Benign Disposal of Arsenic Treatment Residuals:

Phase 1 - Assessment

SBRP/EPA/Univ.Arizona Teleconference

September 2, 2004

Changes and Impacts

- **2001revised arsenic in D.W. standard**
  - **10 ppb MCL (from 50 ppb)**
  - **Implementation by 2006-2012**
- **Predicted impacts**
  - **4000 new utilities impacted (>95% small)**
  - **8M lb solid residuals annually (30,000 # As /yr)**
  - **Present and future Superfund/RCRA sites**
- **Residuals hazard assessment**
  - **Toxicity characteristic leaching procedure (TCLP)**
  - **Waste extraction test (WET)**

Our Corollary Research

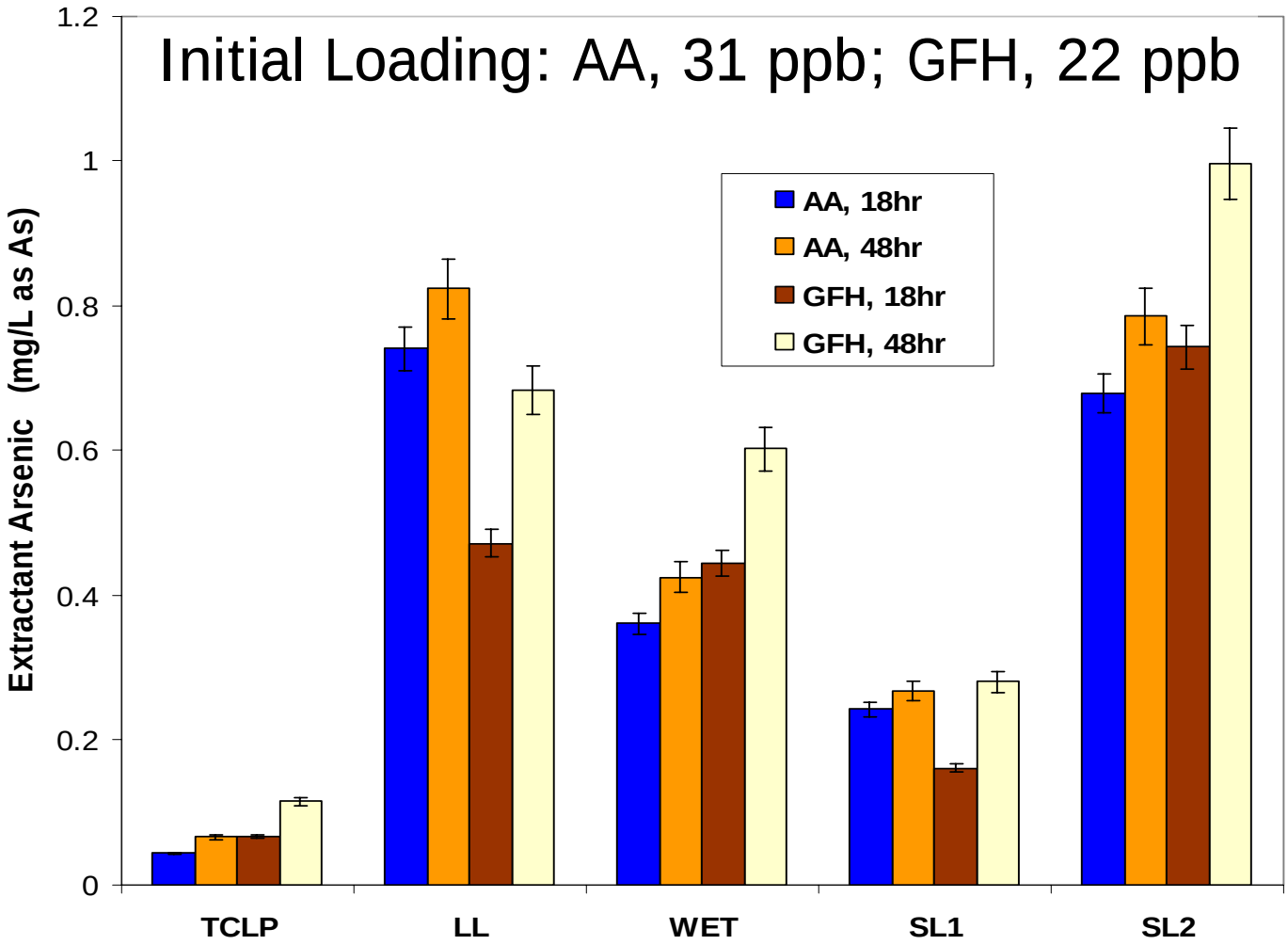
- **Treatment systems evaluation (IHS funding)**
- **Removal technology development (AZ State funding)**
- **Residuals assessment (SBRP/AZ State funding)**
  - **Adequacy of TCLP and WET**
  - **How high should the bar be?**
  - **Alternative test development**
  - **Other contaminants and scenarios**
- **Residuals stabilization (SBRP/AWWARF/AZ State funding)**

Residuals Assessment Tests

Guiding Premise: test induces leaching as or more aggressively than conditions of non-hazardous waste disposal

	TCLP	WET	Mature Landfill
pH	4.95	5.05	7-9
Bioactivity	abiotic	abiotic	biotic
Duration	18 hr	48hr	weeks/months
Active Reagent	acetate	citrate	Mix of organics & inorganics
Redox Condition	oxidizing	neutral	reducing

Solid Media Leaching



Immediate Findings

- **TCLP vs. WET Variables (batch test mode)**
  - **agitation method (tumbler (T) > shaker (W))**
  - **headspace (N_2 (W) > air (T))**
  - **duration (48 hr (W) > 18 hr (T))**
  - **reagent (citrate (W) > acetate (T))**
- **Landfill vs. St'd. Variables (batch test mode)**
  - **pH (6.8 (LL) > ~5 (T&W))**
  - **TOC (above 160 ppm (LL) > below 60 ppm (T&W))**
  - **ORP (below 50 mV (LL) > above 50 mV (T&W))**
- **Study limitations**
  - **batch vs. continuous flow**
  - **abiotic vs. biotic**
  - **excess (non-reactive) vs. limiting (reactive) substrate**

Next Steps for As Residuals

- **Simulate landfills/repositories to determine appropriate performance bar**
- **Develop tractable protocols based on engineering critical leaching mechanisms to clear bar**
- **Evaluate (technically & economically) treatment options, including potential for stabilization**
- **Develop/evaluate hybrid (conventional & innovative) disposal options**

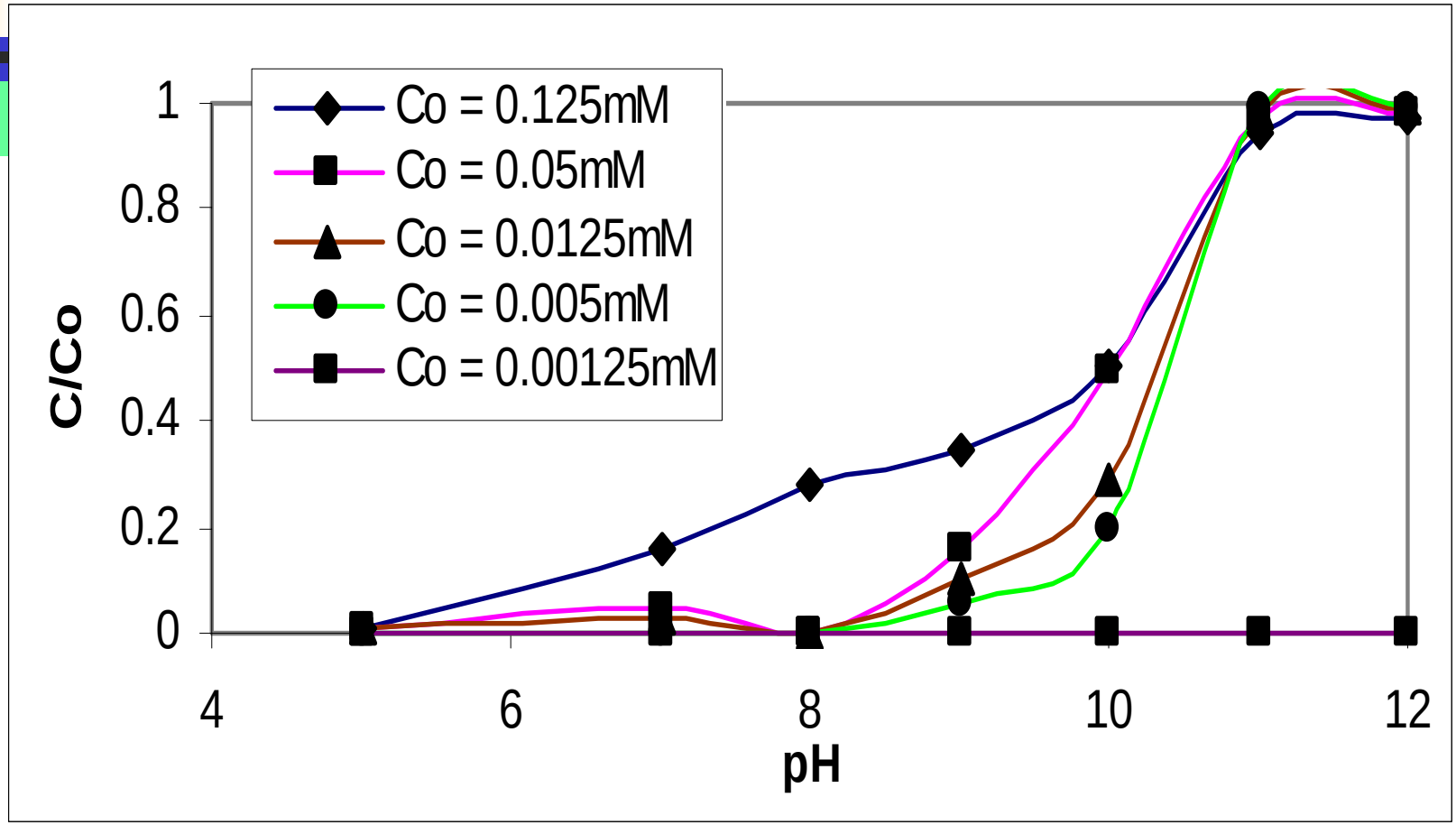
Broader Implications

- **Arsenic as an elemental contaminant**
  - **no destructive technologies**
  - **media and speciation transformations only**
  - **surrogate for heavy metals, metalloids, radionuclides**
- **Arsenic as a redox-sensitive, oxyanion**
  - **inverse pH behavior to metals**
  - **microbially mediated fate and transport**
  - **typically most mobile in reduced form**
  - **surrogate for V, Mo, Se, S, Cl, N, P**
- **Arsenic as a ‘natural’ contaminant**
  - **primarily non-anthropogenic sources**
  - **naturally diffuse but anthropogenically concentrated**
  - **surrogate for Rn, U, Se, S, F, Br, V**

Prerequisites to Prevention

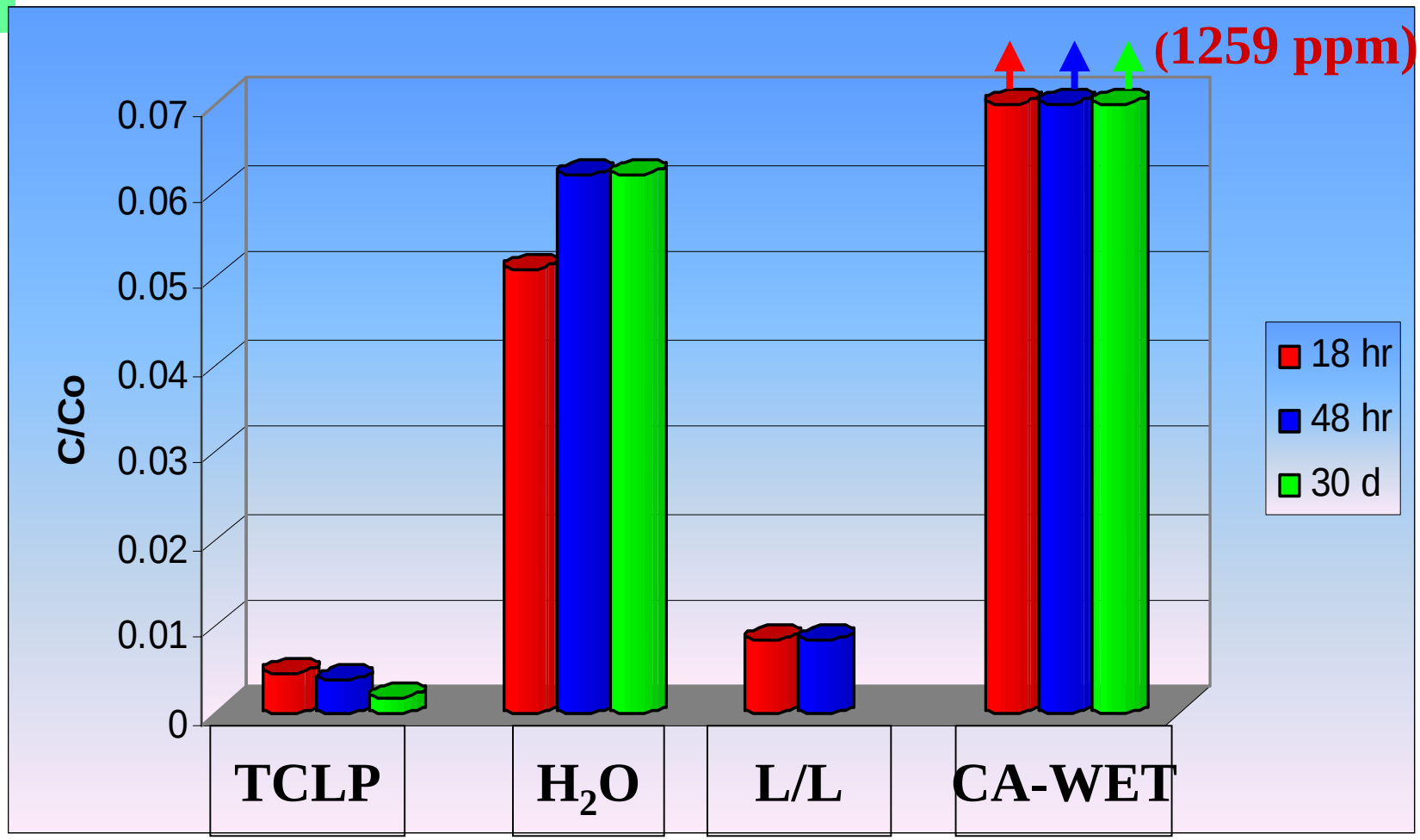
- **Correlate & calibrate leaching tests to various disposal scenario's (address baseline definition)**
- **Apply to spectrum of technologies and contaminants**
- **Develop and apply residual stabilization methods/economics**
- **Apply whole life analysis of elemental contaminants (solid/liquid/atmospheric considerations)**

AA Adsorption Edge

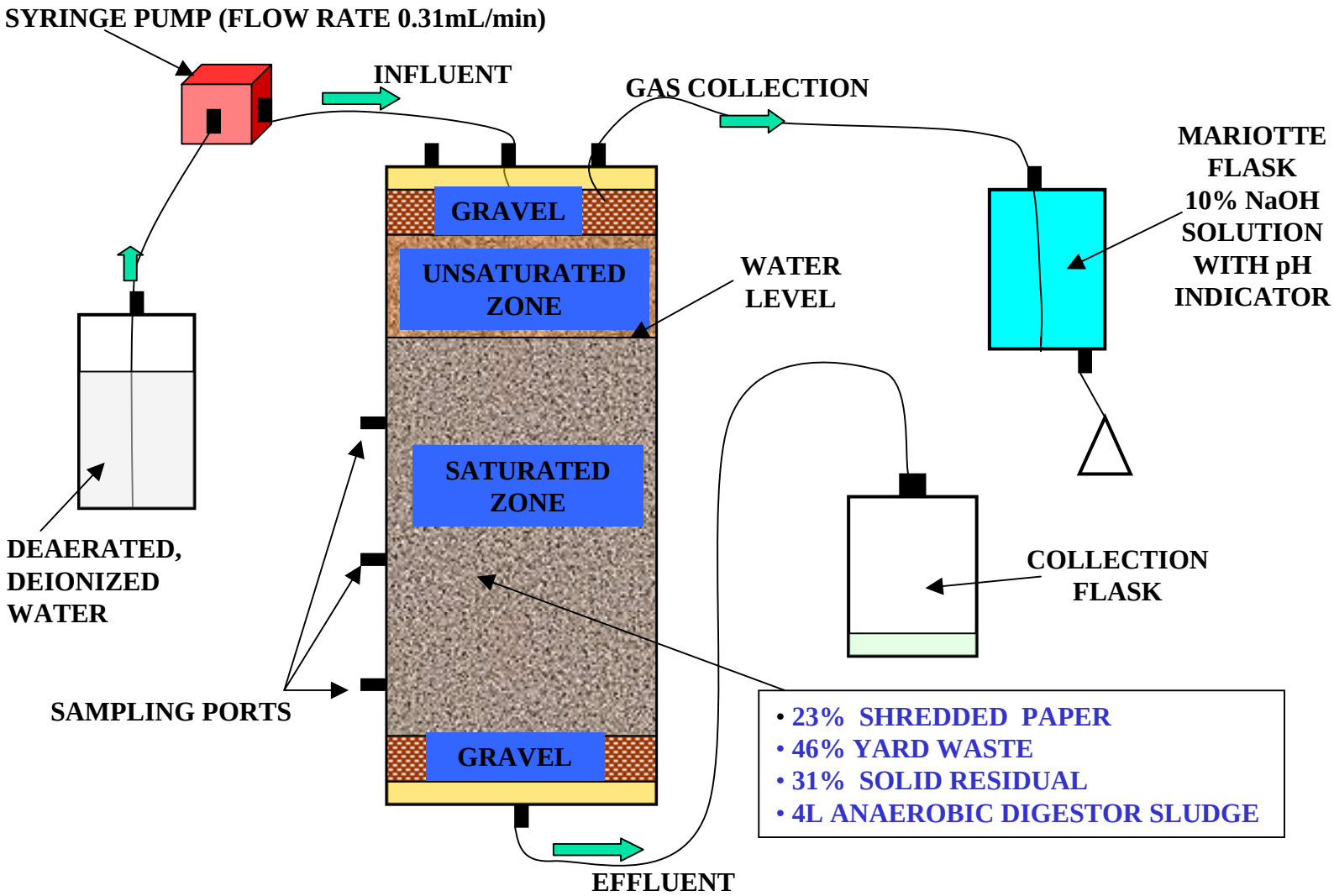


- Co - Initial arsenic concentration in solution
- C - Equilibrium arsenic concentration in solution

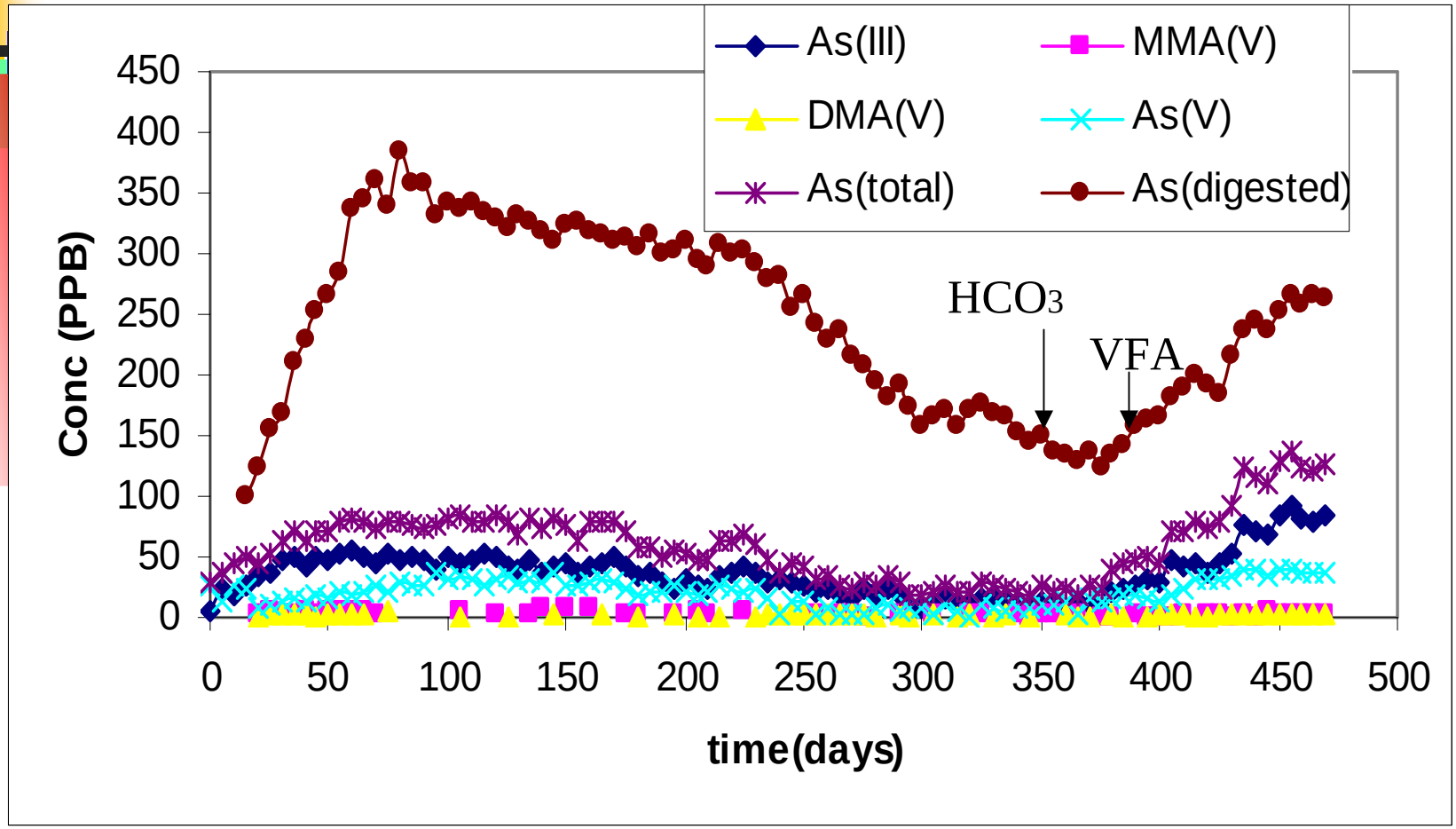
Sludge Leaching Tests



Simulated Landfill



GFH Column Results



Equilibrium As Concentration : 25.66ppb