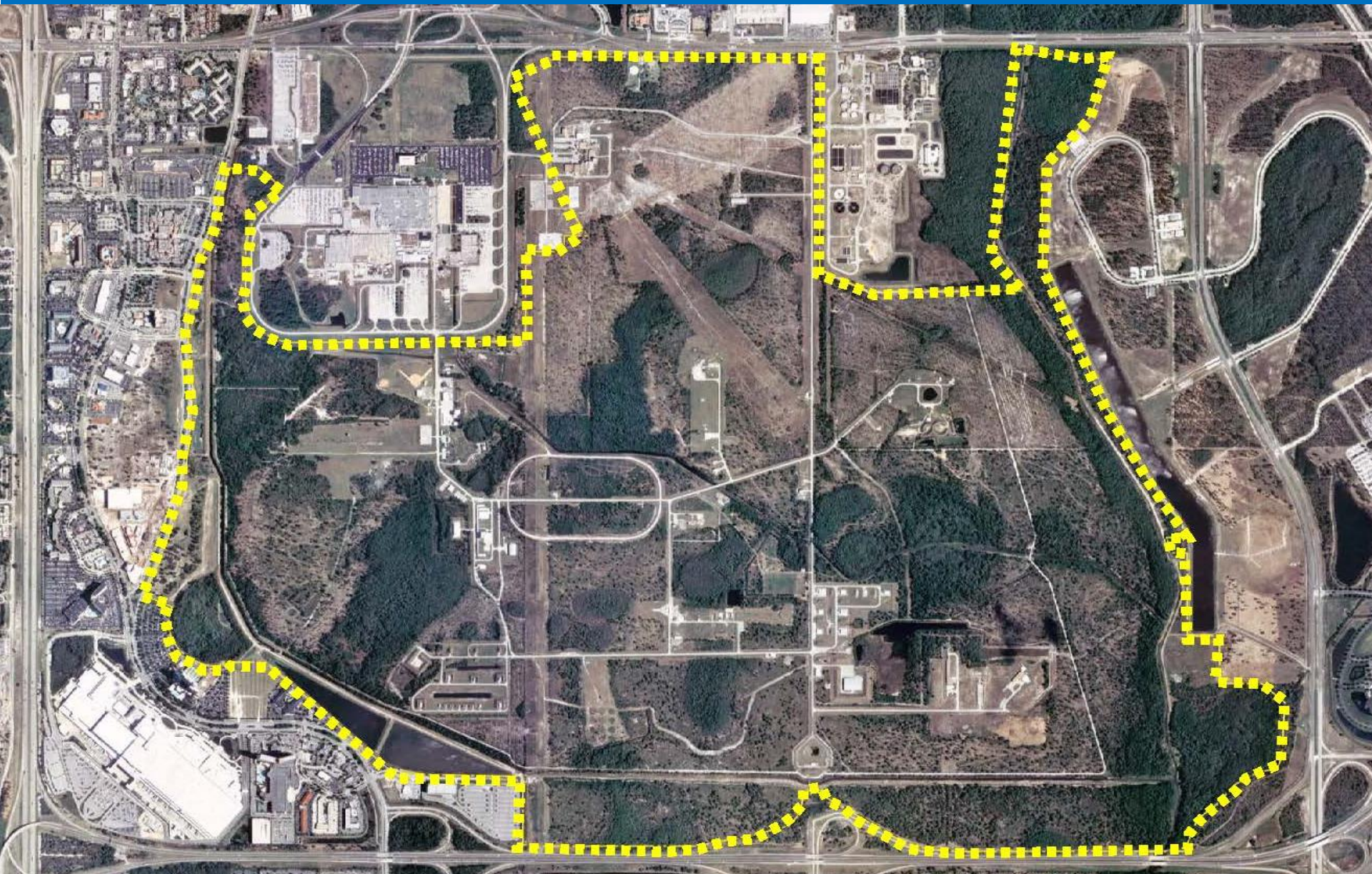
UCPM Environmental

Demonstrating Plume Stability to Support Risk-based Closure

Ed Meyers, P.G.

UCPM Facility -1997



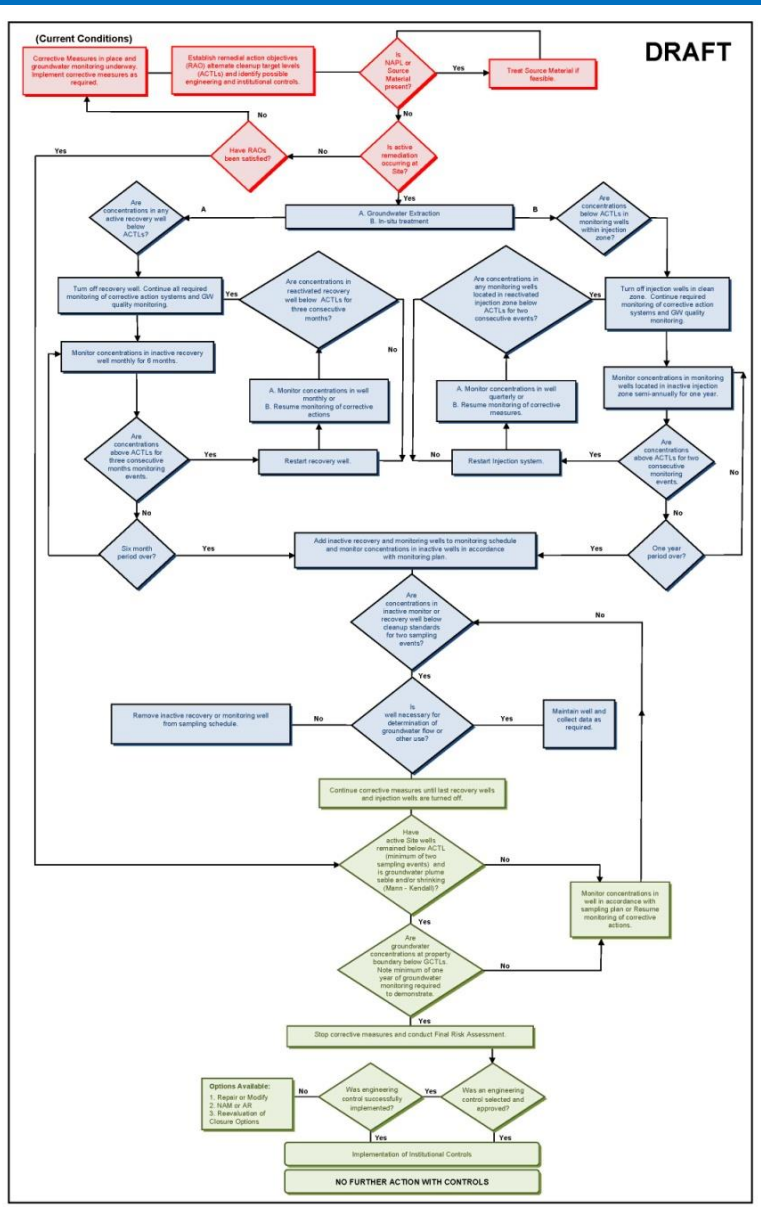
UCPM Facility -1997

Site Remediation – Meeting EPAs GPRA Goals

Direct Exposure / Source Removal

Hydraulic Control

Remediation Exit Strategy



- Source Removal
- **Establish Remedial Goals / ACTLs**

- Groundwater Treatment
- **Reduce Contaminant Concentrations**
- Identify milestones to stop treatment

- **Post Active Remediation Monitoring (PARM)**
- Risk Assessment
- **Demonstrate Plume Stability**
- Site Closure

Sources: Chapter 62-780 FAC
ITRC – Enhanced Attenuation of Chlorinated Organics (April 2008)

Plume Stability and Site Closure

Post Active Remediation Monitoring

…designated monitoring wells shall be sampled **quarterly**, or at a frequency specified in the Post Active Remediation Monitoring Plan approval, for analyses of contaminants that were present prior to the initiation of active remediation.

FDEP requirements for risk based closure

Chapter 62-780 …demonstrated to the Department by a minimum of **1 year** of groundwater monitoring data and, if applicable, fate and transport modeling results, that the groundwater contamination will not …impact fresh or marine surface water body and…

- (RMO II) …is not migrating from a localized source area…
- (RMO III)…at the institutional boundary does not and will not exceed the appropriate cleanup target level…

Plume Stability - Questions

How do you know contaminant reductions have occurred and not just observing dilution?

Will rebound occur?

How long for the system to reach equilibrium following remediation?

Will the remnant plume migrate and cross property boundaries?

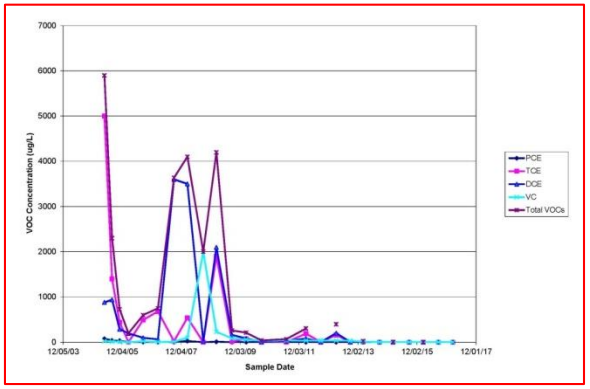
Where's the plume?

Plume Stability

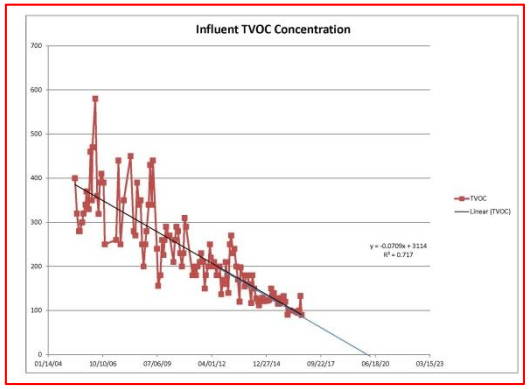
Every annual remedial action status and PARM report includes:

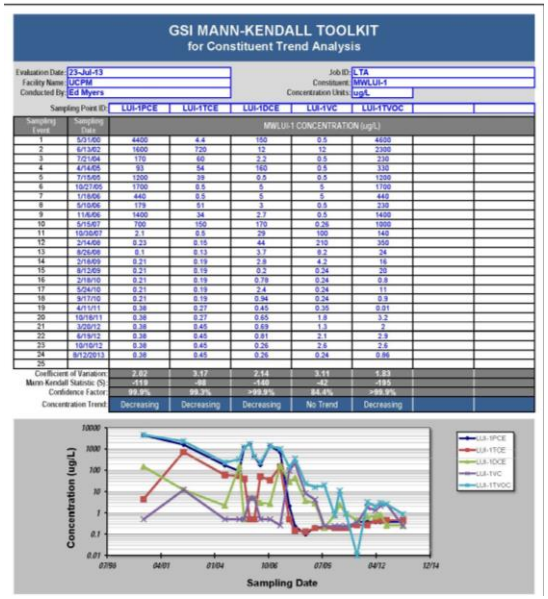
- Concentration vs. time trend analysis graphs for all impacted wells
- Plume foot print figures and plume area discussion
- Mann Kendall analysis
- Mass removal estimates
- Groundwater flow velocity

Monitoring Well Data



Treatment Plant Data

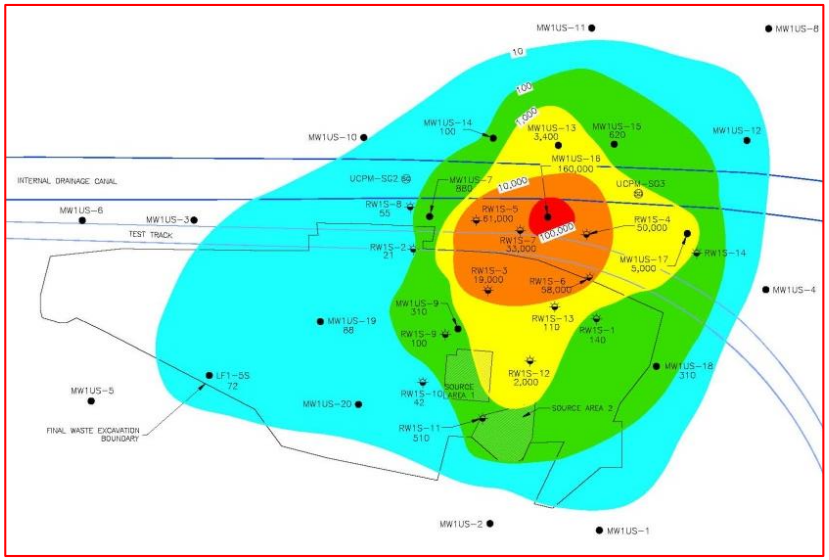


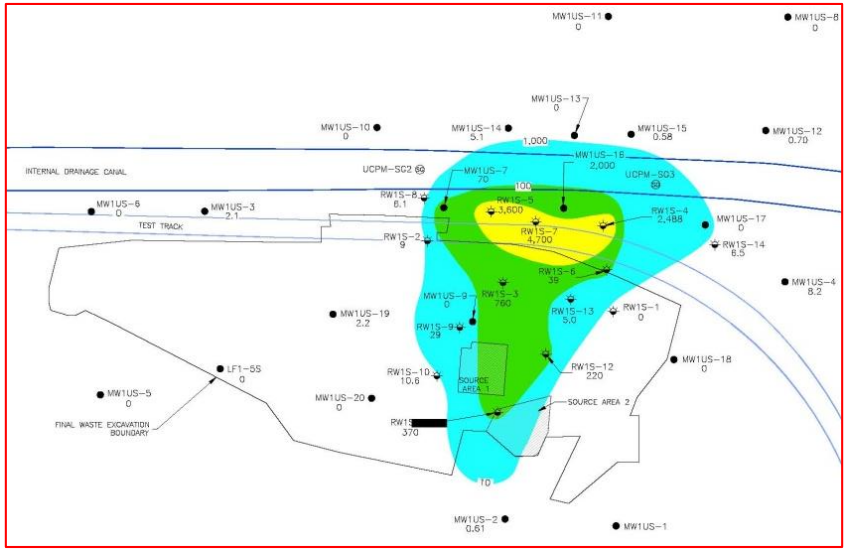


Plume Stability

Other lines of evidence used at UCPM:

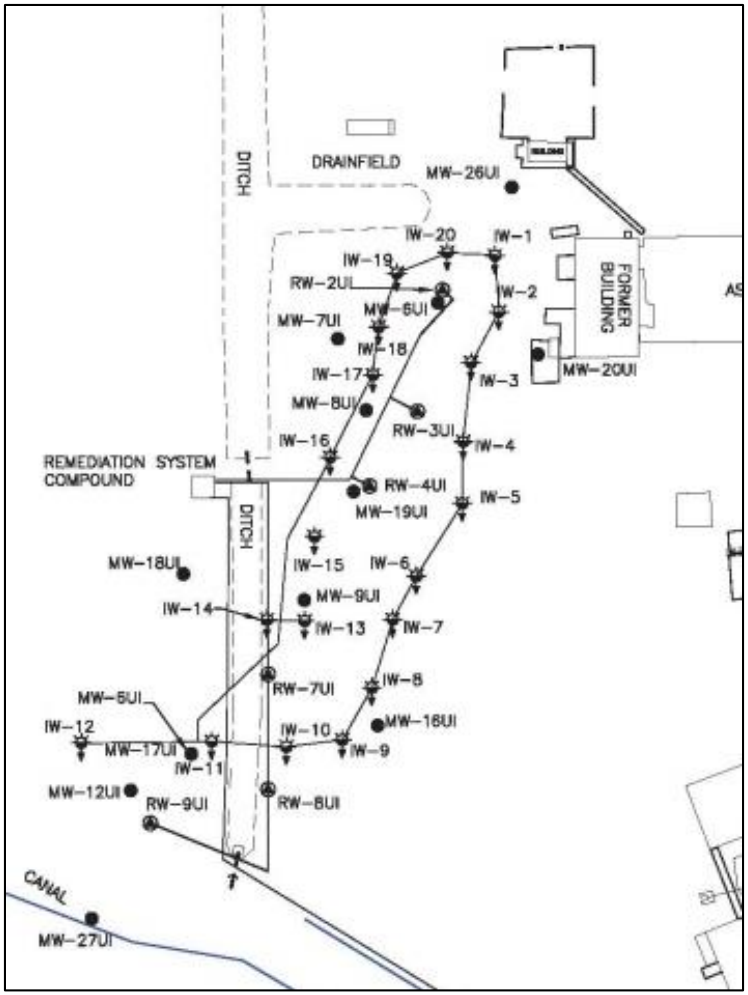
- Biochlor
- MAROS
- Stable isotopes
- MNA Parameters





Example 1 - SWMU-59

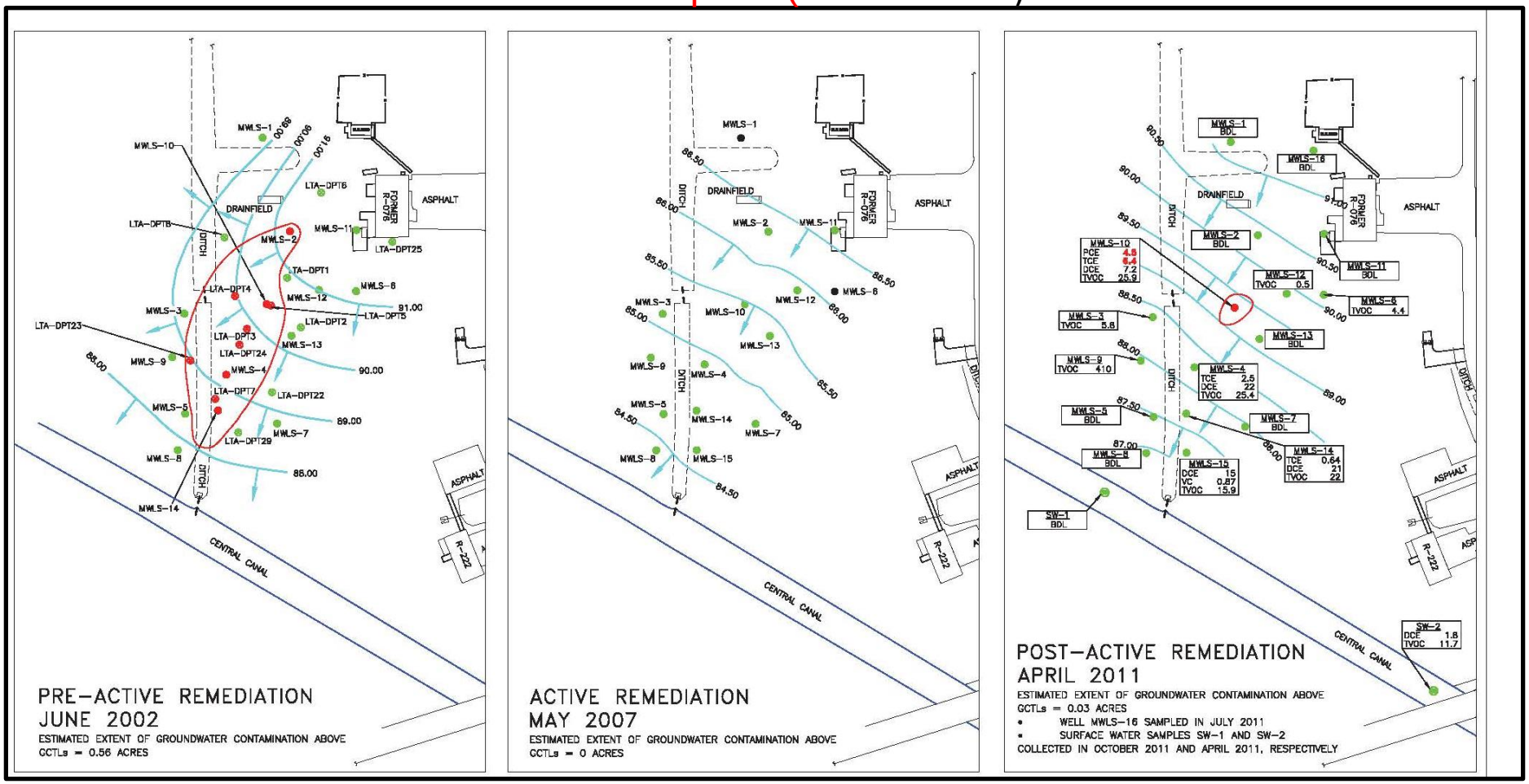
- Former Missile Component Testing Facility
- Active from 1960's to 1995
- Treatment Train Approach
  - Septic Tank Source Removal
  - Air Sparge
  - P and T
  - Bioremediation



	Pre-Remedial Concentration (ug/)	PARM (ug/)
PCE	4,400	40
TCE	4,400	37
DCE	150	15

SWMU-59- Qualitative Estimation

Surficial Aquifer (0-25 feet bls)



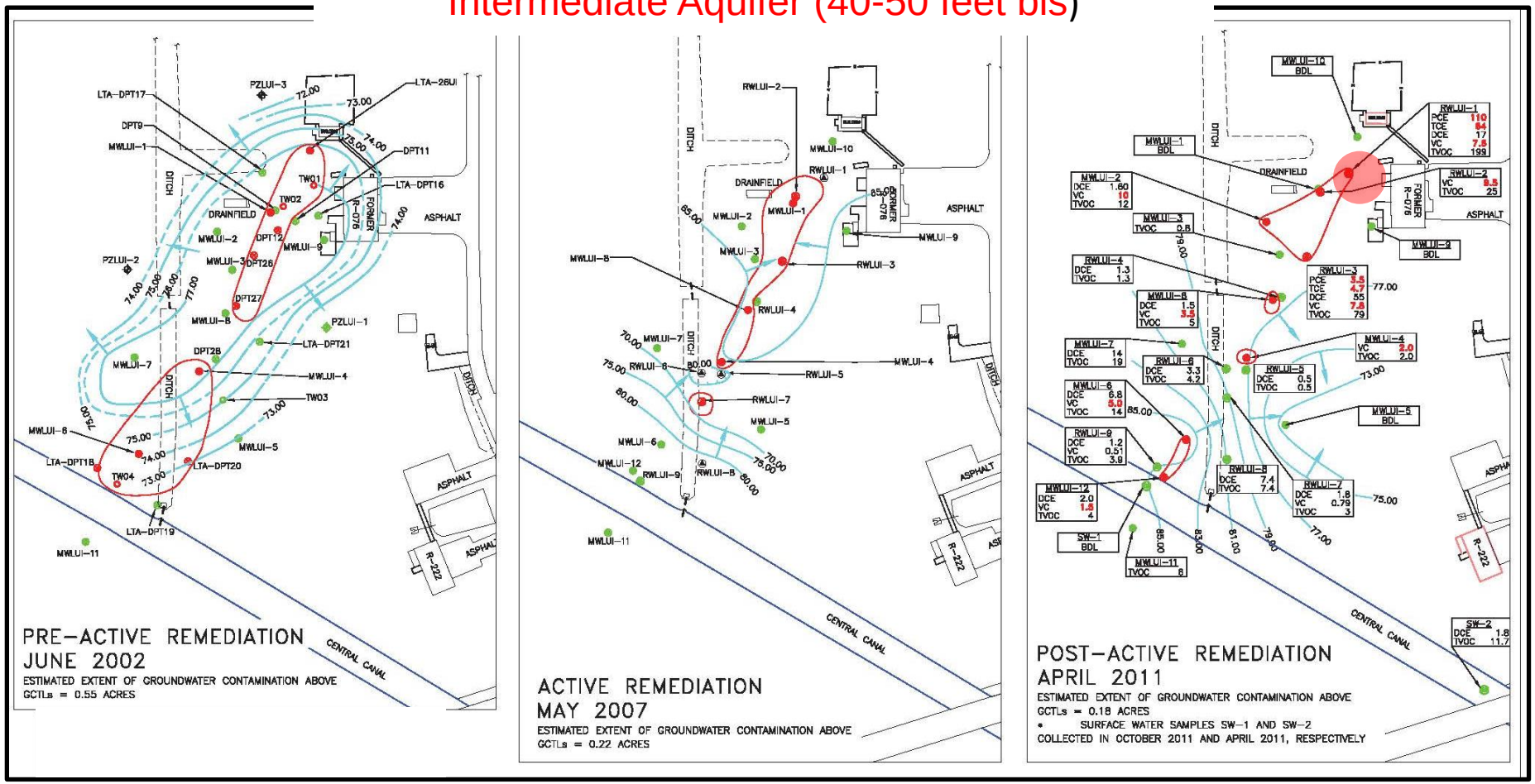
Pre-Remediation
June 2002

Active Remediation
May 2007

PARM
April 2011

SWMU-59 - Qualitative Estimation

Intermediate Aquifer (40-50 feet bls)

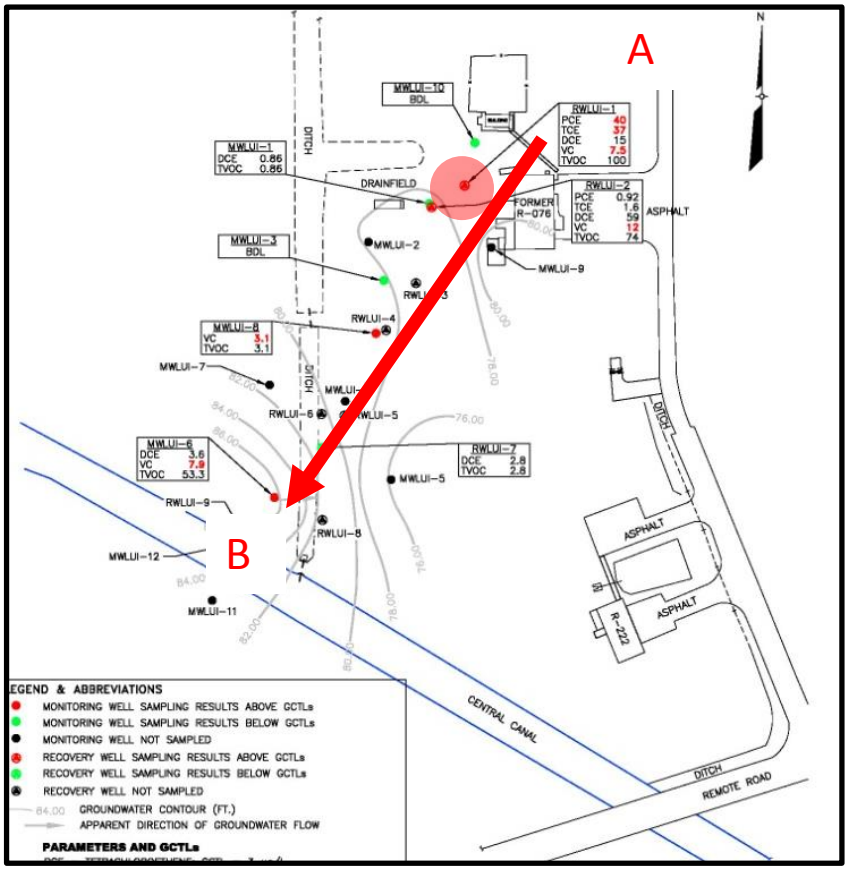


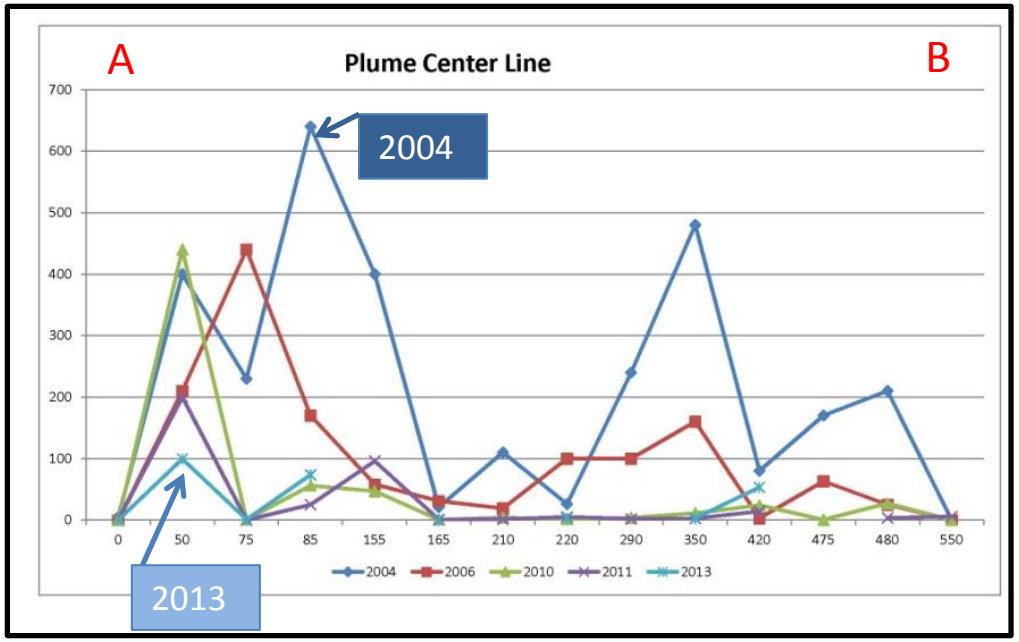
Pre-Remediation
June 2002

Active Remediation
May 2007

PARM
April 2011

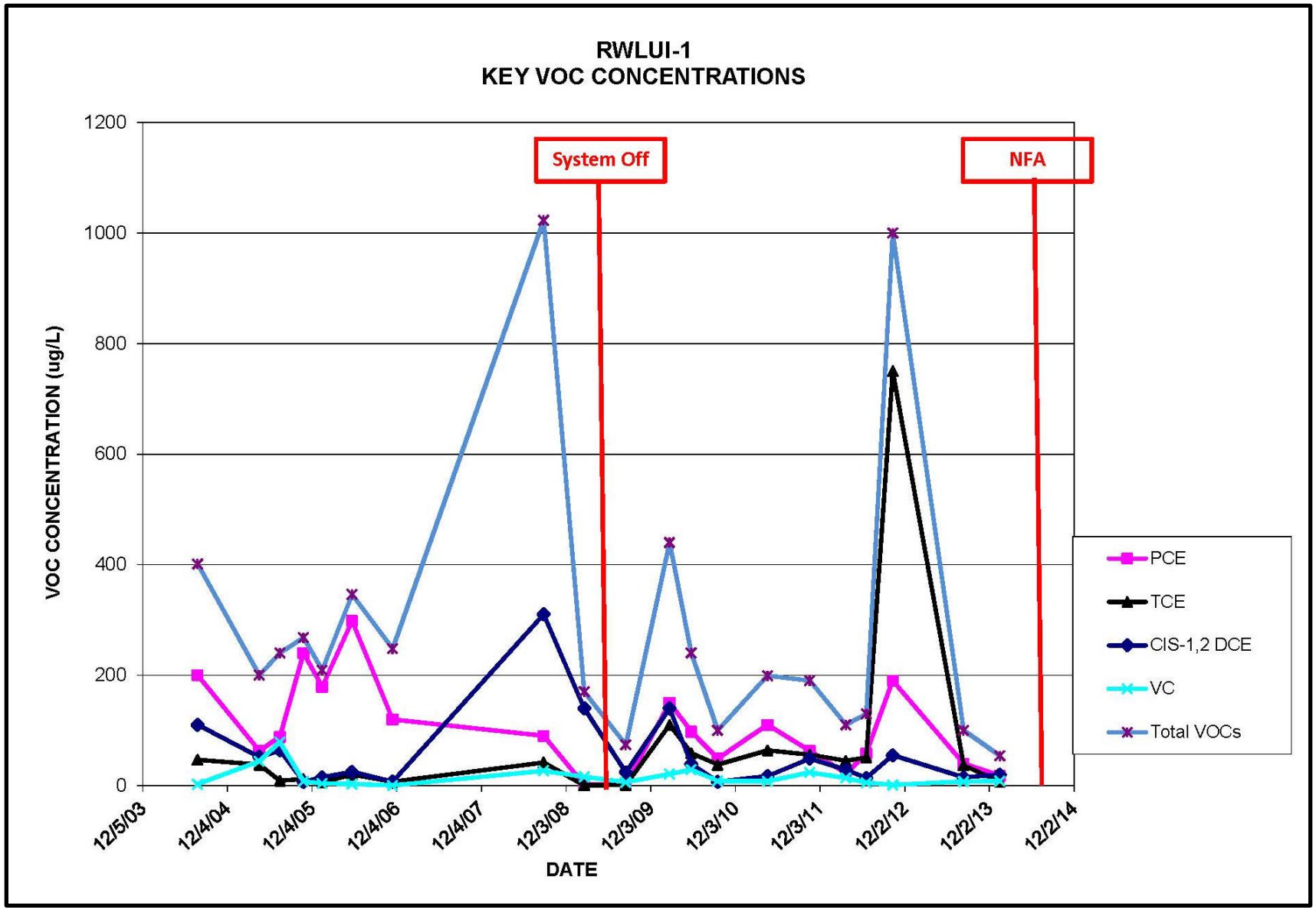
SWMU-59 – Mass Movement





Decreasing VOC concentrations confirm stable center of mass

SWMU-59– Trend Analysis

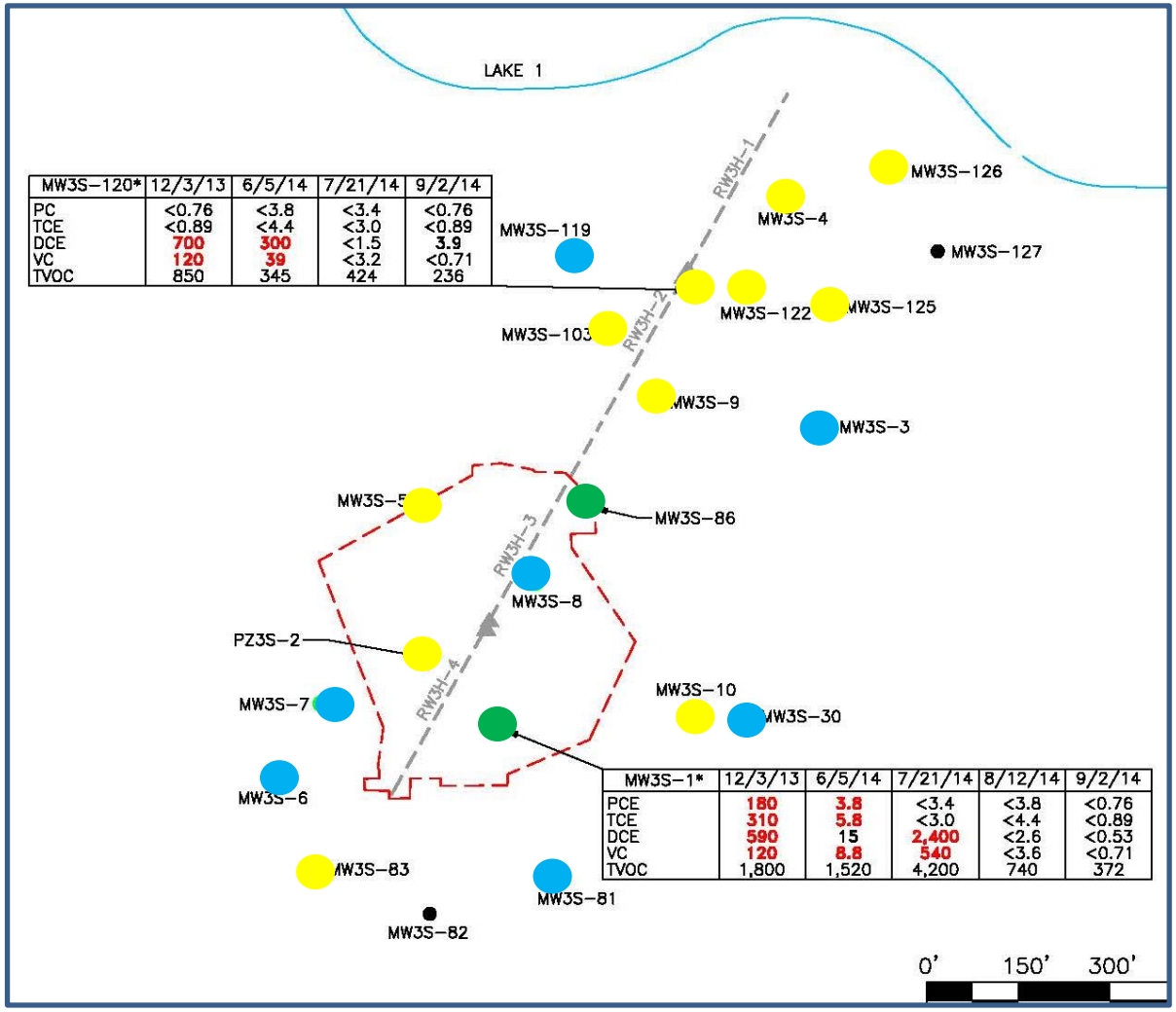


Example 2 – Landfill 3

- Former Industrial Landfill
- Active 1960,s
- Treatment Train Approach
  - Landfill Excavation
  - P and T
  - Large Scale ISCO

	Post - Excavation Concentration (ug/)	PARM (ug/)
TCE	68,000	310
DCE	40,000	700
VC	<500	120
TVOC	120,000	1,800

Landfill 3 – Mann-Kendall



MW3S-120*	12/3/13	6/5/14	7/21/14	9/2/14
PC	<0.76	<3.8	<3.4	<0.76
TCE	<0.89	<4.4	<3.0	<0.89
DCE	700	300	<1.5	3.9
VC	120	39	<3.2	<0.71
TVOC	850	345	424	236

MW3S-1*	12/3/13	6/5/14	7/21/14	8/12/14	9/2/14
PCE	180	3.8	<3.4	<3.8	<0.76
TCE	310	5.8	<3.0	<4.4	<0.89
DCE	590	15	2,400	<2.6	<0.53
VC	120	8.8	540	<3.6	<0.71
TVOC	1,800	1,520	4,200	740	372

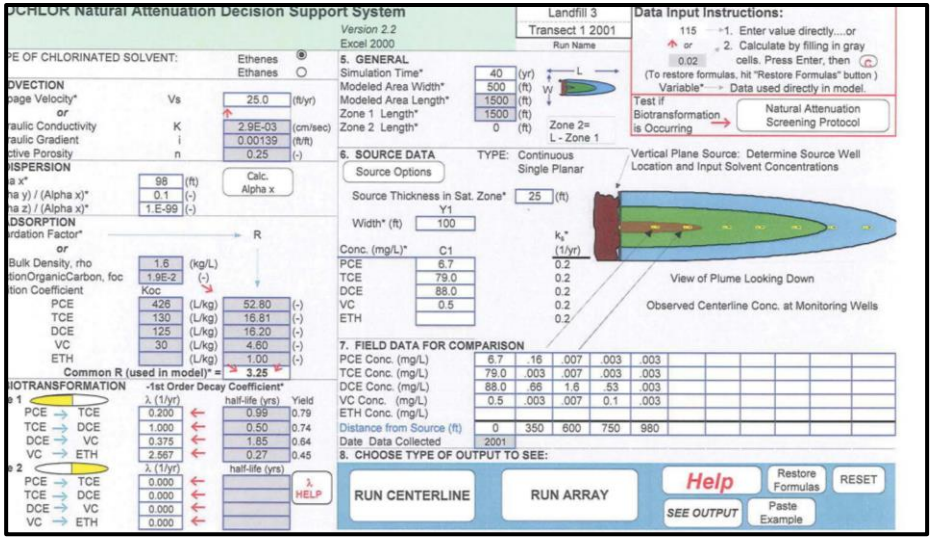
PARM - 2013

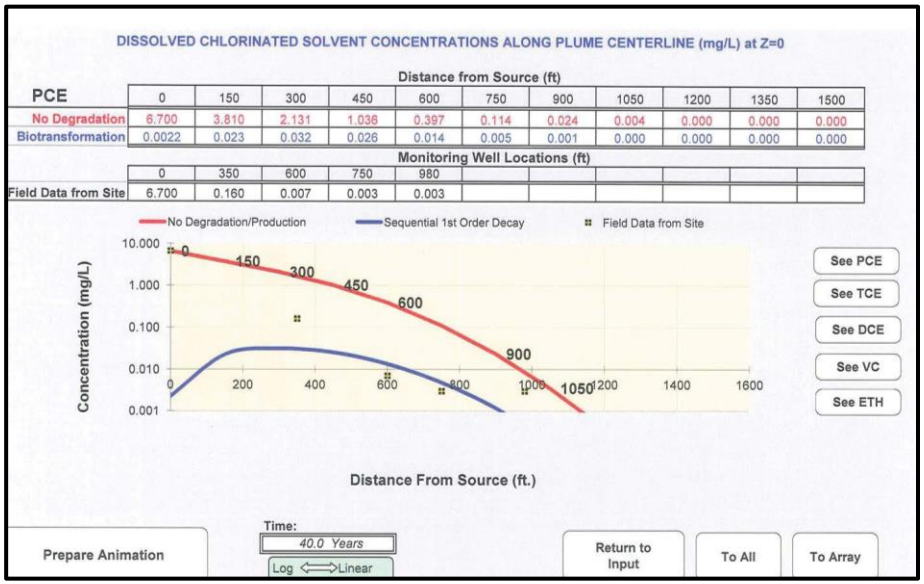
- Increasing / Probably Increasing
- No Trend / Stable
- Decreasing / Probably Decreasing
- All Parameters BDL

FDEP Concerns:

- Elevated concentrations at 2 locations:
- K evaluation
- Limited hot spot polishing
- Extend PARM period 2 quarters

Landfill 3– BIOCHLOR



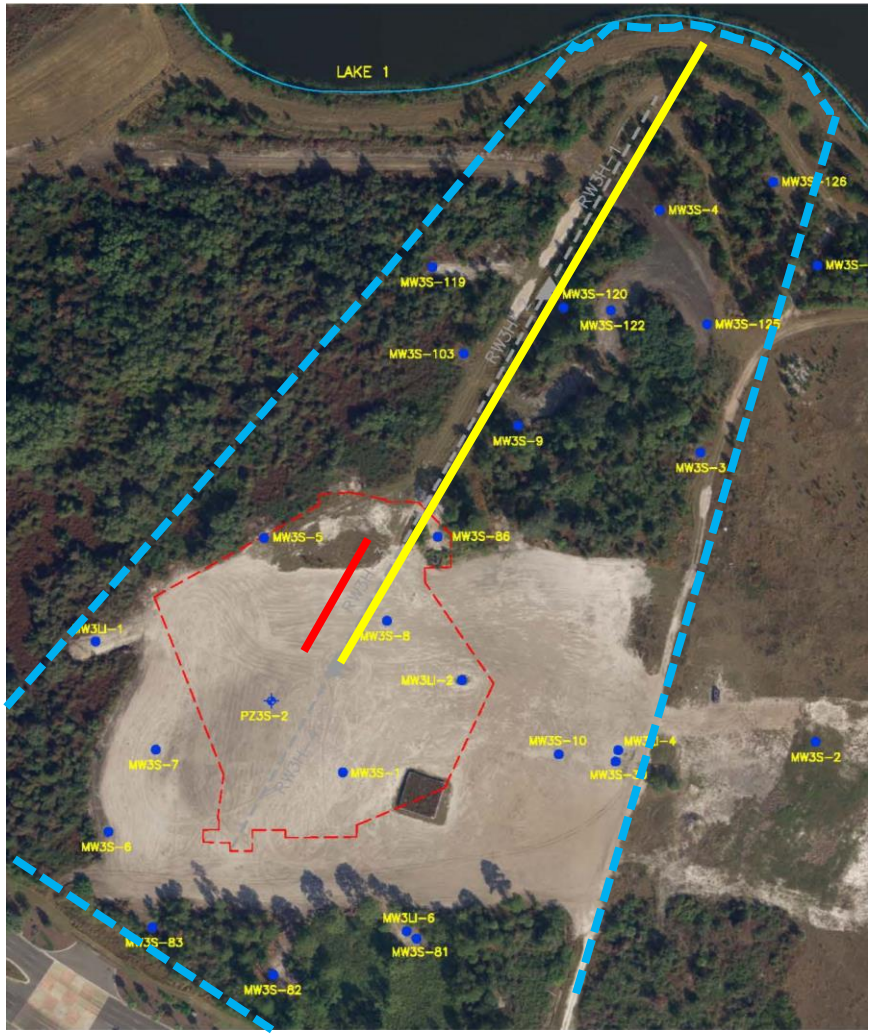


BIOCHLOR used to:

- Estimate decay coefficients prior to remediation
- Demonstrate that contaminants present following remediation will decrease below GCTLs in less than 50 years
- Estimate distance that plume attenuates to below GCTLs – using different estimates of hydraulic conductivity
- Verify that the plume will be below GCTLs before surface water body and Intuitional Control boundary

BIOCHLOR EPA 2002

Landfill 3 – BIOCHLOR

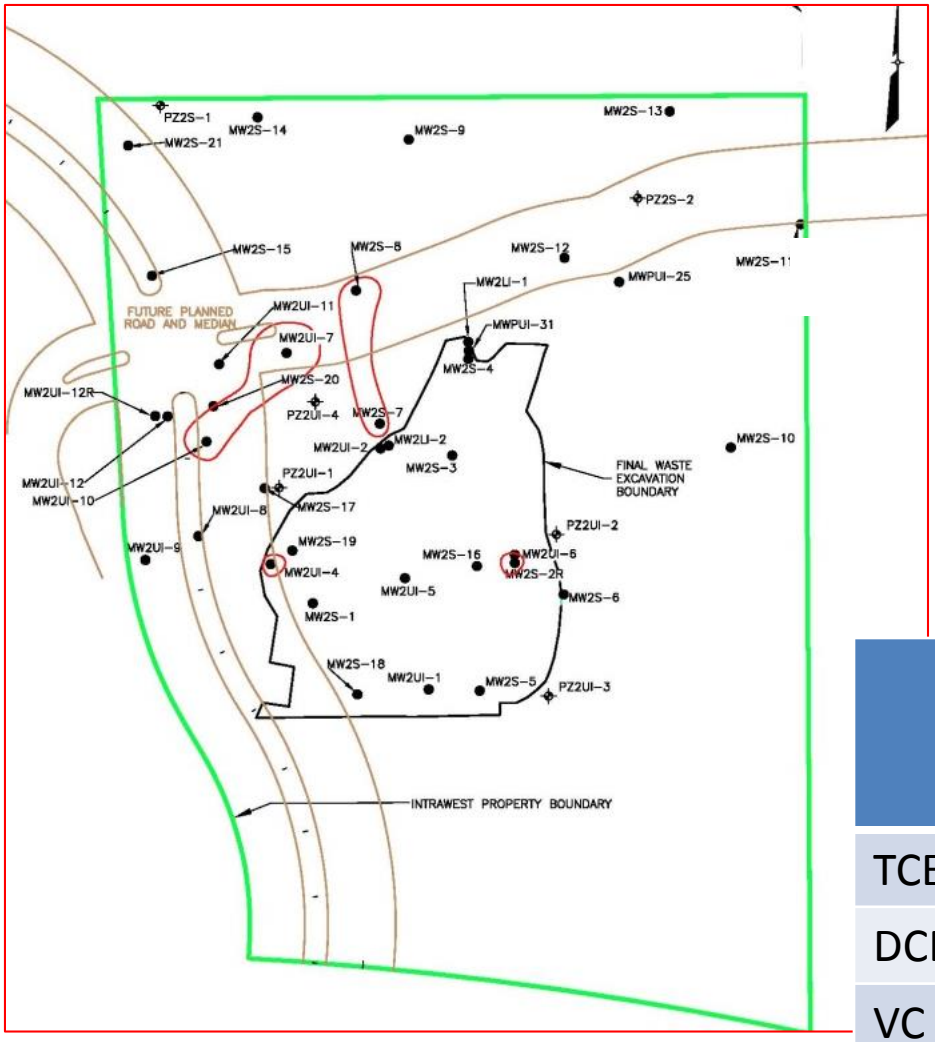


Low K Transport distance

High K Transport distance

IC Boundary

Example 3 – Landfill 2



- Former Industrial Landfill – primarily used for electroplating sludge
- Treatment Train Approach
  - Landfill removal
  - Bioremediation

	Pre-remedial Concentration (ug/)	PARM (ug/)
TCE	330	7.0
DCE	180	4.9
VC	ND	6.8

Plume Stability – MAROS

TABLE 14
MAROS Statistical Trend Analysis Summary for Lauch Test Area
Universal Boulevard Planned Development

Well ID	Number of Samples	Number of Detections	Median (µg/L)	Average (µg/L)	MannKendall Trend [1]	LinearRegression Trend [1]
cis-1,2-Dichloroethene (DCE)						
MWLUI-1	19	13	30	2.4	NT	PD
MWLUI-2	19	17	17	4	NT	PD
MWLUI-3	17	11	7.5	1	D	D
MWLUI-4	19	17	47	24	D	D
MWLUI-5	15	9	20	0.62	D	D
MWLUI-6	19	19	28	11	D	D
MWLUI-7	19	19	16	12	D	D
MWLUI-8	19	15	28	5.7	D	D
MWLUI-9	17	2	7.4	0.5	PD	PD
MWLUI-10	18	0	0.49	0.5	ND	ND
MWLUI-11	17	0	0.49	0.5	ND	ND
MWLUI-12	17	17	44	33	D	D
RWLUI-1	14	14	68	32	NT	D
RWLUI-2	13	12	52	15	D	D
RWLUI-3	15	15	34	18	NT	NT
RWLUI-4	12	12	14	14	D	D
RWLUI-5	11	8	2.5	0.61	D	D
RWLUI-6	12	12	25	19	D	D
RWLUI-7	15	15	64	26	D	D
RWLUI-8	12	4	1.5	0.5	NT	NT
RWLUI-9	13	13	14	10	D	D
Tetrachloroethene (PCE)						
MWLUI-1	19	11	630	93	D	D
MWLUI-2	19	0	1.4	1.5	ND	ND
MWLUI-3	17	1	1.4	1.5	S	PD
MWLUI-4	19	0	1.4	1.5	ND	ND
MWLUI-5	18	0	1.4	1.5	ND	ND
MWLUI-6	19	0	1.4	1.5	ND	ND
MWLUI-7	19	1	1.4	1.5	S	PD
MWLUI-8	19	0	1.4	1.5	ND	ND
MWLUI-9	17	0	1.4	1.5	ND	ND
MWLUI-10	18	4	1.4	0.5	D	D
MWLUI-11	17	0	0.49	0.5	ND	ND
MWLUI-12	17	0	1.4	1.5	ND	ND
RWLUI-1	14	14	120	100	S	PD
RWLUI-2	13	9	120	110	D	D
RWLUI-3	15	15	32	6	D	D
RWLUI-4	12	1	3.5	1.5	PD	D
RWLUI-5	11	0	1.4	1.5	ND	ND
RWLUI-6	12	0	1.4	1.5	ND	ND
RWLUI-7	15	1	3.9	1.5	NT	D
RWLUI-8	12	0	0.49	0.5	ND	ND
RWLUI-9	14	0	1.5	1.5	ND	ND

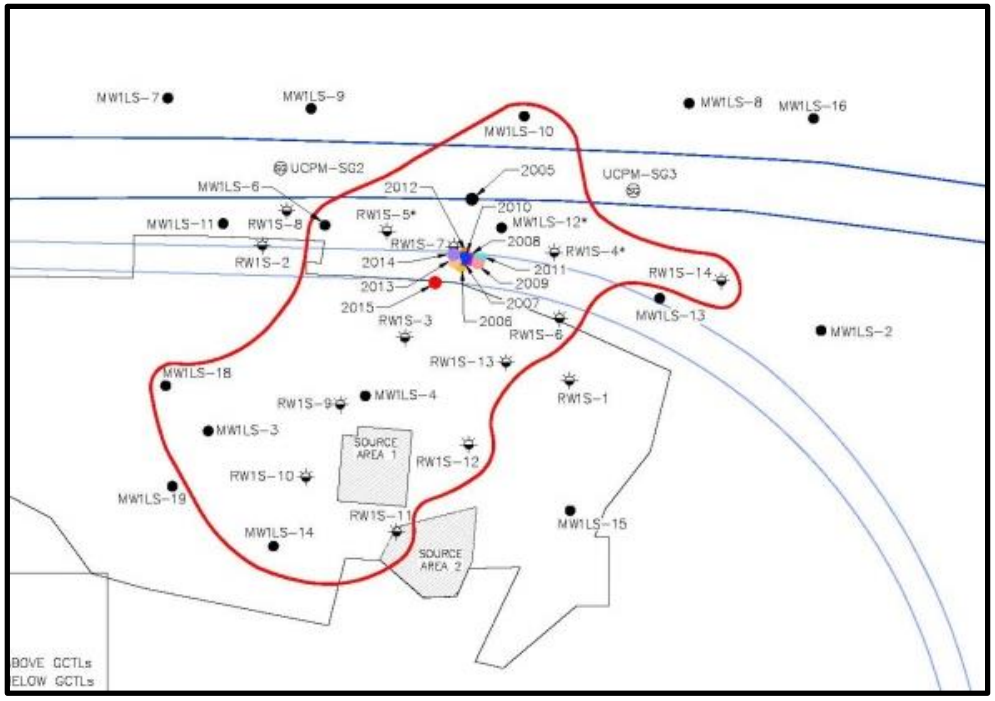
MAROS - Monitoring and Remediation Optimization System (MAROS)

Developed by AFCEE to optimize a site-specific monitoring program

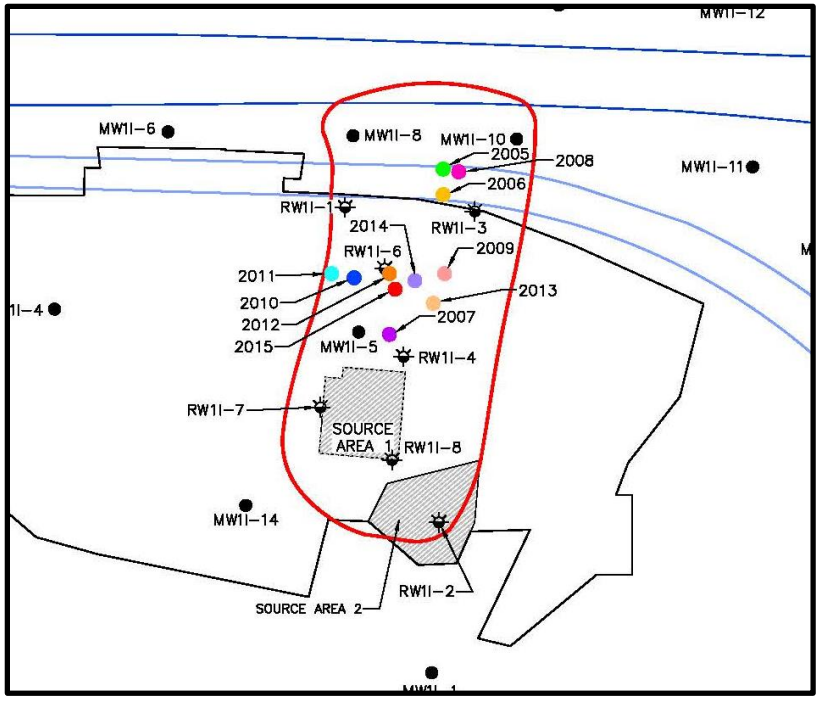
Calculates center of mass and provides estimates of dissolved phase mass

Plume Stability – MAROS

Center of Mass Estimation



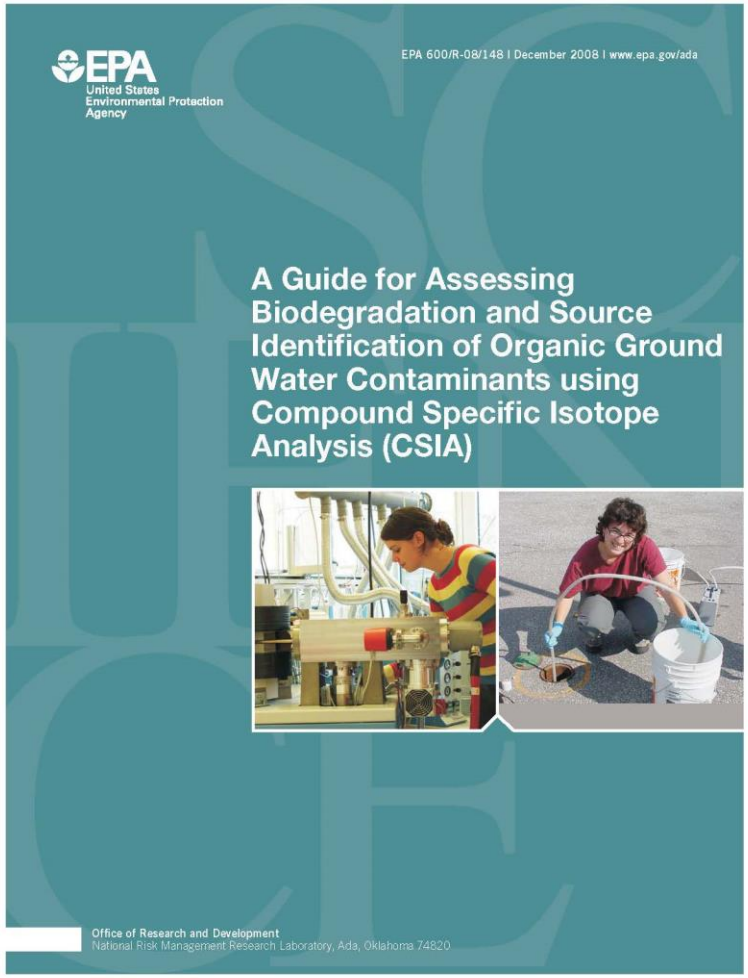
Lower Surficial Aquifer

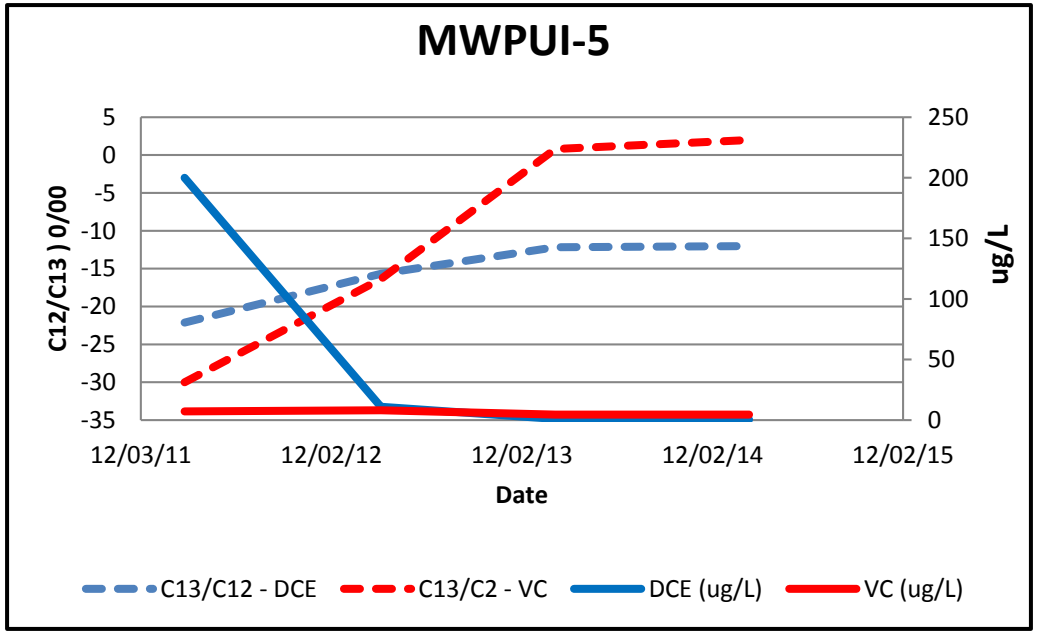


Intermediate Aquifer

Estimated center of mass

Plume Stability – CSIA

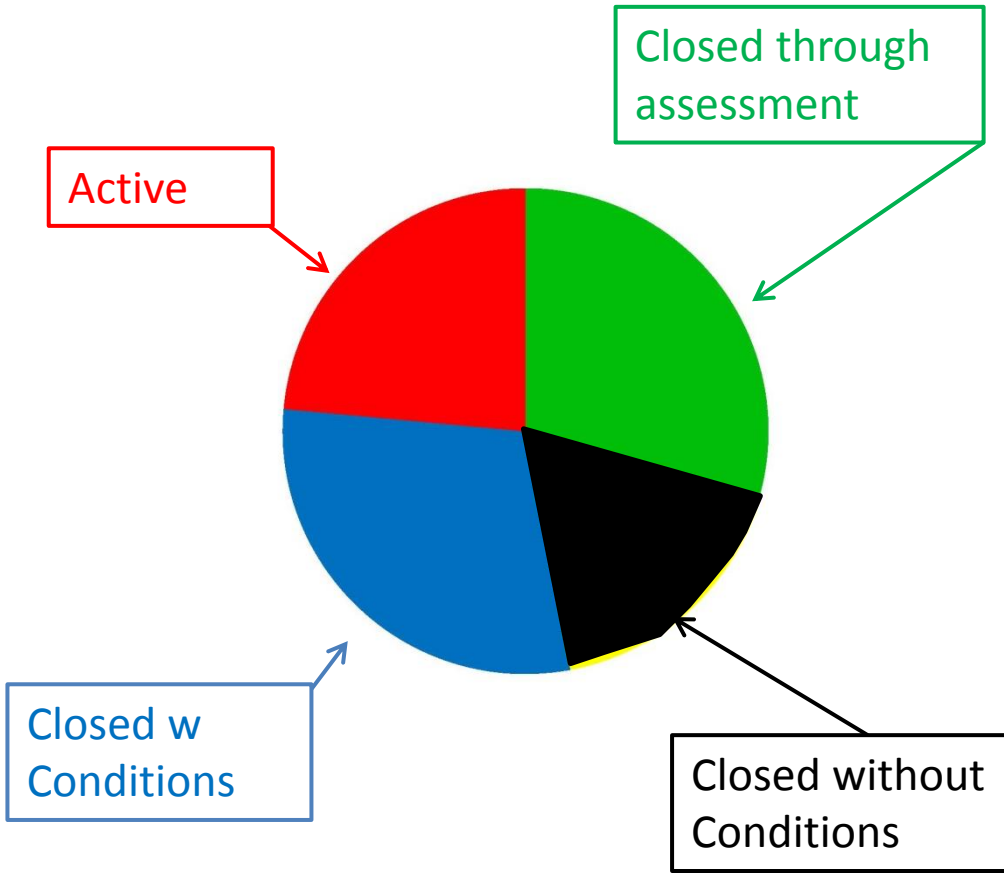




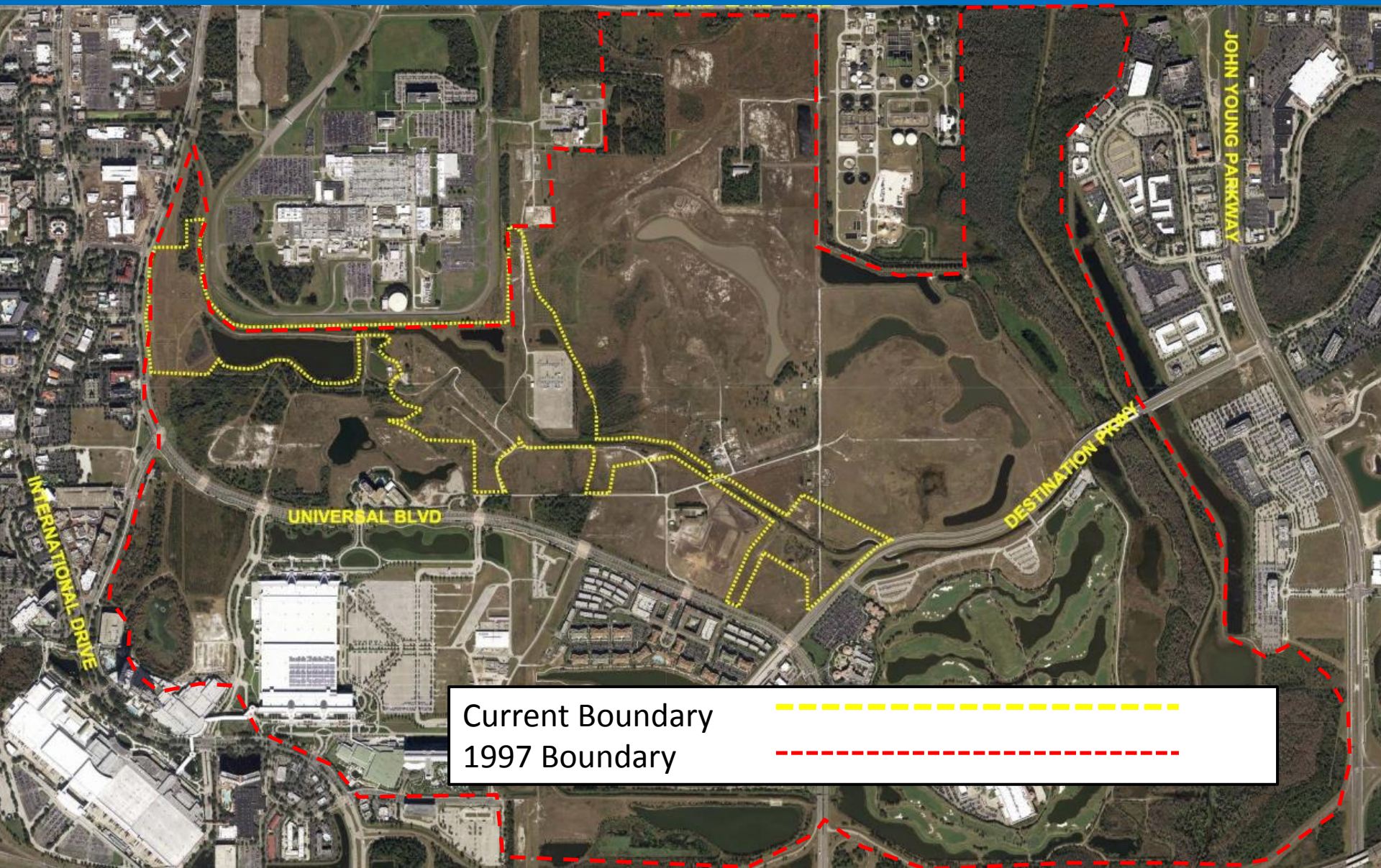
Verification of contaminant degradation

Current Facility Status

- 5 Sites removed from permit following assessment
- 3 Sites closed without conditions (RMO I)
- 5 Site closed with conditions (RMO II)
- 4 Sites remain in active remediation



UCPM Facility -2017



Conclusions

Site	Active Remediation	PARM	NFA /Closure	Contaminants Remaining
Landfill 2	2002 - 2007	2007-2010	2011	TCE – 30 µg/L VC – 8 µg/L Cd – 3 µg/L Fe– 59,100 µg/L Ni – 162 µg/L
Landfill 3	1985 - 2012	2012-2014	2014	TCE - 5 µg/L VC - 62 µg/L
AOC R	2005 - 2006	2006 - 2008	2009	TCE - 16 µg/L
Launch Test Area	2004 - 2009	2009-2013	2014	PCE – 88 µg/L TCE – 76 µg/L VC – 15 µg/L
Ordnance -2	2004 - 2006	2006 - 2011	2011	Al – 33,500 µg/L Fe – 18,000 µg/L

Conclusions

- Multiple lines of evidence to demonstrate plume stability
- Majority of data collected during long-term monitoring and post active remediation
- Statistical analysis completed using publically available software
- 3 years average time in PARM / plume stability evaluation
- FDEP's evaluation of plume stability based on contaminant concentration in groundwater samples
- Future lines of evidence – may include mass flux/discharge and fate and transport modeling

Thank You

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