure. Other information regarding the watershed and stream can also be filled in (Sections 1 and 1a). Also, by filing out one form with the appropriate information regarding the weather, date, etc, you will not have to fill that information in by hand on every sheet. Be sure to make extra field sheets to bring along in case you find new outfalls which have not been mapped/inventoried.
    b. Using AIMS to make maps (or another mapped version of the outfalls) to organize the inventory is helpful. Some watersheds are very large and will need to be completed over multiple days while some are very small. Maps will help the team doing the inventory choose a route to take to find the outfalls so they are not bouncing from one end of the municipality to the other or overlooking any outfalls.
3. Check the weather
    a. In order to complete an ORI accurately, there needs to be dry weather for at least the last 48 hours. Some believe that it is not considered a rain event until at least 0.25 inches of rain has fallen. However, even that small amount of rain could lead to flowing outfalls. In this way, an outfall that may not have any illicit discharge may be running even though it did not rain a lot. This will slow down the inventory and only create more paperwork later. Although it is up to the surveyors discretion on whether or not to conduct water tests, I usually at least use the test strips when an outfall is flowing.
4. Personnel

a. A team of 2 people conducting the inventory is necessary. One person can record information while the other does test. One person can drive while the other figures out where to go next. This is not to say that one person alone cannot conduct the inventory (that is entirely possible).
b. Who is going out into the field and conducting is probably one of the more important things to consider. At times, it comes down to who may/may not be available. With that said, the best people to go into the field with are those who know the infrastructure (i.e. people in the stormwater department of a particular municipality or someone who works in DPW). While it is possible to go out with interns and other representatives from a municipality, questions/concerns come up all the time in the field. Someone with more local knowledge may be more capable of answering these questions.

Conducting the ORI Inventory:

1. Equipment
   a. ORI Kit – Obviously, you will need to bring the ORI kit into the field with you in order to complete the inventory. I have also found it helpful to bring a book-bag. I usually put everything into the book-bag short of things needed for full testing (I always do full testing back at the vehicle). A book-bag also comes in handy when you are hiking or doing multiple inventories before returning to the vehicle (the kit is heavy and sometimes awkward).
   b. ORI Binder – This might not seem like a priority, but it has several note pages in it regarding how to complete different parts of the inventory. They come in very handy as ways to clarify any questions which may/will come up while doing the inventory.
2. Paperwork
3. Personnel

How to use the Optical Brighteners (OB):
Information complied from the "Eight Towns and the Bay" Optical Brightener Handbook and should be referred to for more detailed explanations/information.

1. What do OBs test for?
    a. They test for fluorescent white dyes that are present most laundry detergents and soaps.
2. When should the Optical Brighteners be used?
    a. If there is foam or excessive bubbles in the water.
    b. If there is unusual growth of algae or other plants indicating nutrient loading.
    c. If you have completed other tests and decided that you still want to put in an optical brightener.
3. Keeping track of data using the Optical Brightener Sheet
    a. All pertinent information should be written on the OB sheet
    b. Placement, Retrieval, and Results are all included on the sheet
    c. Amount of rainfall, flow data, and the number of days the sample was in place is needed information.
4. Proper Handling
    a. Always wear gloves when placing optical brighteners because your hands or clothes might have soaps/detergents on them. So, if the OB comes into contact with either, there might be some cross contamination.
    b. Always wear gloves when retrieving optical brighteners because the water that the OB pad was exposed to might also contain other waste water.
    c. All sampling devices (cages and nets) should be rinsed thoroughly before being re-used to prevent cross contamination.
    d. OB pads should be checked under a long wave Ultra Violet (UV) fluorescent light before use to make sure they do not contain OBs.
5. Placement
    a. Wearing gloves, take the net or the cage and insert the OB pad. Add stones to the net to weigh it down.
        i. Use the black cages in an open pipe or stream.
        ii. Use the nets in catch basins.
    b. Close the open end by threading the fishing line or using a rubber band.
    c. Tie the other end of the fishing line to a nail/popsicle stick and put it in the ground/wedge it into the side of a grate cover.
6. Retrieval
    a. Wearing gloves, remove the pad from the cage/net.
    b. Rinse the pad off in the sampling waters as much as possible to remove excess sediment.
    c. Squeeze the pad to remove water. Do not tear/rip the pad.
    d. Label/tag the pads for cross referencing (included location, day of placement, and day of removal). Staple the label to the pad. Make sure that the labels you are using do not have optical brighteners by checking under a UV light.
    e. Put the sampling pads in separate plastic bags and place them in a dark area hanging over a fishing line (if possible; this line should be wiped down or replaced after each use).

    f. Let the pads dry out (at least overnight) in a place out of direct sunlight.

7. Analysis
    a. Place dried out pads on a table in a dark room and view under UV light.
        i. HINT: The darker the room the easier it is to see the results.
    b. Use an unused OB pad to compare the sampling pads to as they are exposed to UV light.
    c. There are 3 possible results:
        i. Positive – it will glow
            1. Sometimes only part of the OB pad will fluoresce, but that could be how it was sitting in the water. It is still positive.
        ii. Negative – it will look like the unused OB pad
        iii. Retest – undertermined
            1. When in doubt, retest.
    d. It is common to see some specks or spots on the unused and sample pads. These should be ignored and not used to indicate a positive result.
    e. Place the OB pads in respective result piles (positive, negative, retest) as they are read.
    f. After all the pads have been read, turn the lights back on and record the results.
8. The Next Step
    a. If necessary, a larger sampling of brighteners can now be done in areas with positive results.
    b. OBs can help detect faulty septic systems, sewage exfiltration, storm-drain cross connections, and human/animal waste differentiation.
    c. See the “Eight Towns and the Bay” packet Appendix C for more results and different courses of action.

How to calibrate & use the pH HI 1207 Probe:

1. Turn the switch to "ON" and remove the plastic cap (which contains distilled water) from the tip of the probe.
2. Submerge the probe in the #4 buffer – stir it around a bit so it really gets in there.
3. Allow time for the numbers on the probe to stabilize then take the small screwdriver and twist the screw on the top of the probe with the #4 next to it until the value of the probe reaches 4. Do this very slowly.
4. After the probe is set to 4, remove it from the buffer and dry it off using the rag or rinse it using the distilled water (the waste from this should go into the waste disposal container.
5. Next, place the probe in the #7 and the #10 buffers following the same procedure as was done when calibrating the probe to 4.
6. Be sure not to cross contaminate the buffer solutions (i.e. do not submerge the probe in one buffer and then move it directly to the next buffer without rinsing).
7. Give the end of the probe one last rinse and the put the cap (filled with distilled water) back on and turn the probe off.
8. The probe is now ready to be used for the day. The probe should be recalibrated frequently to restore its accuracy.
9. The probe itself can be submerged directly into the water you are testing but should be rinsed thoroughly after.

Outfall Reconnaissance Inventory (ORI) Training

Stormwater Coalition of Albany County

May 6, 2015

I. Outfalls
   a. What are outfalls?
      i. Intermunicipal
         1. Connection from one MS4 to another
      ii. End of drainage
         1. Where the stormwater system infrastructure discharges to a surface water of the United States
      iii. Review the NYS DEC guide for examples of outfalls (in ORI Binder)
   b. Rationale for ORI
      i. Canvasing the MS4 for illicit discharges, be thorough, but also efficient

II. ORI Binder
   a. Basic background information
      i. NYS DEC
      ii. CWP for IDDE
   b. Tip/How to sheets
      i. Water sampling tips
      ii. pH probe
      iii. Optical brightener
      iv. GPS unit
      v. Weather data

III. ORI Kit
   a. Guides
      i. When trying to complete the ORI field sheet, you can always use the guides/dummy sheets for help
   b. Equipment
      i. Physical qualities
         1. GPS unit
         2. Tape measure
      ii. Water chemistry
         1. DR890 Calorimeter, pH probe, test strips, thermometer, etc
      iii. Extended testing
         1. Brightener

IV. ORI Field sheet (see field sheet)
   a. Importance of ORI field sheet (see attached EPA Audit Response document)
   b. Section 1: Background Data
      i. Weather info (see NOAA data)
      ii. Location of outfall (see map of the Patroon Creek, the Village of Colonie and of the outfall from AIMS; see pictures of outfall)
         1. Description of drainage area
      iii. Some of this information can be filled out before going into the field; this will facilitate the inventory process
            a. Outfall ID
            b. Maps created using AIMS

c. Section 1a (see screenshot for outfall data and of waterbody data from AIMS; Waterbody Inventory data sheet)
    i. Information that is important for determining outfalls according to the NYS DEC
    ii. Some of this information can be filled out before going into the field; this will facilitate the inventory process
d. Section 2: Outfall Description
    i. Closed vs. Open
    ii. Material types
    iii. Discharge present?
e. Section 3: Quantitative Characterization
    i. Flow volume and temperature
f. Section 3a: Additional Quantitative Characterization
    i. Chemical testing
        1. DR890 Calorimeter
        2. Test strips
        3. pH probe
g. Section 4: Physical Indicators for Flowing Outfalls Only
    i. Assessment of the flow to determine if there is an illicit discharge
h. Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls
    i. Used to indicate if there was something flowing from the outfall that was illicit but is not currently coming out of the outfall (i.e. paint dumped down catch basin)
i. Section 6: Overall Outfall Characterization
    i. Summary of assessment
        1. Is/was there an illicit discharge?
j. Section 7: Data Collection
    i. A way to record if any samples were taken or a test was left and needs to be collected at a future time (i.e. brightener test)
k. Section 8: Any Non-Illicit Discharge Concerns
    i. If there is something that need to be repaired, large debris, etc, it can be noted here
l. Space for photos

V. Logistics
a. Completing ORI by watershed/drainage area facilitates paperwork and creates an achievable amount of area to cover
b. Two people to complete ORI
    i. Paperwork and testing can be completed more efficiently
    ii. Helpful to bounce ideas off someone else
c. Mobility
    i. Back packs are good for long walks/hikes to outfalls
d. Photo management
    i. Naming photos by Outfall ID# for easy organization

Outfall and System Mapping
For Illicit Discharge Detection and Elimination (IDDE) in NY

Introduction:
The Municipal Separate Storm Sewer System (MS4) permit (GP-02-02) requires permittees to develop a map of the MS4 that shows, at a minimum, the location of all outfalls and the names and locations of all waters of the United States and other MS4s that receive discharges from those outfalls. It also requires that the regulated MS4, to the extent allowable, effectively prohibit illicit discharges into their systems. This assistance document defines some of the technical details regarding the mapping and data management for this control measure.

The New York State Department of Environmental Conservation (NYS DEC) recommends the EPA's *Illicit Discharge Detection and Elimination, A Guidance Manual for Program Development and Technical Assessment* as the primary resource for implementation of a municipal Phase II Illicit Discharge Detection and Elimination (IDDE) program. Another useful document is the New England Interstate Water Pollution Control Commissions (NEIWPCC) *Illicit Discharge Detection and Elimination Manual.* These assistance documents provide excellent resources for the implementation of an IDDE program.

The purpose of this document is to provide assistance on some of the details of IDDE implementation to complement the NEIWPCC and EPA manuals. It provides a set of specifications for mapping, collecting and reporting data. This document defines an acceptable level of detail, establishes consistency among the neighboring MS4s, and facilitates the final delivery of the program.

NYSDEC encourages all regulated MS4 communities to use Global Positioning System (GPS) and Geographic Information System (GIS) technology for data collection, analysis and storage. Use of GIS makes the process more efficient and accurate, and facilitates data sharing between cooperating municipalities. GIS provides a tool to not only track and manage the IDDE program, but also to effectively utilize the system for integrating with other components of the MS4 program.

Regulated MS4 communities are encouraged to work together on mapping their stormwater outfalls and conveyance system and detecting and eliminating illicit discharges. This is especially important for smaller MS4's, where only a small part is in an urbanized area. Using GPS and GIS is the recommended approach to outfall and system mapping. MS4's who may not have the capacity or expertise in these areas of technology are encouraged to work with their county planning department and/or regional planning board. The county and regional entities will most likely have the resources to assist with GPS and GIS capabilities.

It is strongly recommended that MS4s join coalitions of local governments that have been formed to address the Phase II regulations. The need for collaboration is particularly beneficial for the detection and elimination of illicit discharges that originate and discharge from different municipalities. Examples of such circumstances are discharges to or from school districts, state roads, or federally owned properties.

The NYS DEC's mapping requirements generally follow the standards set by the New York State Geographic Information Systems (GIS) Clearinghouse. The Clearinghouse[1] is operated by the New York State Office of Cyber Security & Critical Infrastructure Coordination. The Clearinghouse is established to disseminate information about New York's Statewide GIS Coordination Program and to provide access to the New York State GIS Metadata and Data Repository.

This document provides assistance on outfall mapping, system mapping and documentation of the collected information. A series of elements that are prerequisite (*minimum*) to achieve compliance and a series of optional elements (*preferred*) that municipalities are encouraged to consider are identified.

GIS topics related to outfall mapping include collection method, data storage, scale, accuracy, projection, basic attributes, data sources, and metadata. System mapping addresses all the elements of outfall mapping in addition to those involving illicit discharge detection and inter-municipal implementation. Data management aspects include data collection, record keeping and reporting. The data management components of the above activities include the minimum elements of acceptable data such as type, attributes, format, frequency, and data structure and data dictionary for validation.

A collection of GIS datasets and examples has been developed to help the MS4 with implementation of the IDDE minimum measure. This collection is on a CD, which can be distributed to MS4s upon their request, and is on the NYS DEC's file transfer protocol (FTP) site[2].

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[1] http://www.nysgis.state.ny.us/

[2] ftp://ftp.dec.state.ny.us/dow/stormdocuments/ms4/illicit_discharge_detection_and_elimination/

MAPPING ELEMENT 1: MAP OF OUTFALLS (TABLE 1)

Regulated MS4s are required to provide the DEC with a map detailing all outfalls to Waters of the United States, to another MS4, or to other conveyances that lead to these waters. Data needed to map each outfall includes, at a minimum, the geographic coordinates of each outfall, along with identification of the first (downstream) receiving Water of the US to which the outfall discharges. The community keeps, as part of its Stormwater Management Plan (SWMP), written documentation of the process by which the outfalls were identified. For example, the methodology may include using available record drawings to locate outfalls. At some point field staff needs to verify these outfall locations by inspecting them.

While DEC recognizes the challenges associated with providing data in a digital (i.e., GIS) format, the agency strongly recommends using GPS and GIS technology to locate and store data, and partnering with adjacent regulated MS4s to achieve this goal. In addition, DEC recommends collecting data regarding "physical indicators," such as colors and presence of flow, at each outfall to help prioritize later monitoring efforts.

Table 1. Minimum and Preferred ELEMENTS OF OUTFALL MAPPING

Element	Minimum	Preferred	Technical Guidance Documents
Map of Outfalls	Map (digital or paper) of outfalls that discharge to waters of the United States. Map all inter-municipal surface and subsurface connections. Field verify outfall locations. Document the methodology used to ID outfalls.	Digital map, using GPS to locate outfalls. Collect basic information including field observations at each outfall (see Monitoring section).	NEIWPCC guidance EPA guidance by CWP State mapping guidance below

Identification of "Water of the US":

Minimum: The regulated MS4 identifies, wherever possible, the downstream water that the outfall discharges to. The permit requires identification of outfalls to the Waters of the US. The best representations of Waters of US in NY State are surface Waters of NY. The Water Index Number (WIN) indicates that the segment is mapped and documented in the New York

Codes, Rules, and Regulations (NYCRR). For mapping purposes, the National Hydrography Dataset (NHD)[3] may be used as an alternative source for segment identification. This dataset provides the most up-to-date delineation of surface waters and can be use for identification of the surface waters of NY, as referenced in this guidance document. Because field identification of the waters may be indirect or complex, the community should also clarify the mode of entry, and the certainty of this assignment. The certainty is defined by one of four confidence levels: verified, calculated, historical data, or none (see Table 2 for descriptions). The examples below demonstrate several cases where these data would be applied.

Preferred: The regulated MS4 may identify the Water of the US, to which their system discharges, by indicating the segment's WIN.

Inter-municipal Connections:

Minimum: Identify the downstream owner to which all inter-municipal outfalls discharge, and attempt to identify the water of the US. Municipalities document any interconnections by which the discharge flows to another MS4. Conveyances discharging to another municipality's system are identified by the operator of the originating system. If identification of receiving water is not feasible, MS4s may attempt to identify the downstream water based on general topography, educated guess, or historical data.

Preferred: Report inter-municipal connections to the receiving municipalities. Form an inter-municipal coalition to coordinate outfall/system delineation among the involved municipalities.

[3] The National Hydrography Dataset (NHD) is a vector geospatial theme for surface water hydrography obtained from topographic maps and additional sources.

Outfall Mapping Examples

The following examples address outfall mapping scenarios. The regulated MS4 in the examples is represented by ‘MS4(R)’.

Example 1) Direct discharge to a Water of NY

Example 2) Discharge to a Water of NY via a ditch or swale, map the end of channel or trace to the stream

Example 3) Discharge to an intermittent stream, from a municipal outfall, via overland or concentrated flow

Example 4) Discharge from another regulated MS4 system not owned by the municipality (non-traditional MS4)

Example 5) Discharge to unregulated wetland (no obvious hydraulic connection to downstream water); documenting the outfall is encouraged as a sound practice

Example 6) Discharge to a wetland that is hydraulically connected to downstream water

Example 7) Other non-regulated discharges, detected during field survey, are encouraged to be documented and presence of illicit discharges be reported to the Department

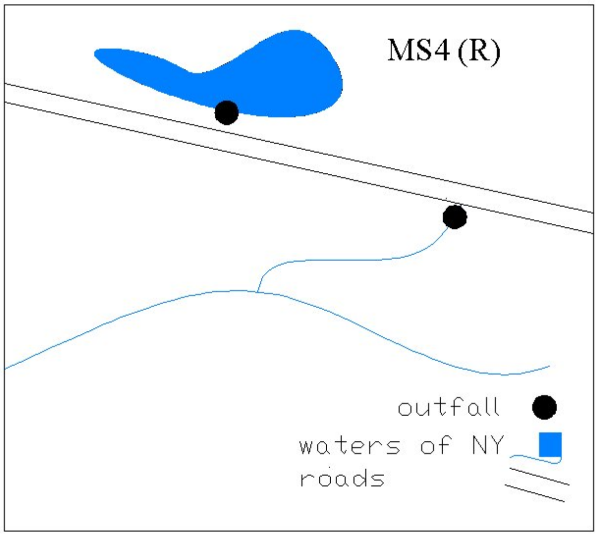
Example 8) Discharges originating in non-regulated areas (do not need to be reported)

Example 9) Inter-municipal outfall discharging to a non-regulated MS4; report the location of interconnection and the receiving water, final outfall not required

Example 10) Inter-municipal outfall discharging to a non-regulated MS4; report the location of interconnection, identify receiving water to the extent practicable, final outfall not required

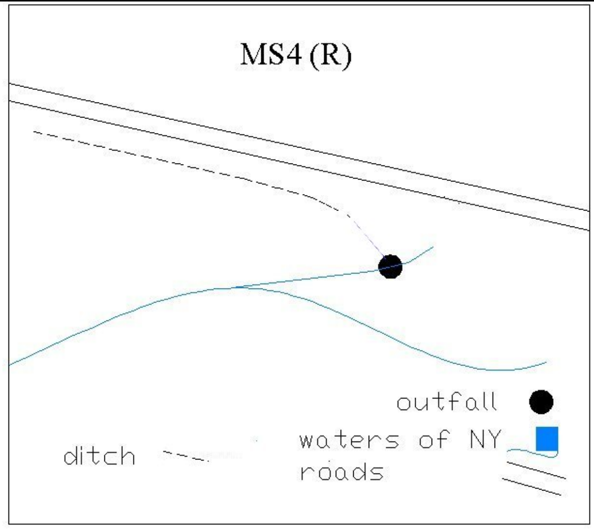
Example 11) Inter-municipal outfall discharging to another regulated MS4:
MS4b: report the location of interconnection, identify receiving water, final outfall not required
MS4a: identify outfall and receiving water

Example 12) Inter-municipal outfall discharging to another regulated MS4:
MS4b: report the location of interconnection; identify receiving water to the extent practicable, final outfall not required
MS4a: identify outfall and receiving water



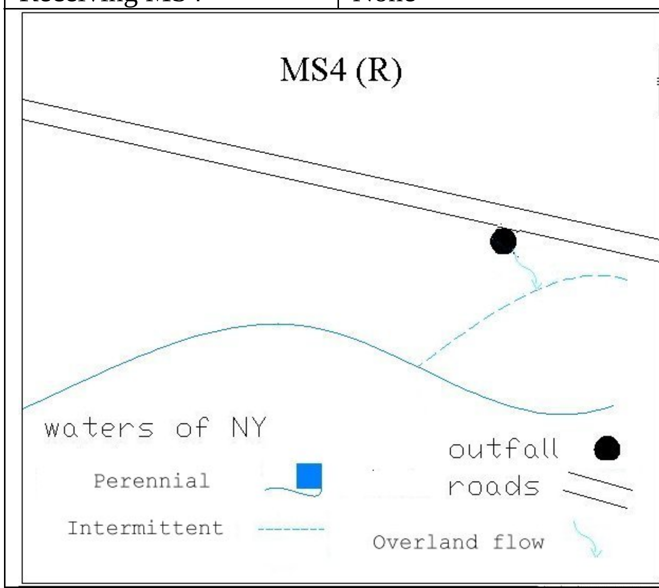
1. Direct discharge to Water of NY

Receiving Water	Stream/lake name
Mode of Entry	Direct
Outfall Type	Culvert
Confidence Level	Verified
Receiving MS4	None



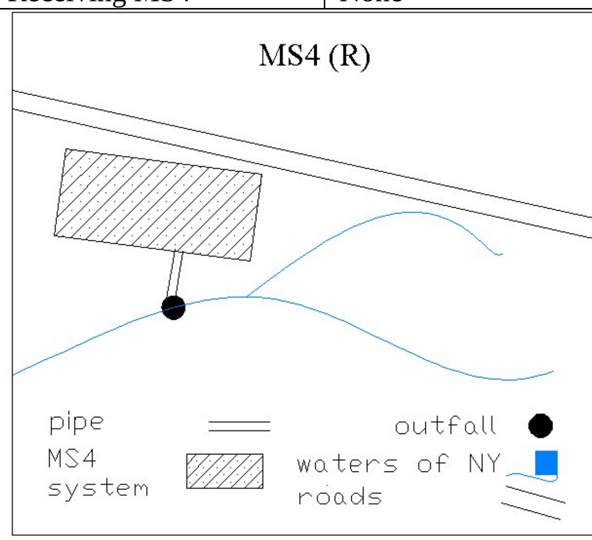
2. Direct discharge to Water of NY via ditch or swale

Receiving Water	Stream name
Mode of Entry	Direct
Outfall Type	Ditch
Confidence Level	Verified
Receiving MS4	None



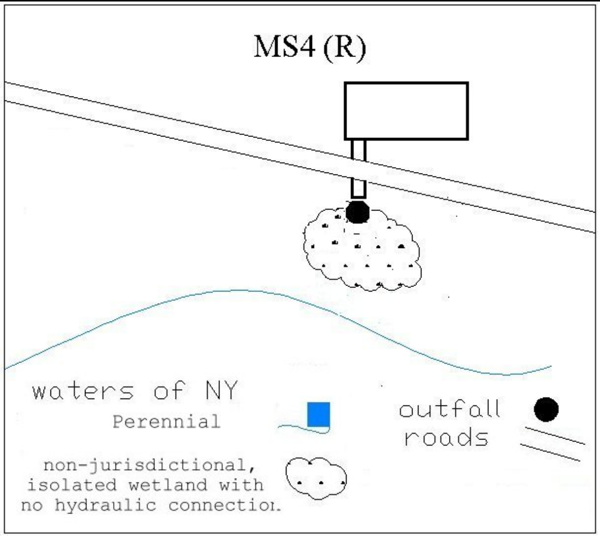
3. Discharge to intermittent stream via overland flow or concentrated flow

Receiving Water	First named stream
Mode of Entry	Intermittent
Outfall Type	Overland flow
Confidence Level	Calculated
Receiving MS4	None



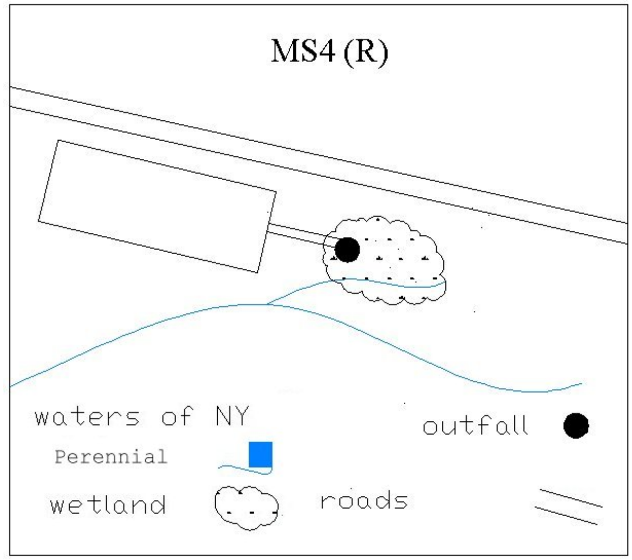
4. Discharge from another regulated MS4 system not owned by municipality (non-traditional MS4)

Receiving Water	Stream name
Mode of Entry	Direct
Outfall Type	Pipe
Confidence Level	Verified
Receiving MS4	None



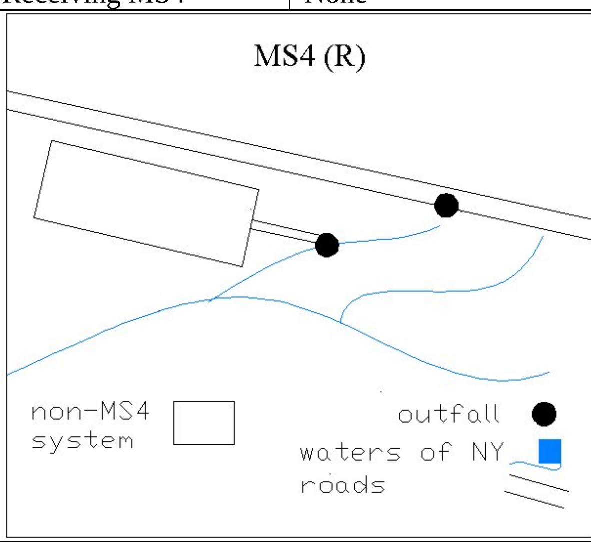
Example 5. Discharge to unregulated wetland (no obvious hydraulic connection to downstream water); documenting outfall is encouraged

Receiving Water	Stream name
Mode of Entry	Indirect
Outfall Type	culvert
Confidence Level	None
Receiving MS4	None



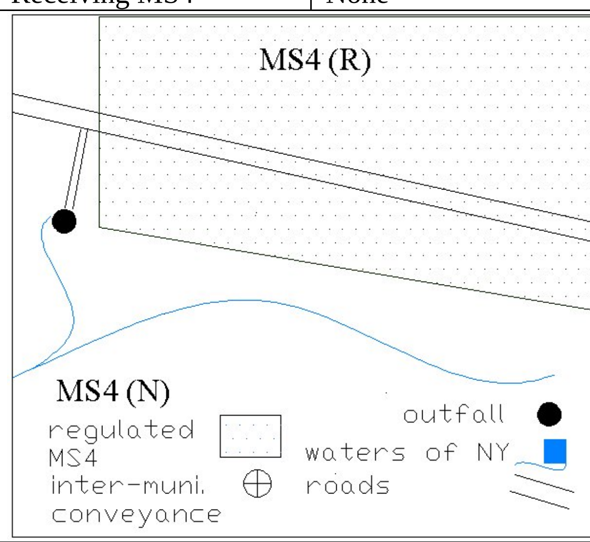
Example 6. Discharge to a wetland that is hydraulically connected to downstream water

Receiving Water	Stream name
Mode of Entry	Indirect (Overland flow)
Outfall Type	Pipe
Confidence Level	Verified
Receiving MS4	None



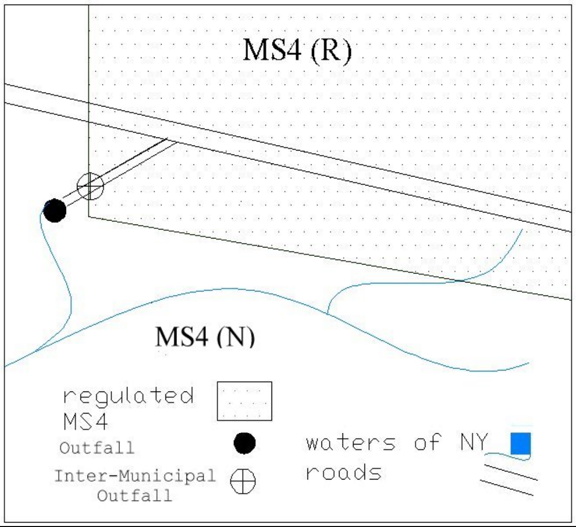
Example 7. Non-regulated discharges detected during field survey

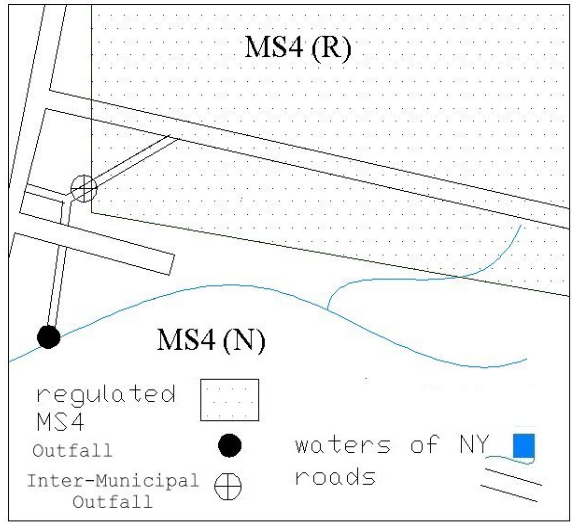
Other non-permitted discharges in regulated MS4	Mapping encouraged



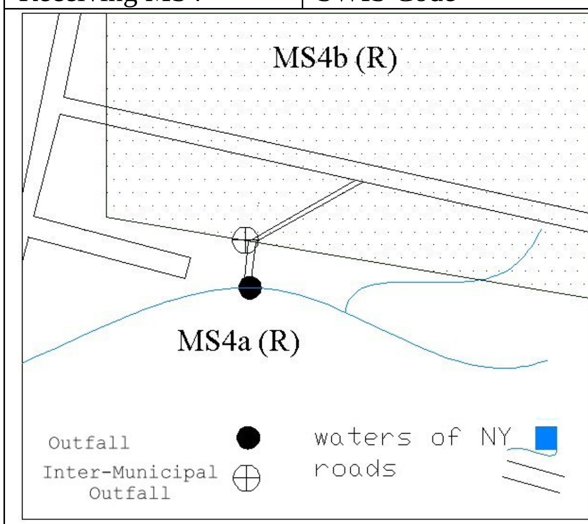
Example 8. Discharges originating in non-regulated areas (do not need to be reported)

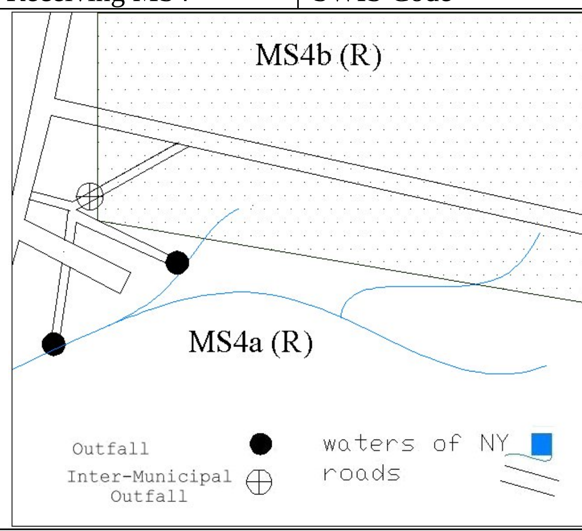
Discharges originating in non-regulated areas	Not required





Example 9. Intermunicipal outfall discharging to a non-regulated MS4; interconnection & receiving water easily identified		Example 10. Intermunicipal outfall discharging to a non-regulated MS4; interconnection & receiving water to the extent practicable	
Receiving Water	Stream name	Receiving Water	Stream name
Mode of Entry	MS4	Mode of Entry	MS4
Outfall Type	Pipe	Outfall Type	Catch basin/manhole
Confidence Level	Calculated	Confidence Level	Historical data
Receiving MS4	SWIS Code	Receiving MS4	SWIS Code





Example 11. Intermunicipal discharge: MS4b:		Example 12. Intermunicipal discharge: MS4b:	
Receiving Water	Stream name	Receiving Water	Stream name
Mode of Entry	MS4	Mode of Entry	MS4
Outfall Type	Catch basin/manhole	Outfall Type	Catch basin/manhole
Confidence Level	Calculated	Confidence Level	None
MS4	NYRxxxxxx	MS4	NYRxxxxxx
Example 11. Intermunicipal discharge: MS4a:		**Example 12. Intermunicipal discharge: MS4a:**	
Receiving Water	Stream name	Receiving Water	Stream name
Mode of Entry	Direct	Mode of Entry	Direct
Outfall Type	Pipe	Outfall Type	Pipe
Confidence Level	Verified	Confidence Level	Verified
Receiving MS4	None	Receiving MS4	None

Data Structure/Dictionary:

Minimum: The attributes in Table 2 documented for each identified outfall.

Table 2. Data Structure / Dictionary

Field	Type	Length	Attributes	Description
MS4 Permit #	character	9	NYRxxxxxx	DEC MS4 permit number
XY coordinate of the outfall or interconnection	numeric	X=6 digits Y=7 digits no decimal		Coordinate values in UTM or other selected projection
Outfall ID	character	6		See notes below
Source of X, Y data	character	10	GPS, map, etc	Method of data collection
HUC #	numeric	11-12	11 or 12 digit	Hydologic Unit Code, the most recent HUC available
Waters of NY name	character	30	Stream name or number	From NHD dataset, if not available reference local names or unnamed
Waters of NY ID	character	14	NHD rch-code	Sample NHD provided on CD
Receiving MS4	character	9	None Permit # (NYRxxxxxx) SWIS code (xxxxxx)	same MS4 Discharge to another regulated MS4, Discharge to non-regulated MS4
Outfall type	character	15	pipe, culvert, ditch, swale, catch basin, manhole	
Mode of Entry	character		Direct MS4 Indirect	Discharge to an identified NY water Discharge to another regulated MS4 Discharge via overland flow, intermittent/unidentified stream (no WIN), no obvious hydraulic connection such as wetlands
Confidence Level	character		Verified Calculated Historical data None	Verified with field observation, Educated guess or desk calculated Existing records or previous knowledge No records
Notes	character	250		

Data Structure/Dictionary (continued):

Outfall ID Description:

Minimum: Assign an outfall ID number with a maximum of 6 digits, preferably starting from lowest to highest on the drainage system, with some gap between identified outfalls to allow future outfall additions. Identification of an outfall is made by a sequence of attributes that include Permit#, HUC#, RCH-Code, and outfall ID. The final product provides a unique identification system, specifying each receiving water and also the MS4.

Preferred: Modify based on field observations as appropriate

Data storage:

Minimum: Paper map, accompanied by tabular data of outfall's geographic coordinates in digital format. Digital format can be in any of the generally acceptable spreadsheet or database formats.

Preferred: Geographic Information System. All data transfer and reporting to DEC or other MS4s would be in digital format.

Scale:

Minimum: 1:24,000

Preferred: 1:12,000. The larger scale (1:12,000) is required when the minimum distance between data features is less than a few meters.

Accuracy

Minimum: To the nearest 2 second (equivalent to approximately 45 meters) in geographic coordinates as set by 6 NYCRR Part 750 of the State Pollutant Discharge Elimination Systems Permits.

Preferred: ± 5 meters

Collection Method:

Minimum: Paper maps, field verified and transferred to digital format by using other available digital data sources such as the NYSDEC Stormwater Interactive Map or desktop GIS software.

Preferred: GPS technology (providing ± 3-5 meter accuracy with a maximum of ± 10 meter accuracy during adverse reading condition).

Data Structure/Dictionary (continued):

Projection:

Minimum: Universal Transverse Mercator (UTM), NYTM or zones 17, 18, or 19, NAD 83 datum. Other projection systems such as, the State Plane Coordinate System, or geographic coordinate system (longitude and latitude) may also be used. However, all data collected in other projection units need to be converted to UTM system if the data is going to be transferred to DEC in digital format.

Data sources:

Minimum: - 1:24,000 National Hydrography Dataset (on IDDE CD, FTP Site[2])
- USGS DRG Images (on IDDE CD, FTP Site[2])
- NRCS 11 digits Hydrologic Unit Code (HUCs), draft USGS sub-watersheds (on IDDE CD, FTP Site[2])

Preferred: Digital Orthophoto quads, other datasets addressed on IDDE CD and FTP Site[2]

Metadata:

Minimum: Information supporting collected digital data, generic format provided. An example is provided on the IDDE CD.

Preferred: Any additional documentation on methodology and data organization. Consistency with the GIS clearinghouse or the Federal Geographic Data Committee (FGDC)[4]-compliant metadata is needed for any geographic data set delivered in a GIS format.

[4] http://www.fgdc.gov/
http://www.fgdc.gov/metadata

MAPPING ELEMENT 2: SYSTEM MAPPING (TABLE 3)

System Mapping is a map of surface and subsurface conveyances within an MS4. Producing an easily usable map of the system can be extremely valuable, but is not required by GP-02-02. However, mapping inter-municipal subsurface connections, delineating storm sewersheds and creating a system for the mapping are prerequisites for a complete IDDE program and are all very useful for creating a system map. Regulated MS4s should develop and retain system mapping in some format as it will be needed to find the source of suspected illicit discharges identified either at outfalls or within stream systems. In addition, the MS4 should identify and map all subsurface conveyances that discharge to the storm drain system of another municipality (inter-municipal discharges).

TABLE 3. ELEMENTS OF NY IDDE SYSTEM MAPPING			
Element	**Minimum**	**Preferred**	**Technical Guidance Documents**
Map of Storm Sewer System	Develop and retain system mapping as needed to find the source of identified illicit discharges Preliminary storm sewershed delineation	System mapping should be available (paper or digital). Digital, consistent maps of the system in targeted sub-watersheds. Map system for detecting source of illicit discharge	EPA guidance by CWP State mapping guidance below

System Mapping:

All the methods used for outfall mapping should also be applied to system mapping.

Extent:

Minimum: a) System mapping: as needed to eliminate suspected illicit discharges. Tracking an illicit discharge to its source will involve identification of pipes, manholes, catch basins, and other system components.

b) MS4 storm sewershed delineation: Identification of the actual boundaries of the storm sewersheds is a prerequisite to IDDE. This will involve identification of their system components that are within the Phase II urbanized or designated areas or areas that they are otherwise required to control (includes areas tributary to urbanized or designated areas within the control of the permittee).

Preferred: a) Include in the system map all inter-municipal surface and subsurface conveyances (permit requirement to be mapped as outfalls). This information is useful for system delineation because it helps an MS4 determine where their responsibility begins and ends. This is particularly helpful when the system is discharging an illicit discharge to or receiving an illicit discharge from a neighboring municipality. The reported illicit discharge needs to be reported to the receiving MS4.

b) A map of the entire separate storm sewer system that includes all of the system configuration in GIS or CAD format.

Data sources:

Minimum: Watershed and sub-watershed boundaries are needed to help with the MS4 delineation. System boundaries, however, are not just a function of topographic features of the landscape and are often controlled by the underground piping and man made structures. This infrastructure information needed for storm sewershed or system boundaries may be available at the local level. Existing information can be located in city records, drainage maps, storm drain maps, state or federal storm water permit files, state transportation maintenance maps, or water and sewer agency files.

Preferred: Mapping stormwater drainage infrastructure. Some municipalities may require this information as a part of their engineering/drainage plan review process or during the municipal infrastructure development/maintenance. Normally these plans are in Computer Aided Drafting (CAD) format such as AutoCAD®.

Compatibility with other departments within the municipality, other MS4s and NYS DEC's GIS is an important consideration. If maps are developed in CAD environment, data layers need to be geo-registered. A projection file should accompany CAD drawings to secure data transfer to the GIS environment.

Inter-municipal Discharges:

Minimum: a) Regulated municipalities cooperate in elimination of reported illicit discharges that flow across jurisdictional boundaries. These conveyances are identified and documented by the operator of the originating system.

b) Report illicit discharges to the waters of NY during outfall identification /mapping to NYSDEC.

Preferred: Conveyances that discharge to another municipality's system are reported to the receiving municipalities. Coordinate tracking and elimination among the involved municipalities through an inter-municipal coalition.

SUPPLEMENTAL DATA

As outfalls are mapped, some additional data can be invaluable for future illicit discharge detection. It is recommended that these data be stored in a digital format if possible within a GIS framework. Two types of data include field observations, and chemical monitoring data. For more detail on protocols for collecting these data, consult EPA's *Illicit Discharge Detection and Elimination, A Guidance Manual for Program Development and Technical Assessment* (Brown et al., 2004). Example data structures and sheets are included in the State IDDE guidance CD and on the FTP site[2].

Field observations:

As outfalls are mapped, several field observations can help identify potential illicit discharges, and also characterize and verify basic outfall characteristics. Table 4 shows the example data structure and descriptions for IDDE field observations based on the Outfall Reconnaissance Inventory (ORI) field sheet in Brown et al., 2004.

Table 4. Example data structure for IDDE field observation.

Field name	Type	Data Validation
Outfall Description		
Outfall dimensions or diameter	numeric	4 digits with 2 decimals
Outfall type – closed pipe or open drainage	character	pipe, ditch/swale, culvert, manhole/catch basin, overland flow, seep
Outfall material	character	granite, cast iron, red clay, corrugated metal, plastic, concrete, white PVC, green PVC, asbestos, earthen, other
Outfall shape	character	Circular, elliptical, box, trapezoid, parabolic, other
Submerged in water or with sediment	character	no, partially, yes
Functioning	character	no, possibly, yes
Physical Outfall Indicators		
Flow amount	character	dry, moist, drip, trickle, moderate, standing water
Odor	character	none, sewage, oil/gas, laundry, sulfide, other
Color	character	gray, brown, yellow, green, other
Turbidity	character	none, cloudy, opaque
Floatables	character	none, sewage, oil sheen, soap suds, foam, other
Deposit	stain, character	none, black, brown, yellow, white
Vegetative growth	character	normal, excessive, inhibited
Note	memo or text field	(note description of functioning condition, turbidity, deposits, vegetative growth

This chart provides suggested data validation descriptions. All of these descriptions are not required. If you are using the ORI field sheet, you are not required to collect additional data that is not addresses on that sheet. Additional examples of indicators and descriptions of data that could be collected are provided on the IDDE CD and on the FTP site[2].

Monitoring:

Chemical monitoring data for some key constituents at outfalls can identify the presence of an illicit discharge, and sometimes help investigators find the source of the discharge. Example guidance on how to select parameters is provided in Brown et al. (2004).

The ORI field sheet in Brown et al. (2004) is one example of a data sheet for investigating illicit discharges. The NYS IDDE guidance CD also provides example data sheets from the following sources:

Monroe County
NYS Department of Transportation
New Hampshire database

Basic:

Chapter 11 of Brown et al. (2004) provides more detailed explanations of the information below. Section 11.6 – *ORI Section 3 – Quantitative Characterization for Flowing Outfalls* is most applicable.

Quantitative: Follow flow measurement methods identified in Section 11.6.

Descriptive: Identify physical indicators, such as odor, color and turbidity of the discharge.

Laboratory Analysis: Identify potential chemicals in illicit discharges by simple testing methods, such as chemical test strips or inexpensive probes.

Advanced:

Chapter 12 of Brown et al. (2004) provides more detailed explanations of the information below. While identifying and eliminating illicit discharges, use water quality standards as a goal or the number of illicit discharges removed to identify actual measures of resource protection or improvement.

Advanced analyses must be performed if the identification of an illicit discharge needs to be legally defensible in court.

Quantitative: Chapter 12 describes parameters that could be analyzed to determine the possible source of the discharge. Follow DEC approved monitoring protocols and procedures.

Descriptive: description of the mapped outfalls, suspected illicit discharges, identified actions, elimination activities and management decisions.

Laboratory Analysis: Chapter 12 describes parameters that could be analyzed to determine the possible source of the discharge. Use State approved labs if sample analysis is needed. NYSDEC provides a list of acceptable labs for sample analysis in cases when lab analysis is needed.

Glossary/References:

Accuracy: The closeness of observations, computations or estimates to the true value as accepted as being true. Accuracy relates to the exactness of the result, and is distinguished from precision, which relates to the exactness of the operation by which the result was obtained. http://www.geo.ed.ac.uk/agidexe/term?137

Attributes: A trait, quality or property describing a geographical feature. A fact describing an entity in a relational data model, equivalent to the column in a relational table. http://www.geo.ed.ac.uk/agidexe/term?460

Brown, T., Deb Caraco, and Robert Pitt, 2004. *Illicit Discharge Detection and Elimination, A Guidance Manual for Program Development and Technical Assessment,* USEPA. http://cwp.org
To download this document go to:
http://cwp.org.master.com/texis/master/search/+/form/IDDE.html

Data dictionary: repository of information in a database in which information is stored on all the objects within the database and their relationships.
http://www.geo.ed.ac.uk/agidexe/term?194

Data structure: The logical arrangement of data as used by a system for data management; a representation of a data model in computer form.
http://www.geo.ed.ac.uk/agidexe/term?1155

Geo-coordinates: Values represented by x, y, and possibly z, that define a position in terms of a spatial reference framework. Coordinates are used to represent locations on the earth's surface relative to other locations.
http://support.esri.com/index.cfm?fa=knowledgebase.gisDictionary.search&search=true&searchTerm=coordinates

Geographic Information System (GIS): A computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface.

Global Positioning System (GPS): A satellite based navigational system allowing the determination of any point on the earth's surface with a high degree of accuracy, given a suitable GPS receiver is used. http://www.geo.ed.ac.uk/agidexe/term?275

Metadata: Data about data and usage aspects of it. This information will often include some of the following: (http://www.geo.ed.ac.uk/agidexe/term?205)

- What it is about
- Where it is to be found
- Who one needs to ask to get it
- How much it costs

- Who can access it
- In what format it is available
- What is the quality of the data for a specified purpose
- What spatial location does it cover and over what time period
- When and where the data were collected and by whom and what purposes the data have been used for, by whom and what related data sets are available, etc.

New England Interstate Water Pollution Control Commissions, *Illicit Discharge Detection and Elimination Manual.* January 2003. http://www.franklinswcd.org/adobeDoc/Illicit%20Discharge%20Manual%20from%20New%20England%20IWPCC.pdf

Projection: A method of representing the earth's three-dimensional surface as a flat two-dimensional surface. This normally involves a mathematical model that transforms the locations of features on the earth's surface to locations on a two-dimensional surface. http://www.geo.ed.ac.uk/agidexe/term?79

Scale: The ratio of the distance measured on a map to that measured on the ground between the same two points. http://www.geo.ed.ac.uk/agidexe/term?831

Sewershed: An urban drainage area where the boundaries are defined based on not only the surface topography, but also the topography of the sewer system. Point(s) of discharge and service areas are subject to the configuration of man-made structures and direction of conveyance systems, which do not necessarily follow surface topography. Storms sewersheds are generally identified as non-sewered, combined, and separate depending on the contributing storm sewer system.

Tabular: of, relating to, or arranged in a table; *specifically*: set up in rows and columns or computed by means of a table.
http://www.m-w.com/cgi-bin/dictionary?book=Dictionary&va=tabular&x=18&y=14

New York State Codes Rules and Regulations (NYCRR), Volumes B-F, Parts 800-941
West Publishing, Eagan, MN

United States Geological Survey National Hydrography Dataset, http://nhd.usgs.gov last visited April, 2006

Sources:

Association of Geographic Information
http://www.geo.ed.ac.uk/root/agidict/html/welcome.html

ESRI Support Center: http://support.esri.com/index.cfm?fa=homepage.homepage

Merriam-Webster Online Dictionary
http://www.m-w.com/dictionary.htm

Chapter 11: The Outfall Reconnaissance Inventory

This chapter describes a simple field assessment known as the Outfall Reconnaissance Inventory (ORI). The ORI is designed to fix the geospatial location and record basic characteristics of individual storm drain outfalls, evaluate suspect outfalls, and assess the severity of illicit discharge problems in a community. Field crews should walk all natural and man-made streams channels with perennial and intermittent flow, even if they do not appear on available maps (Figure 19). The goal is to complete the ORI on every stream mile in the MS4 within the first permit cycle, starting with priority subwatersheds identified during the desktop analysis. The results of the ORI are then used to help guide future outfall monitoring and discharge prevention efforts.

11.1 Getting Started

The ORI requires modest mapping, field equipment, staffing and training resources. A complete list of the required and optional resources needed to perform an ORI is presented in Table 30. The ORI can be combined with other stream assessment tools, and may be supplemented by simple indicator monitoring. Ideally, a Phase II community should plan on surveying its entire drainage network at least once over the course of each five-year permit cycle. Experience suggests that it may take up to three stream walks to identify all outfalls.

Figure 19: Walk all streams and constructed open channels

Best Times to Start

Timing is important when scheduling ORI field work. In most regions of the country, spring and fall are the best seasons to perform the ORI. Other seasons typically have challenges such as over-grown vegetation or high groundwater that mask illicit discharges, or make ORI data hard to interpret[9].

Prolonged dry periods during the non-growing season with low groundwater levels are optimal conditions for performing an ORI. Table 31 summarizes some of the regional factors to consider when scheduling ORI surveys in your community. Daily weather patterns also determine whether ORI field work should proceed. In general, ORI field work should be conducted at least 48 hours after the last runoff-producing rain event.

Field Maps

The field maps needed for the ORI are normally generated during the desktop assessment phase of the IDDE program described in Chapter 5. This section provides guidance on the basic requirements for good

[9] Upon initial program start-up, the ORI should be conducted during periods of low groundwater to more easily identify likely illicit discharges. However, it should be noted that high water tables can increase sewage contamination in storm drain networks due to infiltration and inflow interactions. Therefore, in certain situations, seasonal ORI surveys may be useful at identifying these types of discharges. Diagnosis of this source of contamination, however, can be challenging.

Table 30: Resources Needed to Conduct the ORI		
Need Area	**Minimum Needed**	**Optional but Helpful**
Mapping	• Roads • Streams	• Known problem areas • Major land uses • Outfalls • Specific industries • Storm drain network • SIC-coded buildings • Septics
Field Equipment	• 5 one-liter sample bottles • Backpack • Camera (preferably digital) • Cell phones or hand-held radios • Clip boards and pencils • Field sheets • First aid kit • Flash light or head lamp • GPS unit • Spray paint (or other marker) • Surgical gloves • Tape measure • Temperature probe • Waders (snake proof where necessary) • Watch with a second hand	• Portable Spectrophotometer and reagents (can be shared among crews) • Insect repellant • Machete/clippers • Sanitary wipes or biodegradable soap • Wide-mouth container to measure flow • Test strips or probes (e.g., pH and ammonia)
Staff	• Basic training on field methodology • Minimum two staff per crew	• Ability to track discharges up the drainage system • Knowledge of drainage area, to identify probable sources. • Knowledge of basic chemistry and biology

Table 31: Preferred Climate/Weather Considerations for Conducting the ORI		
Preferred Condition	**Reason**	**Notes/Regional Factors**
Low groundwater (e.g., very few flowing outfalls)	High groundwater can confound results	In cold regions, do not conduct the ORI in the early spring, when the ground is saturated from snowmelt.
No runoff-producing rainfall within 48 hours	Reduces the confounding influence of storm water	The specific time frame may vary depending on the drainage system.
Dry Season	Allows for more days of field work	Applies in regions of the country with a “wet/dry seasonal pattern.” This pattern is most pronounced in states bordering or slightly interior to the Gulf of Mexico or the Pacific Ocean.
Leaf Off	Dense vegetation makes finding outfalls difficult	Dense vegetation is most problematic in the southeastern United States. This criterion is helpful but not required.

field maps. First, ORI field maps do not need to be fancy. The scale and level of mapping detail will vary based on preferences and navigational skills of field crews. At a minimum, maps should have labeled streets and hydrologic features (USGS blue line streams, wetlands, and lakes), so field crews can orient themselves and record their findings spatially.

Field maps should delineate the contributing drainage area to major outfalls, but only if they are readily available. Urban landmarks such as land use, property boundaries, and storm drain infrastructure are also quite useful in the field. ORI field maps should be used to check the accuracy and quality of pre-existing mapping information, such as the location of outfalls and stream origins.

Basic street maps offer the advantage of simplicity, availability, and well-labeled road networks and urban landmarks. Supplemental maps such as a 1": 2000' scale USGS Quad sheet or finer scale aerial photograph are also recommended for the field. USGS Quad sheets are readily available and display major transportation networks and landmarks, "blue line" streams, wetlands, and topography. Quad maps may be adequate for less developed subwatersheds, but are not always accurate in more urban subwatersheds.

Recent aerial photographs may provide the best opportunity to navigate the subwatershed and assess existing land cover. Aerial photos, however, may lack topography and road names, can be costly, and are hard to record field notes on due to their darkness. GIS-ready aerial photos and USGS Quad sheets can be downloaded from the internet or obtained from local planning, parks, or public works agencies.

Field Sheets

ORI field sheets are used to record descriptive and quantitative information about each outfall inventoried in the field. Data from the field sheets represent the building blocks of an outfall tracking system allowing program managers to improve IDDE monitoring and management. A copy of the ORI field sheet is provided in Appendix D, and is also available as a Microsoft Word™ document. Program managers should modify the field sheet to meet the specific needs and unique conditions in their community.

Field crews should also carry an authorization letter and a list of emergency phone numbers to report any emergency leaks, spills, obvious illicit discharges or other water quality problems to the appropriate local authorities directly from the field. Local law enforcement agencies may also need to be made aware of the field work. Figure 20 shows an example of a water pollution emergency contact list developed by Montgomery County, MD.

Equipment

Basic field equipment needed for the ORI includes waders, a measuring tape, watch, camera, GPS unit, and surgical gloves (see Table 30). GPS units and digital cameras are usually the most expensive equipment items; however, some local agencies may already have them for other applications. Adequate ranging, water-resistant, downloadable GPS units can be purchased for less than $150. Digital cameras are preferred and can cost between $200 and $400, however, conventional or disposable cameras can also work, as long as they have flashes. Hand-held data recorders and customized software can be used to record text, photos, and GPS coordinates electronically in the field. While these technologies can eliminate field sheets and data entry procedures, they can be quite expensive. Field crews should always carry basic safety items, such as cell phones, surgical gloves, and first aid kits.

Staffing

The ORI requires at least a two-person crew, for safety and logistics. Three person crews provide greater safety and flexibility, which helps divide tasks, allows one person to assess adjacent land uses, and facilitates tracing outfalls to their source. All crew members should be trained on how to complete the ORI and should have a basic understanding of illicit discharges and their water quality impact. ORI crews can be staffed by trained volunteers, watershed groups and college interns. Experienced crews can normally expect to cover two to three stream miles per day, depending on stream access and outfall density.

11.2 Desktop Analysis to Support the ORI

Two tasks need to be done in the office before heading out to the field. The major ORI preparation tasks include estimating the total stream and channel mileage in the subwatershed and generating field maps. The total mileage helps program managers scope out how long the ORI will take and how much it will cost. As discussed before, field maps are an indispensable navigational aid for field crews working in the subwatershed.

Delineating Survey Reaches

ORI field maps should contain a preliminary delineation of **survey reaches**. The stream network within your subwatershed should be delineated into discrete segments of relatively uniform character. Delineating

Department of Environmental Protection

WATER POLLUTION PHONE NUMBERS TO CALL WHEN A WATER QUALITY PROBLEM IS OBSERVED or TO OBTAIN FURTHER INFORMATION ABOUT WATER QUALITY ISSUES
Spring 2001

COUNTY AGENCIES

DEP: Department of Environmental Protection
- DEPC: Division of Environmental Policy & Compliance
- WMD: Watershed Management Division

DPS: Department of Permitting Services
- LDS: Land Development Services
- SWM: Stormwater Management
- WS: Wells & Septic

INTER-COUNTY AGENCIES

MNCPPC: Maryland-National Capital Park & Planning Commission

WSSC: Washington Suburban Sanitary Commission

DHCD: Department of Housing & Community Development

DPWT: Department of Public Works & Transportation

PROBLEM/QUESTION		AGENCY & TELEPHONE NUMBER
ILLEGAL DUMPING HOTLINE	DEPC:	**240-777-7700** Daytime hours ←
	→ Nighttime hours	**240/777-DUMP (3867) or 240-777-7788**
Blocked storm drain, inlet or pipe or erosion from public storm drain	DPWT:	240/777-ROAD (7623) Highway Maintenance)
Discolored public drinking water, odor to drinking water		301/206-4002
Erosion, flooding, drainage problems between private properties	DHCD:	240/777-3600 (Code Enforcement)
Erosion - stream banks on park land	MNCPPC:	301/495-2535
Fire & Rescue Services (emergencies: 911)	(Non-Emergencies):	240/777-0744
Recycling Programs/Special pick up services	DPWT:	240/777-6400 or 6466
Sanitary sewer problems	WSSC:	301/206-4002
Sediment (mud) from construction site entering streams	LDS:	240/777-6366
Septic Leaks/ Septic Tanks	WS:	240/777-6300
Stormwater Management, pond safety and maintenance	DEPC:	240/777-7744
Stormwater Management and Sediment Control Plan Review issues	SWM:	240/777-6320
Stream Clean-ups	WMD:	240/777-7712
Swimming Pool Discharges	DEPC:	240/777-7770
Trash and debris in parks and streams	MNCPPC:	301/495-2535
Water main break	WSSC:	301/206-4002
Water pollution	DEPC:	240/777-7770
(discharging, dumping, chemical spills into streams or storm drains)	LDS:	240/777-6260
Water quality monitoring programs for schools (Stream Teams)	WMD:	240/777-7714
Wells and Well Inspections	WS:	240/777-6300

askDEP.com

Figure 20: Example of a comprehensive emergency contact list for Montgomery County, MD

survey reaches provides good stopping and starting points for field crews, which is useful from a data management and logistics standpoint. Each survey reach should have its own unique identifying number to facilitate ORI data analysis and interpretation. Figure 21 illustrates some tips for delineating survey reaches, and additional guidance is offered below:

- Survey reaches should be established above the confluence of streams and between road crossings that serve as a convenient access point.
- Survey reaches should be defined at the transition between major changes in land use in the stream corridor (e.g. forested land to commercial area).
- Survey reaches should generally be limited to a quarter mile or less in length. Survey reaches in lightly developed subwatersheds can be longer than those in more developed subwatersheds, particularly if uniform stream corridor conditions are expected throughout the survey reach.
- Access through private or public property should be considered when delineating survey reaches as permission may be required.

It should be noted that initial field maps are not always accurate, and changes may need to be made in the field to adjust survey reaches to account for conditions such as underground streams, missing streams or long culverts. Nevertheless, upfront time invested in delineating survey reaches makes it easier for field crews to perform the ORI.

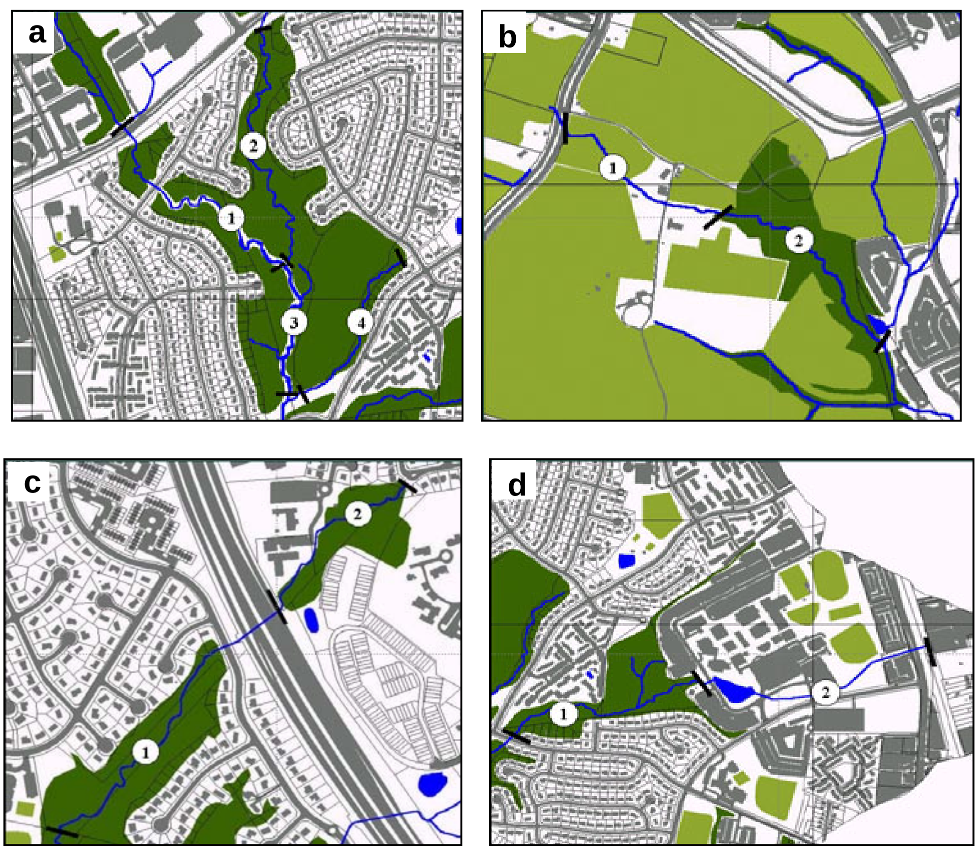


Figure 21: Various physical factors control how survey reaches are delineated. (a) Survey reaches based on the confluence of stream tributaries. (b) A long tributary split into ¼ mile survey reaches. (c) Based on a major road crossing (include the culvert in the downstream reach). (d) Based on significant changes in land use (significant changes in stream features often occur at road crossings, and these crossings often define the breakpoints between survey reaches).

11.3 Completing the ORI

Field crews conduct an ORI by walking all streams and channels to find outfalls, record their location spatially with a GPS unit and physically mark them with spray paint or other permanent marker. Crews also photograph each outfall and characterize its dimensions, shape, and component material, and record observations on basic sensory and physical indicators. If dry weather flow occurs at the outfall, additional flow and water quality data are collected. Field crews may also use field probes or test strips to measure indicators such as temperature, pH, and ammonia at flowing outfalls.
The ORI field sheet is divided into eight sections that address both flowing and non-flowing outfalls (Appendix D). Guidance on completing each section of the ORI field sheet is presented below.

Outfalls to Survey

The ORI applies to **all** outfalls encountered during the stream walk, regardless of diameter, with a few exceptions noted in Table 32. Common outfall conditions seen in communities are illustrated in Figure 22 As a rule, crews should only omit an outfall if they can definitively conclude it has no potential to contribute to a transitory illicit discharge. While EPA's Phase I guidance only targeted major outfalls (diameter of 36 inches or greater), documenting all outfalls is recommended, since smaller pipes make up the majority of all outfalls and frequently have illicit discharges (Pitt *et al.*, 1993 and Lalor, 1994). A separate ORI field sheet should be completed for each outfall.

Table 32: Outfalls to Include in the Screening

Outfalls to Record	Outfalls to Skip
• Both large and small diameter pipes that appear to be part of the storm drain infrastructure • Outfalls that appear to be piped headwater streams • Field connections to culverts • Submerged or partially submerged outfalls • Outfalls that are blocked with debris or sediment deposits • Pipes that appear to be outfalls from storm water treatment practices • Small diameter ductile iron pipes • Pipes that appear to only drain roof downspouts but that are subsurface, preventing definitive confirmation	• Drop inlets from roads in culverts (unless evidence of illegal dumping, dumpster leaks, etc.) • Cross-drainage culverts in transportation right-of-way (i.e., can see daylight at other end) • Weep holes • Flexible HDPE pipes that are known to serve as slope drains • Pipes that are clearly connected to roof downspouts via above-ground connections

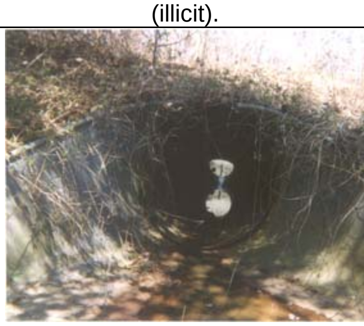
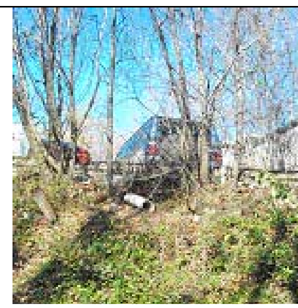
 Ductile iron round pipe	 4-6” HDPE; Check if roof leader connection (legal)	 Field connection to inside of culvert; Always mark and record.
 Small diameter (<2”) HDPE; Often a sump pump (legal), or may be used to discharge laundry water (illicit).	 Elliptical RCP; Measure both horizontal and vertical diameters.	 Double RCP round pipes; Mark as separate outfalls unless known to connect immediately up-pipe
 Culvert (can see to other side); Don’t mark as an outfall.	 Open channel “chute” from commercial parking lot; Very unlikely illicit discharge. Mark, but do not return to sample (unless there is an obvious problem).	 Small diameter PVC pipe; Mark, and look up-pipe to find the origin.
 CMP outfall; Crews should also note upstream sewer crossing.	 Box shaped outfall	 CMP round pipe with two weep holes at bridge crossing. (Don’t mark weep holes)

Figure 22: Typical Outfall Types Found in the Field

Obvious Discharges

Field crews may occasionally encounter an obvious illicit discharge of sewage or other pollutants, typified by high turbidity, odors, floatables and unusual colors. When obvious discharges are encountered, field crews should STOP the ORI survey, track down the source of the discharge and immediately contact the appropriate water pollution agency for enforcement. Crews should photo-document the discharge, estimate its flow volume and collect a sample for water quality analysis (if this can be done safely). All three kinds of evidence are extremely helpful to support subsequent enforcement. Chapter 13 provides details on techniques to track down individual discharges.

11.4 ORI Section 1 - Background Data

The first section of the ORI field sheet is used to record basic data about the survey, including time of day, GPS coordinates for the outfall, field crew members, and current and past weather conditions (Figure 23). Much of the information in this section is self-explanatory, and is used to create an accurate record of when, where, and under what conditions ORI data were collected. Every outfall should be photographed and marked by directly writing a unique identifying number on each outfall that serves as its subwatershed "address" (Figure 24). Crews can use spray paint or another temporary marker to mark outfalls, but may decide to replace temporary markings with permanent ones if the ORI is repeated later. Markings help crews confirm outfall locations during future investigations, and gives citizens a better way to report the location of spills or discharges when calling a water pollution hotline. Crews should mark the spatial location of all outfalls they encounter directly on field maps, and record the coordinates with a GPS unit that is accurate to within 10 feet. Crews should take a digital photo of each outfall, and record photo numbers in Section 1 of the field sheet.

Section 1: Background Data

Subwatershed:		Outfall ID:	
Today's date:		Time (Military):	
Investigators:		Form completed by:	
Temperature (°F):	Rainfall (in.): Last 24 hours:	Last 48 hours:	
Latitutde:	Longitude:	GPS Unit:	GPS LMK #:
Camera:		Photo #s:	
Land Use in Drainage Area (Check all that apply):			
☐ Industrial		☐ Open Space	
☐ Ultra-Urban Residential		☐ Institutional	
☐ Suburban Residential		Other: ____	
☐ Commercial		Known Industries: ____	
Notes (e.g.., origin of outfall, if known):			

Figure 23: Section 1 of the ORI Field Sheet

Figure 24: Labeling an Outfall (a variety of outfall naming conventions can be used)

The land use of the drainage area contributing to the outfall should also be recorded. This may not always be easy to characterize at large diameter outfalls that drain dozens or even hundreds of acres (unless you have aerial photographs). On the other hand, land use can be easily observed at smaller diameter outfalls, and in some cases, the specific origin can be found (e.g., a roof leader or a parking lot; Figure 25). The specific origin should be recorded in the "notes" portion of Section 1 on the field sheet.

11.5 ORI Section 2 - Outfall Description

This part of the ORI field sheet is where basic outfall characteristics are noted (Figure 26). These include material, and presence of flow at the outfall, as well as the pipe's dimensions (Figure 27). These measurements are used to confirm and supplement existing storm drain maps (if they are available). Many communities only map storm drain outfalls that exceed a given pipe diameter, and may not contain data on the material and condition of the pipe.

Figure 25: The origin of this corrugated plastic pipe was determined to be a roof leader from the house up the hill.

Section 2 of the field sheet also asks if the outfall is submerged in water or obstructed by sediment and the amount of flow, if present. Figure 28 provides some photos that illustrate how to characterize relative submergence, deposition and flow at outfalls. If no flow is observed at the outfall, you can skip the next two sections of the ORI field sheet and continue with Section 5.

Section 2: Outfall Description

LOCATION	MATERIAL	SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ Closed Pipe	☐ RCP ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other: _________	☐ Circular ☐ Eliptical ☐ Box ☐ Other: _____	☐ Single ☐ Double ☐ Triple ☐ Other: _____	Diameter/Dimensions: ____________________	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ Open drainage	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: _____	☐ Trapezoid ☐ Parabolic ☐ Other: _____		Depth: _____ Top Width: _____ Bottom Width: _____	
☐ In-Stream	(applicable when collecting samples)				
Flow Present?	☐ Yes ☐ No *If No, Skip to Section 5*				
Flow Description (If present)	☐ Trickle ☐ Moderate ☐ Substantial				

Figure 26: Section 2 of the ORI Field Sheet

Figure 27: Measuring Outfall Diameter

 Submerged: More than ½ below water	 Partially submerged: Bottom is below water	 Fully submerged: Can't see outfall
 Outfall fully submerged by debris	 Fully submerged from downstream trees trapping debris	 Partially submerged by leaf debris "back water"
 Trickle Flow: Very narrow stream of water	 Moderate Flow: Steady stream, but very shallow depth	 Significant flow (Source is a fire hydrant discharge)

Figure 28: Characterizing Submersion and Flow

11.6 ORI Section 3 - Quantitative Characterization for Flowing Outfalls

This section of the ORI records direct measurements of **flowing outfalls**, such as flow, temperature, pH and ammonia (Figure 29). If desired, additional water quality parameters can be added to this section. Chapter 12 discusses the range of water quality parameters that can be used

.

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		RESULT	UNIT	EQUIPMENT
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐Flow #2	Flow depth		In	Tape measure
	Flow width	' "	Ft, In	Tape measure
	Measured length	' "	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer
pH			pH Units	Test strip/Probe
Ammonia			mg/L	Test strip

Figure 29: Section 3 of the ORI

Field crews measure the rate of flow using one of two techniques. The first technique simply records the time it takes to fill a container of a known volume, such as a one liter sample bottle. In the second technique, the crew measures the velocity of flow, and multiplies it by the estimated cross sectional area of the flow.

To use the flow volume technique, it may be necessary to use a "homemade" container to capture flow, such as a cut out plastic milk container that is marked to show a one liter volume. The shape and flexibility of plastic containers allows crews to capture relatively flat and shallow flow (Figure 30). The flow volume is determined as the volume of flow captured in the container per unit time.
The second technique measures flow rate based on velocity and cross sectional area, and is preferred for larger discharges where containers are too small to effectively capture the flow (Figure 31). The crew measures and marks off a fixed flow length (usually about five feet), crumbles leaves or other light material, and drops them into the discharge (crews can also carry peanuts or ping pong balls to use). The crew then measures the time it takes the marker to travel across the length. The velocity of flow is computed as the length of the flow path (in feet) divided by the travel time (in seconds). Next, the cross-sectional flow area is measured by taking multiple readings of the depth and width of flow. Lastly, cross-sectional area (in square feet) is multiplied by flow velocity (feet/second) to calculate the flow rate (in cubic feet/second).

Crews may also want to measure the quality of the discharge using relatively inexpensive probes and test strips (e.g., water temperature, pH, and ammonia). The choice of which indicator parameters to measure is usually governed by the overall IDDE monitoring framework developed by the community. Some communities have used probes or test strips to measure additional indicators such as conductivity, chlorine, and hardness. Research by Pitt (for this project) suggests that probes by Horiba for pH and conductivity are the most reliable and accurate, and that test strips have limited value.

Figure 30: Measuring flow as volume per time

When probes or test strips are used, measurements should be made from a sample bottle that contains flow captured from the outfall. The exact measurement recorded by the field probe should be recorded in Section 3 of the field sheet. Some interpolation may be required for test strips, but do not interpolate further than the mid-range between two color points.

11.7 ORI Section 4 – Physical Indicators for Flowing Outfalls Only

This section of the ORI field sheet records data about four sensory indicators associated with **flowing outfalls --** odor, color, turbidity and floatables (Figure 32). Sensory indicators can be detected by smell or sight, and require no measurement equipment. Sensory indicators do not always reliably predict illicit discharge, since the senses can be fooled, and may result in a "false negative" (i.e., sensory indicators fail to detect an illicit discharge when one is actually present). Sensory indicators are important, however, in detecting the most severe or obvious discharges. Section 4 of the field sheet asks whether the sensory indicator is present, and if so, what is its severity, on a scale of one to three.

Figure 31: Measuring flow (as velocity times cross-sectional area)

Section 4: Physical Indicators for Flowing Outfalls Only
Are Any Physical Indicators Present in the flow? ☐ Yes ☐ No *(If No, Skip to Section 5)*

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX (1-3)		
Odor	☐	☐ Sewage ☐ Rancid/sour ☐ Petroleum/gas ☐ Sulfide ☐ Other:	☐ 1 – Faint	☐ 2 – Easily detected	☐ 3 – Noticeable from a distance
Color	☐	☐ Clear ☐ Brown ☐ Gray ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐Other:	☐ 1 – Faint colors in sample bottle	☐ 2 – Clearly visible in sample bottle	☐ 3 – Clearly visible in outfall flow
Turbidity	☐	See severity	☐ 1 – Slight cloudiness	☐ 2 – Cloudy	☐ 3 – Opaque
Floatables -Does Not Include Trash!!	☐	☐ Sewage (Toilet Paper, etc.) ☐ Suds ☐ Petroleum (oil sheen) ☐ Other:	☐ 1 – Few/slight; origin not obvious	☐ 2 – Some; indications of origin (e.g., possible suds or oil sheen)	☐ 3 - Some; origin clear (e.g., obvious oil sheen, suds, or floating sanitary materials)

Figure 32: Section 4 of the ORI Field Sheet

Odor

Section 4 asks for a description of any odors that emanate from the outfall and an associated severity score. Since noses have different sensitivities, the entire field crew should reach consensus about whether an odor is present and how severe it is. A severity score of one means that the odor is faint or the crew cannot agree on its presence or origin. A score of two indicates a moderate odor within the pipe. A score of three is assigned if the odor is so strong that the crew smells it a considerable distance away from the outfall.

TIP

Make sure the origin of the odor is the outfall. Sometimes shrubs, trash or carrion, or even the spray paint used to mark the outfall can confuse the noses of field crews.

Color

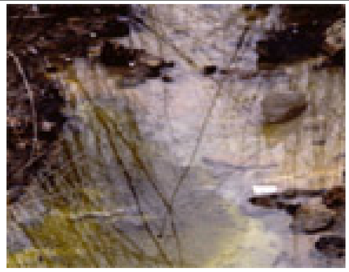
The color of the discharge, which can be clear, slightly tinted, or intense is recorded next. Color can be quantitatively analyzed in the lab, but the ORI only asks for a visual assessment of the discharge color and its intensity. The best way to measure color is to collect the discharge in a clear sample bottle and hold it up to the light (Figure 33). Field crews should also look for downstream plumes of color that appear to be associated with the outfall. Figure 34 illustrates the spectrum of colors that may be encountered during an ORI survey, and offers insight on how to rank the relative intensity or strength of discharge color. Color often helps identify industrial discharges; Appendix K provides guidance on colors often associated with specific industrial operations.

Turbidity

The ORI asks for a visual estimate of the turbidity of the discharge, which is a measure of the cloudiness of the water. Like color, turbidity is best observed in a clear sample bottle, and can be quantitatively measured using field probes. Crews should also look for turbidity in the plunge pool below the outfall, and note any downstream turbidity plumes that appear to be related to the outfall. Field crews can sometimes confuse turbidity with color, which are related but are not the same. Remember, turbidity is a measure of how easily light can penetrate through the sample bottle, whereas color is defined by the tint or intensity of the color observed. Figure 34 provides some examples of how to distinguish turbidity from color, and how to rank its relative severity.

Figure 33: Using a sample bottle to estimate color and turbidity

Color: Brown; Severity: 2
Turbidity Severity: 2



Chromium Spill
Color: Green; Severity: 3
Turbidity Severity: None

Highly Turbid Discharge
Color: Brown; Severity: 3
Turbidity Severity: 3

Sewage Discharge
Color: 3
Turbidity: 3

Paint
Color: White; Severity: 3
Turbidity: 3

Industrial Discharge
Color: Green; Severity: 3
Turbidity Severity: 3

Blood
Color: Red; Severity: 3
Turbidity Severity: None

Failing Septic System:
Turbidity Severity: 3

Turbidity in Downstream Plume
Turbidity Severity: 2
(also confirm with sample bottle)

High Turbidity in Pool
Turbidity Severity: 2
(Confirm with sample bottle)

Iron Floc
Color: Reddish Orange; Severity: 3
(Often associated with a natural source)

Slight Turbidity
Turbidity: 1
(Difficult to interpret this observation;
May be natural or an illicit discharge)

Construction Site
Discharge
Turbidity Severity: 3

Discharge of Rinse
from Floor Sanding
(Found during wet
weather)
Turbidity Severity: 3

Figure 34: Interpreting Color and Turbidity

Floatables

The last sensory indicator is the presence of any floatable materials in the discharge or the plunge pool below. Sewage, oil sheen, and suds are all examples of floatable indicators; trash and debris are generally not in the context of the ORI. The presence of floatable materials is determined visually, and some guidelines for ranking their severity are provided in Figure 35, and described below.

If you think the floatable is sewage, you should automatically assign it a severity score of three since no other source looks quite like it. Surface oil sheens are ranked based on their thickness and coverage. In some cases, surface sheens may not be related to oil discharges, but instead are created by in-stream processes, such as shown in Figure 36. A thick or swirling sheen associated with a petroleum-like odor may be diagnostic of an oil discharge.

Suds are rated based on their foaminess and staying power. A severity score of three is designated for thick foam that travels many feet before breaking up. Suds that break up quickly may simply reflect water turbulence, and do not necessarily have an illicit origin. Indeed, some streams have naturally occurring foams due to the decay of organic matter. On the other hand, suds that are accompanied by a strong organic or sewage-like odor may indicate a sanitary sewer leak or connection. If the suds have a fragrant odor, they may indicate the presence of laundry water or similar wash waters.

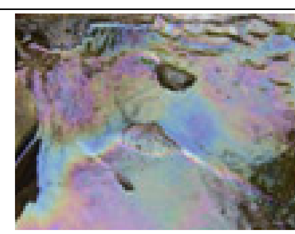
SUDS		
 Natural Foam Note: Suds only associated with high flows at the “drop off” Do not record.	 Low Severity Suds Rating: 1 Note: Suds do not appear to travel; very thin foam layer	 High severity suds Rating: 3 Sewage
OIL SHEENS		
 Low Severity Oil Sheen Rating: 1	 Moderate Severity Oil Sheen Rating: 2	 High Severity Oil Film Rating: 3

Figure 35: Determining the Severity of Floatables

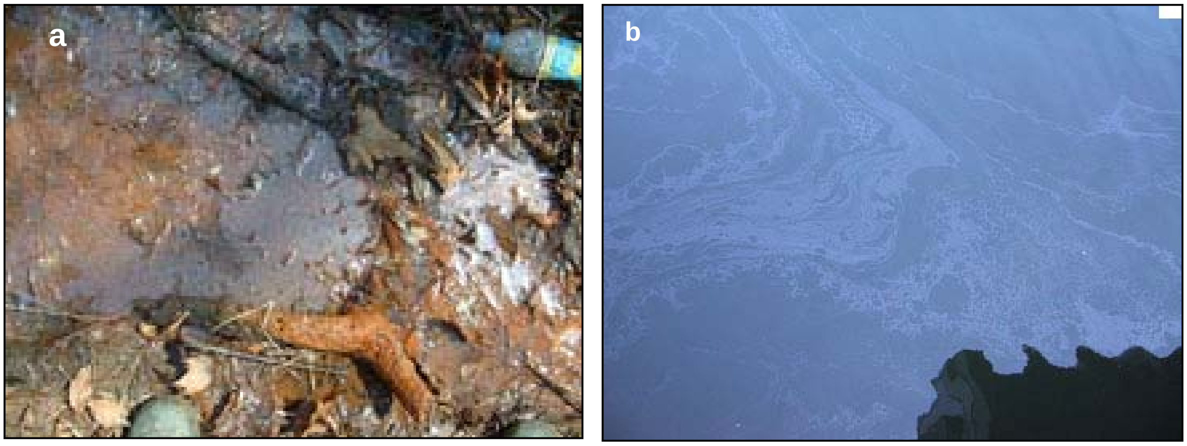


Figure 36: Synthetic versus Natural Sheen (a) Sheen from bacteria such as iron floc forms a sheet-like film that cracks if disturbed (b) Synthetic oil forms a swirling pattern

11.8 ORI Section 5 - Physical Indicators for Both Flowing and Non-Flowing Outfalls

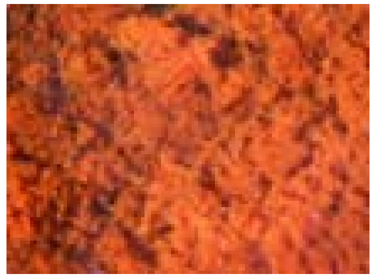
Section 5 of the ORI field sheet examines physical indicators found at both **flowing and non-flowing** outfalls that can reveal the impact of past discharges (Figure 37). Physical indicators include outfall damage, outfall deposits or stains, abnormal vegetation growth, poor pool quality, and benthic growth on pipe surfaces. Common examples of physical indicators are portrayed in Figures 38 and 39. Many of these physical conditions can indicate that an intermittent or transitory discharge has occurred in the past, even if the pipe is not currently flowing. Physical indicators are not ranked according to their severity, because they are often subtle, difficult to interpret and could be caused by other sources. Still, physical indicators can provide strong clues about the discharge history of a storm water outfall, particularly if other discharge indicators accompany them.

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls
Are physical indicators that are not related to flow present? ☐ Yes ☐ No (*If No, Skip to Section 6*)

INDICATOR	CHECK if Present	DESCRIPTION	COMMENTS
Outfall Damage	☐	☐ Spalling, Cracking or Chipping ☐ Peeling Paint ☐ Corrosion	
Deposits/Stains	☐	☐ Oily ☐ Flow Line ☐ Paint ☐ Other:	
Abnormal Vegetation	☐	☐ Excessive ☐ Inhibited	
Poor pool quality	☐	☐ Odors ☐ Colors ☐ Floatables ☐ Oil Sheen ☐ Suds ☐ Excessive Algae ☐ Other:	
Pipe benthic growth	☐	☐ Brown ☐ Orange ☐ Green ☐ Other:	

Figure 37: Section 5 of the ORI Field Sheet

Bacterial growth at this outfall indicates nutrient enrichment and a likely sewage source.



This bright red bacterial growth often indicates high manganese and iron concentrations. Surprisingly, it is 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.

The drainage to this outfall most likely has 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.

Figure 38: Interpreting Benthic and Other Biotic Indicators

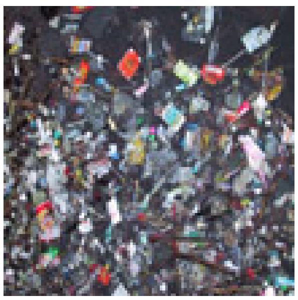
 Reddish staining on the rocks below this outfall indicate high iron concentrations.	 Toilet paper directly below the storm drain outlet.	 Watershed Protection??
 Trash is not an indicator of illicit discharges, but should be noted.	 Staining at the base of the outfall may indicate a persistent, intermittent discharge.	 Excessive vegetation may indicate enriched flows associated with sewage.
 Brownish stain of unclear origin. May be from degradation of the brick infrastructure.	 Cracked rock below the outfall may indicate an intermittent discharge.	 Poor pool quality. Consider sampling from the pool to determine origin.

Figure 39: Typical Findings at both Flowing and Non-Flowing Outfalls

11.9 ORI Sections 6-8 - Initial Outfall Designation and Actions

The last three sections of the ORI field sheet are where the crew designates the illicit discharge severity of the outfall and recommends appropriate management and monitoring actions (Figure 40). A discharge rating is designated as obvious, suspect, potential or unlikely, depending on the number and severity of discharge indicators checked in preceding sections.

It is important to understand that the ORI designation is only an initial determination of discharge potential. A more certain determination as to whether it actually is an illicit discharge is made using a more sophisticated indicator monitoring method. Nevertheless, the ORI outfall designation gives program managers a better understanding of the distribution and severity of illicit discharge problems within a subwatershed.

Section 7 of the ORI field sheet records whether indicator samples were collected for laboratory analysis, or whether an intermittent flow trap was installed (e.g., an optical brightener trap or caulk dam described in Chapter 13). Field crews should record whether the sample was taken from a pool or directly from the outfall, and the type of intermittent flow trap used, if any. This section can also be used to recommend follow-up sampling, if the crew does not carry sample bottles or traps during the survey.

The last section of the ORI field sheet is used to note any unusual conditions near the outfall such as dumping, pipe failure, bank erosion or maintenance needs. While these maintenance conditions are not directly related to illicit discharge detection, they often are of interest to other agencies and utilities that maintain infrastructure.

11.10 Customizing the ORI for a Community

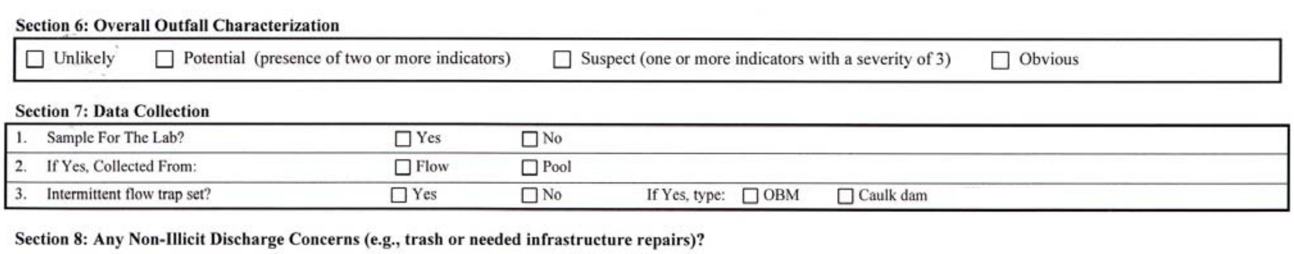
The ORI method is meant to be adaptable, and should be modified to reflect local conditions and field experience. Some indicators can be dropped, added or modified in the ORI form. This section looks at four of the most common adaptations to the ORI:

- Open Channels
- Submerged/Tidally Influenced Outfalls
- Cold Climates
- Use of Biological Indicators

In each case, it may be desirable to revise the ORI field sheet to collect data reflecting these conditions.

Open Channels

Field crews face special challenges in more rural communities that have extensive open channel drainage. The ditches and channels serve as the primary storm water conveyance system, and may lack storm drain and sewer pipes. The open channel network is often very long with only a few obvious outfalls that are located far apart. While the network can have illicit discharges from septic systems, they can typically only be detected in the ORI if a straight pipe is found. Some adaptations for open channel systems are suggested in Table 33.



Section 6: Overall Outfall Characterization

☐ Unlikely ☐ Potential (presence of two or more indicators) ☐ Suspect (one or more indicators with a severity of 3) ☐ Obvious

Section 7: Data Collection

1.	Sample For The Lab?	☐ Yes	☐ No	
2.	If Yes, Collected From:	☐ Flow	☐ Pool	
3.	Intermittent flow trap set?	☐ Yes	☐ No	If Yes, type: ☐ OBM ☐ Caulk dam

Section 8: Any Non-Illicit Discharge Concerns (e.g., trash or needed infrastructure repairs)?

Figure 40: Sections 6-8 of the ORI Field Sheet

Submerged/Tidally Influenced Outfalls

The ORI can be problematic in coastal communities where outfalls are located along the waterfront and may be submerged at high tide. The ORI methods need to be significantly changed to address these constraints. Often, outfalls are initially located from offshore using canoes or boats, and then traced landward to the first manhole that is not tidally influenced. Field crews then access the storm drain pipe at the manhole and measure whatever indicators they can observe in the confined and dimly lit space. Table 33 recommends strategies to sample outfalls in the challenging environment of coastal communities.

Winter and Ice

Ice can be used as a discharge indicator in northern regions when ice forms in streams and pipes during the winter months (Figure 41). Because ice lasts for many weeks, and most illicit discharges are warm, astute field crews can interpret outfall history from ice melting patterns along pipes and streams. For example, exaggerated melting at a frozen or flowing outfall may indicate warm water from sewage or industrial discharge. Be careful, because groundwater is warm enough to cause some melting at below freezing temperatures. Also, ice acts like an intermittent flow trap, and literally freezes these discharges. Crews should also look for these traps to find any discolored ice within the pipe or below the outfall.

A final winter indicator is "rime ice," which forms when steam freezes. This beautiful ice formation is actually a good indicator of sewage or other relatively hot discharge that causes steam to form (Figure 41).

Biological Indicators

The diversity and pollution tolerance of various species of aquatic life are widely used as an indicator of overall stream health, and has sometimes been used to detect illicit discharges. One notable example is the presence of the red-eared slider turtle, which is used in Galveston, Texas to find sewage discharges, as they have a propensity for the nutrient rich waters associated with sewage (Figure 42).

Table 33: Special Considerations for Open Channels/Submerged Outfalls

OPEN CHANNELS	
Challenge	**Suggested Modification**
Too many miles of channel to walk	Stop walking at a given channel size or drainage area
Difficulty marking them	Mark on concrete or adjacent to earth channel
Interpreting physical indicators	For open channels with mild physical indicators, progress up the system to investigate further.
SUBMERGED/TIDALLY INFLUENCED OUTFALLS	
Challenge	**Suggested Modification**
Access for ORI – Tidal Influence	Access during low tide
Access for ORI – Always submerged	Access by boat or by shore walking
Interpreting physical indicators	For outfalls with mild physical indicators, also inspect from the nearest manhole that is not influenced by tides
Sampling (if necessary)	Sample "up pipe"

Figure 41: Cold climate indicators of illicit discharges

Figure 42: One biological indicator is this red-eared slider turtle

11.11 Interpreting ORI Data

The ORI generates a wealth of information that can provide managers with valuable insights about their illicit discharge problems, if the data are managed and analyzed effectively. The ORI can quickly define whether problems are clustered in a particular area or spread across the community. This section presents a series of methods to compile, organize and interpret ORI data, including:

1. Basic Data Management and Quality Control
2. Outfall Classification
3. Simple Suspect Outfall Counts
4. Mapping ORI Data
5. Subwatershed and Reach Screening
6. Characterizing IDDE Problems at the Community Level

The level of detail for each analysis method should be calibrated to local resources, program goals, and the actual discharge problems discovered in the stream corridor. In general, the most common conditions and problems will shape your initial monitoring strategy, which prioritizes the subwatersheds or reaches that will be targeted for more intensive investigations.

Program managers should analyze ORI data well before every stream mile is walked in the community, and use initial results to modify field methods. For example, if initial results reveal widespread potential problems, program managers may want to add more indicator monitoring to the ORI to track down individual discharge sources (see Chapter 12). Alternatively, if the same kind of discharge problem is repeatedly found, it may be wise to investigate whether there is a common source or activity generating it (e.g., high turbidity observed at many flowing outfalls as a result of equipment washing at active construction sites).

Basic Data Management and Quality Control

The ORI produces an enormous amount of raw data to characterize outfall conditions. It is not uncommon to compile dozens of individual ORI forms in a single subwatershed. The challenge is to devise a system to organize, process, and translate this data into simpler outputs and formats that can guide illicit discharge elimination efforts. The system starts with effective quality control procedures in the field.

Field sheets should be managed using either a three-ring binder or a clipboard. A small field binder offers the ability to quickly flip back and forth among the outfall forms. Authorization letters, emergency contact lists, and extra forms can also be tucked inside.

At the end of each day, field crews should regroup at a predetermined location to compare notes. The crew leader should confirm that all survey reaches and outfalls of interest have been surveyed, discuss initial findings, and deal with any logistical problems. This is also a good time to check whether field crews are measuring and recording outfall data in the same way, and are consistent in what they are (or are not) recording. Crew leaders should also use this time to review field forms for accuracy and thoroughness. Illegible handwriting should be neatened and details added to notes and any sketches. The crew leader should also organize the forms together into a single master binder or folder for future analysis.

Once crews return from the field, data should be entered into a spreadsheet or database. A Microsoft Access database is provided with this Manual as part of Appendix D (Figure 43), and is supplied on a compact disc with each hard copy. It can also be downloaded with Appendix D from http://www.stormwatercenter.net. Information stored in this database can easily be imported into a GIS for mapping purposes. The GIS can generate its own database table that allows the user to create subwatershed maps showing outfall characteristics and problem areas.

Once data entry is complete, be sure to check the quality of the data. This can be done quickly by randomly spot-checking 10% of the entered data. For example, if 50 field sheets were completed, check five of the spreadsheet or database entries. When transferring data into GIS, quality control maps that display labeled problem outfalls should be created. Each survey crew is responsible for reviewing the accuracy of these maps.

Outfall Classification

A simple outfall designation system has been developed to summarize the discharge potential for individual ORI field sheets. Table 34 presents the four outfall designations that can be made.

Table 34: Outfall Designation System Using ORI Data

Designation	Description
1: Obvious Discharge	Outfalls where there is an illicit discharge that doesn't even require sample collection for confirmation
2: Suspect Discharge	Flowing outfalls with high severity on one or more physical indicators
3: Potential Discharge	Flowing or non-flowing outfalls with presence of two or more physical indicators
4: Unlikely Discharge	Non-flowing outfalls with no physical indicators of an illicit discharge

Simple Suspect Outfall Counts

The first priority is to count the frequency of each outfall designation in the subwatershed or the community as a whole. This simple screening analysis counts the number of problem outfalls per stream mile (i.e., the sum of outfalls designated as having potential, suspected or obvious illicit discharge potential). The density of problem outfalls per stream mile is an important metric to target and screen subwatersheds.

Based on problem outfall counts, program managers may discover that a particular monitoring strategy may not apply to the community. For example, if few problem outfalls are found, an extensive follow-up monitoring program may not be needed, so that program resources can be shifted to pollution hotlines to report and control transitory discharges such as illegal dumping. The key point of this method is to avoid getting lost in the raw data, but look instead to find patterns that can shape a cost-effective IDDE program.

Mapping ORI Data

Maps are an excellent way to portray outfall data. If a GIS system is linked to the ORI database, maps that show the spatial distribution of problem outfalls, locations of dumping, and overall reach conditions can be easily generated. Moreover, GIS provides flexibility that allows for rapid updates to maps as new data are collected and compiled. The sophistication and detail of maps will depend on the initial findings, program goals, available software, and GIS capability.

Subwatershed maps are also an effective and important communication and education tool to engage stakeholders (e.g., public officials, businesses and community residents), as they can visually depict reach quality and the location of problem outfalls. The key point to remember is that maps are tools for understanding data. Try to map with a purpose in mind. A large number of cluttered maps may only confuse, while a smaller number with select data may stimulate ideas for the follow-up monitoring strategy.

Subwatershed and Survey Reach Screening

Problem outfall metrics are particularly valuable to screen or rank priority subwatersheds or survey reaches. The basic approach is simple: select the outfall metrics that are most important to IDDE program goals, and then see how individual subwatersheds or reaches rank in the process. This screening process can help determine which subwatersheds will be priorities for initial follow-up monitoring efforts. When feasible, the screening process should incorporate non-ORI data, such as existing dry weather water quality data, citizen complaints, permitted facilities, and habitat or biological stream indicators.

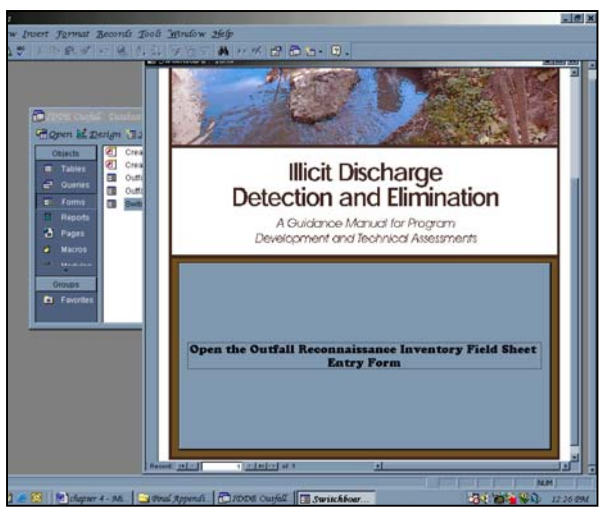


Figure 43: Sample screen from ORI Microsoft Access database

An example of how outfall metrics can screen subwatersheds is provided in Table 35. In this hypothetical example, four metrics were used to screen three subwatersheds within a community: number of suspect discharges, subwatershed population as a percent of the total community, number of industrial discharge permits, and number of outfalls per stream mile. Given these screening criteria, subwatershed C was selected for the next phase of detailed investigation.

Characterizing the IDDE Problem at the Community Level

ORI data should be used to continuously revisit and revise the IDDE program as more is learned about the nature and distribution of illicit discharge problems in the community. For example, ORI discharge designation should be compared against illicit discharge potential (IDP) predictions made during the original desktop analysis (Chapter 5) to refine discharge screening factors, and formulate new monitoring strategies.

In general, community illicit discharge problem can be characterized as minimal, clustered, or severe (Table 36). In the minimal scenario, very few and scattered problems exist; in the clustered scenario, problems are located in isolated subwatersheds; and in the severe scenario, problems are widespread.

Table 35: An Example of ORI Data Being Used to Compare Across Subwatersheds

	# of suspect discharges	Population as % of total community	# of industrial discharge permits	# of outfalls per stream/ conveyance mile
Subwatershed A	2	30	4	6
Subwatershed B	1	10	0	3
Subwatershed C	8	60	2	12

Table 36: Using Stream and ORI Data to Categorize IDDE Problems

Extent	ORI Support Data
Minimal	• Less than 10% of total outfalls are flowing • Less than 20% of total outfalls with obvious, suspect or potential designation
Clustered	• Two thirds of the flowing outfalls are located within one third of the subwatersheds • More than 20% of the communities subwatersheds have greater than 20% of outfalls with obvious, suspect or potential designation
Severe	• More than 10% of total outfalls are flowing • More than 50% of total outfalls with obvious, suspect or potential designation • More than 20% of total outfalls with obvious or suspect designation

11.12 Budgeting and Scoping the ORI

Many different factors come into play when budgeting and scoping an ORI survey: equipment needs, crew size and the stream miles that must be covered. This section presents some simple rules of thumb for ORI budgeting.

Equipment costs for the ORI are relatively minor, with basic equipment to outfit one team of three people totaling about $800 (Table 37). This cost includes one-time expenses to acquire waders, a digital camera and a GPS unit, as well as disposable supplies.

The majority of the budget for an ORI is for staffing the desktop analysis, field crews and data analysis. Field crews can consist of two or three members, and cover about two to three miles of stream (or open channel) per day. Three staff-days should be allocated for pre- and post-field work for each day spent in the field.

Table 38 presents example costs for two hypothetical communities that conduct the ORI. Community A has 10 miles of open channel to investigate, while Community B has 20 miles. In addition, Community A has fewer staff resources available and therefore uses two-person field crews, while Community B uses three-person field crews. Total costs are presented as annual costs, assuming that each community is able to conduct the ORI for all miles in one year.

Table 37: Typical Field Equipment Costs for the ORI

Item	Cost
100 Latex Disposable Gloves	$ 25
5 Wide Mouth Sample Bottles (1 Liter)	$ 20
Large Cooler	$ 25
3 Pairs of Waders	$ 150
Digital Camera	$ 200
20 Cans of Spray Paint	$ 50
Test Kits or Probes	$ 100-$500
1 GPS Unit	$ 150
1 Measuring Tape	$ 10
1 First Aid Kit	$ 30
Flashlights, Batteries, Labeling tape, Clipboards	$ 25
Total	**$ 785-$1185**

Table 38: Example ORI Costs		
Item	**Community A**	**Community B**
Field Equipment[1]	$700	$785
Staff Field Time[2]	$2,000	$6,000
Staff Office Time[3]	$3,000	$6,000
Total	**$5,700**	**$12,785**

[1] From Table 44
[2] Assumes $25/hour salary (2 person teams in Community A and three- person teams in Community B) and two miles of stream per day.
[3] Assumes three staff days for each day in field.

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INTERPRETING WATER ANALYSIS TEST RESULTS

1. **Alkalinity**: This is the sum of components (mainly bicarbonate, carbonate, and hydroxide) in the water that tend to elevate the pH of the water above 4.5. These factors are characteristic of the source of water and the natural processes taking place at any given time. Alkalinity represents the buffering capacity of water and its ability to resist a change in pH. Alken-Murray recommends alkalinity above 75 mg/L to offset acid produced by bacteria nitrifying ammonia.

The acceptable range for most finfish is 20-200 mg/1 (ppm).

CHEMetrics kits recommended K-9810: 10 - 100 ppm & K-9815: 50 - 100 ppm

2. **Ammonia**: Ammonia nitrogen (N) is present in variable concentrations in many surface and ground water supplies. A product of microbiological activity, ammonia when found in natural water is regarded as indicative of sanitary pollution.

Ammonia is rapidly oxidized by certain bacteria, in natural water systems, to nitrite and nitrate--a process that requires the presence of dissolved oxygen. Ammonia, being a source of nitrogen is also a nutrient for algae and other forms of plant life and thus contribute to overloading of natural systems and cause pollution.

In fish, ammonia represents the end-product of protein metabolism and what is important is whether it is present in the un-ionized form as free ammonia, **NH3, which is toxic to fish (both freshwater and marine) at >0.03 mg/L (ppm),** or in the ionized form, NH4+, in which it is innocuous. The relative concentration of each is pH and temperature dependent. **The higher the pH, the more of the NH3 will be present.** Ammonia can block oxygen transfer in the gills of fish, thereby causing immediate and long term gill damage. Fish suffering from ammonia poisoning will appear sluggish and come to the surface, as if gasping for air. In marine environments, the safe level of NH4+ is between 0.02 and 0.4.

The USEPA recommends a limit of 0.02 ppm as NH3 in freshwater or marine environments. Total ammonia levels, at this limit, can range from 160 ppm at pH 6 and temperature of 5 degrees C to 0.06 ppm at pH 9 and temperature of 25 degrees C.

If large quantities of fish are suddenly added to the water body (such as during stocking), the ammonia level can spike because the natural bacteria that degrade ammonia are slow to reporduce (having a 14 day cycle), so it is best to add a seeding quantity of ***Alken Clear-Flo 1100*** or ***Alken Clear-Flo 1200*** at the same time you add your new fish, to avoid this problem.

CHEMetrics kits recommended: K-1510: 0-1 ppm & 1 - 10 ppm

3. **Carbon Dioxide:** Carbon dioxide (CO_2) is present in water supplies in the form of a dissolved gas. Typically, surface waters contain less than 10 ppm free carbon dioxide while ground waters may have much higher concentrations. Dissolved in water, CO_2 forms carbonic acid which lowers pH.

Aquatic plant life, from phytoplankton to large rooted plants, depends upon carbon dioxide and bicarbonates in water for growth. Of significance for fish is the fact that when the oxygen concentration falls (e.g. through the degradation of organic wastes), the carbon dioxide concentration rises. This increase in carbon dioxide makes it more difficult for fish to use the limited amount of oxygen present. To take in fresh oxygen, fish must first discharge the CO_2 in their blood stream, a process which is slowed down considerably when there are high concentrations of CO_2 in the water itself. Unfortunately the CHEMetrics test kits do not measure below 10 mg/L, so if you get a reading on this test, you know your water body is in trouble.

The acceptable range of carbon dioxide for most finfish is <2.0 mg/L (ppm).

CHEMetrics kit recommended: K-1910: 10 - 100 ppm

4. **Chloride**: Chloride is one of the major anions to be found in water and sewage. Its presence in large amounts may be due to natural processes such as the passage of water through natural salt formations in the earth or it may be an indication of pollution from sea water intrusion, industrial or domestic waste or deicing operations. Potable water should not exceed 250 mg/L of chloride. When calcium or magnesium is the cation, up to 1000 mg/L can be tolerated without a salty taste to the water.

CHEMetrics kit recommended: K-2002: 2 - 20 ppm

5. **Dissolved Oxygen**: Vital to aquatic life, oxygen enters the water by diffusion from the atmosphere or through plant photosynthesis. Actual solubility is directly proportional to the partial pressure in the gas phase, to salt concentration and temperature. The dissolved oxygen level in water is constantly changing and represents a balance between respiration and decomposition that deplete

oxygen and photosynthetic activity that increases it. Organic waste may overload a natural system causing a serious depletion of the oxygen supply in the water that in turn leads to fish kills. Likewise, eutrophic waters, that is those rich in nutrients, achieve the same result through causing massive proliferation of algae (algal blooms) whose eventual decomposition uses up the available dissolved oxygen.

Recommended minimum dissolved oxygen levels for fresh water fish are as follows:
warm water fish .... 5.0 mg/L (ppm)
cold water fish .... 6.0 mg/L (ppm)
Koi........... 8.0 mg/L (ppm)
Marine fish......5.0 mg/L (ppm)
Marine Shrimp....> 5.0 mg/L (ppm), close to saturation*

***** Reference for shrimp is page 124 ***Marine Shrimp Culture: Principles and Practices*** edited by Arlo W. Fast & L.James Lester

CHEMetrics kit recommended: K-7510: 0 - 10 ppm & K-7512: 1 - 12 ppm. A dissolved oxygen meter can be used, if calibrated according to manufacturer's instructions. Self-stirring DO probes are easier to work with, if this option is available, but the test kits are often preferred by consumers treating a single pond.

6. **Nitrites**: Nitrites occur in water as an intermediate product in the biological breakdown of organic nitrogen, being produced either through the oxidation of ammonia or the reduction of nitrate. The presence of large quantities of nitrites is indicative of waste water pollution. **The level considered ideal for marine fish is between 0.01 and 0.04 ppm.**

Levels exceeding 0.55 mg/L (ppm) nitrite-nitrogen can cause 'brown-blood' disease in finfish.

CHEMetrics kit recommended: K-7002: 0 - 0.4 ppm & 0.4 ppm - 4 ppm

7. **Nitrates**: Nitrates occur in water as the end product in the biological breakdown of organic nitrogen, being produced through the oxidation of ammonia . Although not particularly toxic to fish, excess nitrates in the water is often used as an indicator of poor water quality. Under anaerobic conditions, such as in the sludge or soil at the botton of a pond, lake or aquarium, denitrification can be used to convert nitrate back to nitrite and from there to nitrogen gas, removing total nitrogen from the aquatic system. **In marine environments, levels of 0.1 to 0.2 are considered ideal.**

Levels exceeding 50 mg/L (ppm) nitrate-nitrogen are considered unhealthy for lakes.

Levels from 10 mg/l to 40 mg/l indicate poor water in aquariums, depending on the species being raised.

CHEMetrics kit recommenended: K-6902: 0 - 1 ppm & 1 - 5 ppm

For larger, seriously polluted ponds, lakes, etc., also use: K-6902D: 0 - 25 ppm & 25 - 125 ppm

8. **pH**: By definition, pH is the negative logarithm of the hydrogen ion concentration. It is in effect an "Index" of the amount of hydrogen ion present in a substance and is used to categorize the latter as acid, neutral, or alkaline (basic).

Most natural waters will have pH values from pH 5.0 to pH 8.5 (compare the range in which ***Alken Clear-Flo*** products work best: 6.0-8.5). Fresh rain water may have a pH of 5.5 to 6.0. The carbon dioxide produced by respiration of animals and plants in water have the effect of lowering pH. Carbon dioxide and bicarbonate removed from the water by the photosynthetic processes of aquatic plants raises pH. The same processes alter the dissolved oxygen content; oxygen drops during respiration and decomposition; it rises with photosynthetic activity. **A pH that is too high is undesirable because free ammonia increases with rising pH.**

The acceptable pH range for most finfish and shellfish species is 6.8-8.5

9. **Total Hardness:** The Total Hardness of a water represents primarily the total concentration of Calcium and Magnesium ions expressed as calcium carbonate. Hardness may range from zero to hundred of parts per million, depending on the origin of the water or the treatment to which the water has been subjected.

Waters containing hardness concentrations of up to 60mg/L (ppm) are referred to as "soft", those containing 120-180 mg/L (ppm) as "hard".

Recommended level: >130 mg/L (ppm)

CHEMetrics kit recommended: K-4502: 2 - 20 ppm & K-452: 20 - 200 ppm

10. **Density:** The amount of crowding each species of finfish and shellfish will tolerate varies between species. For the majority of finfish, the limit is 0.2 to 0.5 lbs of fish per inch of body length per cubic foot of rearing space. When the tolerable limit is exceeded, fish will exhibit signs of stress including darkening of body color, "clubbing" of gills, fin nipping or loss of tissue between the fin rays and reduced immunity to disease. Shrimp and prawns will also become more susceptible to disease when over-crowded.

In addition to your standard tests, there are circumstances which suggest that additional tests may be required before **Alken Clear-Flo®** can be prescribed.

These include:

1. **Chlorine:** Because of its strong oxidizing properties, chlorine acts as a BIOCIDE. The test for this should read "0" (zero), before ***Clear-Flo®*** is added. If this is a problem in your natural waterbody, someone is likely backwashing a swimming pool into your influent water or else there is an industrial or municipal effluent in your influent water. If the problem is a swimming pool nearby, have a talk with your neighbor and encourage them to dump elsewhere. If you cannot locate the source of this problem, contact Ken at Alken-Murray to prescribe a chemical de-chlorination solution for you. Fish, plants, algae and bacteria can all be killed by Chlorine.

CHEMetrics kit recommended: K-2505: 0 - 1 ppm & 1 - 5 ppm

2. **Copper** (total soluble): Copper sulfate is often added to water to control algae. This is toxic to both fish AND bacteria. **DO NOT APPLY *Alken Clear-Flo®* when the copper test measures levels above 0.5 ppm (mg/l). Lethal concentrations of copper for marine organisms is 5.8 to 600 ppm, depending on species. Copper is toxic to *Mysid shrimp* at 77 ppm.**

CHEMetrics kit recommended: K-3510: 0 - 1 ppm & 1 - 10 ppm

3. **Detergents:** Where detergents (anionic surfactants) are used to clean machinery, animals, and the household, the runoff may be contaminated. The ***Clear-Flo® 1200*** will work to eliminate this contaminant when its concentration is less than 1 mg/L. ***Alken Clear-Flo® 7004*** should be used to treat detergents greater than 1 mg/L. Some surfactants can be lethal in quantities as small as 10 to 12 mg/L (Triton-X114), so this is an important parameter if you suspect runoff from animal washing or other industrial effluent. The U.S. drinking water standard prohibits levels above 0.5 mg/L.

CHEMetrics kit recommended: K-9400: 0 - 3 ppm

4. **Iron:** Concentrations above 1 mg/L will impart a foul taste to the water. High concentrations can indicate runoff from mining operations or industrial effluent and indicate the need for further investigation before prescribing a treatment regimen. The US drinking water standard prohibits levels above 0.3 mg/L.

CHEMetrics kit recommened: K-6010: 0 - 1 ppm & 1 - 10 ppm

5. **Lead:** Lead is a poison whose effects are cumulative. **Drinking water should not exceed 20 ppb**. When groundwater contains a higher level, it may indicate contamination from the discharges of smelting or mining operations, or leachate from municipal sewage sludge fertilizer. **Lead is toxic to freshwater species at 1.3 to 8.7 ppm**, while marine species are more tolerant. The LC50 of lead for

diatoms is 7940 ug/L. (Test needs to be performed by a suitable independent laboratory)

6. **Mercury**. Mercury is a common trace metal used in industry as a biocide**.** **Acutely toxic to marine organisms in the range of 3.5 to 1678 ppm. Organomercuric compounds may be toxic to marine organisms in the range of 0.1 to 2.0 ppm**. Alken-Murray's current formulas cannot withstand high levels of mercury, so alternative treatment options must be considered to decrease the level of mercury.(Test needs to be performed by a suitable independent laboratory)

7. **Tributyl Tin.** This substance has been declared, by the California Department of Fish and Game, to be "the most toxic substance ever released in the marine environment." This substance, which **can be toxic in concentrations as low as 50 parts per trillion in water,** is found in marine paints and antifouling coatings. Fortunately, Tributyl tin appears to be less bioavailable in sediment than it is in seawater, so higher levels may have less effect on benthic biota (bottom dwelling creatures) than might be expected, were the substance suspended in water. If you suspect this substance, obtain testing from an environmentally certified laboratory. We are not aware of any test kits for this substance. (sometimes mispelled as tributylin tin)

8. **Sulfite**: Sulfite is not normally found in natural waters. Its presence, therefore, usually indicates contamination from pulp and paper industrial effluent, or food canning (used as a preservative). **An excess of sulfite can lower the pH and render the water corrosive.**

CHEMetrics kits recommended: K-9602: 2 - 20 ppm

For seriously polluted water, you may also need kit K-9610: 10 - 100 ppm

9. **Phosphate**: High phosphate concentrations in surface waters may indicate fertilizer runoff, domestic waste discharge, or the presence of industrial effluents or detergents. If high phosphate levels persist, algae and other aquatic life will flourish, eventually decreasing the level of dissolved oxygen due to the accelerated decay of organic matter. Algae blooms are encouraged by levels of phosphate greater than 25 micrograms/L. Obtain tests in the 0 to 25 ppm and 25 to 200 ppm ranges. To combat waste accumulation, in the presence of high phosphate levels, you must *double the initial dose of **Alken Clear-Flo®*** normally prescribed for the size of the pond/lake/waste treatment plant.

Phosphorous Discharge Standards
1) Total Phosphorous for discharge < 100 micrograms/L
2) Where stream enters lake < 50 micrograms/L
3) Discharge into a lake < 25 micrograms/L
4) Algae blooms are encouraged by levels of phosphate > 25 micrograms/L
5) Phosphate phosphorous - > 100 micrograms/L may interfere with coagulation process in water treatment plant

CHEMetrics kit recommended: K-8510: 0 - 1 ppm & 1 - 10 ppm & K-8510D: 0 -

25 ppm & 25 - 250 ppm

10. **Phenol.** Phenol is usually found in a waterbody if pine cleaners and phenolic sanitizers are used and then washed into the drain system. **If water has more than 1 ppm**, add ***Alken Clear-Flo® 7002*** to your ***Clear-Flo 1000*** line prescription.

CHEMetrics kit recommended: K-8012: 0 - 1 ppm & 1 - 12 ppm

11. **Hydrocarbons.** Although most people know that petroleum spills are toxic to aquatic life, they are often unaware that rinsing used motor oil into the storm sewer or pond is also harmful. **Benzene, Toluene, Xylene and Benz(a)Pyrene should not exceed 0.1 ppm.** Smaller amounts can be handled by ***Clear-Flo*** formulas, but amounts exceeding 0.1 ppm should be treated with ***Clear-Flo 1006***. *Botryococcus braunii*, a chlorophyte order of Chlorococcales algae produces C34 hydrocarbons with characteristics similar to crude petroleum. When it blooms, this algae appears as a **slimy bright green scum** on the surface of the water. *B. braunii* grows especially well in the presence of high nitrates., and will test positive on a hydrocarbon test when present. ***Clear-Flo 1006*** should be prescribed to clean the water, eliminating both the food for this algae and its exudate.

(Kit for this is more expensive than to have TPH tested by an independent lab, so we only recommend CHEMetrics K-9310, along with equipment, for distributors to monitor treatment of soil for their clients.)

12. **Cyanide.** Cyanide is used in many chemical and refining processes. Effluent from electroplating and metal cleaning operations, coke ovens, steel manufacturing, etc. can end up in lakes and ponds if the factory is not careful. **Levels above 0.01 ppm are unsafe for marine species.** . If the waterbody **does** contain fish, you can apply ***Alken Clear-Flo 1015,*** but request that *Yucca schidigera* be omitted, to allow application of higher dosages, with safety. For wmunicpal or industrial astewater with cyande problems, you can apply ***Alken Clear-Flo 7015***, which is currently available or ask Alken-Murray to augment whatever bacteral product has been selected, to remediate other pollutants in your system, with a serious percentage of Alken-Murray's cyanide-degrading *Bacillus megaterium,* AMC 300. Fortunately, *B.megaterium* AMC 300 has demonstrated remarkable compatibility with a wide assortment of strains in the Alken-Murray microbial collection, but any new combinations should be verified with Valerie Anne Edwards.

A chemical solution for cyanide in wastewater that does not also contain high levels of ammonia is alkaline chlorination to safely remove cyanide, but if ammonia levels are high, you could end up with undesirable levels of chloramines.

CHEMetrics kit recommended: K3810: 0 - 0.1 & 0.1 to 1.0

13. **COD.** Chemical Oxygen Demand measures organic and inorganic content as indicators of the amount of dissolved oxygen that will be removed from the water column or sediment due to bacterial and/or chemical activity. **Normal COD in a pond should be less than 10 mg/L**. A COD of 60 mg/L in a natural pond or lake or aquaculture pond or tank is in emergency need of treatment.

CHEMetrics kit recommended to distributors only, as equipment is needed too:K-7351(0 - 150 ppm), K-7361 (0 - 1500 ppm), & K-7371 (0 - 15000 ppm) plus Hach COD Reactor model 45600, Lab-Guard or Hach Safety Shield, Hach DR-890 datalogging colorimeter and Eppendorf Electronic pipettor (100 l - 5 ml).

14. **BOD.** Biological Oxygen Demand measures the amount of oxygen utilized by organisms in the biochemical oxidation of organic matter in a wastewater sample in a specified time (usually 5 days), and at a specified temperature. BOD measurements are used as a measure of the organic strength of the water. Although it is not identical to COD, the speed with which one can obtain COD test results, often dictates that this test is used for prescription purposes. **Typical natural water has a BOD from 0.8 to 5 mg/L.** Anything above 6 mg/L needs to be treated as it will rob the water of needed oxygen for the fish.

Testing for BOD should be performed by an outside lab unless distributor has appropriate equipment. The BOD test performed independently is fairly inexpensive for an individual pond owner.

15. **Pesticides.** Although the USA banned the use of DDT since the early 1970's, nondegraded DDT can still be found in water, released by erosion and storm runoff. **Levels as low as 14 ppm in the water are acutely toxic to marine organisms. Chlordane is acutely toxic between 2.4 and 260 ppm. Heptachlor epoxide is acutely toxic at 0.04 ppm. Endrin is acutely toxic from 0.037 to 1.2 ppb. Dieldrin is toxic above 0.1**. Alken-Murray's formulas can withstand and degrade small amounts of these substances, but a large scale contamination may require alternative treatment options. Independent laboratory tests are required if you suspect pollution from particular pesticides.

16. **FOG**, aka Fats, Oils, and Grease (from natural plants, fish and animal feed etc) can cause stress to aquatic animals if the level is above 0.1 mg/L. **Sudden die-offs will occur if this level reaches 85 - 100 mg/L.** Most ***Alken Clear-Flo 1000* line** aquatic products contain some degraders of fats and greases, but if the level exceeds 6 mg/L, you should add ***Clear-Flo 1003*** to your regimin of pond water treatment.

Independent laboratory tests are recommended for this only if you suspect this to be high in your pond or lake, such as from kitchen waste runoff (illegal in the USA), fatty diet fed to cultured fish showing an oily layer at the top of the water.

17. **Silicate**, often contributes to pond water turbidity and helps diatoms and algae to proliferate. Higher levels of microbial assistance are needed when silicate levels are high (up to 100 mg/L has been found). Adding sand to a formula, adds silica, which can feed algae. **Ideal levels to discourage algae**

should be low, < 15 mg/L.

CHEMetrics kit recommended: K-9010: 0 - 1 ppm & 1 - 10 ppm & K-9011: 0 - 0.2 ppm

1. **Selenium:** No specific toxicity data is available, but the USEPA 1986 has set 54 - 410 ppb (parts per billion) as an action level for this compound in marine environments. This element is necessary in small amounts in feeds.

If you suspect a large contamination, have an independent laboratory test this parameter for you.

2. **Chromium**: Chromium is toxic to marine organisms at 2000 to 105,000 ppm. The most toxic form, hexavalent chromate, is produced in pickling and plating operations, anodizing aluminum, leather tanning, manufacturing of paints, dyes and explosives. Also used to inhibit corrosion in open and closed system cooling towers. After PG&E lost a lawsuit over hexavalent chromium discharged to drinking water of the plant's neighbors, causing major health problems and a movie, named Erin Brockovich became a huge hit, most manufacturers of chemical water treatment for cooling towers can easily convince their clients to use other corrosion inhibitors with less hazardous environmental consequences attendant to accidental release from holding lagoons, so hopefully we will see less hexavalent chromium in ground water, reservoirs and recreational ponds and lakes.

I recommend CHEMetrics kits K2810B (measures 0 to 120 mg/L and 120 to 1200 mg/L) and K2810C (measures 0 to 1200 mg/L and 1200 to 12, 000 mg/L), but you can also purchase K2810D to measure 0 to 30 mg/L and 30 to 300 mg/L and K2810A to measure 0 to 60 mg/L and 60 to 600 mg/L, if you want to test the entire range possible with visual test kits, using the Diphenyl Carbazine method, APHA Standard Methods for Analysis of Water and Wastewater, method 3500-Cr-D (approved in 1995) Alternatively, you can ask an accredited USEPA laboratory to perform this test for you, especially valuable if you intend to sue the company discharging hexavalent chromium to a source that could end up in your lake, pond or reservoir.

3. **Nickel:** Nickel is toxic to marine organisms at 141 ppm. Get an EPA lab to test for this, if you suspect it to be causing fish deaths.

4. **Zinc:** Zinc causes acute marine toxicity at 192 to 320,000 ppm, depending on the species and is chronically toxic at levels of 120 ppm. The average acceptable level of zinc in potable water is 1 mg/L.

Although CHEMetrics offers test kits that measure up to 6 mg/L, to test for serious contamination, send sample to an accredited USEPA laboratory that tests water and wastewater.

5. **Cadmium:** Cadmium is acutely toxic to freshwater species at 10 ppb - 1 ppm.

Cadmium is acutely toxic to marine species at 320 ppb to 15.5 ppm. If suspected, send a water sample to a USEPA accredited lab that tests water and wastewater.

6. **Manganese:** Manganese is required by aquatic species and no toxicity data is available. Surface and ground water rarely contain more than 1 ppm of manganese. Acceptable levels in potable water is less than 0.05 mg/L.

7. **Inorganic Arsenic:** Arsenic is toxic to marine organisms at the level of 2000 mg/L. If this is suspected, send sample to an accredited USEPA laboratory, testing water and wastewater samples. If a massive fish kill or human death is suspected to be caused by Arsenic, contact your local police department for forensic testing for arsenic. If only minor toxicity is suspected, a USEPA accredited laboratory will test water and wastewater samples.

8. **Hydrogen Sulfide:** Hydrogen sulfide inhibits aerobic respiration, inhibits muscle contractions, including breathing, and promotes excess breakdown of glucose. Hydrogen sulfide develops when sulfate-reducing bacteria grow up in the anaerobic sludge of a pond, and no harm is noticed shrimp, prawns, catfish and other bottom-feeders disturb the sludge layer, releasing hydrogen sulfide into the water, where it is first noticed when dead shrimp, prawns or fish float to the surface and a rotten egg odor, is observed. The rotten egg odor will be noticed when as little as 0.25 micrograms of unionized hydrogen sulfide is present in each 1 Liter of pond water. Levels of unionized H_2S in ponds is toxic above 0.033 mg/L are toxic to shrimp and many fish. Some researchers suggest that H_2S above 0.005 mg/L should be considered toxic and treated with ***ALKEN CLEAR-FLO 1005***

If a pond owner attempts mechanical dredging to recover pond depth taken up by organic sludge, this process can accidentally release sufficient hydrogen sulfide gas to cause human deaths, unless workers wear NIOSH approved SCBA (self-contained breathing apparatus). See **Biodredging** to learn about biological dredging of ORGANIC sludge, another option for recovering pond depth lost to an accumulation of organic sludge. If sufficient percentages of inorganic sludge are present (sand, rocks, dirt, etc.) washed down due to soil erosion, mechanical dredging may be the only option to recover pond depth, but to avoid issues with hydrogen sulfide, sludge should be pre-treated with ***ALKEN ENZ-ODOR 6*** to avoid the risk of releasing dangerous levels of hydrogen sulfide when the mechanical dredging begins. This pre-treatment is especially important if the pond is located close to the owner's home. Alkalinity and nitrate levels should be tested to determine if addition of sodium nitrate or ***ALKEN ENZ-ODOR 9*** are also needed or if pond pollution levels are sufficient to prevent formation of acid during oxidation of unionized hydrogen sulfide in the sludge layer of the pond.

CHEMetrics test kit recommended by Alken-Murray for pond testing is: K-9510: 0 - 1 ppm & 1 - 10 ppm., since any level above 10 ppm will have killed everything in the pond and be obvious due to severe rotten egg odor coming frrom the pond. For wastewater testing, Alken-Murray recommends CHEMetrics kits K-9510D for 0 - 30 and 30 - 300 ppm, K9510A for 0 - 60 ppm and 6 0 - 600 ppm, K9510B for 0 to 120 and 120 to 1200 ppm, and 9510C for 0 - 1200 and 1200 to 12,000 ppm, providing you the entire possible range of sulfide in water. The protocol for all of these kits is the APHA Standard Methods method 4500-S-2D, which uses methylene blue methodology to detect sulfides in solution in water.

9. **Sulfate:** I have not found any aquatic limits for sulfate, but the US Public Health has set 250 mg/L as the limit allowed in drinking water.

This test requires an independent laboratory to test. . We usually do not test for this parameter in natural waterbodies, but it is of interest in wastwater treatment.

10. **Salt:** The average acceptable levels for freshwater fish are 0 - 5 ppt. Seawater averages 25 to 70 ppt.**The level that is toxic varies with the species of aquatic animal, from 205.5 ppb for *Zebra danio* to 3,412,000 ppb for pond snails.** LaMotte offers a test kit that measures 0 - 20 ppt of salt. A ***Sper Scientific Refractometer,*** measures 0 - 28% Salinity, and this is the instrument Alken-Murray uses to test salinity.

11. **Magnesium:** The US Public Health has set 150.3 mg/L as the acceptable level of magnesium in drinking water. I cannot find any limits for aquatic applications.

From P. Hazel, PE
Websearch No. Central Texas IDDE Program, ~ Dec. 2013

Table to help analyze field test results

Tier I Parameters	Potential Sources	Level of Concern
Ammonia-Nitrogen	Microbial decomposition of animal and plant proteins, sanitary wastewater, raw or partially-treated sewage, petroleum refining and chemical industries, synthetic fibers and dyes, drugs, pesticides, and fertilizer	1.0 mg/L
Chlorine	Used to indicate inflow from potable water sources; used as disinfectant in water and wastewater treatment processes	0.2 mg/L
Conductivity	Used to measure total dissolved solids (TDS); TDS can increase as a result of wastewater discharges, irrigation, and overuse of fertilizers	1500 µS/cm
Copper	Can indicate waste from manufacture of electrical components, coins, bronze, and brass products	0.2 mg/L
Detergent	Can indicate a discharge from wash water or laundry	0.2 mg/L
pH	Extreme pH values (low or high) may indicate commercial or industrial flows	Below 6.0 su or above 9.0 su
Tier II Parameters	**Potential Sources**	**Level of Concern**
Bacteria (Fecal coliform; *E. coli*)	Can be found in the feces of human and other warm blooded animals from direct discharge	*400 col/100 mL - fecal coliform 394 col/100 mL - *E. coli*
Dissolved Oxygen (DO)	Low DO can indicate sewage problem or excessive nutrient load; as water temperature increases, DO generally	**Exceptional - 4.0 mg/L High/Intermediate - 3.0 mg/L

Texas IDDE

	decreases	Limited - 2.0 mg/L Minimal - 1.5 mg/L
Fluoride	Potable water	0.5 mg/L
Lead	Used in construction material for tank linings, piping, and other equipment for corrosive gasses and liquids	0.1 mg/L
Nickel	Used in making stainless steel and other alloys, coinage, armor plates	0.2 mg/L
Nitrogen Nitrate Nitrite	High levels of nitrate may indicate biological waste or runoff from heavily fertilized areas; nitrites are often used as corrosion inhibitors in industrial process and cooling water and are used in food as preservatives	1.0 mg/L
Phosphates	Found in fertilizer and industrial waste	0.5 mg/L

Txes J 9/7/12

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The NATURE of PLACE

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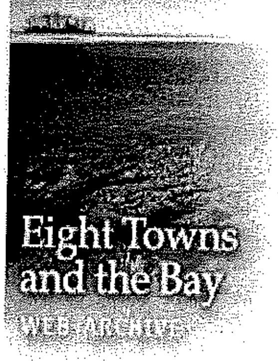

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Water Quality Sampling
An Optical Brightener Handbook

By DAVE SARGENT and WAYNE CASTONGUAY

Summary: The use of Optical Brightener testing as an indicator in helping to identify: faulty septic systems, sewage exfiltration, storm drain cross-connections, and human/animal waste differentiation

Contents

Acknowledgements

Many people helped with this project; too many to mention in the small confines of this report. We have received complete cooperation from everybody concerned - neighbors, City Officials, as well as State Officials.

There are some people, however, that do need to be acknowledged, for without them, there would be no Optical Brightener Handbook. A special note of thanks to Bruce Lorentzen, Robert "Stubby" Knowles, Laura Savina, and Bob Cram for volunteer work above and beyond what anyone could reasonably expect. A special thank you is in order to both the Massachusetts Division of Marine Fisheries and the Gloucester Health Department for never losing faith in the value of this project.

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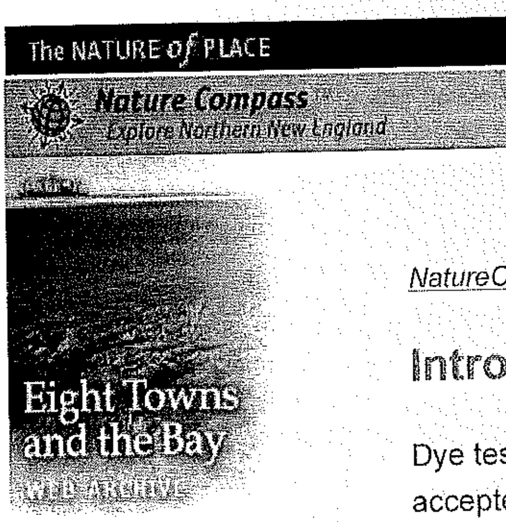

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Introduction

Dye testing (eg. rhodamine, fluorescein) has long been an accepted and successful method in detecting failing septic systems.

This is usually done by placing dye into a toilet bowl, flushing several times, and then visually inspecting the area around the septic adsorption field for surface outbreak. The surface of the ground immediately above the septic system as well as the surface of the ground (and receiving waters) that are immediately down gradient from that septic system are visually monitored for several days. If surface outbreak does occur (when that dye is visually detected) then that septic system is in regulatory failure. (Knowles, personal communication)

Placing an Optical Brightener sampling device into a stream

Optical Brighteners are fluorescent white dyes that are added to almost all laundry soaps and detergents because clothing made from cotton fabrics naturally looks yellowish and drab. This occurs because cotton absorbs blue rays that are present in sunlight. When Optical Brightener is applied to cotton fabrics, they will absorb ultraviolet rays in sunlight and release them as blue rays.

[illegible] why? cotton absorbs blue

Absorb UV rays, release (reflect?) blue rays — makes garment appear whiter than white

Optical Brighteners dyes generally found in domestic waste water (component of laundry effluent)

Brighteners enter subsurface environment — due to ineffective sewage treatment

If sewage treatment (septics) operating effectively

[illegible] Brighteners
1) adsorption onto soil & organic materials
2) photo decay

These blue rays will then interact with the yellowish color and give the garment the appearance of being "whiter than white". Because the main commercial use of these dyes is in laundry detergents and textile finishing, Optical Brightener dyes are generally found in domestic waste waters that have a component of laundry effluent. Optical Brighteners can therefore enter the subsurface environment as a result of ineffective sewage treatment (Fay, Spong, and Alexander, 1995) .

Optical Brighteners are removed from underground waters by adsorption onto soil and organic materials, they are removed from surface waters by adsorption and by photo decay. Since adsorption is a critically important process in the performance of septic field systems, the recovery of Optical Brighteners in nearby waters (either surface or ground water) indicates ineffective natural cleansing of waste waters (Aley, 1991).

Fluorescent dyes (such as Optical Brightener) have been used extensively for tracing surface water and groundwater because of their low detection limits, ease and economy of detection, availability and safety. Fluorescent dyes have successfully been used for delineating otherwise unpredictable groundwater movement (Quinlan, 1981). Fluorescent dyes have also been used as adsorbing tracers in order to predict the possible breakthrough of pesticides in agricultural settings (Everts and Kanwar, 1994).

Because Optical Brighteners are fluorescent white dyes that absorb ultraviolet "U.V." light and fluoresce in the blue region of the visible spectrum, they can therefore be detected by use of a long wave fluorescent "U. V." or a "black" light.

Two Massachusetts groups, the Ipswich Coastal Pollution Control Committee and the Gloucester Shellfish Department / Shellfish Advisory Commission, have found that Optical Brightener testing when done in combination with a larger sampling program is a reliable indicator in helping to identify: faulty septic systems, sewage exfiltration, storm drain cross-connections, and human/animal waste differentiation.

This project links together key individuals of these two North Shore groups for the expressed purpose of producing an Optical Brightener Handbook that can then be used by other water quality monitoring groups.

Next: **Step 1**

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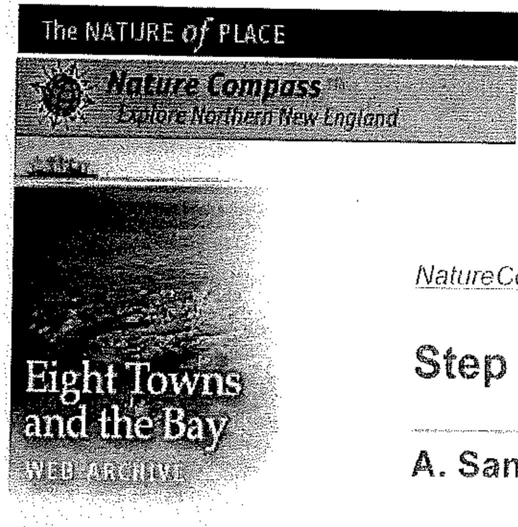

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Step 1: Getting Started

A. Sampling Plan

A sampling plan should be conducted before any sampling has begun. The following are special considerations that should be taken into account when formulating an Optical Brightener Sampling Plan.

1. Combining Optical Brightener sampling with other data

One should be very careful in drawing conclusions from Optical Brightener sampling alone. Optical Brightener sampling is infinitely more accurate and therefore much more useful when it is part of a larger sampling program. When conducting Optical Brightener sampling for marginal or failing septic systems, it is recommended that the monitoring plan also include information on:

a.) Rainfall - Quite obviously, there are fewer potential sources of contamination during dry weather than during wet weather. Rainfall data is therefore vital in being able to pin-point a source(s).

b.) Bacterial Sampling- Because Optical Brightener sampling only provides presence/ absence data, it is important to remember that in many instances, bacterial sampling is necessary to provide quantitative results about a pollution source. Quantitative results are required to determine the concentration of pollutants in a water sample to evaluate the relative contribution of a pollution source to water quality problems and to help guide pollution remediation and enforcement decisions.

c.) Flow data - Flow data is vital information in monitoring as well as in remediation because:

- Without water as a transport vehicle, waste water has no way of reaching and then impacting receiving waters from upland sources.

- Volume flows are needed when calculating bacterial loading. Bacterial loading is calculated by measuring flow in gallons per minute, the number of bacteria in a 100 ml portion taken from that source, and entering this information into the formula: Bac/day = bac x Q x 54800 (where bac= bacterial concentration per 100ml of water and Q is gallons per minute) Kittrell, 1969. Bacterial loading calculations are used to figure the total number of bacteria per day that is being contributed by a source (or sources) to receiving waters and is critical in being able to compare the relative contribution of pollution sources. (As an example: a site which has a bacterial count of 240/100ml and a volume of 100 gallons per minute would have ten times the bacterial loading as a site that has a count of 2,400/100ml and a volume flow of only 1 gallon per minute.)

- Sometimes rainfall and high groundwater can dilute Optical Brightener dye to such a degree that it can not be detected through qualitative sampling.

- By profiling dry weather flow data, one is able to calculate periods of seasonally high and seasonally low groundwater tables.

- Because a high water table can sometimes cause substandard on-site septic systems to fail, there are instances where a sample will be repeatedly negative during low groundwater periods and yet positive during periods of high groundwater.

- It is advantageous to take flow measurements just prior to placement of the rigid O.B. sampling device.

d.) Field Observations- Probably the most essential of all monitoring programs as well as the most difficult to quantify into a database. Some of the more common field observations are :

- Noting the presence of waterfowl or other animal activity.
- Suspicious flows that might indicate either surface outbreak of an on-site septic system or break in a sewer line.
- Unusual growth of algae or other wetland plants that might indicate nutrient loading.

2. Optical Brightener Data Sheet (see Appendix A)

Measuring Water Flow with a Flowmeter

It is essential that all pertinent information be written on the Optical Brightener Data Sheet, at the time of placement, at the time of retrieval, and immediately after reading the results. Information as to total rainfall and the total number of days the sample was in place can be entered at a more convenient time if it is so desired. It should also be noted (because the

O.B. pad remains on site for a period of time) that the total amount of rain that has fallen while the sample is in place is more appropriate than when the last rainfall occurred. For purposes of simplicity, it is sufficient to note total rainfall in one-half inch increments.

3. Proper handling

When handling samples that have been exposed to waters that might contain waste-water, it is always advisable to wear plastic or rubber gloves while handling these samples and to wash ones hands very thoroughly afterwards.

All rigid sampling devices should be rinsed thoroughly in a strong stream of tap water before reuse to prevent potential cross contamination.

It is also a good precaution to avoid *direct contact* with laundry soaps and detergents for 24 hrs. prior to handling any sampling equipment.

4. Quality Control

Although the analysis is relatively simple and straight forward, the reading of these samples should be done by people who have been trained in the reading of Optical Brightener results or at least involved in other forms of qualitative sampling.

As a quality control check, it is recommended that 10 to 20% of all O.B. pads be re-read by properly trained personnel. One source of obtaining this quality control check is the Gloucester Shellfish Department at (978) 281-9741

Another quality control check for monitoring groups is to have a designated portion of their retrieved samples quantitatively sampled. One source for obtaining quantitative results for a fee is:

Ozark Underground Laboratory
Rt. 1, Box 62
Protem, Mo.
417-785-4289

It should be noted that some laboratories require different protocol for the retrieving and handling of samples that will be tested for quantitative results. This information is best obtained by contacting the laboratory that will be conducting those tests.

B. Materials

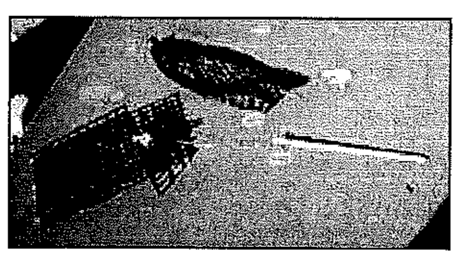
1. Because Optical Brightener is so pervasive when dealing with cotton products, the first hurdle a would-be monitor must overcome is to find a reliable source of untreated cotton pads.

One source for purchasing untreated cotton pads is:

V.W.R. Scientific Products
200 Center Square Rd.
Bridgeport, New Jersey 08014
1-800-932-5000

All cotton pads, regardless of their source, should be checked under a long wave Ultra Violet fluorescent light to make sure they do not contain Optical Brightener before they are used.

2. It is necessary to have a rigid sampling device that will hold the cotton pad securely in place while allowing water to



3/24/09 Notes w/ Doug

5" x 5"

easily pass through it.

Optical Brightener Sampling Devices

In open pipe or stream sampling it is recommended that the rigid sampling device be non-metal plastic or a vinyl coated black 1/2" wire cage that consists of two hinged pieces that measure approximately 5" by 5". This cage should be fabricated so that it will rest at approximately a 30 to 45 degree angle. The open end of this cage is closed with an elastic band.

#5.50/lb 40' x 8" - 1lb

40 bags - rubberbands

galva

Doug Clotgo.

$2.00/cage.

5" square

In sampling catch basins it is recommended that the sampling device be constructed from 1/2" mesh black plastic netting that is closed at the bottom to create a bag. Small stones are placed in the bottom of the bag so that it will not float. The cotton pad sampler is then stapled above these stones to the plastic netting.

Available 9/14, 73

Lobster trap bag

opens to 8"

1½ ft long closed at like onion bag.

shipping $10.00/25

Municipal purchase order

One source for purchasing sampling devices is:

Winchester Fishing Co.
18 Washington St.
Gloucester, Mass. 01930
(978) 281-1619, 283-0757

3. A long wave 4-6 watt fluorescent Ultra Violet (U.V.) light should be used for analysis. Although the most costly component of O.B. sampling, this is critical as the U.V. light must be of sufficient strength and quality to make definitive results possible.

$1.00/bag. L

ship

custom

One source for purchasing a long wave U.V. 4-6 watt fluorescent light is:

V.W.R/Scientific Products
200 Center Square Rd.
Bridgeport, New Jersey 08014
1-800-932-5000

Next: **Step 2**

Text/art: Eight Towns and the Bay *Top*

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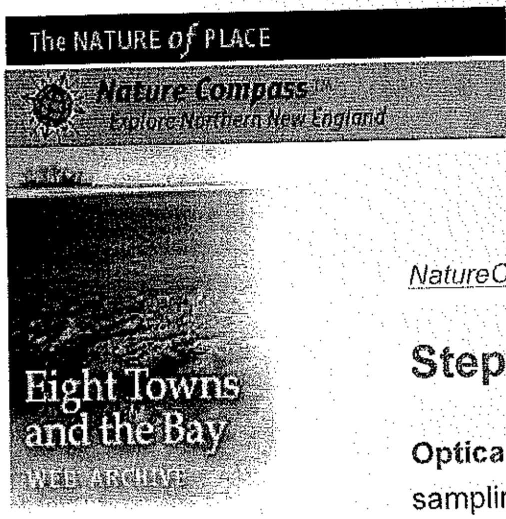


Step 2: Placement

Optical Brightener sampling is best suited for storm drains, pipes, and small streams. Avoid placement in larger bodies of water such as ponds, lakes, rivers, or estuaries, as the larger volume of water contained in these systems will likely dilute the concentration of Optical Brightener to such a degree that it can not be qualitatively detected.

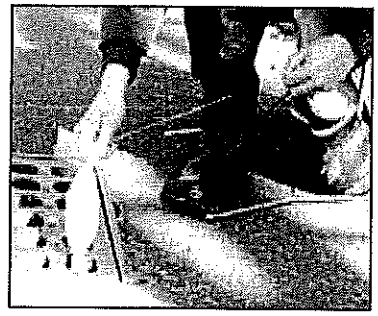
Placing an Optical Brightener sampling device into a stream

In open pipe or stream sampling, the rigid vinyl coated sampling device is secured by an attached monofilament fishing line that is tied at the other end to either a branch, a rock, or an aluminum spike.

In sampling catch basins, the plastic net bag is lowered into the catch basin by use of monofilament fishing line that is tied several times to the top of the bag. The other end of this monofilament line is tied to a craft (popsicle) stick that is then wedged into the side of the grate cover. The monofilament line should be of sufficient length so that the bag will be suspended within the flow of water.

Properly placed rigid sampling devices are almost invisible to the casual passerby. Close attention must be paid to the exact location where they are placed or they may be difficult to retrieve.

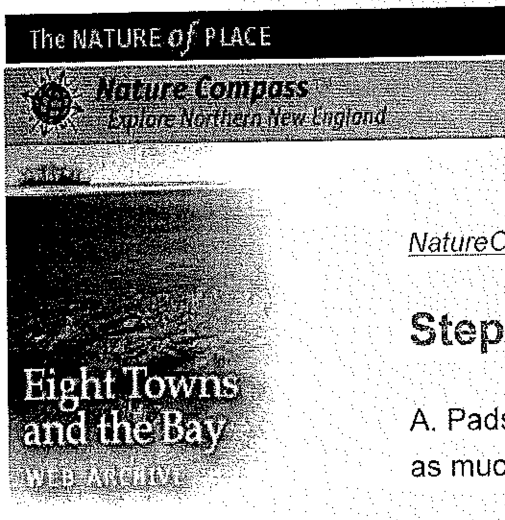
The Optical Brightener sample is generally exposed for 7 days. This is done for a variety of reasons.



Placing an Optical Brightener sampling device into a catch basin

Usually a volunteer(s) will have the same time off from one week to the next. This time frame also allows sufficient time for laundry to be done in the event one is monitoring a direct discharge from a single residence. If background interference hinders the sample from being read (eg. rust or sedimentation) then the length of time the sample is exposed can be shortened. If the result is repeatedly inconclusive (eg. retest) then the time exposed can be lengthened

Next: **Step 3**



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Step 3: Retrieval

A. Pads are first rinsed in the sampling waters to remove as much sediment as is possible.

B. Then the samples are squeezed to remove as much water as is practicable without tearing or ripping the pad.

Retrieving and rinsing the exposed Optical Brightener pad ina stream

C. Next the exposed sampling pads are labeled or tagged for cross referencing.

Most tags and labels are made from white paper and contain Optical Brightener and can interfere with the reading of the sample. Labels cut from darker manila envelopes many times do *not* contain Optical Brightener. *All labels regardless of their source should be checked under the U.V. light to make sure they do not contain Optical Brightener before they are used .*

Labels should have information written on them as to location, day of placement, and day of removal. They are then stapled to the retrieved sampling pads and placed in a zip lock bag (to prevent cross contamination) and placed in a dark area.

D. After all the pads have been retrieved, cleaned, and labeled they are dried out in a space where they will not come in contact with direct sunlight (preferably overnight) on a monofilament line. Cotton line can not be used as it contains Optical Brightener and can interfere with the reading of the sample.

The monofilament line should either be replaced or wiped clean before and after each drying with a damp non-exposed cotton sampling pad.

Next: **Step 4**

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Step 4: The Analysis

A. The pads are placed on a table and viewed in a dark room under a long wave ultra violet fluorescent light. All lights are turned out, doors closed, and all measures possible are taken to prevent ambient light from entering the analysis room. The darker the room is, the easier it will be to read the results.

B. *A non-exposed sampling pad is used as a control and compared to each pad as it is exposed to the U.V. light .*

U.V. light and Optical Brightener sampling pads in the analysis room

C. There are three Qualitative Results: Positive, Retest, and Negative.

A pad will very definitely glow (fluoresce) if it is positive. If it is negative it will be noticeably drab and similar to the control pad. All other samples are undetermined or retests. As each pad is read it is placed in either the positive, negative, or retest pile.

D. In some instances only a portion of the pad or simply the outer edge will fluoresce after being exposed to Optical Brightener. This can be caused by many factors but is usually the result of an uneven exposure to the dye in the watercourse due to sedimentation or the way the pad was placed in the water.

In these cases, one can always account for the unevenness by associating the pattern with the sedimentation distribution, folds in the pad, etc. Regardless, as long as a portion of the pad fluoresces and one can explain why the remainder was not, it should be considered positive.

When in doubt, call it a retest.

There is never a borderline positive or a negative call.

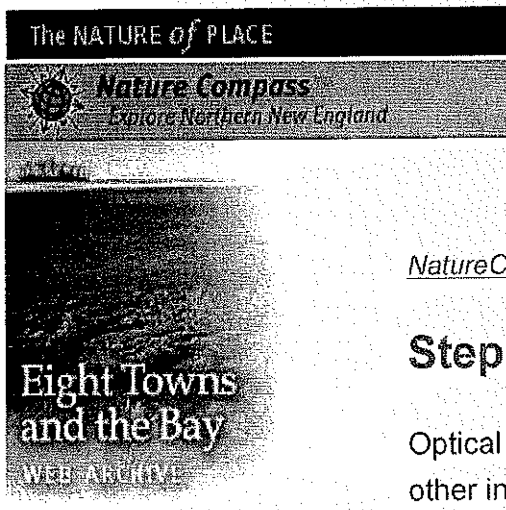
Three piles of Optical Brightener sample results with control pads

Samples can be left in for a longer period of time and/or placed closer to a suspected source in order to get a more definitive result.

E. Since paper and cotton dust is so pervasive, it is common to see specks or spots of fluorescence on the sample or control pads. These should be ignored and not used to indicate a positive result.

F. After all the pads have been read, lights are turned back on and the labels read as to the sampling location.

Next: **Step 5**



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Step 5: Data Interpretation

Optical Brightener results, especially when combined with other information can be an invaluable tool in identifying and locating sources of waste water pollution. The table in Appendix C, which is based on over 1,000 O.B. samples collected in Gloucester demonstrates the many ways this data can be utilized. Appendix B is a breakdown of all the results from those samples in Gloucester and is probably representative of what one might expect in a watershed based approach to a sampling program. The following are examples of case studies which demonstrate some of the different ways that Optical Brightener sampling has been used.

A. Storm Drain Cross-Connection

In Ipswich during routine storm drain monitoring, a sampling site repeatedly tested positive for Optical Brightener and yet parallel bacterial sampling indicated the site was relatively free from dry weather fecal coliform bacteria. When the upstream portion of this drainage system was subsequently sampled through use of Optical Brightener, a direct discharge from a washing machine was found connected into the storm drain. The homeowner had separated the laundry waste from his septic waste in an attempt to reduce flow to a very stressed septic system.

B. Sewage Exfiltration

In a nearby City, a local monitoring group found extremely high fecal coliform levels in a storm drain that discharged into the harbor. Since the City was totally sewered, it was first thought that the source of bacteria must be non-human in origin. Optical Brightener sampling was then conducted at this site and results were consistently positive. After tracing the Optical Brightener through the street drain system, the group located the source of the problem, a leaky sewer pipe. Similar work done within this City identified several similar cases of sewer system exfiltration and even entire City streets in the older sections of town which were never tied into the central sewer system.

C. Human/Animal Waste Differentiation

In 1996 voluntary sampling was conducted in Gloucester prior to the seasonal opening of a conditionally approved shellfishing area.

- During dry weather, sampling was conducted at the discharge point of a perennial feeder stream. Volume measurements were taken and while Optical Brightener results were negative, fecal coliform results were unacceptably high.
- This site was again sampled in dry weather as was an additional site located further upstream.
- Fecal coliform results for the discharge point were once again unacceptably high and Optical Brightener results once again were negative.
- While volume measurements and Optical Brightener results for the upstream site mirrored those taken at the discharge point, fecal coliform results were significantly lower.
- Bacterial loading was then calculated for the discharge point and converted into human equivalents. Bacterial

loading sometimes is expressed as human equivalents (H.E.). One H.E. is the amount of fecal coliform produced by an adult human in one day, or two billion fecal coliforms per day. The H.E. calculated at the discharge point was 11.75 people per day.

- It was known from previous experience (as well as volume measurements) that there was no other inflow to this stream between the two sampling sites. From past experience it was also known that this section of the stream is fairly urbanized and was bordered by only four houses.

- Negative Optical Brightener results and knowledge of the surrounding watershed suggested that it was unlikely this amount of bacterial loading was human in origin. Based on the negative Optical Brightener results, the dry weather bacterial loading, and previous watershed knowledge it was predicted that the likely source for the unacceptably high fecal coliform results was probably non-human in source. Because of the urbanized nature of the stream and the limited number of warm blooded species that could be expected to reside there, it was further predicted that the non-human source was very likely to be waterfowl. Whatever the source, it still needed to be pinpointed and remediated.

- The stream was then walked and sampled by the two Local Shellfish Constables. Midway up the stream between the two sampling sites they found several waterfowl penned in the middle of the stream. Fecal coliform results taken above the pen were low and fecal coliform results taken below the pen were very high. The source had been "boxed in".

- The Local Health Department was contacted and a Health Agent spoke to the residents of the property.

The problem was explained to them in detail and they agreed to remove the pen from the stream.

- Subsequent sampling confirmed that the penned waterfowl were the cause of the unacceptably high fecal coliform results and the shellfishing area was opened on schedule.

Next: **Conclusions**

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Conclusions

A. Simple, low cost but labor intensive "detective" work

- In its simplest form the Optical Brightener sampler is merely dye testing. At the "business end of the pipe" people generally are obliging enough to place dye into their domestic waste water. It is only logical that nearby streams, wetlands, and storm drains be sampled to see if it is detectable from the other end.

Drainage from a perimeter drain to a catch basin

- Although an effective Optical Brightener sampling program is *very* labor intensive, the cost of materials is only about $450.00. Most of that expense is for a good 4-6 watt long wave U.V. fluorescent light. With extra bulbs this should cost about $240.00.

- It has been our experience that a two person team can comfortably do 12 - 15 Optical Brightener samples per day. Any more samples than that and one runs the risk of having a trade-off between quantity of samples with quality of results.

- Optical Brightener sampling is very labor intensive because of: 1.) the paperwork, 2.) care and cleaning of various sampling devices and 3.) because the O.B. pad remains on site for a period of time, a person must travel twice to the same sampling location (placement and retrieval).

B. Optical Brightener results alone are not suitable for enforcement action but when done in combination with a larger sampling program is an invaluable indicator in helping to identify:

Placing an Optical Brightener sampling device at a suspected septic system break out through a retaining wall

- faulty septic systems
- sewage exfiltration
- storm drain cross-connections
- human/animal waste differentiation < e --

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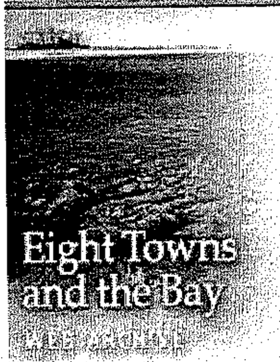

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Appendix A

Optical Brightener Data Sheet

Drainage Area ____________ Collected by ____________ Page __ of __						
Remarks ____________						
Location	Placed	Pulled	No. days	Volume	O.B. +/-	Total Rain

Next: **Appendix B**

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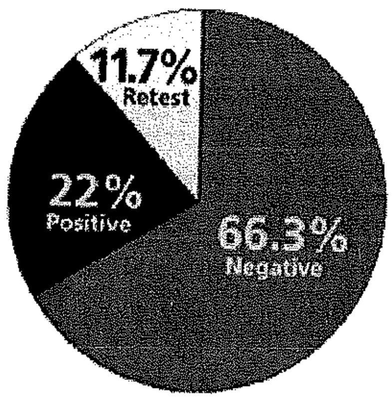
Appendix B

Breakdown by % of 1123 Optical Brightener Samples from 294 different locations in Gloucester



Results as of 10/15/98:

Negative 745
Positive 247
Retest 131

Next: Appendix C

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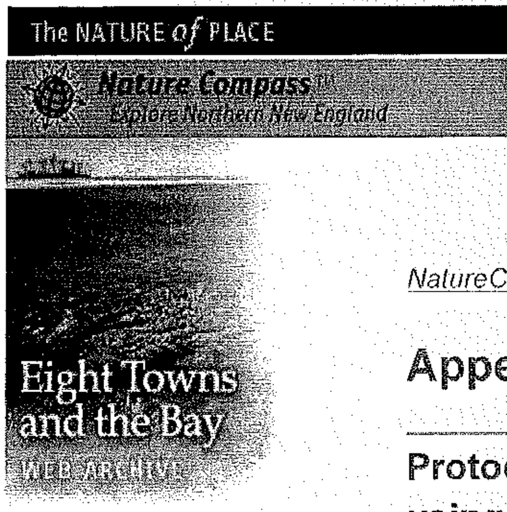

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Appendix C

Protocol for boxing in pollution sources using bacterial loading and optical brightener sampling

Bacterial loading		Optical brightener		Sampling period		Preferred course of action
high	low	pos	neg	wet	dry	
Yes		Yes			Yes	Most likely the result of failing septic systems. Follow the dry weather flow and box in using O.B. and bacterial loading.
Yes			Yes		Yes	Could be caused either by humans or other warm blooded animals. Follow the dry weather flow and box in using bacterial loading
Yes			Yes	Yes		Inconclusive, because there are so many potential sources. Wait and gather dry weather

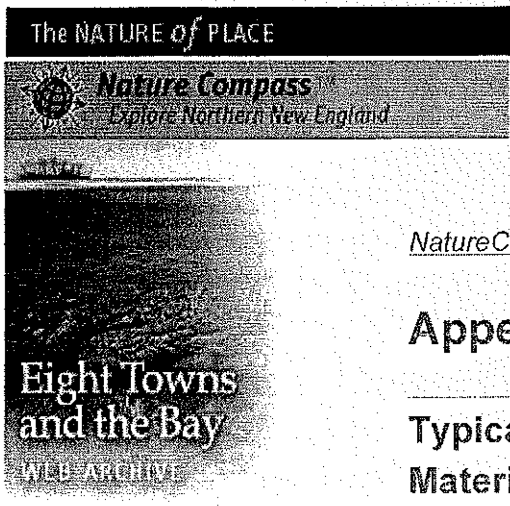
						data.
Yes		Yes		Yes		Most likely the result of marginal or failing septic systems. Either wait to gather dry weather data, or box in using O.B. and bacterial loading
	Yes	Yes			Yes	Most likely the result of marginal septic systems. Follow the dry weather flow and box in using O.B. sampling. Because these systems are more likely to fail during periods of high ground water, volume flows and rainfall events should be closely monitored to try and pick up episodic slugs of bacterial loading
	Yes		Yes		Yes	No evidence of pollution at that time. Wait and gather wet weather data and continue periodic monitoring.
						No evidence of pollution at that

	Yes		Yes	Yes		time. Continue periodic monitoring.
	Yes	Yes		Yes		Most likely the result of marginal or failing septic systems. Either wait to gather dry weather data, or box in using O.B. sampling
Yes						High bacterial loading in the summer and not in the winter usually indicates either lessened seasonal groundwater dilution and/or increased usage by humans or other warm blooded animals during the summer months
Yes						High bacterial loading in the winter during periods of high groundwater and little or no bacterial loading in the summer during periods of low groundwater usually indicates inadequate separation of groundwater from

						septic systems. Box in using O.B. and bacterial loading during periods of high groundwater.

It should be noted that the term "marginal septic systems" refers not only to those septic systems that just partially treat waste water, but also to those septic systems that can only treat human waste by the separation and then improper disposal of grey water.

Next: **Appendix D**



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Appendix D

Typical example of an Optical Brightener Materials List *(1996 prices)*

25 - 1/2" wire mesh (cages)	$ 75.75
42 feet black plastic mesh	$ 4.50
100 yards 20 lb. test monofilament	$ 2.00
500 elastics	$ 10.00
1000 staples	$ 5.00
unexposed labels	$ 12.00
5 boxes plastic bags	$ 5.00
200 craft sticks	$ 2.00
25 aluminum spikes	$ 23.00
1 case unwashed cotton pads	$ 88.00
12 rubber gloves	$ 16.00
6 watt UV light with 2 bulbs	$ 240.00
Total	**$ 483.25**

Black Light

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