

Hach Eclox Rapid Response Water Test Kit



Outline

- **Background**
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- **Cleaning/Maintaining**
- **Safety/Decon Procedures**



Background

- Received Queen's Awards for Enterprise recognition.
- Technique validated by USEPA Environmental Technology Verification (ETV) program to yield reliable detection of heavy metals, poisons, and chemical warfare agents on site.
- Field kit is designed to serve in various applications as a first-line tool in general water quality assessment.



Applications

Municipal applications

- Rapid on-site detection of contamination
 - Intentional: terrorism, vandalism, trespassing, tampering
 - Accidental: automobile accident, cargo spill
- Environmental Monitoring (mapping)
- Natural disaster response
 - Evaluate water quality after floods, tornados or hurricanes
- Pollution incident tracking



Specifications

- **Dimensions:** 520 x 450 x 215 mm (20.5 x 17.5 x 8.5 inches)
- **Weight:** 9 kg (20 lb), fully loaded
- **Operating Temperature:** Tested from -20 to 55 °C (-4 to 131 °F)
- **Quality Standards:** Manufactured by ISO9000 certified company
- **Military Standards:**
 - Def Stan 08-41 Chemical hardness
 - Def Stan 07-55 Robustness
 - Def Stan 00-35 Environmental conditions
- **Batteries (luminometer):** Alkaline cell, lithium cell, AA
- **Battery Life (luminometer):** AA batteries: more than 250 tests
- **Compliance:** CE Marked for compliance with European standards
- **Data Logging (luminometer):** Up to 60 test results recorded in full detail
- **Communication (luminometer):** RS232 cable provided for results download to computer
- **Software:** Database software provided to record and analyze results
- **Tests:**
 - Arsenic
 - Chemiluminescence toxicity
 - Chlorine, free and total
 - Color, APHA Platinum-Cobalt
 - Nerve agents/Pesticides
 - pH
 - Total Dissolved Solids (Conductivity)



Routine Analysis

7 standard tests

- Arsenic
- Pesticide/Nerve agent
- Chlorine
- Color
- TDS/Conductivity
- pH



Routine Analysis

Hands-on

- **Arsenic**

Why?

- *Many CW agents contain arsenic*
 - *Broad range of organoarsenic agents*
 - *Vesicants - Lewisite, Clark I/II, Mustards, arsine*
- EZ Arsenic, 0–500 ppb (0, 10, 25, 50, 100, 250, 500)
- EZ Arsenic, 0–4000 ppb (0, 35, 75, 175, 1500, 4000)
 - Procedures
 - Calibration verification



Routine Analysis

Hands-on

- **Pesticides/Nerve agents**

Why?

- *Pesticides are typically organophosphates*
 - *Most nerve agents contain phosphates*
 - *G-series – tabun, sarin, soman, cyclosarin*
 - *V-series – VE, VG (Amiton), VM, VX*
- Presence/Absence test
- Procedures
 - Positive control



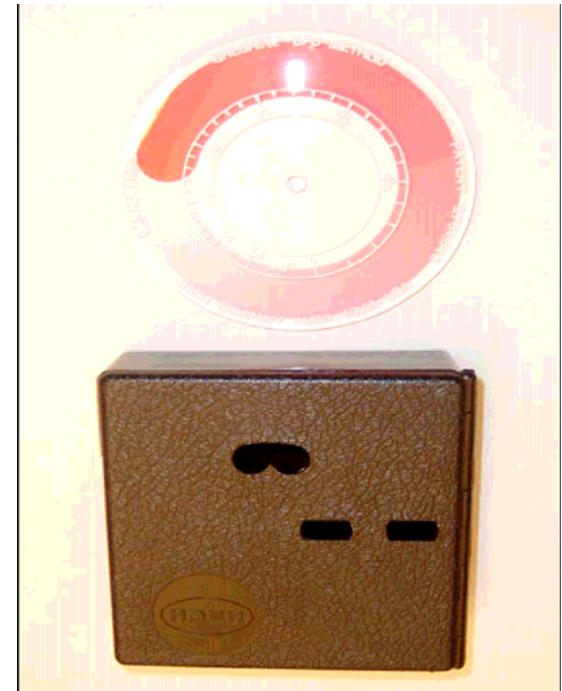
Routine Analysis

Hands-on

- **Chlorine (free or total)**

Why?

- *Determine if pre-conditioner needed*
 - *Chlorine >0.4 mg/L interferes*
- *Process control*
- Chlorinated vs Chloraminated
- Total Chlorine, 0–3.5 mg/L
 - Procedures
 - Monochloramine/free ammonia test
 - Calibration verification



Routine Analysis

Hands-on

- **Color**

Why?

- *Possible indication of contaminant*
- *Process control*



- Color Test, Low Range, 0-100 Pt-Co units (resolution = 1 Pt-Co unit)
- Color Test, High Range, 0-500 Pt-Co units (resolution = 5 Pt-Co unit)
 - Procedures
 - Calibration verification

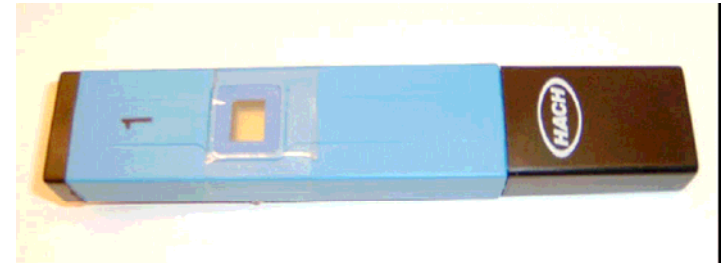
Routine Analysis

Hands-on

• TDS/Conductivity

Why?

- *Possible indication of contaminant*
- *Process control*



- Pocket Pal TDS Tester, 10-1990 ppm TDS (resolution = 1 ppm)
- $TDS = 0.5 \times \text{Conductivity}$ - (Based on NaCl)
 - Calibration
 - Procedures
 - Calibration verification
 - Care and maintenance

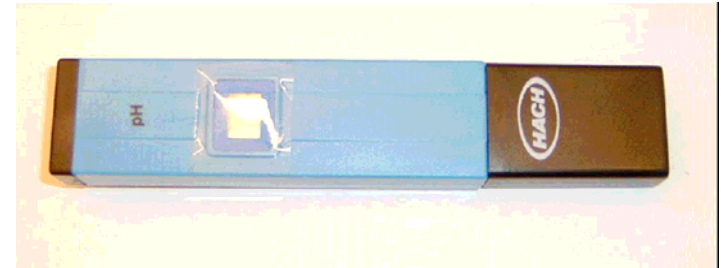
Routine Analysis

Hands-on

- **pH**

Why?

- *Possible indication of contaminant*
- *Process control*



Pocket Pal pH Tester, 0-14 pH units (resolution = 0.1 pH units)

- Calibration
- Procedures
- Calibration verification
- Care and maintenance

Instrument Preparation

- Before operation:
 - Initial electronics and software check (pass)
 - Stem tests
 1. Cell zeroing test
 2. Confirm min/max values
 3. Backlight
 4. Clear all measurements



Instrument Preparation

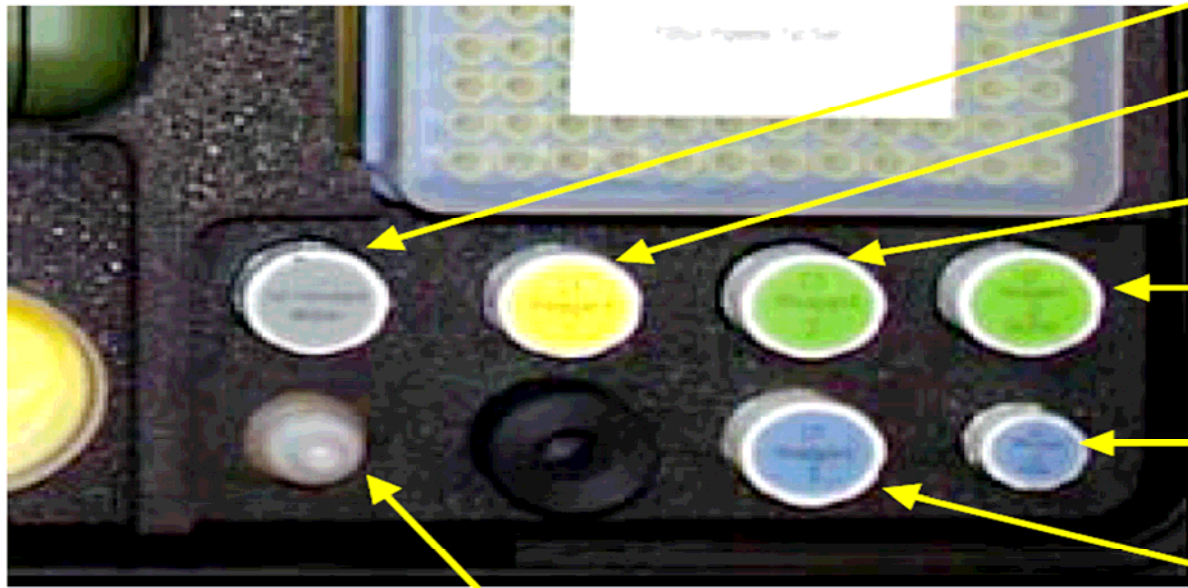
- Understand how to:
 - Set LCD contrast
 - Recall graphs/results
 - Change measurement range
 - 0-1000 light units (normal use)
 - Drinking water in distribution line
 - Raw water influent
 - 0-2000 light units (sea water use)
 - Salt water incursion
 - Natural disasters



Reagent Preparation

Hands-on

- _ CT2 reagent preparation
- _ CT3 reagent preparation



DI Water

CT 1 = Luminol

CT 2 = Oxidant

CT2 Buffer

CT3 = Plant Enzyme
Horse Radish Peroxodate
(concentrate)

CT3 Buffer

Conditioning Solution

Reagent Preparation


Chemiluminescence reagent stability

Reagent	Refrigerated	Raised Temperatures (+40 °C)
Reagent 1	1 year	1 year
Reagent 2 (stable form)	1 year	6 months
Reagent 2 (diluted form)	1 year	72 hours
Reagent 3 (stable form)	1 year	4 months
Reagent 3 (diluted form)	1 year	72 hours

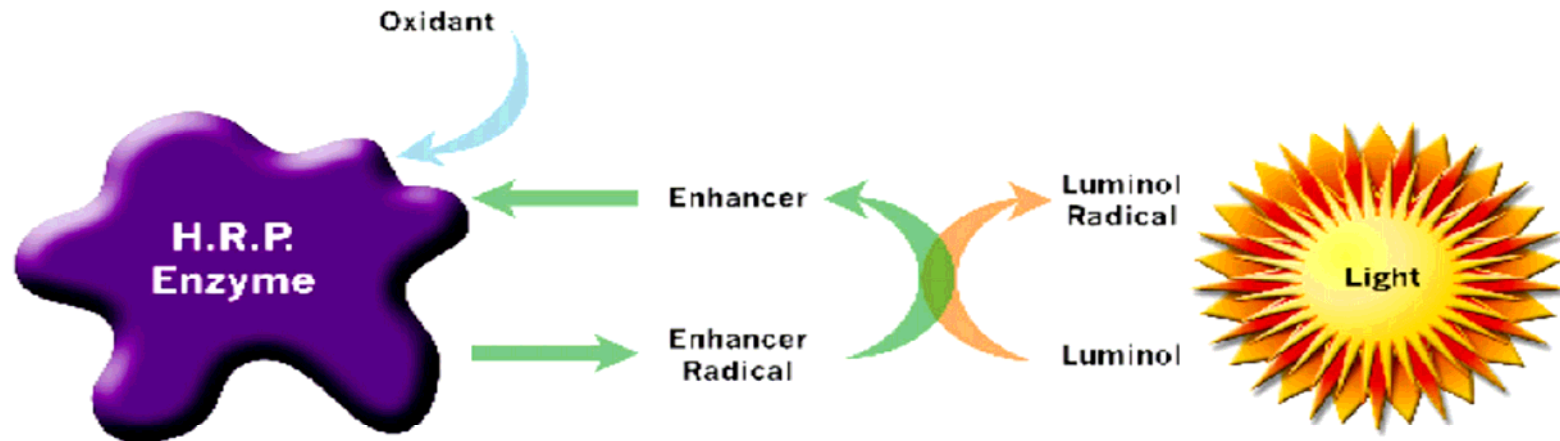


Chemiluminescence Theory

Reagents:

- Luminol $C_8H_7O_3N_3$
 - Same chemical used by forensic investigators to detect blood. It luminesces upon reacting with hydrogen peroxide.
- Horseradish peroxidase (HRP) 
 - Enzyme used in immunohistochemistry to label antigens and their antibodies. Very sensitive, stable enzyme.
- Oxidant (Sodium perborate tetrahydrate) $NaBO_3 \cdot 4H_2O$
 - Sodium perborate undergoes hydrolysis in contact with water, producing hydrogen peroxide and borate. It serves as a source of active oxygen in many detergents and cleaning products.

Chemiluminescence Theory



- Horseradish peroxidase (HRP) reacts with the oxidant to form a reactive oxidized compound, which in turn oxidizes luminol with simultaneous production of chemiluminescence.
- The oxidant concentration is linearly proportional to luminescence intensity.
- Free radical scavengers or anti-oxidants such as those contained in faeces or urine will interfere with the reaction thus reducing the light emission.
- Substances such as phenols, amines, heavy metals or compounds that attack or coat the enzyme, will also reduce the light output.

Chemiluminescence test

- Instrument Calibration
- Sample Measurement
- Interpretation of Results
- Mapping



Chemiluminescence test

Hands-on

- Instrument Calibration

1. Main menu → measure reference
2. Stem tests
3. Procedures
 - a. Add 1000 μL of deionized water to cuvette
 - b. Remove lids from reagent 1, 2, and 3
 - c. Add 100 μL of reagent 1, 2, and 3 to cuvette (new tip for each)
 - d. Tap twice to mix
 - e. Place cuvette in luminometer, close lid → Proceed
 - f. Remove cuvette and dispose of product and cuvette
 - g. Reference should be between 300-900 light units



(Only one reference measurement required for multiple measurements)

Chemiluminescence test

Hands-on

- **Sample Measurement**

1. Main menu → measure sample
2. Stem Tests
3. Procedures
 - a. Fill beaker with 50 mL of sample
 - b. Add two drops of pretreatment reagent if chlorine (total) >0.4 mg/L
 - c. Add 1000 μ L of sample to cuvette
 - d. Add 100 μ L of reagent 1, 2, and 3 to cuvette (new tip for each)
 - e. Tap twice to mix
 - f. Place cuvette in luminometer, close lid → Proceed
 - g. Record % inhibition and graph on test record sheet
 - h. Remove cuvette and dispose of product and cuvette
 - i. Sign test record sheet
 - j. Dispose of unused sample from beaker accordingly



Results

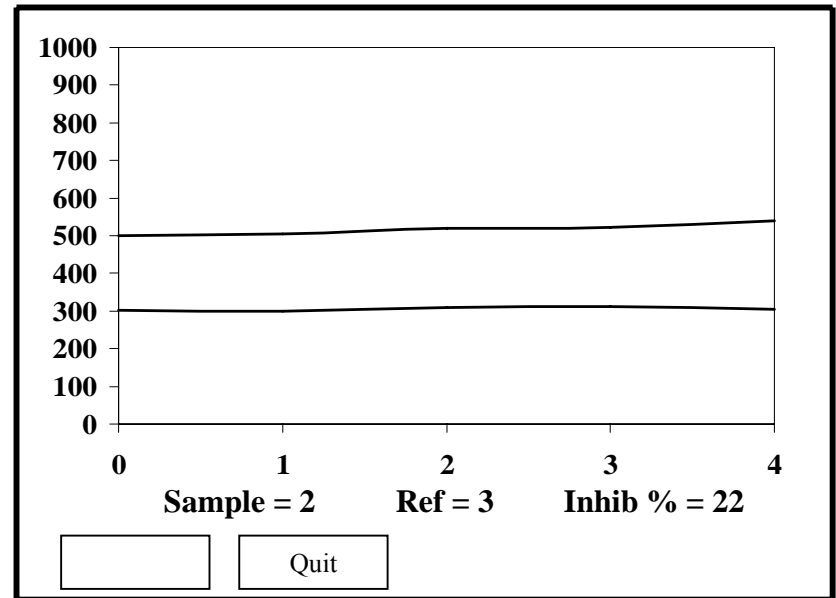
- Luminometer Display
- Previous Results
- Previous Graphs
- Interpretation



Results

Luminometer Display

- After 4 min analysis display will show:
 - Analysis graph
 - Reference measurement
 - Sample measurement
 - Sample number
 - Measured inhibition



Results

Previous Results

- Up to 60 previous results and graphs can be stored
(Includes sample and reference used)
 - A. Main menu → previous results
 - B. Previous results
 1. Recall results → **Enter**
 - C. Table displays:
 1. Sample #
 2. Reference #
 3. Inhibit %

Sample	Reference	Inhibit %
1	3	17
2	4	19
3	5	42
4	6	64

Results

Previous Graphs

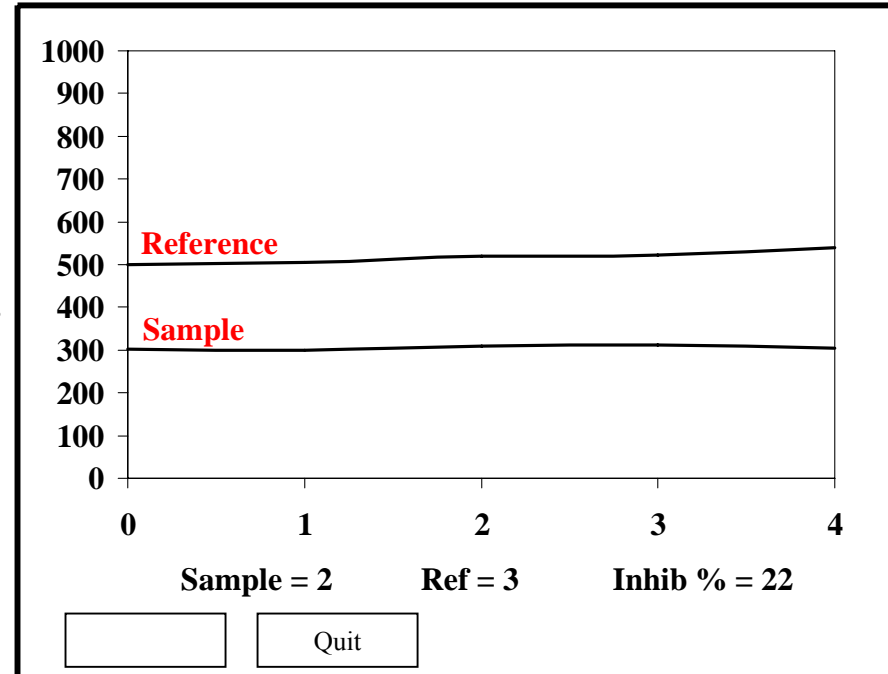
A. Main menu → previous results

B. Previous results

1. Recall graphs → **Enter**

C. Select multiple stored graphs

1. Press **select** button a second time on last selected graph number and select new graph.



Results

Interpretation of Results

- Results are qualitative
- Positive inhibition
 - radical scavengers, anti-oxidants (reduce light emission)
 - Pesticides, herbicides, CW/BW, hydrocarbons, polluted samples
- Negative inhibition
 - Non-polluted sea water samples (~-40% inhibition)
 - As non-polluted sea water → polluted seawater
 - % inhibition will increase (towards 0%) and then go positive, e.g. 10%.
 - Low concentrations of accumulative metals

Results

Positive inhibition

Negative inhibition

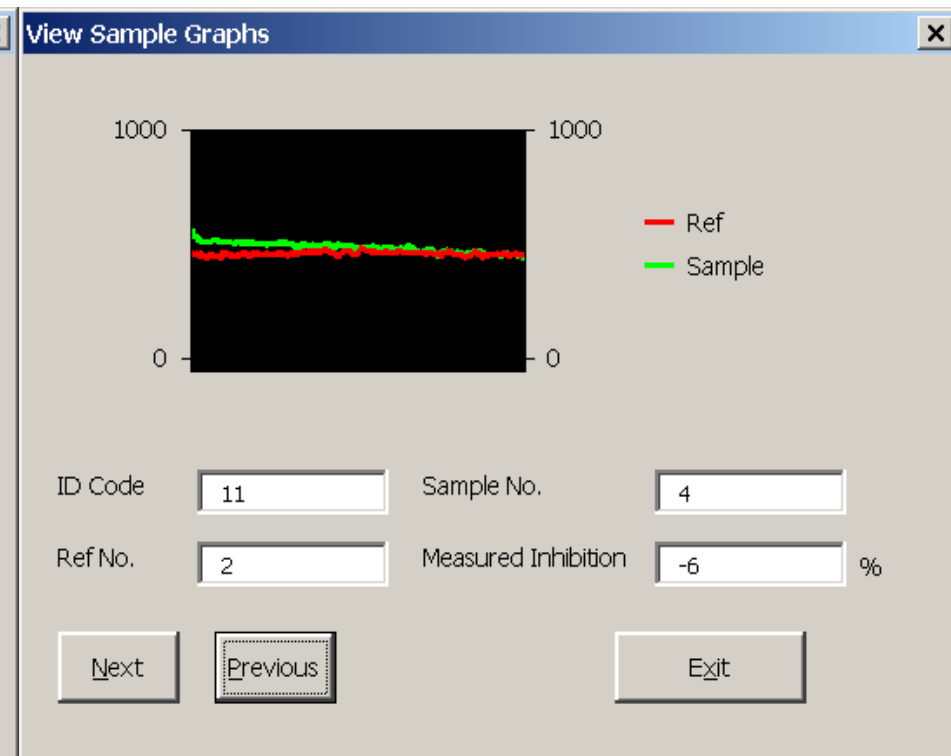
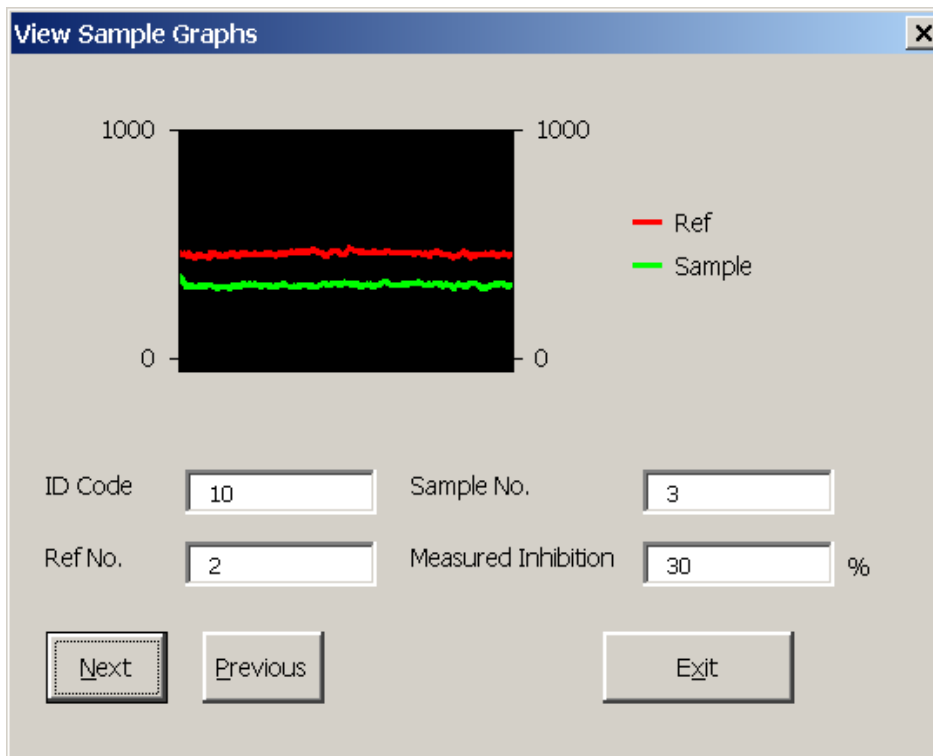
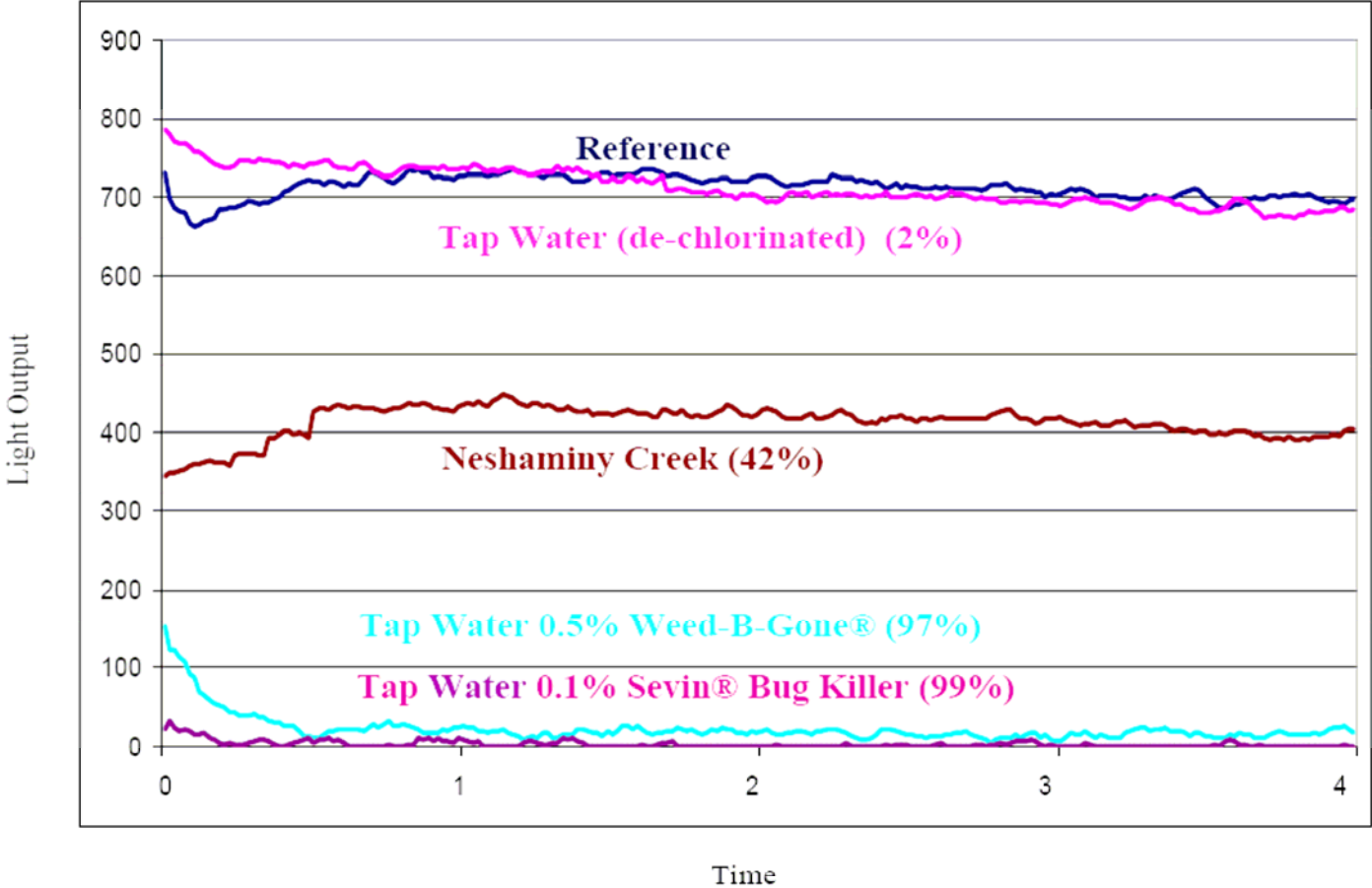


Fig 1: Fort Collins, Cache La Poudre (surface water)

Fig 2: 10 mg/L Copper standard (deionized water matrix)

Results



Mapping

So what do we compare these results with?

- Previously measured sites
 - Seasonally
 - Monthly
- Environmental Monitoring
 - *def*: The process of checking, observing, or keeping track of something for a specified period of time or at specified intervals.
- Pollution incident tracking



Mapping

1 w Sample Graphs

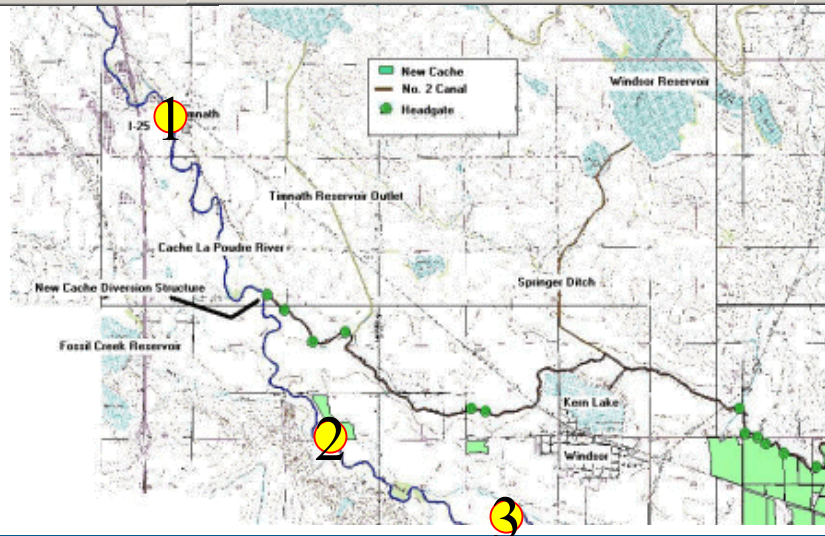
ID Code: Sample No.:
 Ref No.: Measured Inhibition: %

2 w Sample Graphs

ID Code: Sample No.:
 Ref No.: Measured Inhibition: %

3 w Sample Graphs

ID Code: Sample No.:
 Ref No.: Measured Inhibition: %



- 1** Upper Cache La Poudre
- 2** Fort Collins, Cache La Poudre
- 3** Windsor, Cache La Poudre



Download Results

Downloading data to PC

- Install Disc Program Automatic Data Processing CD-ROM
- Data transferred by clicking on the Luminometer Transfer icon
- Once transferred data can be stored on hard drive or floppy disk
- Data can be viewed and analyzed in graphical and tabular format using Microsoft[®] Excel[®] 97 (or greater)

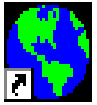


Download Results

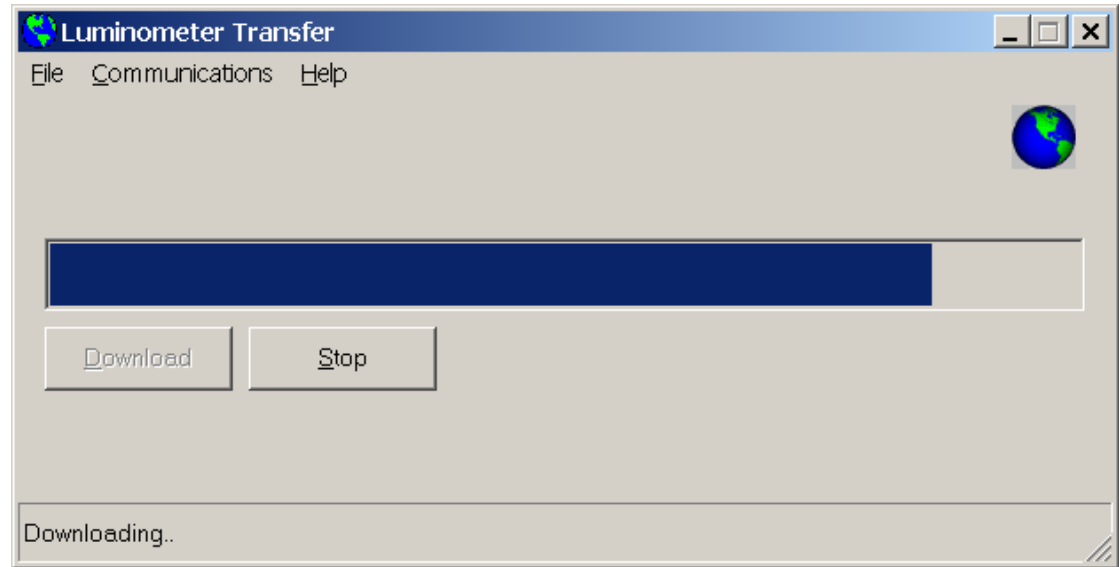
Set up luminometer:

Main menu → previous results → Download to PC

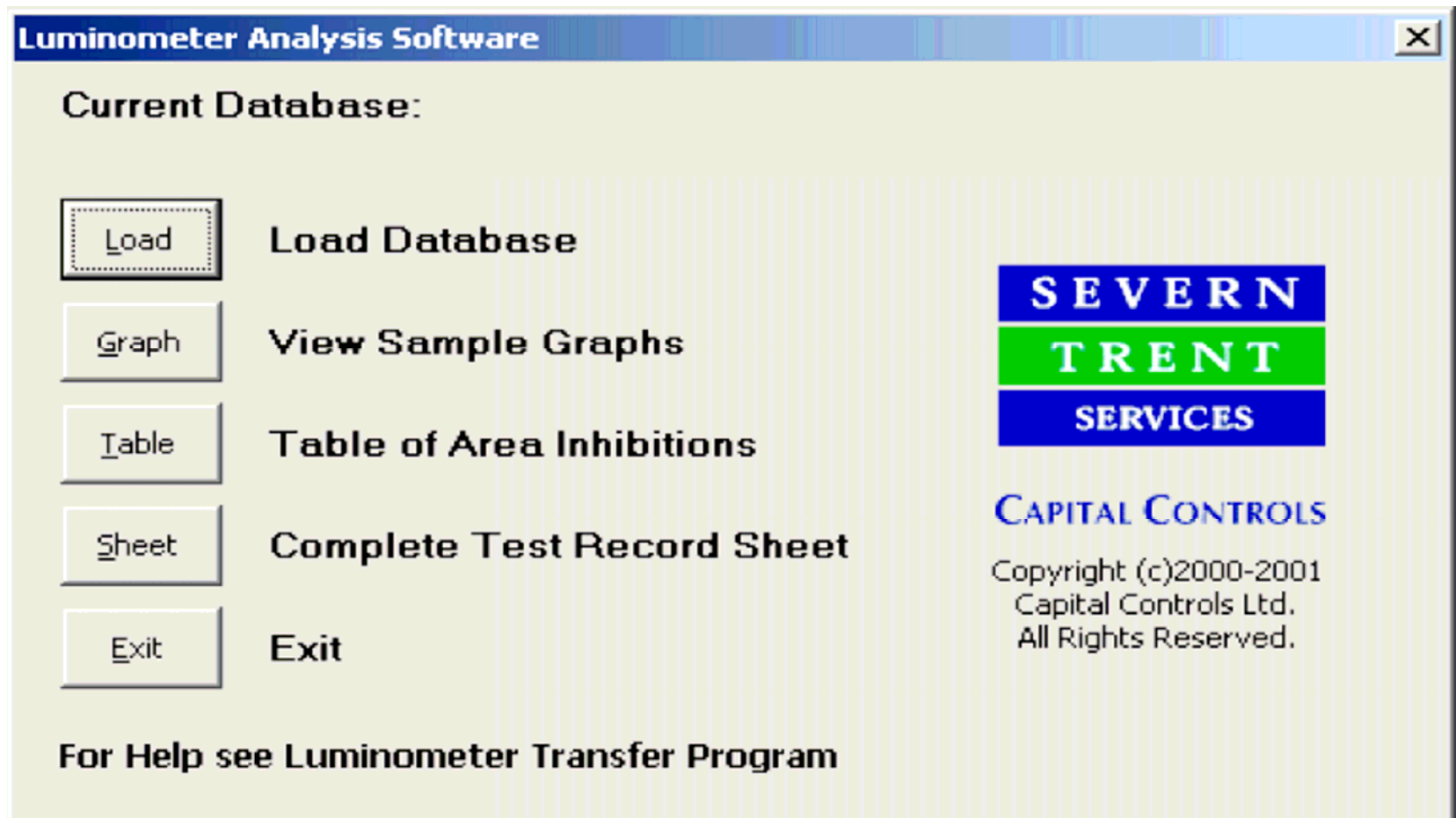
Set up PC:



Luminometer Transfer.Ink

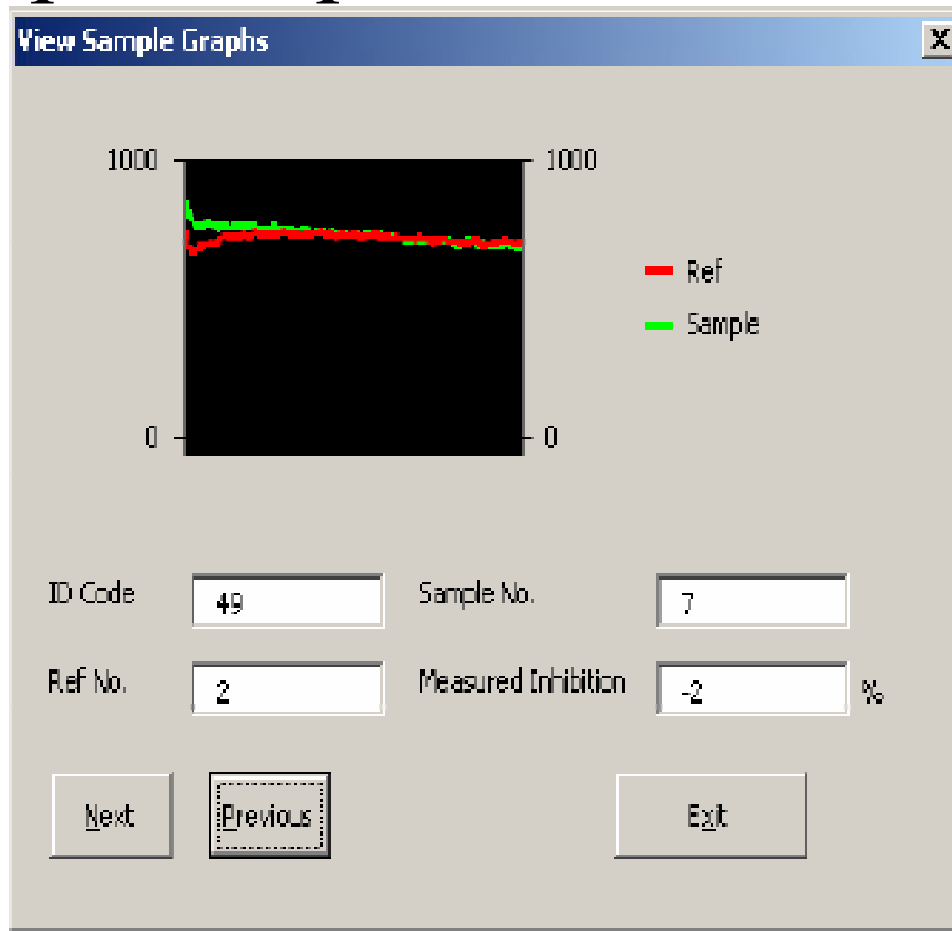


Download Results



Download Results

View Sample Graph:



Download Results

Table of Area Inhibitions:

ID Code	Sample Number	Measured Inhibition %
8	1	93
9	2	-5
10	3	30
11	4	-6
12	5	54

Displayed in Microsoft[®] Excel 97 (or greater)



Download Results

Complete test record sheet:

Water Test Kit (Biological & Chemical) Test Record Sheet

Operator: FSK Date Time Group: NOV 17 2003

Location: Main service tap

Sample: Source Water Following WPU(S) Following WPU(NBC)

LUMINOMETER Serial Number: 22-98653331

Test No.	Test Description	Results (tick or fill in result)			
1	Mustard Gas Test	No test run	<input checked="" type="checkbox"/>	Red (no mustard gas)	<input type="checkbox"/> Blue (mustard gas)
2	Arsenic Test	Arsenic value mg/l	0.0	1.4 or under	<input checked="" type="checkbox"/> Over 1.4
3	Pesticide/Nerve agent strip	Test Complete	<input checked="" type="checkbox"/>	Blue (no agent)	<input checked="" type="checkbox"/> White (agent present)
4	Chlorine	Chlorine value mg/l	.5	5 or under	<input checked="" type="checkbox"/> Over 5
5	Colour	Colour value Hazen	10	25 or under	<input checked="" type="checkbox"/> Over 75
6	Total Dissolved Solids	TDS value mg/l	390	1500 or under	<input checked="" type="checkbox"/> Over 1500
7	pH	pH value	7.8	between 5.0-9.2	<input checked="" type="checkbox"/> under 5.0 over 9.2
8	Chemiluminescence	If Chlorine value mg/l: add number of drops of pre-conditioner: <input type="checkbox"/> 0 - 0.4 mg/l add 0 drops <input checked="" type="checkbox"/> over 0.4 mg/l add 2 drops			
	Add 1000ul sample	<input checked="" type="checkbox"/>	Sample Number	6	
	Add 100ul reagent 1	<input checked="" type="checkbox"/>	Ref Number	2	
	Add 100ul reagent 2	<input checked="" type="checkbox"/>	ID Code	48	
	Add 100ul reagent 3	<input checked="" type="checkbox"/>	Measured Inhibition	-1 %	
	Empty Luminometer	<input checked="" type="checkbox"/>			
	Empty Beaker	<input checked="" type="checkbox"/>			

Initial When Complete: FSK

Buttons: Next, Previous, Exit



Cleaning/Maintenance

Cleaning the Luminometer:

- Wipe down with clean damp cloth
- Exterior of luminometer can be decontaminated in event of CW

Cleaning the Kit:

- Reliable results obtained when kit is cleaned/maintained
- Clean the kit prior to storing
- Case can be decontaminated in event of CW
- All other components of kit must be discarded and quarantined in event of CW (Replace all components)
- Decontamination form filled in kit



Cleaning/Maintenance

Decontaminating Kit:

- Dispose of kit contents properly if contaminated (Make sure latches are engaged)
- Wet surface of kit/luminometer with water
- Scrubbing using decon solution (15 min)
 - Industry standard (Calcium hypochlorite, 1% - 9%)
 - Detergent
- Rinse thoroughly
- Mop up contaminated water with cloth or paper and dispose of properly



Safety/Decon Procedures

- Safety Gear
- Isolating and Marking
- Methods of Decontaminating Individuals
- Methods of Decontaminating Exterior Surfaces
- Methods of Decontaminating Interior Surfaces

Source: NAVSEA - <http://www.dcfp.navy.mil/index.htm>



Training Lesson 4.7



Safety/Decon Procedures

Safety Gear

- Protective coat
- Protective trousers
- Protective mask
- Overboots
- Glove inserts
- Chemical resistant gloves
- Canteen
- Decon kit – (Calcium hypochlorite)

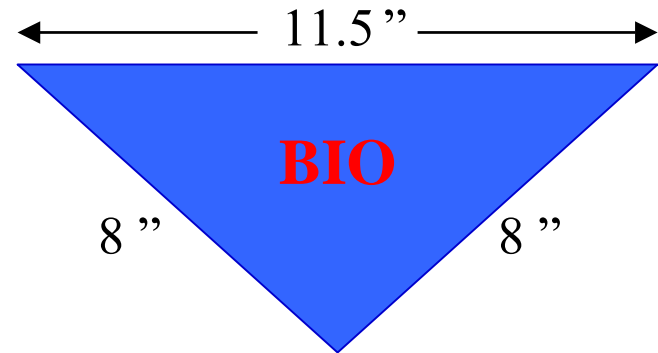


CBR-D Kit Bag

Safety/Decon Procedures

Isolating and Marking

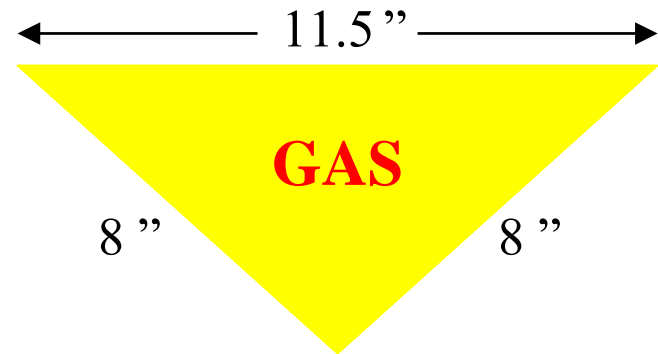
- Contact Appropriate Authorities
- Bio Marking
 - Required info on marker
 - Agent
 - Date
 - Time
 - Attach marker so letters face away from contaminated area



Safety/Decon Procedures

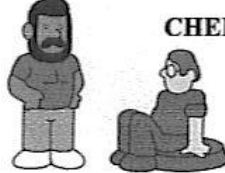
Isolating and Marking

- Contact Appropriate Authorities
- Chemical Marking
 - Required info on marker
 - Agent
 - Date
 - Time
 - Attach marker so letters face away from contaminated area



Safety/Decon Procedures

- Self and Buddy Decon Procedures



**CHEMICAL STOCKPILE EMERGENCY
PREPAREDNESS PROGRAM
(CSEPP)**

SELF AND BUDDY DECON

Begin immediately. Don't wait to be "officially" decontaminated by special decon personnel. Buddy Decon is easier and allows for more thorough rinsing of places difficult to reach.

DECON STEPS:

- Remove all clothing, cutting off that normally removed over head. Decon hands using undiluted household bleach. Remove eyeglasses/contact lenses. If eyeglasses needed to evacuate, soak in bleach 5 minutes; rinse thoroughly with plain water.
- Remove hearing aids, artificial limbs, jewelry, watches, toupees, and wigs from body. If artificial limb needed to evacuate, remove it, wipe down with bleach, air it 5 min, rinse it, and reattach it.
- Flush eyes with lots of lukewarm water.
- Gently wash face & hair with soap/lukewarm water; thoroughly rinse with lukewarm water.
- Decon other body surfaces with bleach. Blot (not swab or wipe) with cloth soaked in bleach. If don't have bleach, wash and rinse with lukewarm water.
- Put on uncontaminated clothing. Clothing stored in drawers/closets unlikely to be contaminated.
- Place contaminated items in plastic bags.
- Proceed to nearest decon station, carrying only critical items (in plastic bag).

Source: Emergency Management Center -

<http://www.emc.ornl.gov/>



Safety/Decon Procedures

Most Heavily Contaminated Areas

Areas most heavily contaminated

⌘ CW agents

- ☑ All decks & horizontal surfaces
- ☑ Vertical surfaces facing wind
- ☑ Painted surfaces may absorb CW agents

⌘ BW agents

- ☑ Small diameter cylinders such as lines, halyards, ropes & handles
- ☑ All surfaces close to edges, corners, and protruding fittings

Safety/Decon Procedures

Methods of Decontaminating Exterior Surfaces

Decontamination procedures

⌘ Exterior surfaces

- ☑ Countermeasure wash down system
- ☑ Decon teams
- ☑ Work top to bottom, windward to leeward
- ☑ Fire hosing & scrubbing
- ☑ 1% hypochlorite/detergent solution
- ☑ Heavily contaminated use 9%

Safety/Decon Procedures

Methods of Decontaminating Interior Surfaces

Decontamination procedures

- ⌘ Vertical surfaces, scrub top to bottom
- ⌘ Horizontal surfaces, scrub one direction
- ⌘ Retest area for contamination
- ⌘ Interior spaces using HTH/decon solution
 - ☑ Push contamination toward center of the contaminated area
 - ☑ Mop up contaminated water with cloth or paper & dispose of in containers



Source: NAVSEA - <http://www.dcfp.navy.mil/index.htm>



LANGE 

Hach Eclox Rapid Response Water Test Kit

