Battelle 7th International Conference, May 2010

Comparing a Passive Sampling Method to a Conventional Sampling Method for Long-term Monitoring at Hill AFB, Utah

May 2010

Paula Gellner, Jennifer Miller, P.G., and Hhan Olsen, P.G., MWH

Britt E. Grunewald and Erik Dettenmaier, PhD, Hill AFB

Rita Hanover, Westport Compass

MWH

BUILDING A BETTER WORLD

Overview

Background

- Drivers and Site Description
- Conventional vs. Passive Sampling Methods
- Selected Passive Method Rational

Alternative Sampling Study

- Objective, Assumptions, and Design

Data Evaluation

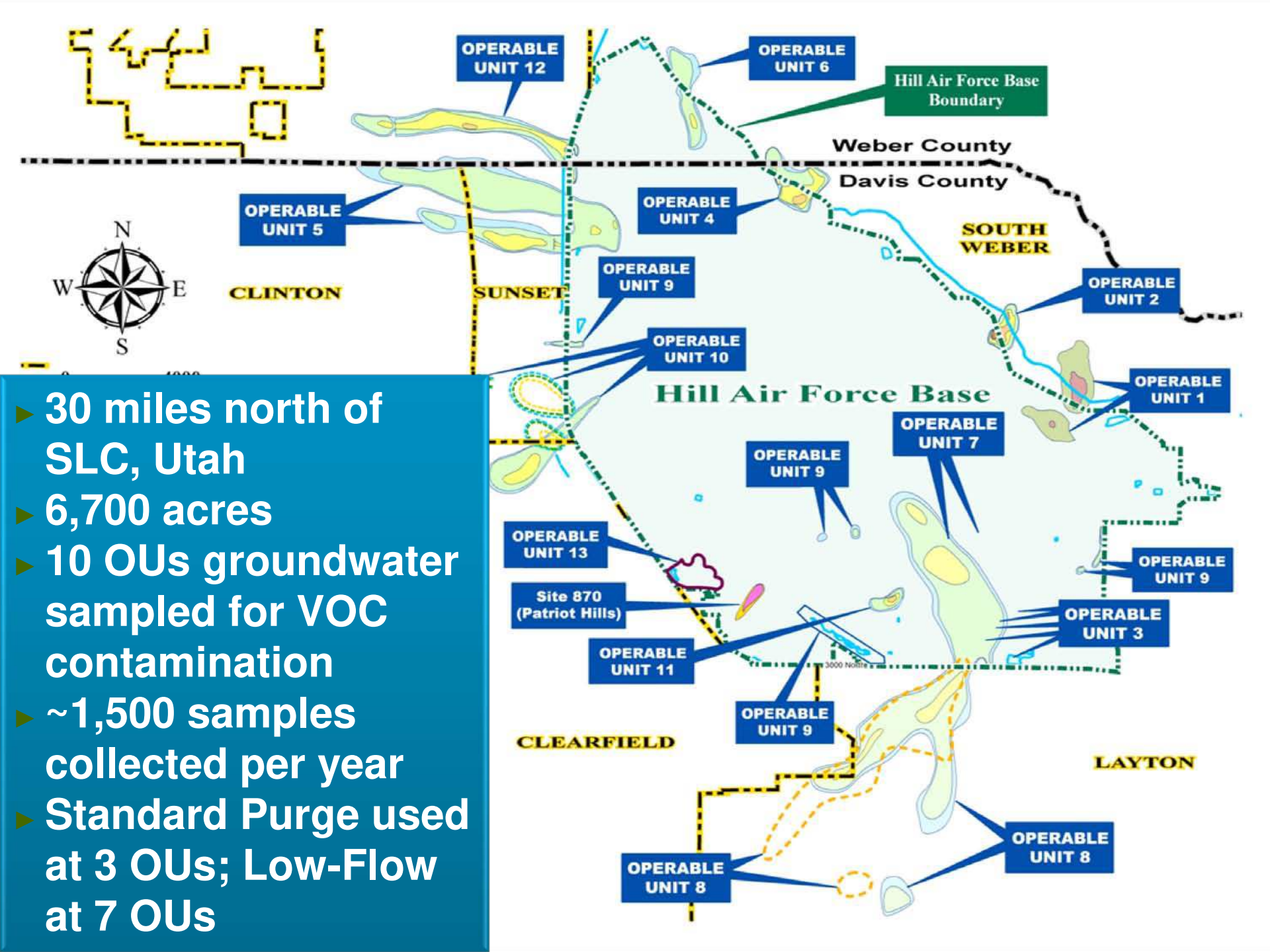
- Statistical Data Evaluation
- Practical Data Evaluation

Cost-benefit and Carbon Footprint Analysis

Conclusions & Recommendations

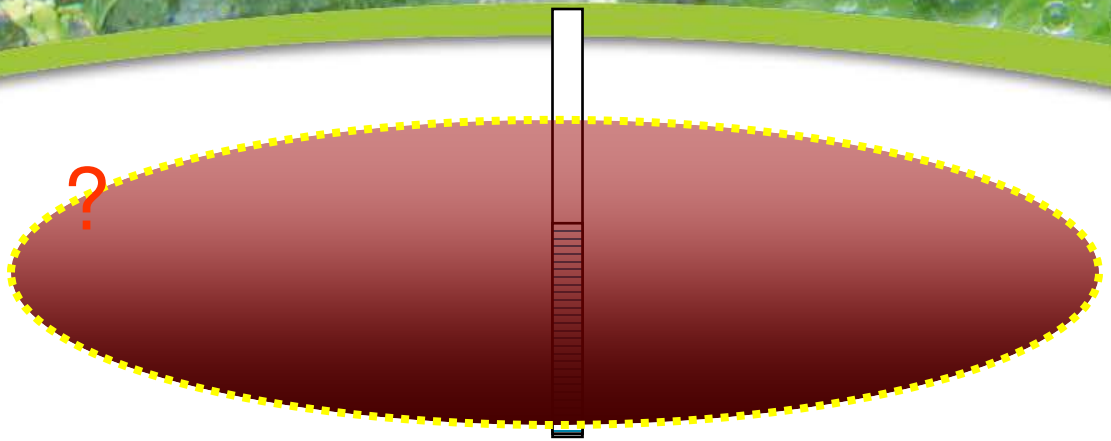
Background:
Drivers for Considering a Passive Sampling Method

- Streamline Sampling Program across all Operable Units (OUs) at Hill AFB to make more **efficient** and **cost effective,** while maintaining **data quality**
- Assist Hill AFB in implementing Green Remediation Practices as mandated by the Air Force and EPA

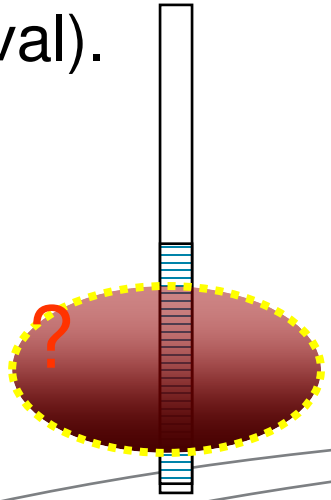


- 30 miles north of SLC, Utah
- 6,700 acres
- 10 OUs groundwater sampled for VOC contamination
- ~1,500 samples collected per year
- Standard Purge used at 3 OUs; Low-Flow at 7 OUs

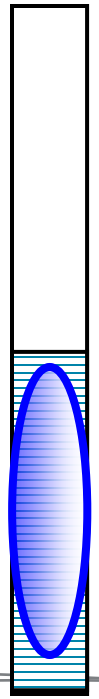
Background:
Conventional vs. Passive Methods



Volume Purge: Pumping required, water actively drawn from well and adjacent formation (composite sample of screened interval).



Low Flow: Volume Purge/Passive hybrid, slower pumping rate, less waste water.



Passive: No-Purge, grab sample of water within the well casing (discrete interval sampling within the screened area).

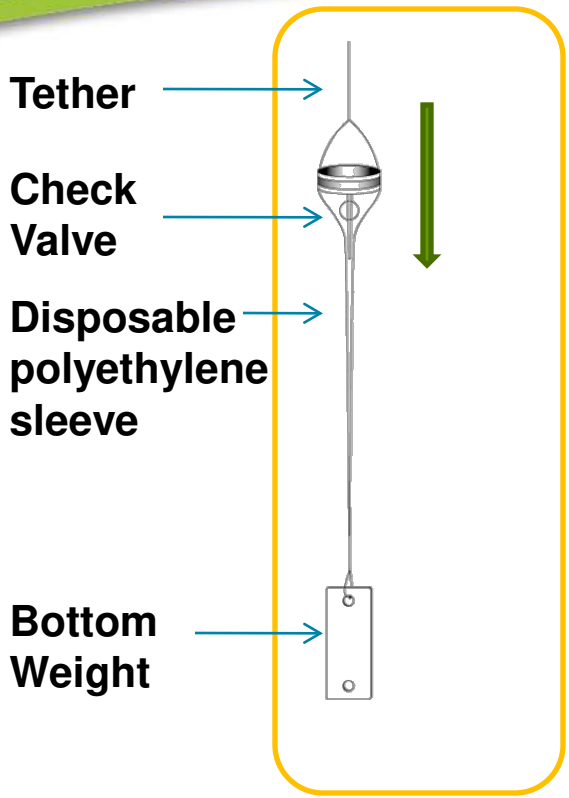
75th AIR BASE WING

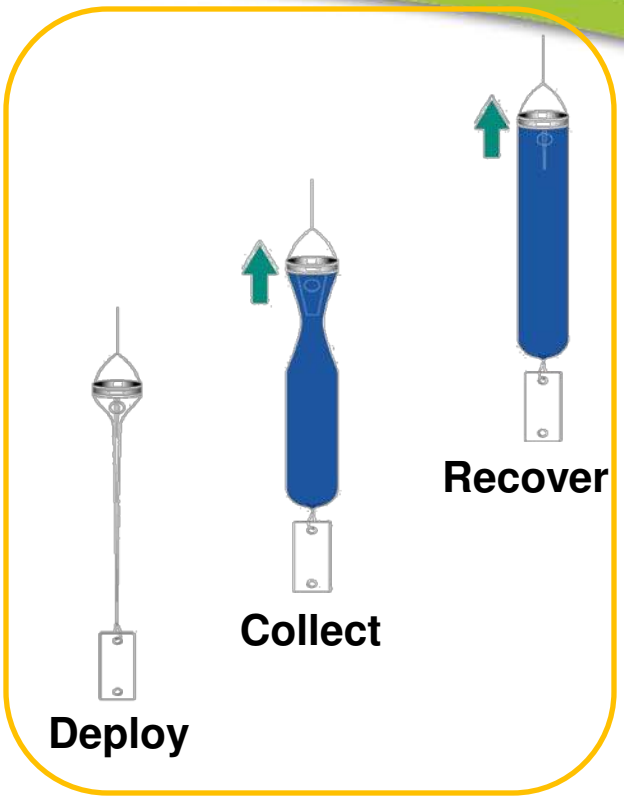
MWH

Background:
Selected Passive Method

- **Performed Lit. Review; assessed a number of passive sampling devices (ITRC, 2006; Parsons, 2005, etc.)**
- **Many passive devices available for various needs**
- **Selected HydraSleeve™ for Study based on Hill AFB site specific conditions**
  - Technically acceptable
  - Comprehensive analyte list
  - Adequate sample volume
  - Easy to set-up, deploy, and retrieve
  - Projected reduction in cost and environmental footprint

Background:
Selected Passive Method





Discharge sample into container

- Deploy sleeve; check valve keeps water from entering device
- Device is triggered by firmly and continuously pulling on the tether and bringing the sleeve to the ground surface

75th AIR BASE WING

MWH

Alternative Sampling Study: Objective and Assumptions

Evaluate data comparability between Standard Purge (SP) and HydraSleeve™ (HS) to determine if HS provides an **acceptable, cost effective, and energy-efficient alternative** for use at Hill AFB

Assumptions for Hill AFB Study

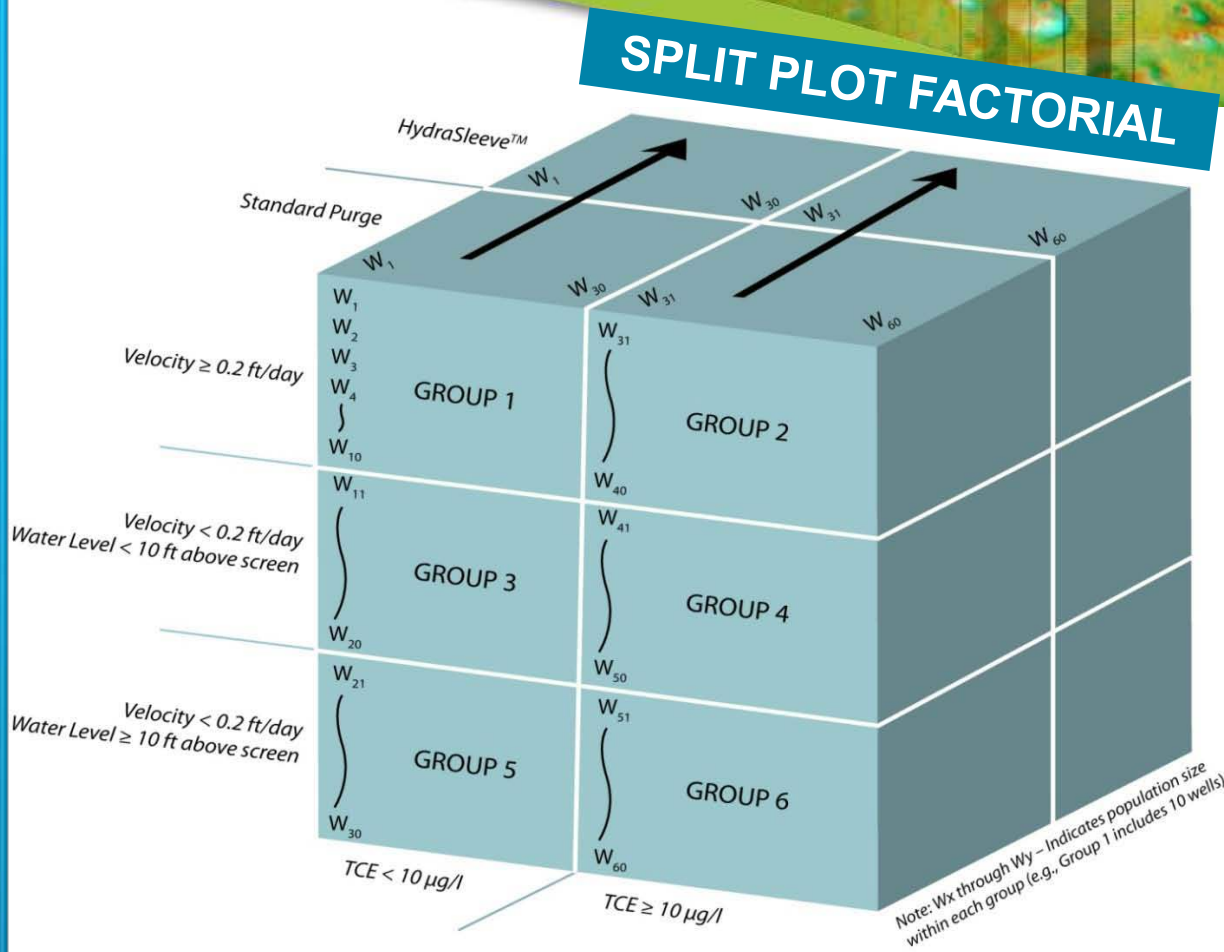
- TCE used in data evaluation because primary contaminant of concern (COC); study results could apply to all COCs
- Study results representative across all 10 OUs
- At Hill AFB it is shown that SP is equivalent to Low-flow; therefore if SP=HS then assume LF=HS

75th AIR BASE WING

MWH

Alternative Sampling Study:
Study and Statistical Design

- 60 locations
- HS followed by SP
- 120 samples
- Locations organized into 6 groups
- Groups organized by well characteristics that could influence method comparison
  - ➢TCE concentration
  - ➢ GW velocity
  - ➢Water column height
- 10 locations/group

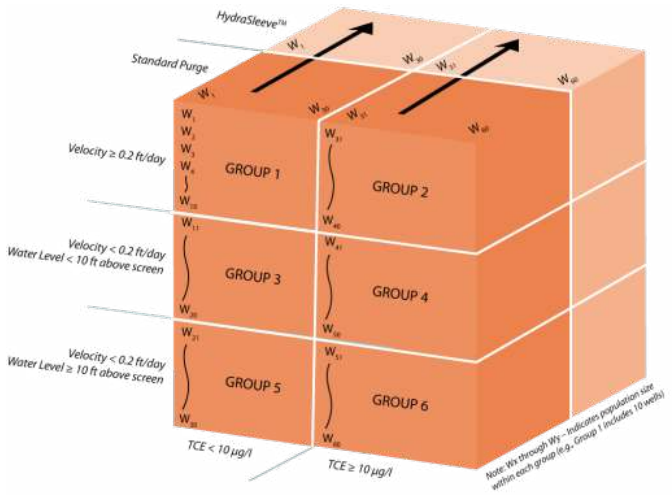


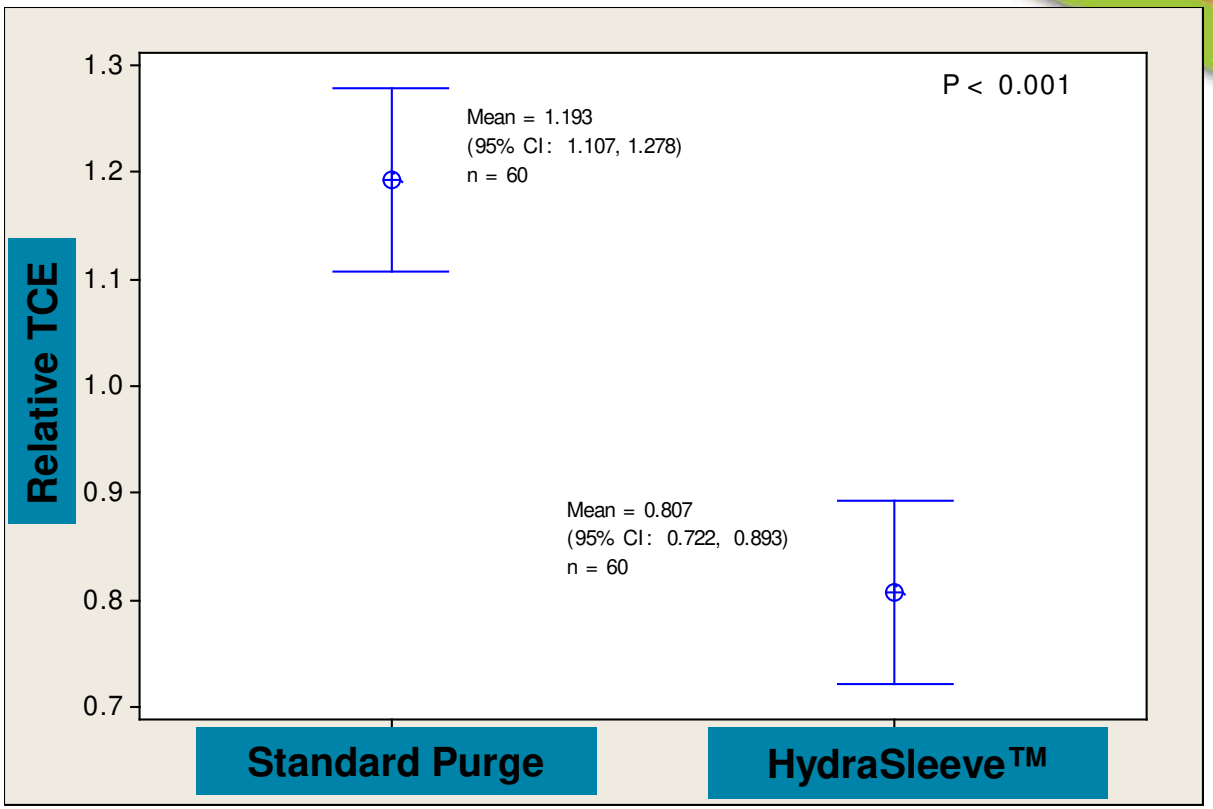
MWH

Statistical Data Evaluation

REJECTED

Hypothesis #1:
SP = HS regardless of three well characteristics





SP ≠ HS (p<0.001); HS results lower 72% of the time

Note: Repeated Measure ANOVA

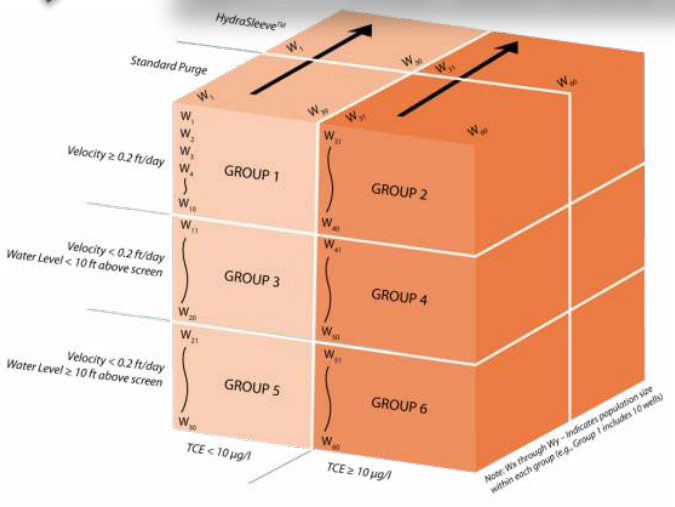
75th AIR BASE WING

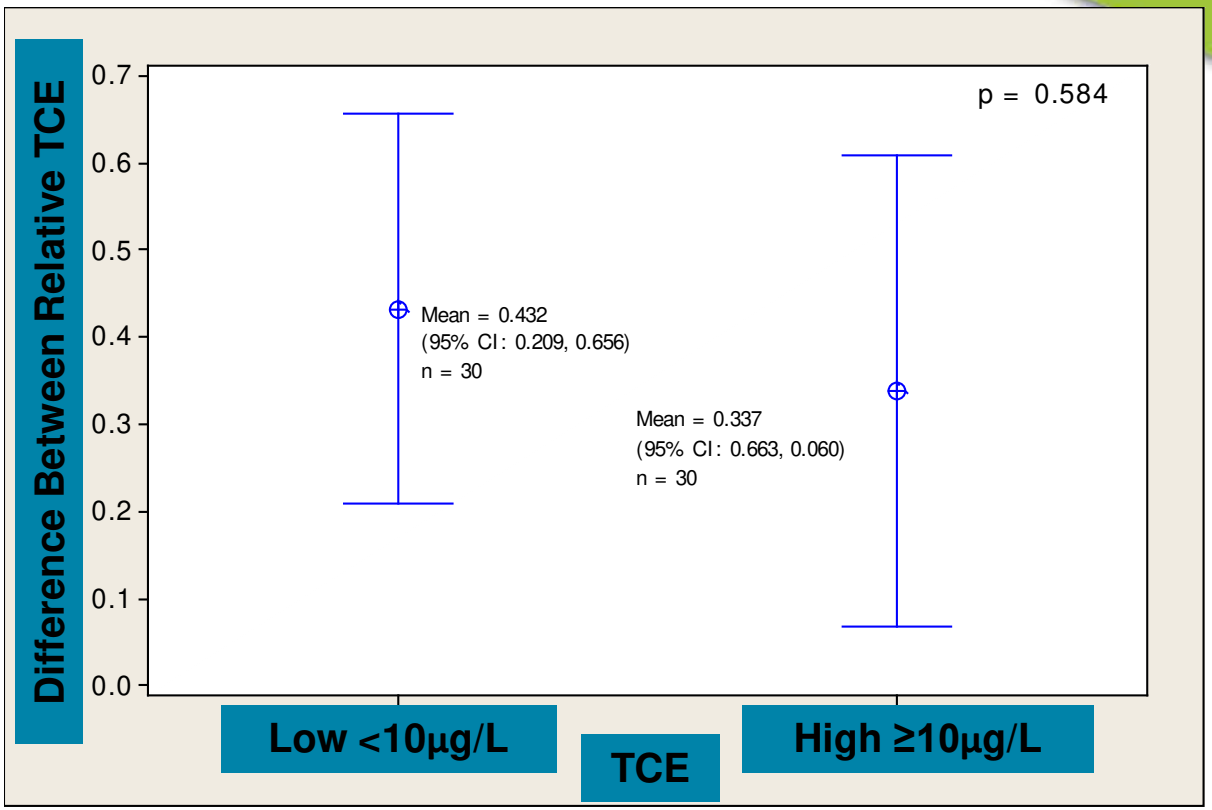
MWH

Statistical Data Evaluation

ACCEPTED

Hypothesis #2:
SP = HS across both levels of TCE concentrations





Difference between methods is not significantly influenced by high or low TCE

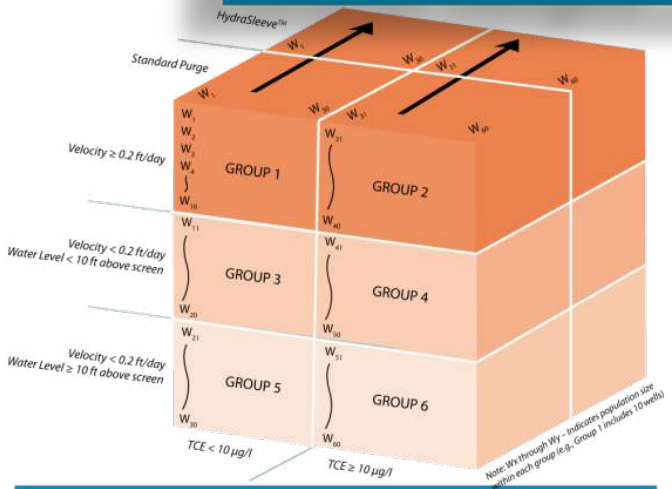
Note: One-way ANOVA

MWH

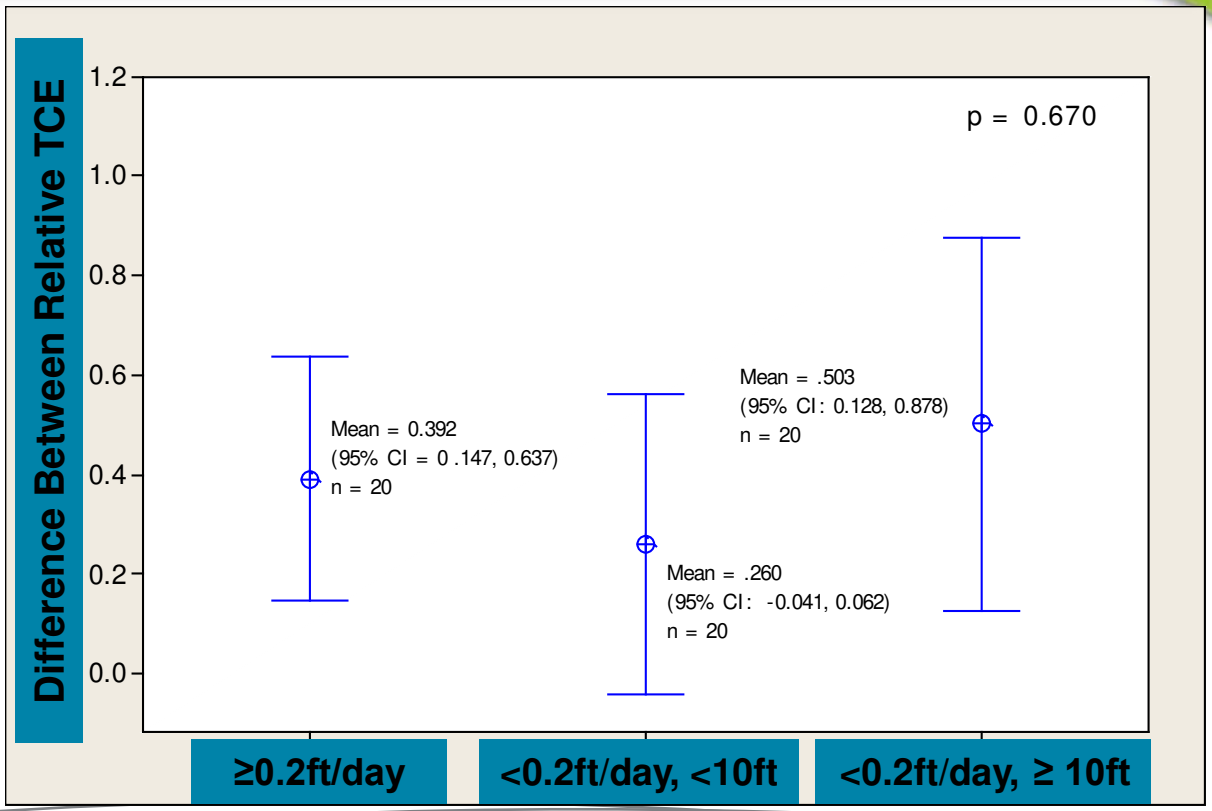
Statistical Data Evaluation

ACCEPTED

Hypothesis #3a:
SP = HS across all levels of gw velocity and water column height



Difference between methods is not significantly influenced by high or low velocity and water column height



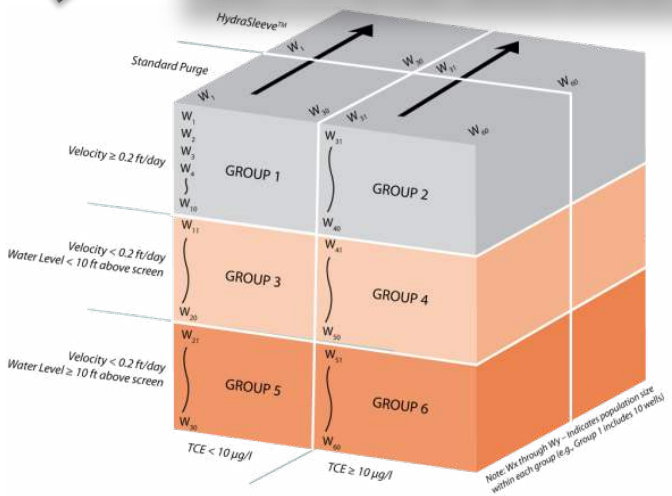
Note: One-way ANOVA

MWH

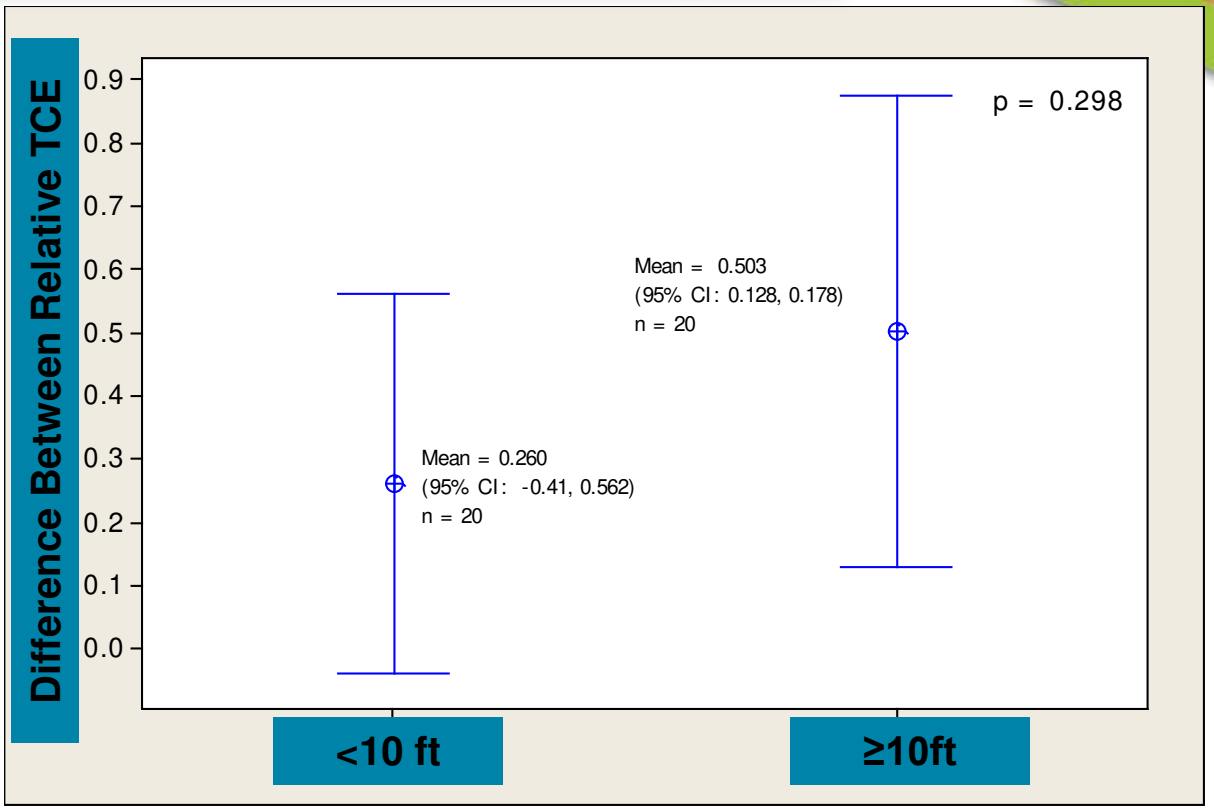
Statistical Data Evaluation

ACCEPTED

Hypothesis #3b:
SP = HS across both water column heights



Difference between methods is not significantly influenced by low or high water column height

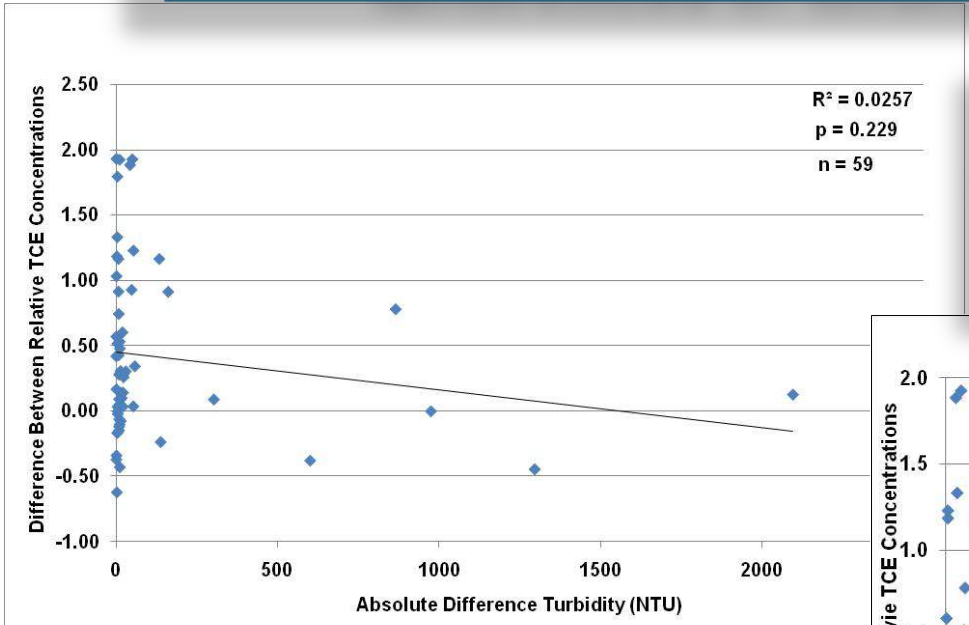


Note: One-way ANOVA

MWH

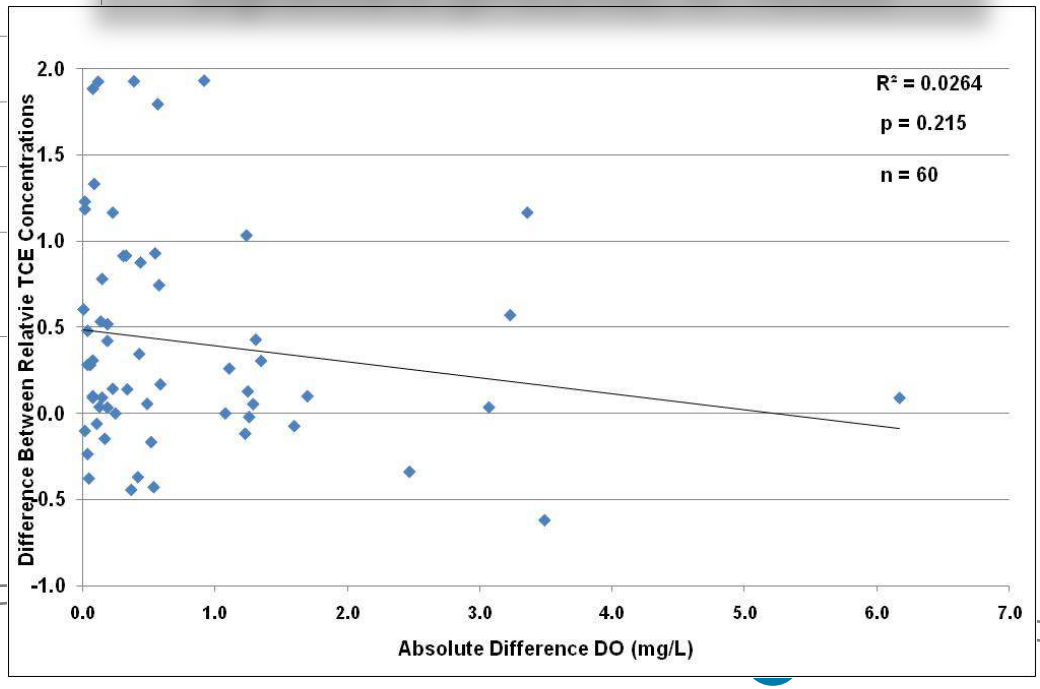
Statistical Data Evaluation

Could differences between methods be related to differences in turbidity and/or DO?



Relationship b/t absolute difference in turbidity and differences in relative TCE for both methods NOT statistically significant (p=0.229); R^2 =0.026

Relationship b/t absolute difference in DO and differences in relative TCE for both methods NOT statistically significant (p=0.215); R^2 =0.026



Statistical Data Evaluation: Summary

- **SP and HS methods are different in a predictable pattern; not influenced by selected well characteristic variables**

Results are not unexpected, **methods are inherently different**

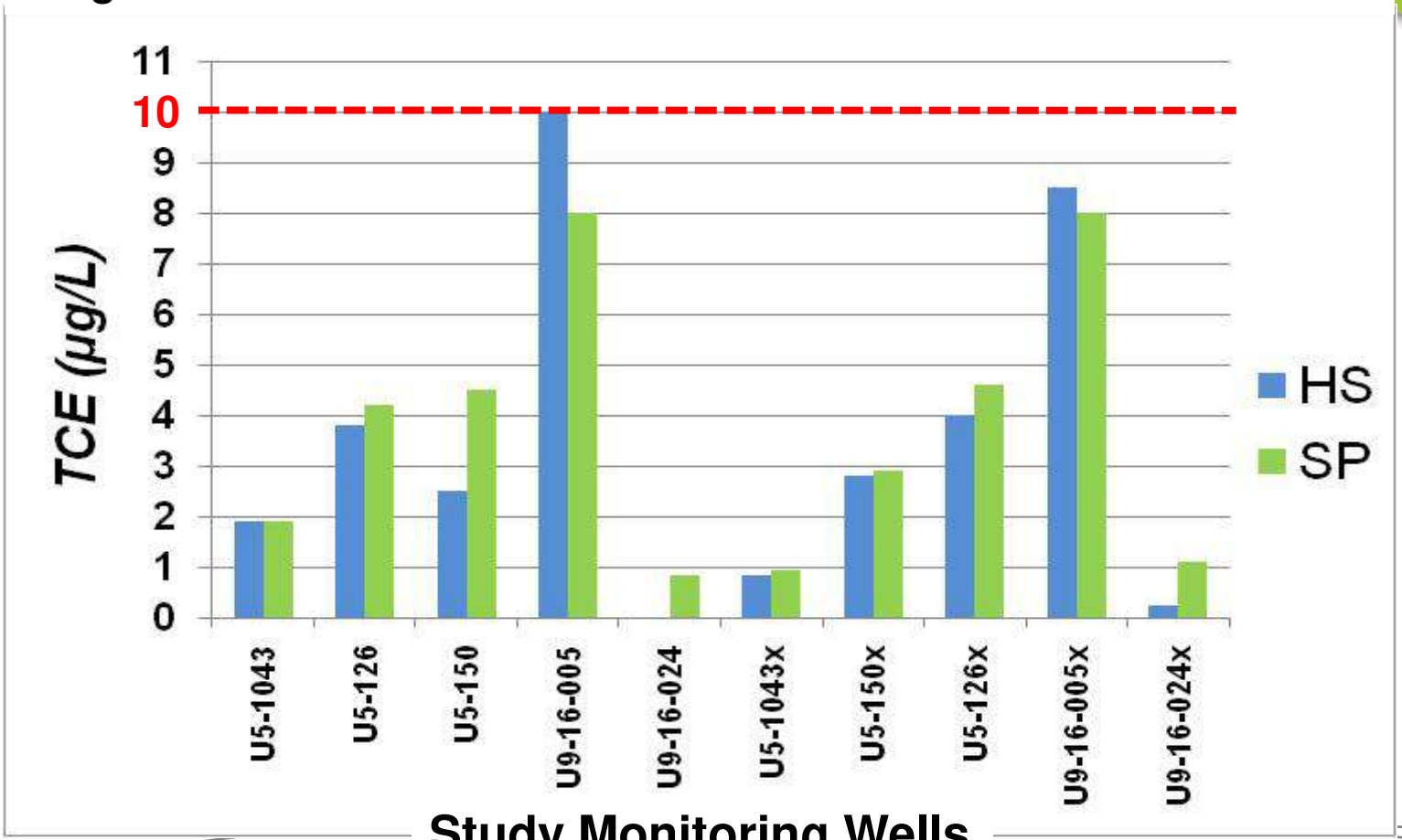
- **Need to consider sampling and analysis methods induce certain level of error and variability**

Absolute concentration at any time is unknown

Performed a Practical Data Evaluation to look at whether site management strategies and long-term plume dynamics would be impacted

Practical Data Evaluation: Visual Inspection of Differences

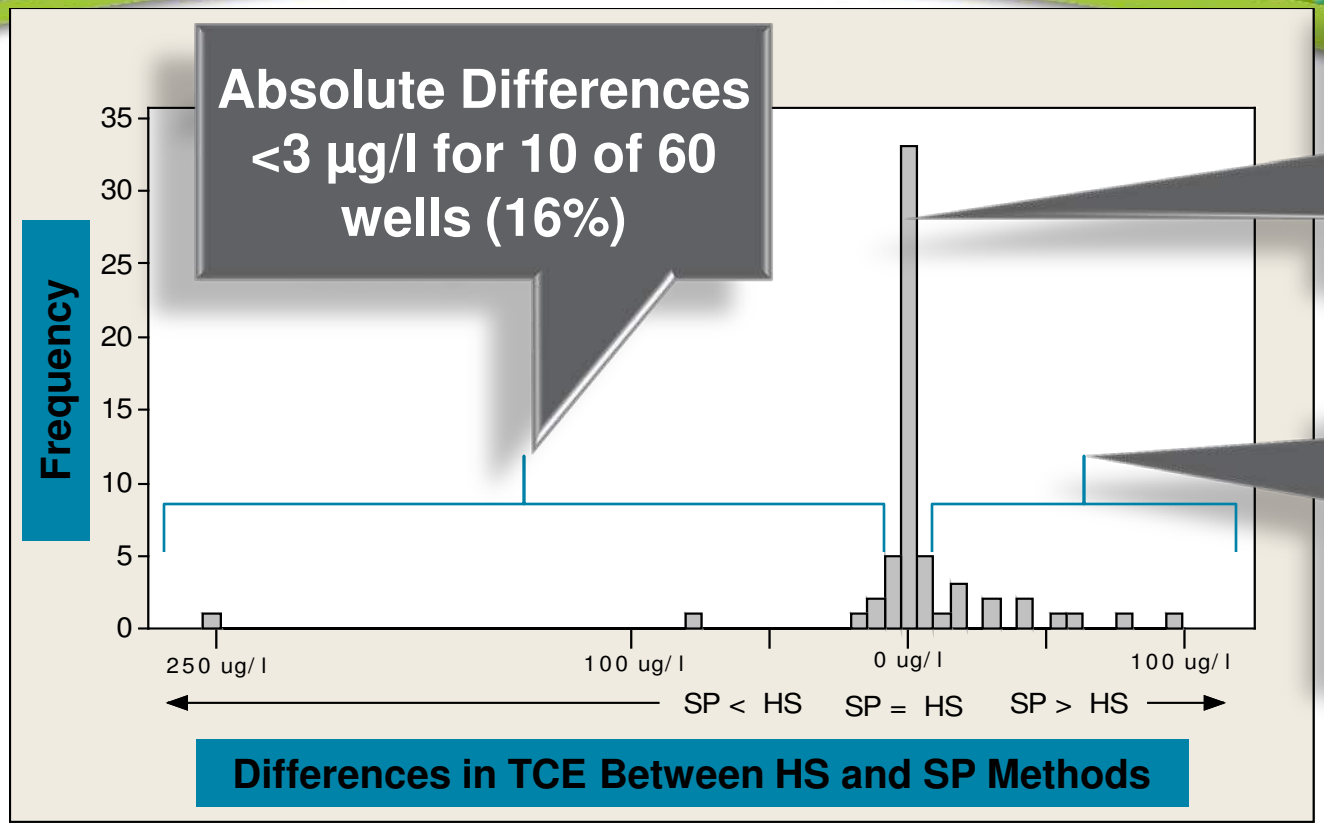
Group 3 Wells: TCE < 10 µg/L, Velocity <0.2, Water Column Height <10 ft above screen



75th AIR BASE WING

MWH

Practical Data Evaluation: Magnitude of Differences



Histogram shows majority of differences were very small (± 3 µg/l)

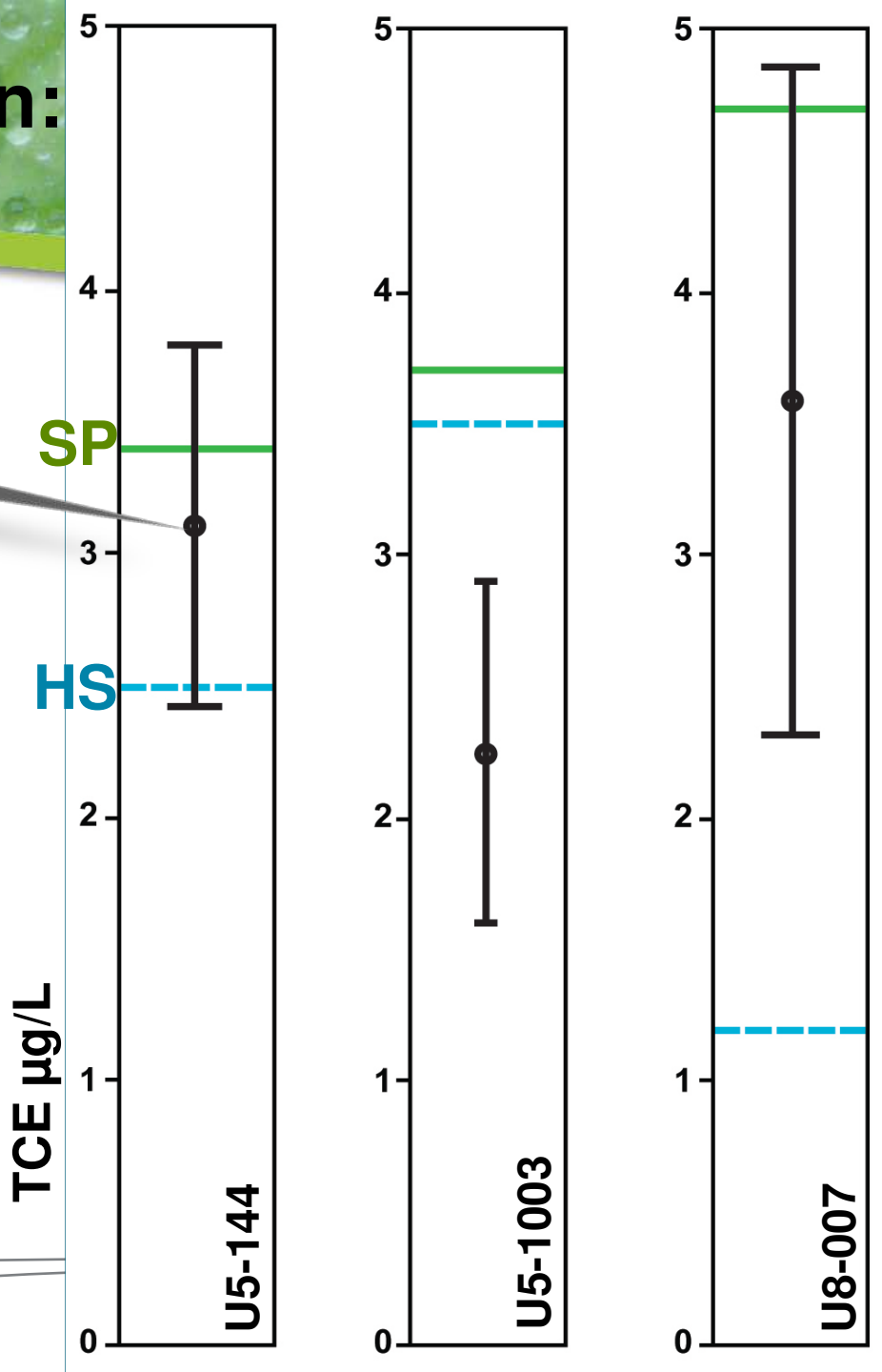
75th AIR BASE WING

MWH

Practical Data Evaluation: Historical Trends

Historical Data Range
CI = 95%

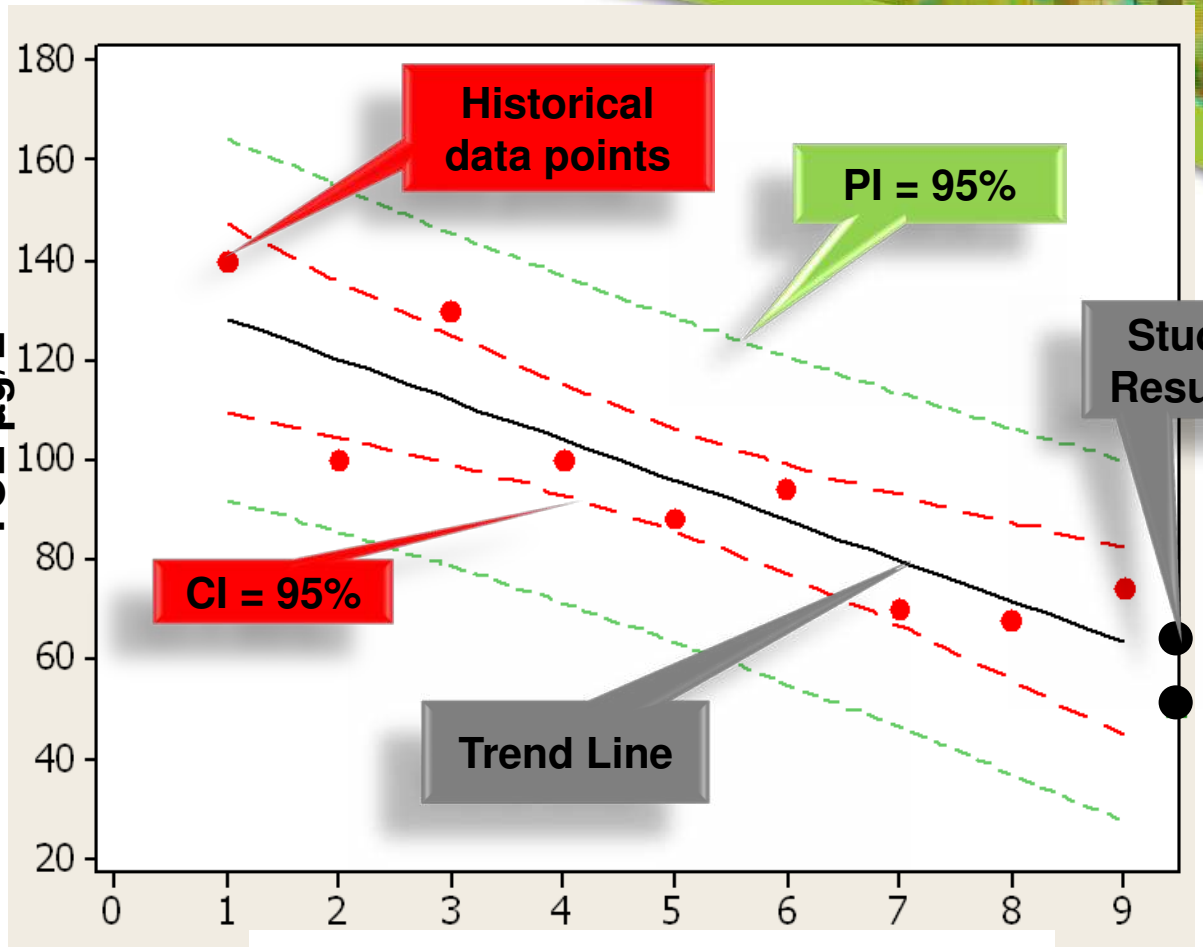
HS results fell within the 95% CI for 17 of 60 (28%) vs. 31 of 60 for SP (52%)



Note: SE Mean reflects how precisely the obtained historical concentration mean estimates the true population mean

Practical Data Evaluation: Historical Trends (cont.)

- 20 of 60 wells had statistically significant historical trends ($p<0.05$)
- HS fell within the PI in 15 of those 20 wells



Note: CI = estimate for population mean; PI = estimate for future outcome of an individual value; Least-squares approach used to trend.

MWH

Practical Data Evaluation:
Repeatability and Variability

- 10 wells not available to populate all 6 groups
- Paired sampling occurred at 12 wells twice
- Treated as individual samples

	HydraSleeve 1	HydraSleeve 2	Standard Purge 1
HydraSleeve 2	r=0.985 (R^2 = 0.970)		
Standard Purge 1	r=0.997 (R^2 = 0.994)	r=0.979 (R^2 = 0.958)	
Standard Purge 2	r=0.999 (R^2 = 0.998)	r=0.987 (R^2 = 0.974)	r=0.998 (R^2 = 0.996)

All method combinations are highly repeatable with most variation explained

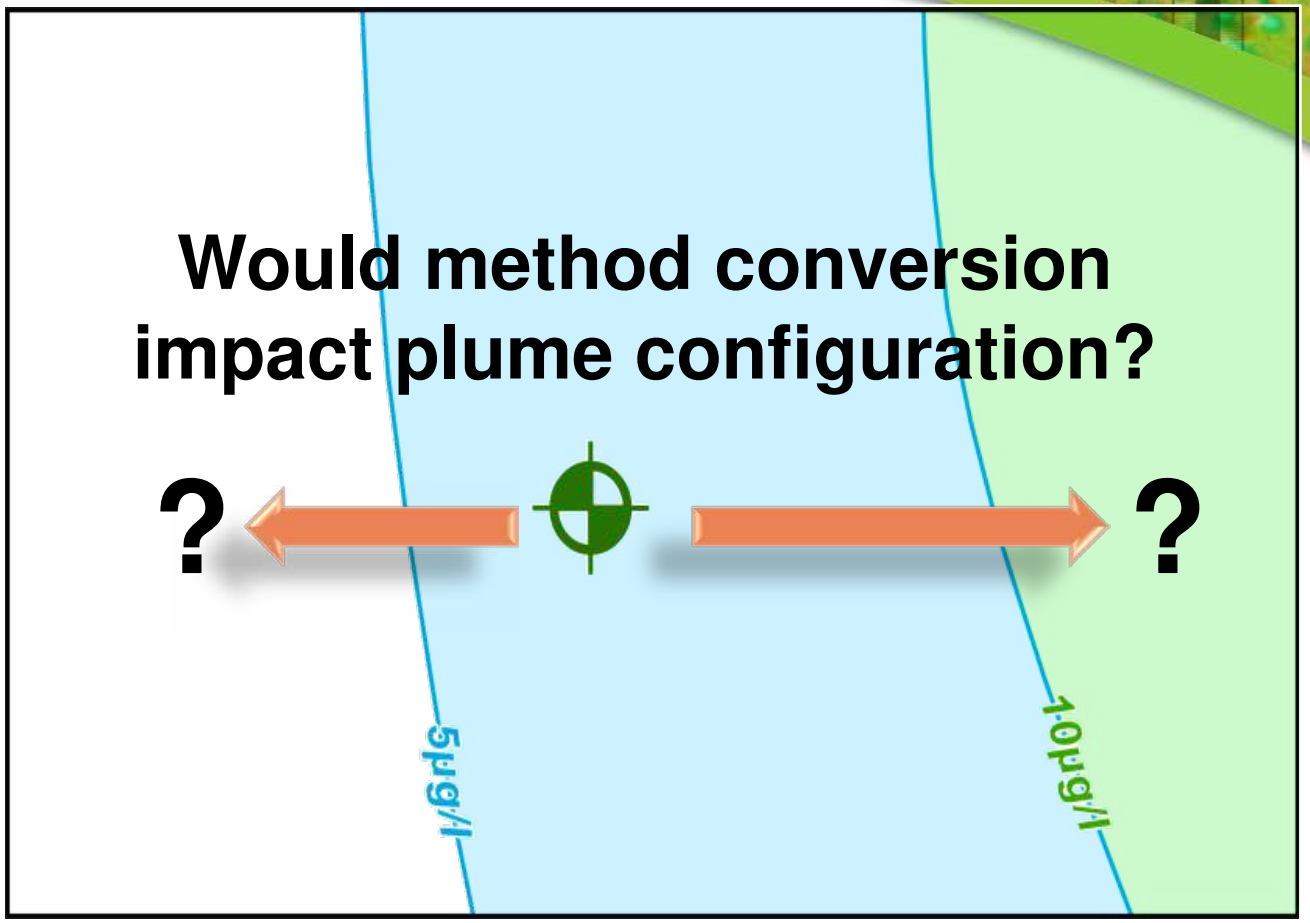
Note: Correlation coefficient (r) = degree to which repeated measures agree;
R^2 = how much variability in one sample explained by other

75th AIR BASE WING

MWH

Practical Data Evaluation:
Plume Contouring

53 of 60 (88%) HS Study results fell within the current plume contouring interval



75th AIR BASE WING

MWH

Footprint:
Cost-benefit and Carbon Footprint Analysis

Cost-benefit: Converting to a passive sampling method (HydraSleeve™) from conventional methods could produce cost savings of up to $9 million over 20 year period.

CFA Components	CFA Results
Mileage	**58%** reduction in CO_2
Idle time and fuel use	**99.8%** reduction in waste water
Compressor/ generator fuel use	**49%** reduction in sampling days
Sampling time/ samples per day	
Average volume water	

***Assumes 1,500 samples**
750 using SP
750 using Low-flow

75th AIR BASE WING

MWH

Conclusions & Recommendations

***Statistical Data Evaluation* showed methods are different and that selected well characteristic variables did not significantly influence those differences.**

***Practical Data Evaluation* revealed inherent variability in sampling, and that conversion to HydraSleeve™ was unlikely to impact site management strategies and long-term plume dynamics.**

***Recommend converting all qualifying wells at Hill AFB* (non-qualifiers - insufficient water columns, large sample volumes, require redevelopment) with evaluation of data within one year of implementation.**

Many useful passive devices; do the homework and pick the device that is right for your site specific needs.