

# DoD Environmental Monitoring & Data Quality Workshop

# April 2005 Myrtle Beach, South Carolina





## **Speakers**



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An Innovative Field-Based Analytical Method for Low-Level Detection of Chlorinated Compounds in Groundwater and Soil Samples

# **Color-Tec Method**

DoD Environmental Monitoring & Data Quality Workshop

#### **Field Analytical Chemistry Session**





## **Color-Tec Method**



- Field-based analysis of water and soil samples
  - Innovative combination of sample purging with colorimetric detector tubes
  - Detects low concentrations (< 10 ppb) of chlorinated compounds
  - Provides qualitative analysis
  - Provides tentative quantification of total chlorinated compounds (approximate concentrations)





## **Color-Tec Method – Assembly Diagram**



# **Color-Tec Method – Purge and Analysis**



# **Color-Tec Method – Purge and Analysis**



# Color-Tec Method – Soil Sample Preparation



- × Place ~30 gram soil sample in vial
   × Add water to ~75% capacity in
  - vial
- x Seal vial and shake to mix soil and water
- x Purge procedure same as with water samples





## **Color-Tec Method – Colorimetric Tubes**

- × Manufactured by Gastec® Corporation
- × Similar to Dräger tubes
- Originally designed for occupational breathing-zone air monitoring
- × Four concentration ranges (LL, L, M, HA)



# **Color-Tec Method Compounds Detected**

#### **Chlorinated Alkenes**

EPA MCL (µg/	
5	
5	
70	
9 100	
7	
2	

#### **Chlorinated Alkanes**

<u>Compound</u>	EPA MCL (µg/L)
Carbon tetrachloride	5
Dichloromethane (methylene chloride)	5
1,1-Dichloroethane	-
1,2-Dichloroethene	5
1,1,1-Trichloroethane	200

#### All Chlorinated Alkenes and Alkanes are Detected - Stated as "Total Chlorinated Compounds"



# Color-Tec Method Potential Limitations

- x Possible Chemical Interferences
  - Free Chlorine **Positive Interference**
  - HCL
  - Toluene
- **Negative Interference**
- Xylenes
- **x** Possible Physical Limitations
  - Subtle color change at low levels
  - Airborne contaminants
  - Temperature





# **Color-Tec Method – Analytical Sensitivity**

Determined in two ways:

- Detected PCE and vinyl chloride prepared standards
  - 1.0 μg/L 70%
  - 。10 μg/L- 100%
- x Routinely detects PCE, TCE, 1,2-DCE and vinyl chloride to near or below the EPA MCL in field sample GC/MS data pairs



## Color-Tec Method - Comparative Accuracy Anderson's Cleaners, Walterboro, SC

- Delineated lateral and vertical extent of groundwater plume (primarily vinyl chloride)
- Determined impact of contaminants on a creek intersecting the groundwater plume.
- 258 liquid samples collected for Color-Tec analysis plus 100 split samples for laboratory analysis
  - Groundwater (Profiles & Wells)
  - Wastewater (sewer)
  - Pore-water (Ireland creek)
  - Surface water (Ireland creek)





#### Color-Tec Method - Comparative Accuracy Anderson's Cleaners, Walterboro, SC





#### Color-Tec Method - Comparative Accuracy Anderson's Cleaners, Walterboro, SC

- x 42 of the split sample pairs exhibited Color-Tec zero readings:
  - 69% (29 samples) contained no contaminants detectable by GC/MS
  - 31% (13 samples) exhibited below-MCL concentrations by GC/MS
- × All GC/MS detections above MCLs detected by Color-Tec
- x The highest GC/MS concentrations undetected by Color-Tec were:
  - PCE 2.55
  - Cis 1,2-DCE 2.40
  - Vinyl chloride 1.8



Color-Tec Value// Tube Reading	Corresponding GC/MS Value Range (µg/L)		Number of Data Pairs
	Low	High	(N)
0/LL	ND	2.6	42
0.1/LL	0.32	10.1	7
0.2/LL	0.52	33.9	8
0.5-0.8/LL	3.05	177	18
1-3/LL	13.5	300	13
6-20/L	49.8	1,814	8
25-100/M	2,186	13,744	4
Total Quantity of Split Sample Pairs			100

## **Color-Tec Method – Cost**



- x Kit Purchase
- x Colorimetric tubes
- x Disposables
  - Needles and tubing
  - VOA vials

\$1500.00\$5.00 per sample\$3.00 per sample

# **Total Cost Per Sample**

\$8.00



# Color-Tec Method Applications Dynamic Field Activities and EPA Triad



# Field-Based Decision/Collaborative Data Approach Using Color-Tec

#### Stand-Alone Definitive Analysis Approach



- Definitive analysis provides high analytical accuracy.
- Sampling quantity is reduced to control cost, resulting in poor sampling coverage.
- The second source area remains undetected, creating low overall data quality.

#### **Collaborative Data Approach**

- The low per-sample cost allows for more sampling points.
- The secondary source area is located.
- The increased sampling coverage reduces sampling uncertainty.
- The color-Tec data is used to focus the definitive analysis methods onto critical areas.
- Combining Color-Tec and laboratory sampling increases overall data quality by providing improved sampling coverage with high analytical accuracy.





# Field-Based Decision Approach Former Callaway Drum Recycling



**Orlando** 

Preliminary Assessment/Site Inspection for a CERCLA Hazard Ranking System (HRS) Evaluation

- Determine operational history of facility
- Identify Contaminants of Concern
  - ${\bf q}_{\rm I}$  chlorinated and petroleum compounds
- Locate source areas
  - $_{\mbox{\scriptsize q}}$  Drum cleaning and processing
- Identify potential receptors
  - g Drinking water wells
- Evaluate potential migration pathways
- Determine HRS Score

Auburndale, Florida



# Field-Based Decision Approach Former Callaway Drum Recycling



Primary Assessment Goal

 Locate source areas – find highest concentrations of COCs

Limited budget = limited sampling quantity

- Scope of Work
- Direct-Push Soil and Groundwater Profiling
- Field-Based analysis of 140 samples using Color-Tec and FID/PID to locate hot spots
- Laboratory analysis of 12 samples (based on field data)



# Field-Based Decision Approach Former Callaway Drum Recycling



#### Focus Area A

- 21 samples collected for fieldbased analysis
- 3 samples selected for labanalysis based on field results
- A1 and A3 = Zero or low-level results on Color-Tec and TVA
- A2 = Positive response on CT and TVA
- Laboratory data confirmed field results



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Color-Tec Units	T\			
	PID	FID	Laboratory	
110	432 ppm	4,000 ppm	PCE 7,300 μg/L	

# Field-Based Decision Approach Former Callaway Drum Recycling



#### Focus Area B

- 38 samples collected for field-based analysis
- 3 samples collected for Lab-based analysis
- Low-level or zero Color-Tec/TVA responses
- Lab data confirmed the field-based results only low levels detected





# Field-Based Decision Approach Former Callaway Drum Recycling



#### Focus Area C

- 37 samples collected for field-based analysis
- 6 samples collected for Lab-based analysis
- TVA detected high concentrations in all borings
- Lab analysis confirmed TVA results –several petroleum compounds detected
- All Color-Tec results were negative (zero)
- Lab analysis confirmed Color-Tec results, no chlorinated compounds were detected





# Field-Based Decision Approach Former Callaway Drum Recycling



#### Assessment Results

- Primary source areas located
- Highest concentration samples identified and sampled
- Site scored based on potential impact to drinking water aquifer

# **106 field samples > 12 laboratory samples**

Increased Sample Coverage + Definitive Analytical Data



Reduced Sampling UncertaintyIncreased Overall Quality

# **Color-Tec Method Applications Plume Delineation**

#### x Vertical Profiling

- Collection of discrete samples at multiple depths and locations to define the lateral and vertical extent of a contaminant plume
- Used with in-field sample analysis, the real-time data allows for immediate decisions regarding sampling further locations







Magnitude and Extent of Contamination Unknown





Identified Magnitude and Extent of Contamination



Identified Magnitude and Extent of Contamination



Identified Magnitude and Extent of Contamination





Identified Magnitude and Extent of Contamination



Plume Delineation Complete





DAY 0

Magnitude and Extent Unknown





DAY 1 Profiling Begins





DAY 3 Profiling Continues





DAY 5 Profiling Continues





DAY 7 Profiling Continues





DAY 9 Profiling Continues





DAY 10 Profiling Complete

Groundwater Contaminant Plume Delineated





Monitoring Well Network Installed Based on Profiling Field Data

Plume Boundaries Confirmed Using Laboratory Analysis



# **Color-Tec Method Applications Remediation & Monitoring**

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- In-field confirmation of cleanup objectives Segregation of soils for various treatment x options
- **Reduce long term monitoring costs by using** x **Color-Tec analysis in place of laboratory** analysis for selected sampling events







# Phytoremediation Monitoring Former Utilities Site, LaSalle Illinois

- Treatment of PCE and TCE shallow in groundwater using phytoremediation
- Approximately 1100 trees (willow and cottonwood)
- Contaminant up-take is monitored using Color-Tec Method
- Detects low-concentrations (<5 µg/kg) in tree tissue samples</li>
- Low cost allows for increased sampling
- Using real-time analysis reduces loss of volatiles resulting from shipping.









# Color-Tec Method O Rec Mathod



