PASSIVE GROUNDWATER SAMPLING: Effective Tools and Lessons Learned to Make the Transition

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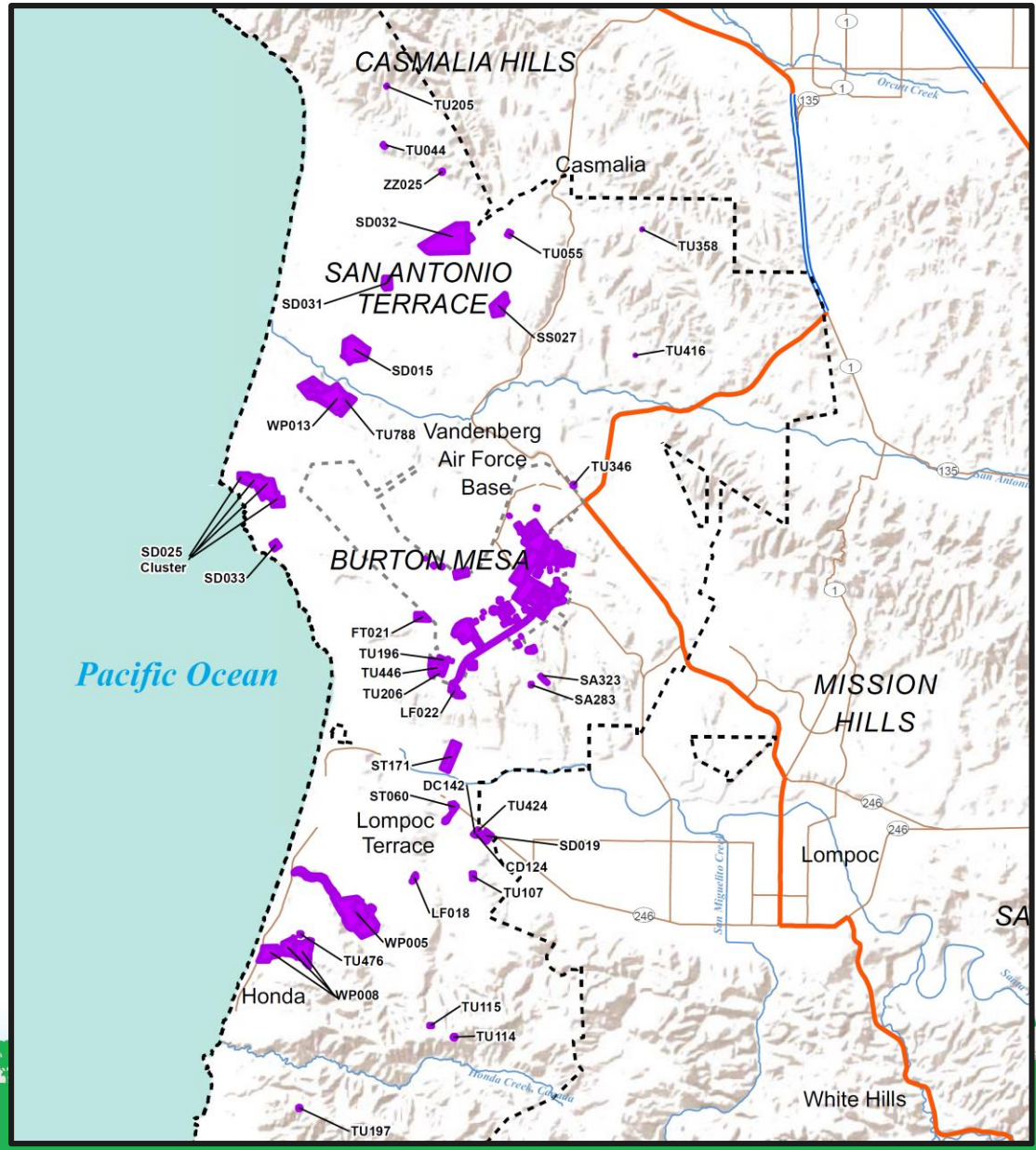
Transitioning Vandenberg AFB Groundwater Program to Incorporate Passive Sampling

- 100,000 acre installation
- 21 groundwater sites
- 184 to over 700 monitoring wells sampled at some frequency (quarterly to biannually)
- Baseline program:

Number of Wells by Well Diameter			
1"	2"	4"	6"
13	140	406	2

Number of Wells by Sampling Method		
Low-Flow	Standard	Bailer
323	129	95



What is Passive Groundwater Sampling?

Passive Groundwater Sampling = Collection of a groundwater sample without purging the well

Acquire a sample from a discrete location without the active media transport induced by pumping or purge techniques (ITRC, 2006)

Assumes screen interval water is in equilibrium with, and representative of, formation groundwater

Established record of statistically comparable data since the 1990s

Passive Groundwater Sampling: Advantages and Limitations

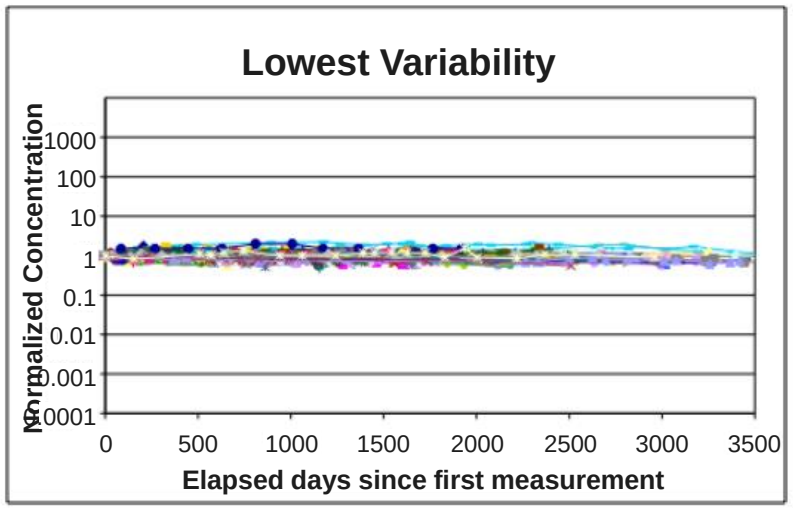
Advantages

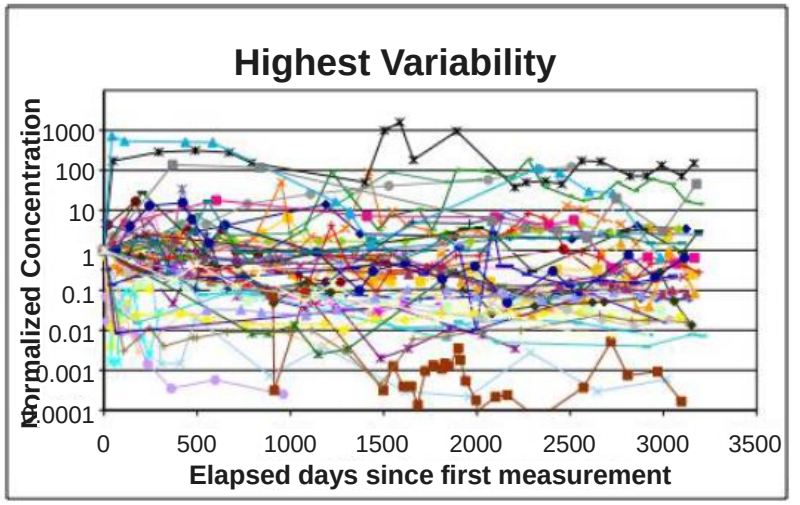
- High-quality data with reduced time/labor/cost for each sampling event
- Less equipment, energy, and waste → more sustainable

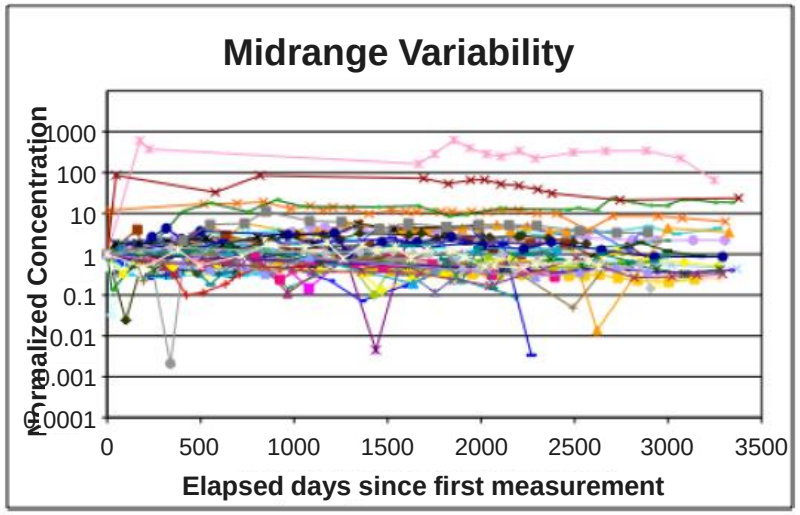
Limitations

- Physical constraints of well (e.g., well diameter, depth to water, and water column thickness)
- Analyte/sampler compatibility
- Analyte sample volume requirements
- Potential upfront costs in addition to capital expense (e.g., comparative study or reporting changes to assure regulatory acceptance)

Sources of Variability in Sampling Methods







Large differences in monitoring variability between different monitoring wells

Monitoring data from Hill AFB, from GSI Environmental and SERDP Presentation by David Adamson, Charles Newell, and Tom McHugh, RemTEC 2013

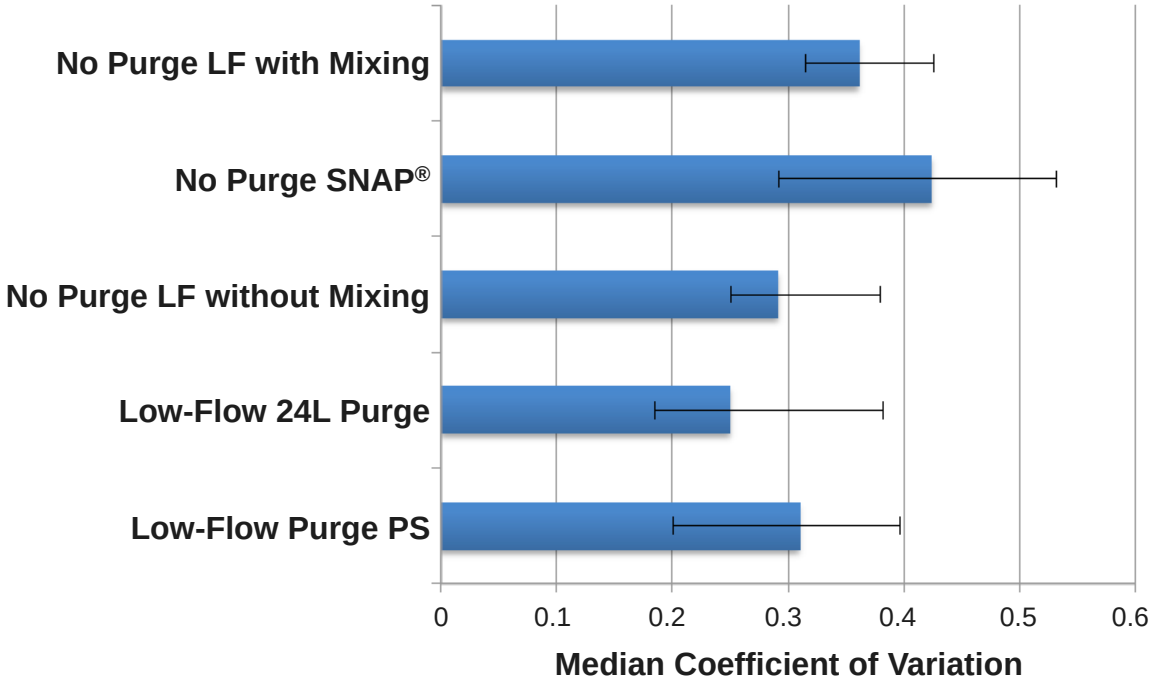
Sources of Variability in Sampling Methods (cont.)

Every sampling method has inherent variability even low-flow and 3 volume purge

Sources of variability

- Collection and analysis methods
- Aquifer and well dynamics (including heterogeneity and permeability)
- Depth to groundwater and changes in groundwater elevation

GSI Environmental and SERDP 2013



Consider source and scale of variability when initiating sampling method change

Screening Sites for Transition to Passive Sampling

Compile Site Data

Estimate Cost Savings and Efficiencies

Short-list Passive Sampling Method/s and Develop Decision Points

Agree on site-wide transition vs. side-by-side comparison

Early engagement of Stakeholders and Regulators for buy-in and to understand hurdles

Compile Site Data

Compile information which addresses the following

1. Site and Monitoring Well Characteristics

- Number of wells, well construction characteristics and materials, age of well, analytical parameters
- Water levels, hydraulic, and geologic information

2. How the Data will be Used

- Closure sampling, remedy performance monitoring, long-term monitoring, etc.

3. Local Regulatory Acceptance/Awareness

- **Early** buy-in is key to success
- Track record, established regulatory guidance or history of approving passive sampling methods
- Current working relationship, e.g., positive vs. high conflict

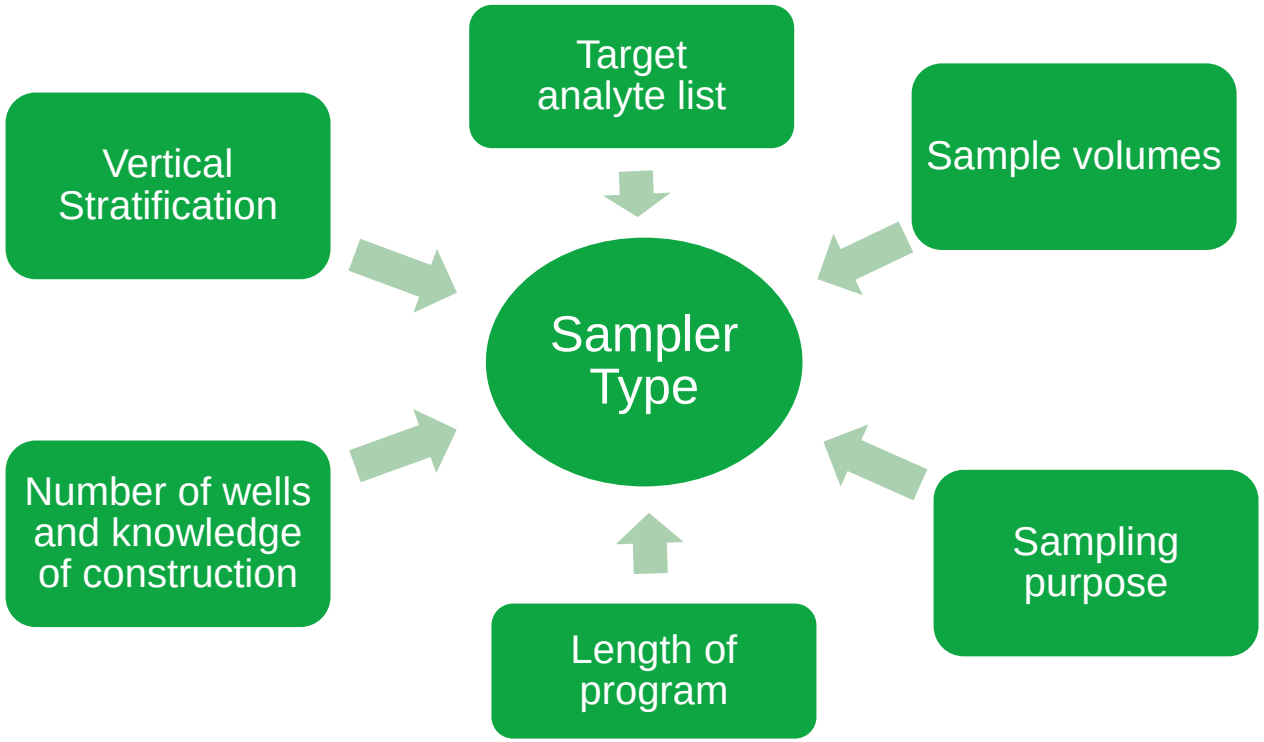
Estimate Expected Efficiencies, Cost Savings, and Return on Investments

- Lifecycle cost savings provide a basis for decisions and can inform sample method selection
- Broader support for stakeholder discussions when GSR, waste generation and health and safety considerations are factored in
- Consider passive sampler type to determine capital costs vs. ongoing costs

KEY POINT

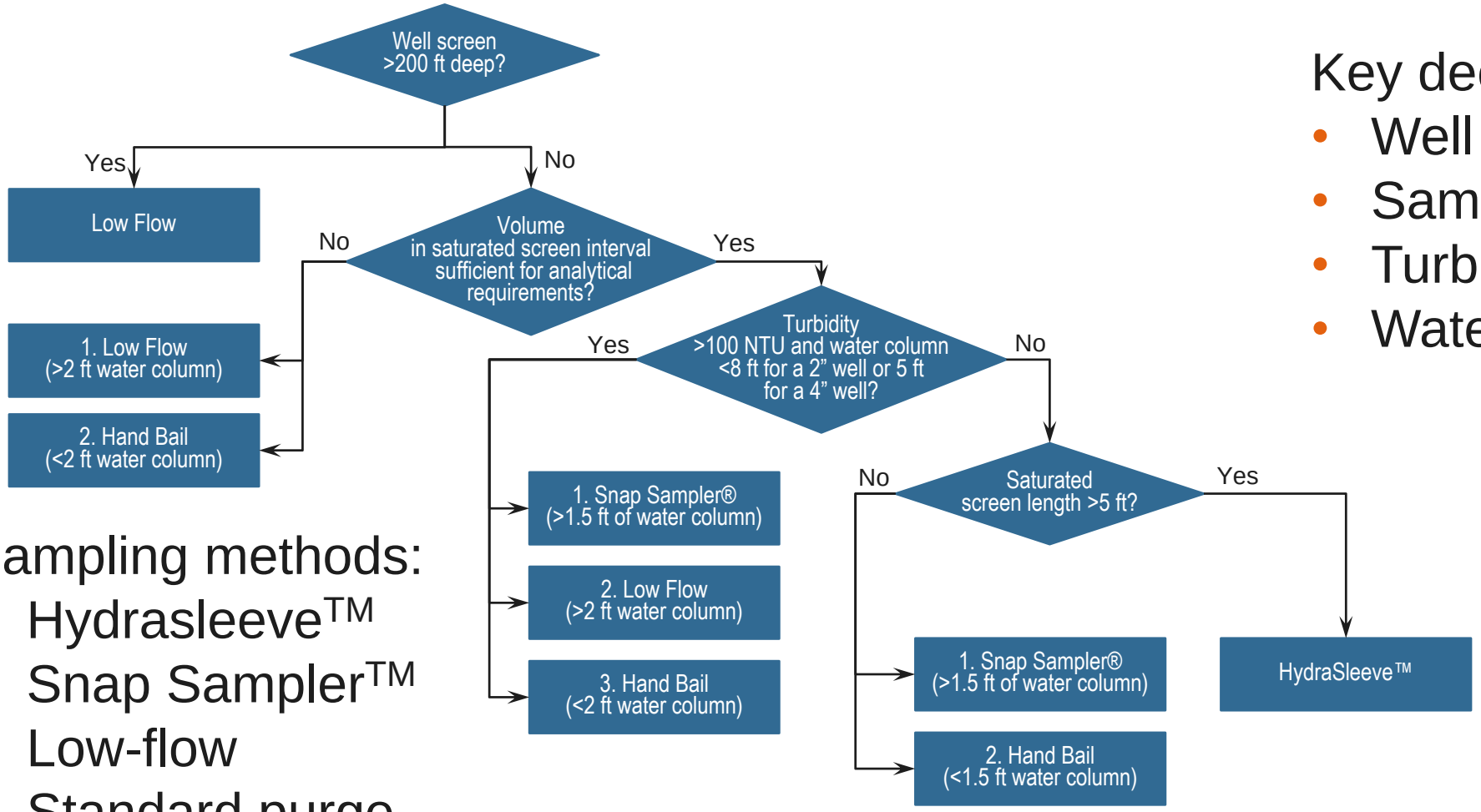
- **Look at big picture for maximizing cost savings/avoidance**
  - **e.g., reduced equipment needs, increased efficiency, decreased mobilization costs, waste disposal costs**

Specific Considerations for Passive Sampler Selection



Consider a combination of methods (including traditional sampling) rather than a single passive sampling technology if needed

Sampling Method Flow Chart



Key decision parameters:

- Well depth
- Sample volume
- Turbidity
- Water column height

Sampling methods:

- Hydrasleeve™
- Snap Sampler™
- Low-flow
- Standard purge

Continuous stakeholder input as decision framework was developed

Side-by-Side vs. Site-Wide Conversion

Side-by-Side

Traditional approach: Sample every well with both methods and determine if data comparable

- Perceived as direct measurement of comparability
- Increase surety for closure sampling
- Good for limited historical datasets
- Costly and time consuming

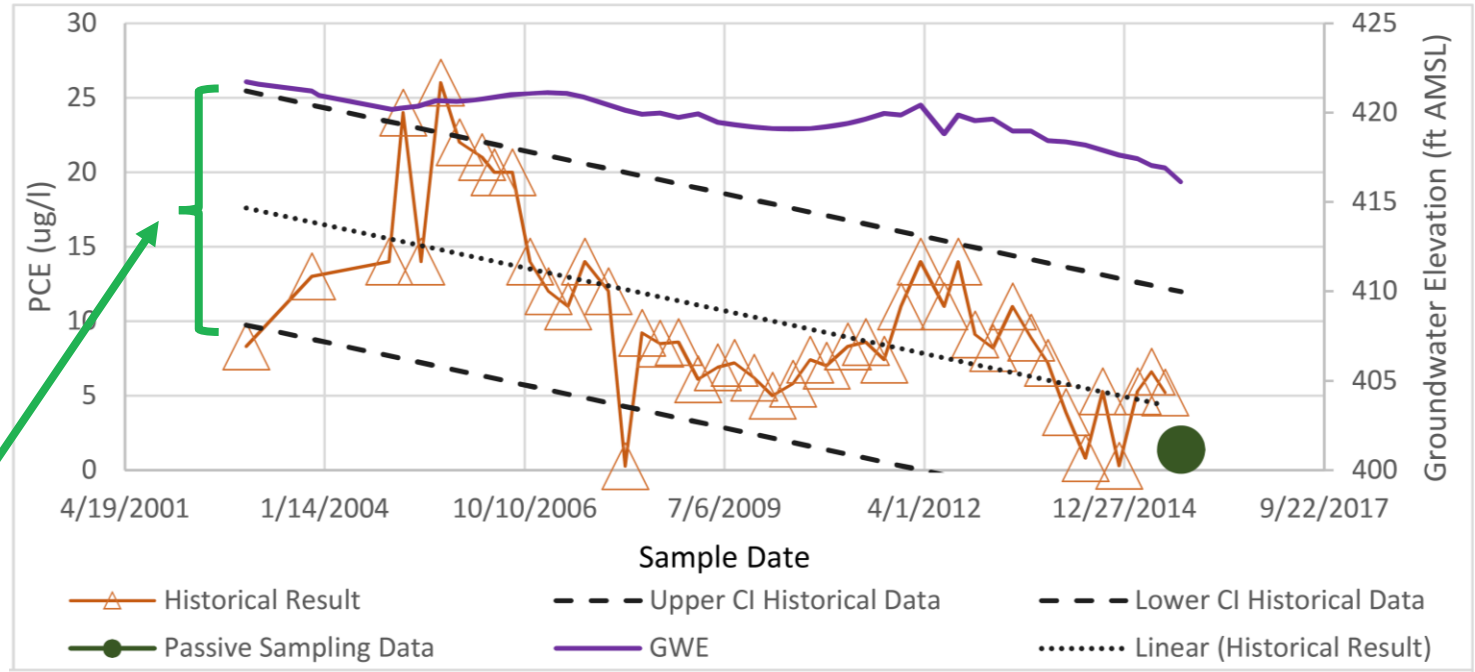
Site-Wide Conversion

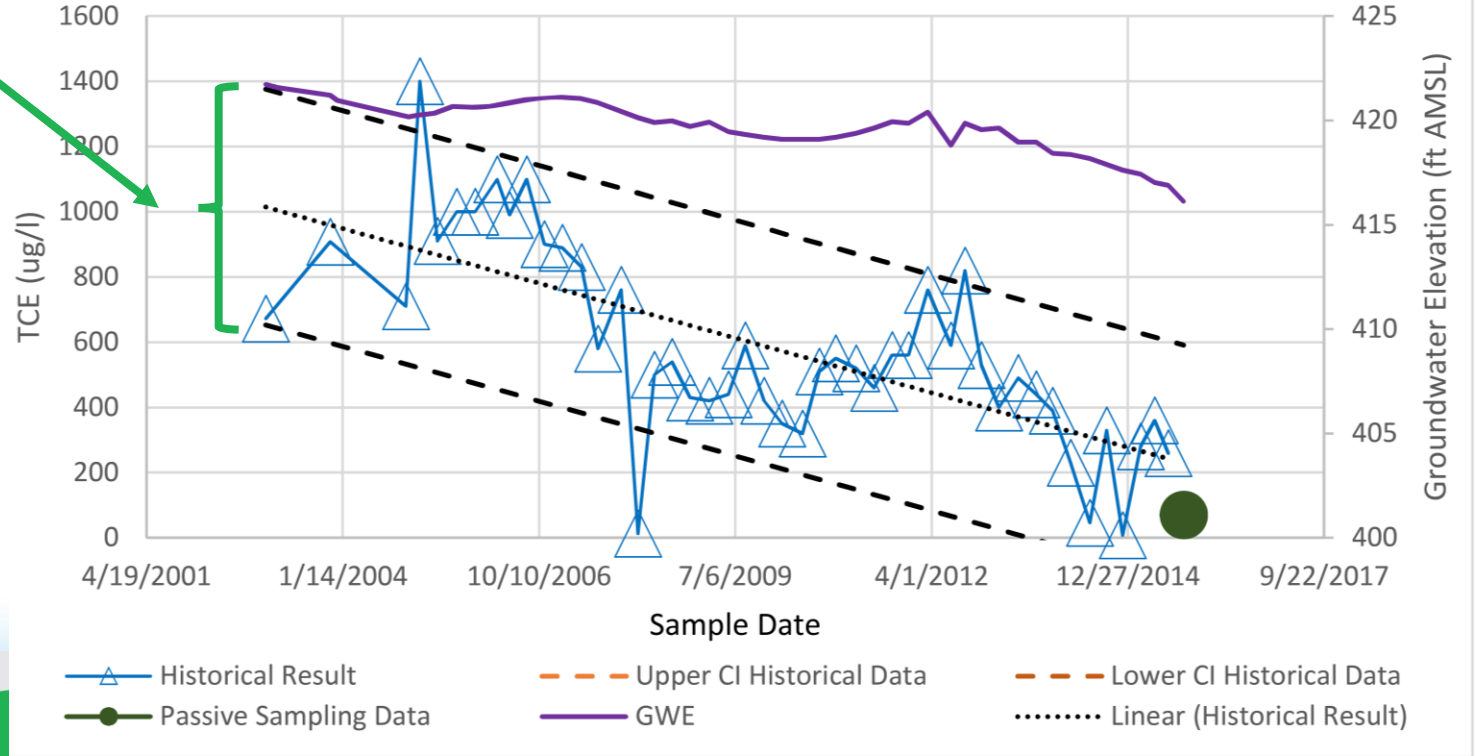
Accepts inherent variability in all methods (construction, water levels, seasonality, sampler bias, etc.)

- Some level of variability acceptable for all methods
- Uses historical data to define inherent variability
- If variability for ‘new’ method within inherent variability of existing method, and gives the same outcome with respect to decision criteria, change is acceptable

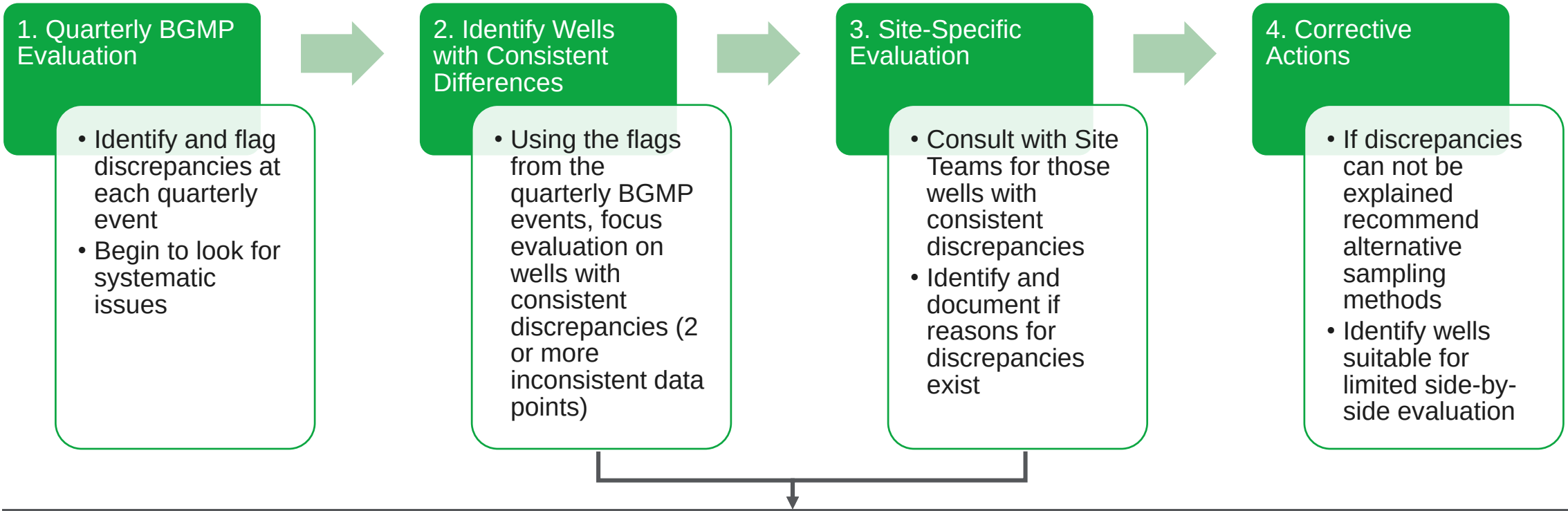
Site-Wide Conversation Data Analysis

- Automated evaluation of each analyte from every monitoring well with passive sampler
- Screen against 90% confidence interval along trend
- Flag inconsistent wells for further evaluation
- Data analysis after 4 quarterly events



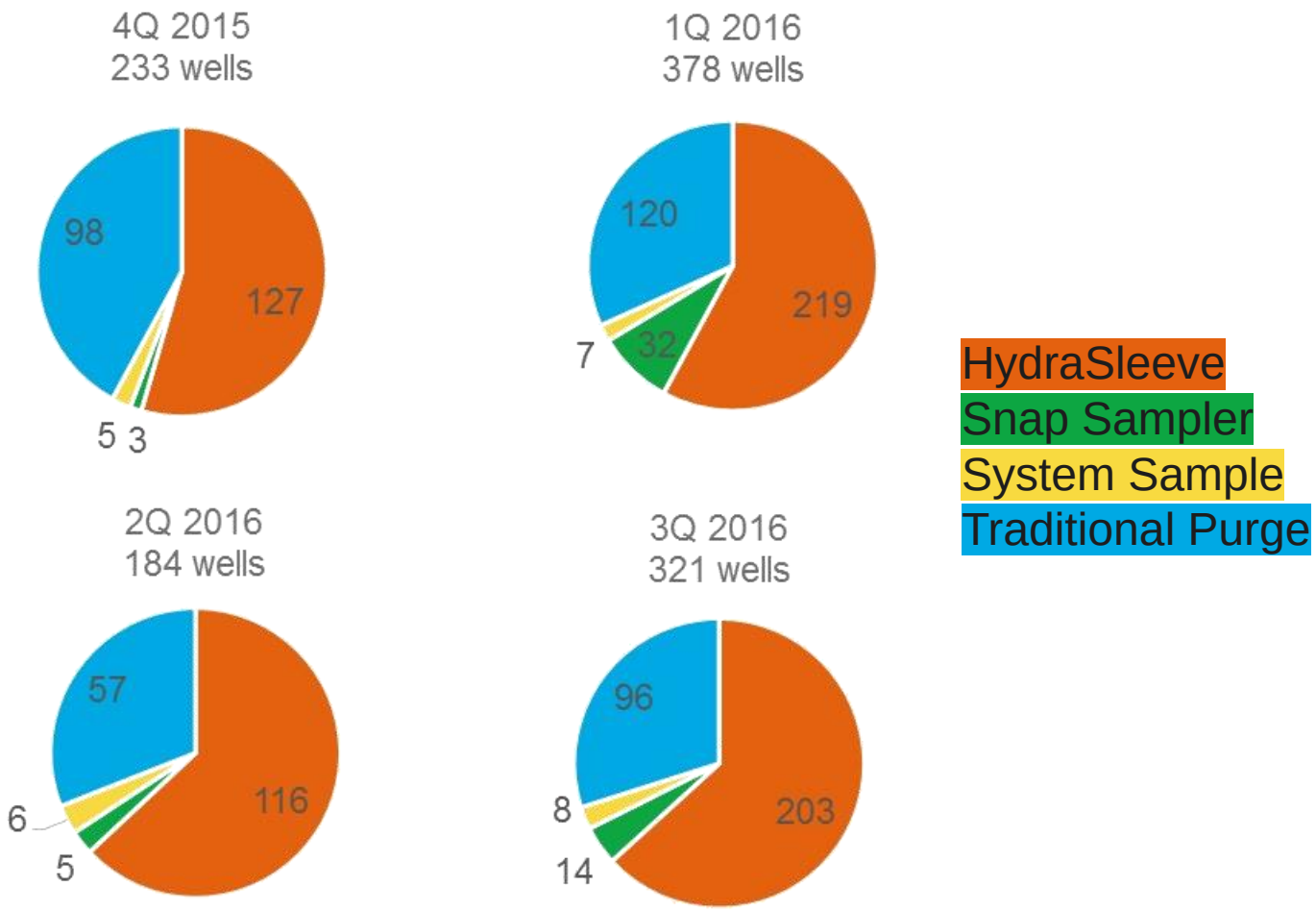


Evaluation Logic and Decision Steps

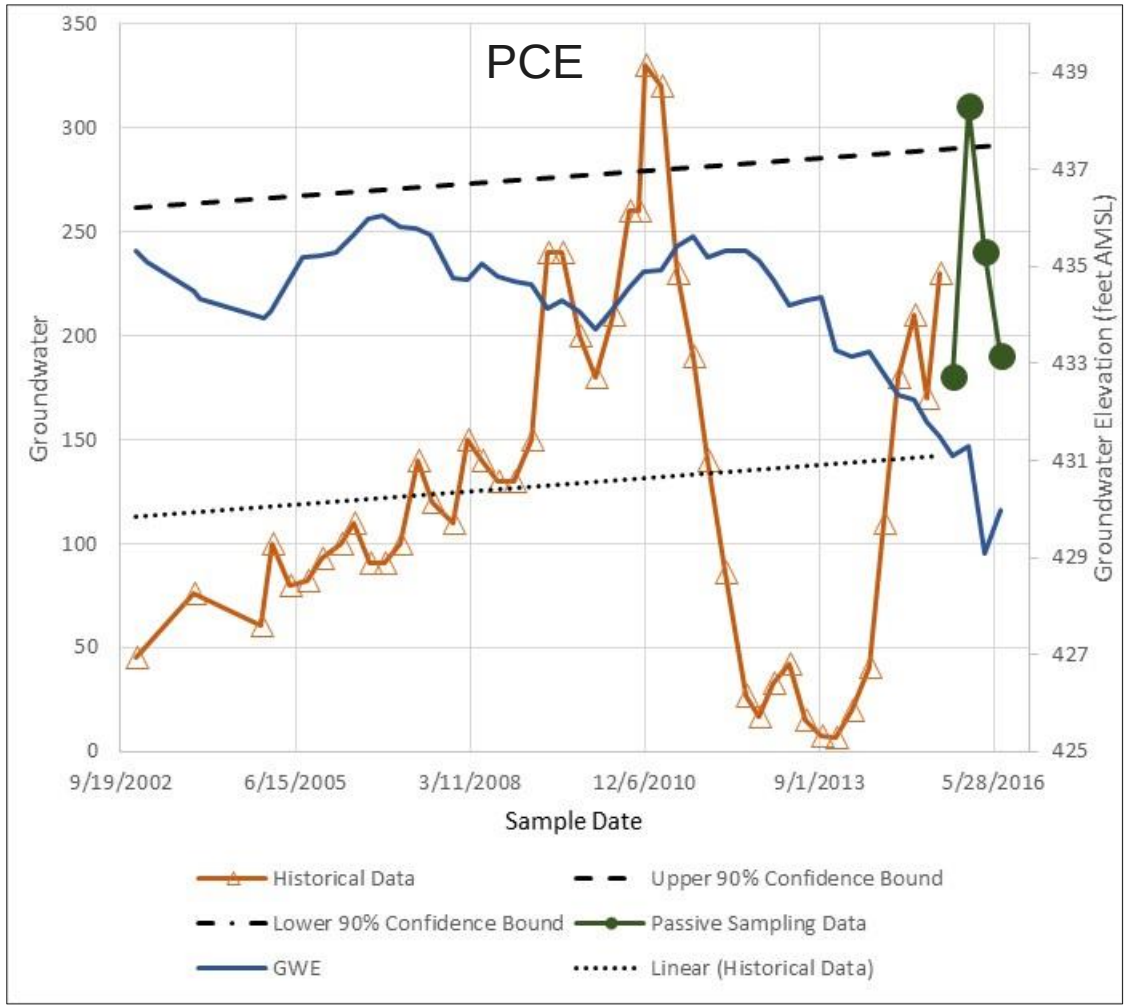


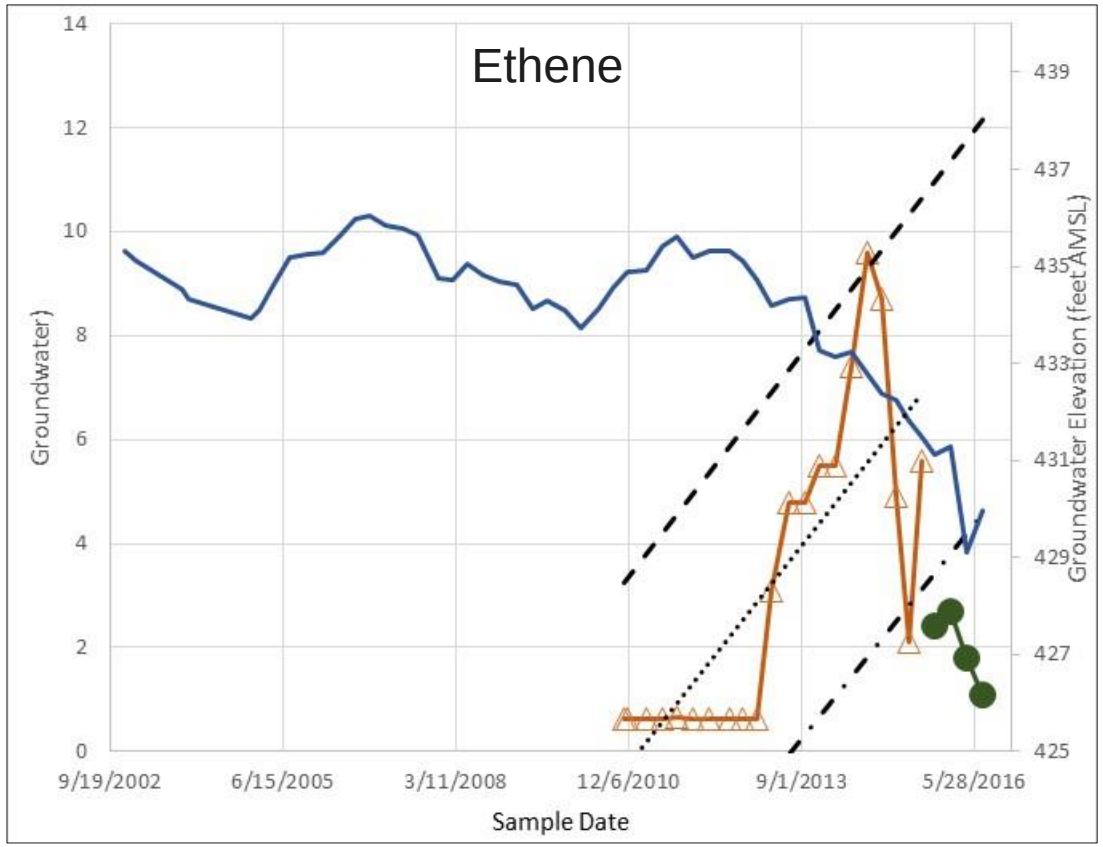
Summary of No-Purge Sampling Activities

- No-purge sampling devices deployed during 3Q 2015, for the initial sampling event in 4Q 2015
- Completed four quarterly BGMP sampling events since 4Q 2015
- Flagged monitoring well and analytes that were inconsistent in each quarterly evaluation for future reference



Site-Specific Detailed Data Evaluation





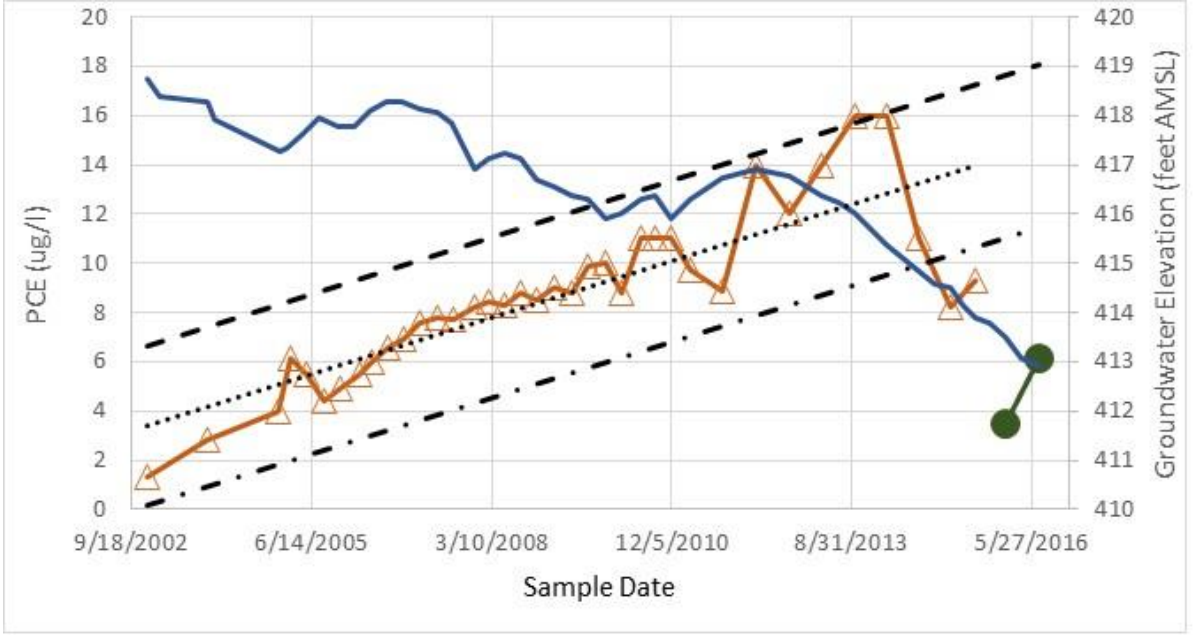
- Well influenced by in situ bioremediation system
- Data rationalized during site-specific evaluation

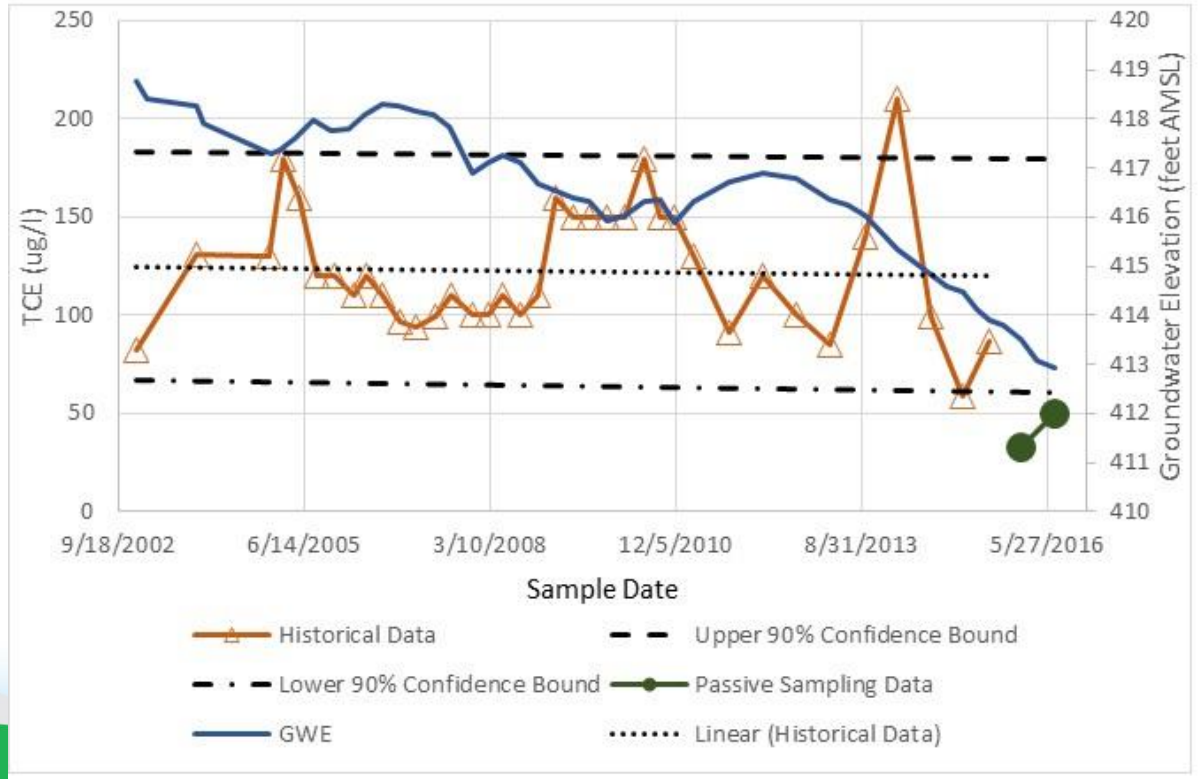
Site-Specific Evaluation –

Further Evaluation and Potential Corrective Action Required

PCE and TCE

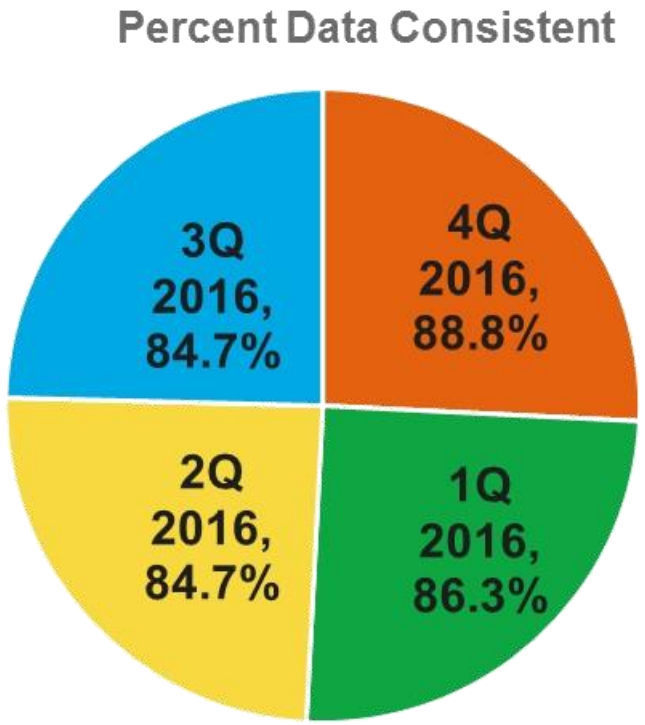
- No-purge data inconsistent with historical trends and cannot be explain by the CSM, water level changes or active remediation
- Corrective action is recommended





Quarterly Evaluations

- No-purge sampling methods were found to be consistent with historical data and trends for ~86% of monitoring well/analyte pairs evaluated
- No obvious signs of systematic or consistent bias between sampling events, or at individual sites, identified
  - Possible exception of 3 wells at a single site

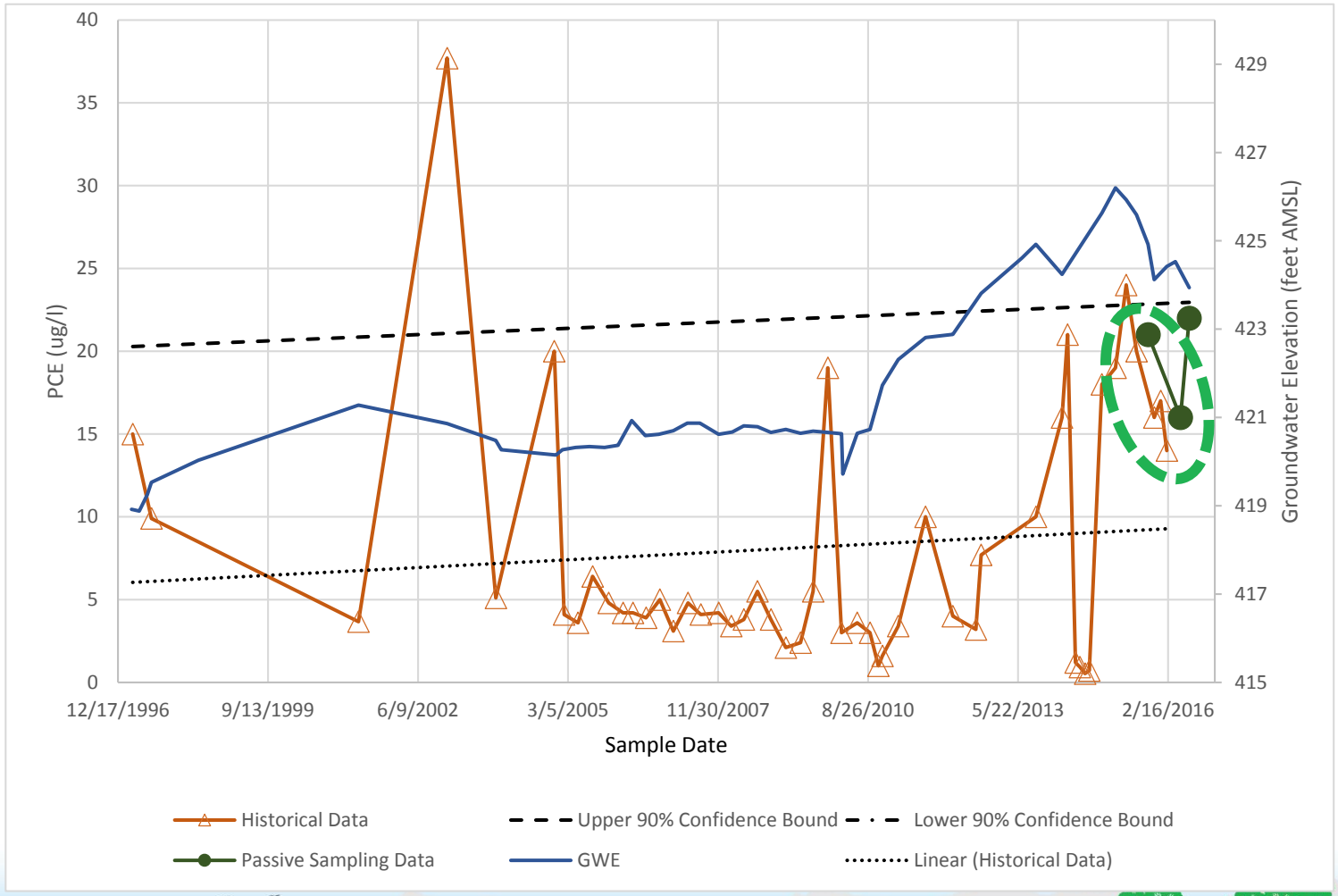


No. Monitoring Well/Analyte Pairs Evaluated

4Q 2015: 545
1Q 2016: 811
2Q 2016: 444
3Q 2016: 695

Percent Data Consistent = percent of total monitoring wells and analyte pairs evaluated that showed no-purge data consistent with historical trends

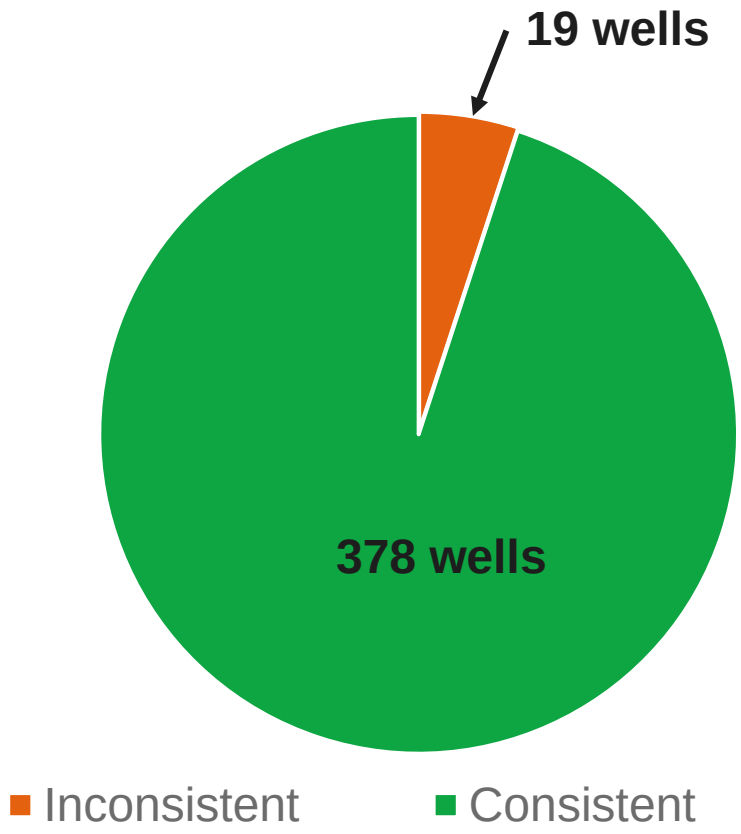
Further Analysis – Multiple Sampling Methods



- Opportunistic data sets from select number of wells sampled by multiple methods
- No inconsistent data identified

Corrective Actions

- 19 monitoring wells (5%) proposed for side-by-side evaluations
  - These wells had consistent discrepancies over multiple quarters of sampling that could not be reconciled during review of the CMS or remedial history
  - One-time side-by-side sampling event
  - If data are inconsistent, revert to previous purge-based sampling at a given well
- Well redevelopment



Vandenberg AFB Transition to No-Purge Conclusions

- Blind screening of data based on 90% confidence interval for first four quarters of data:
  - 84 to 89 percent **consistency** for each quarter based on monitoring well and analyte pairs
  - 10 percent **inconsistent** data (88 out of 922) for two or more quarterly events – includes 19 individual monitoring wells selected for back-end side-by-side analysis
- No obvious systematic bias from transition to no-purge sampling
- No-purge sampling included in base-wide groundwater monitoring program, with exception of pending side-by-side analysis on 19 monitoring wells (5% of 378 wells) with inconsistent data sets

Questions…

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