New Arsenic Burdens in Landfills:

Water Treatment Residuals

Boston Workshop
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Background

- **2001revised arsenic in D.W. standard**
  - **10 ppb MCL (from 50 ppb)**
- **Estimated impacts**
  - **4000 new utilities impacted (>95% small)**
  - **~ 400 Arizona utilities impacted**
  - **6 - 24M lb solid residuals annually**
  - **~ 30,000 # As /yr**
  - **arsenic-bearing solid residuals (ABSR) pass TCLP**
  - **ABSR suitable for non-hazardous landfill disposal**

    (California exception: WET & TTLC)

ABSR

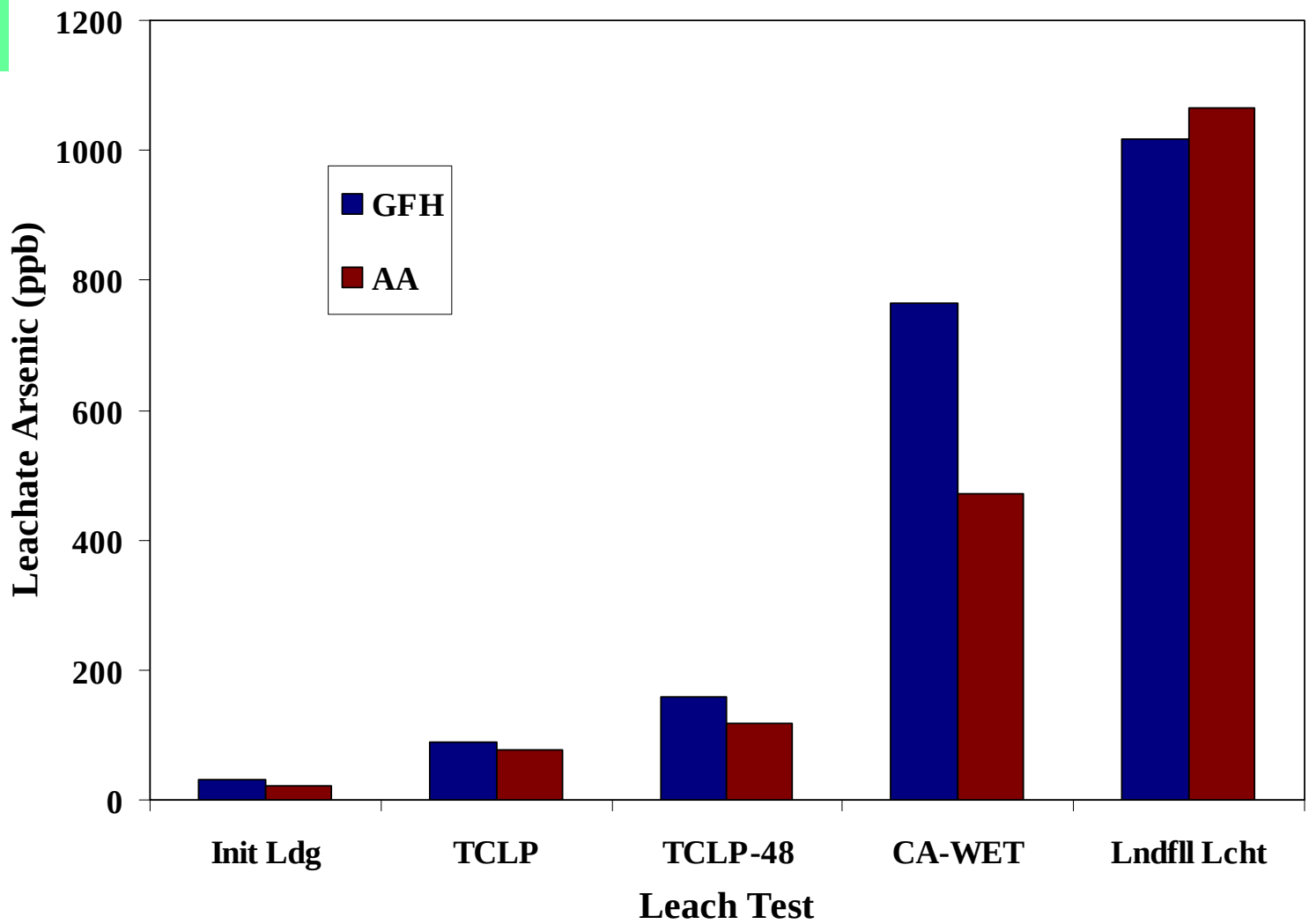
Spent Solid Sorbents

- Alumina-based Media (Alcan AA)
- Iron-based Media (GFH, Sorb 33, greensand)
- Zeolites (Z33)
- Other Sorbents (SAMMS, Mn Oxides, TiO_2)

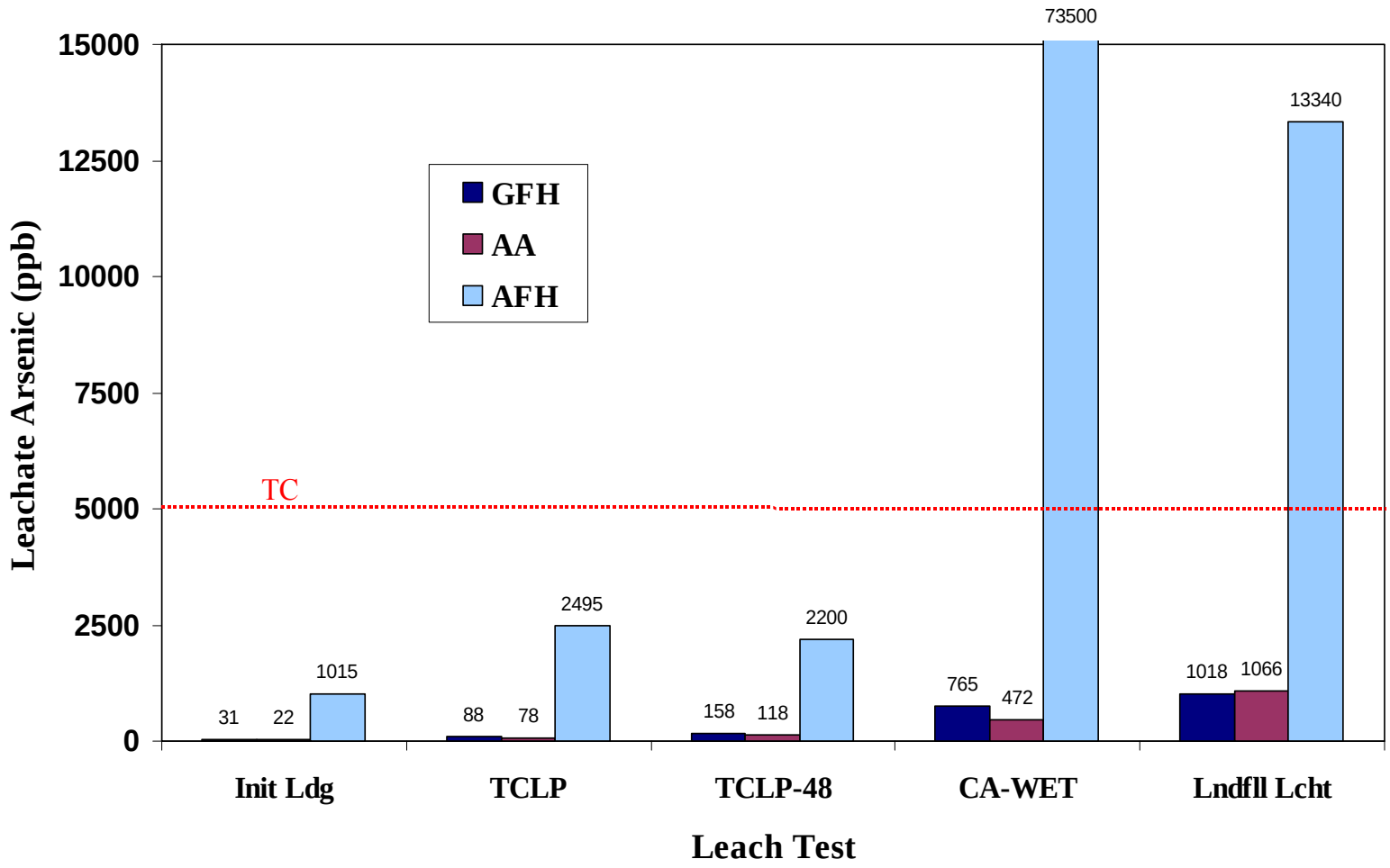
Precipitated Sludges

- **Direct**
  - Precipitation/Softening
  - Conventional coagulation / flocculation
  - Coagulation assisted microfiltration
- **Indirect**
  - Anion exchange (incl. enhanced media & recovery*)
  - Regenerable sorbents (ArsenX^{np}, AA)
  - Reverse osmosis

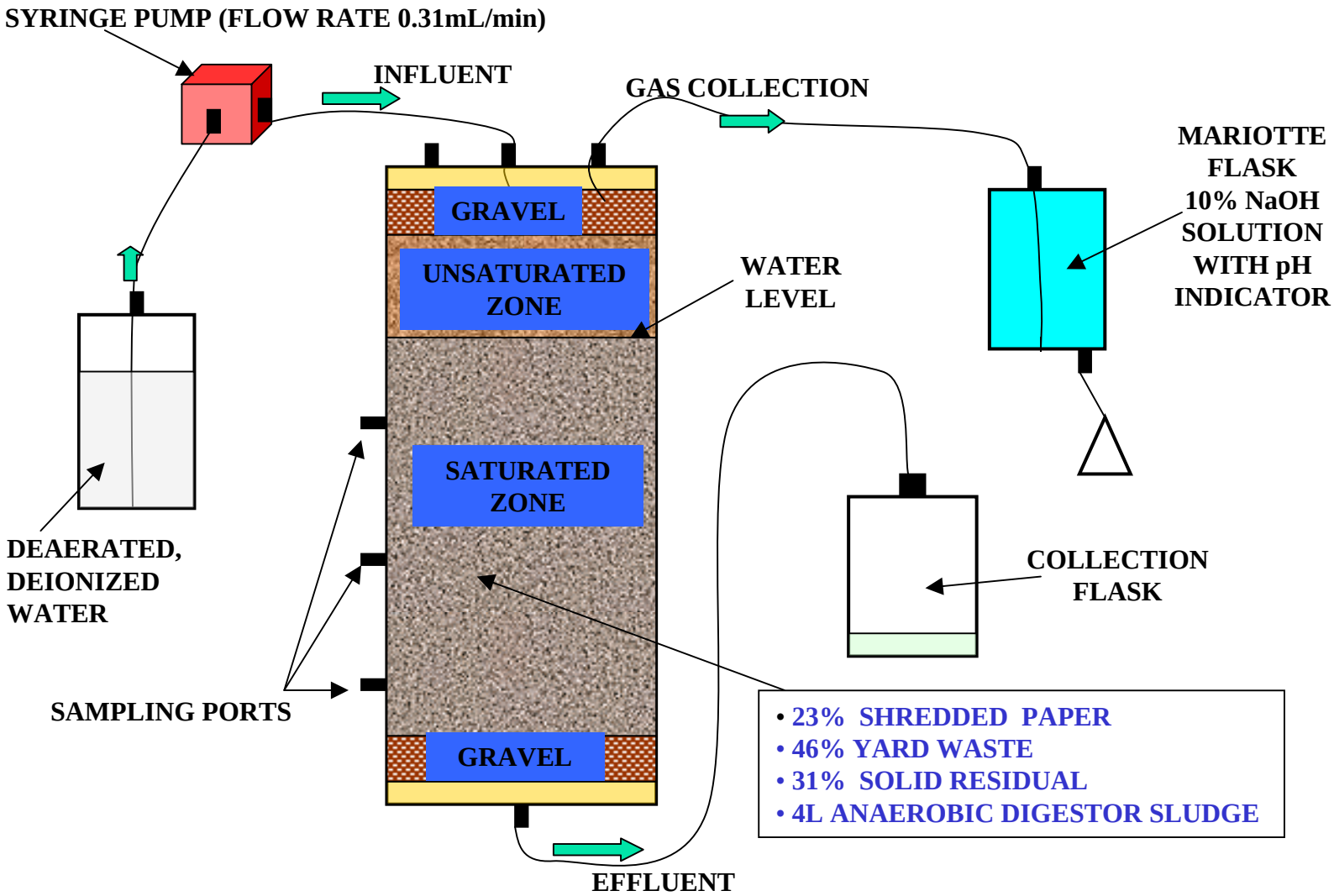
Spent Sorbent Leaching



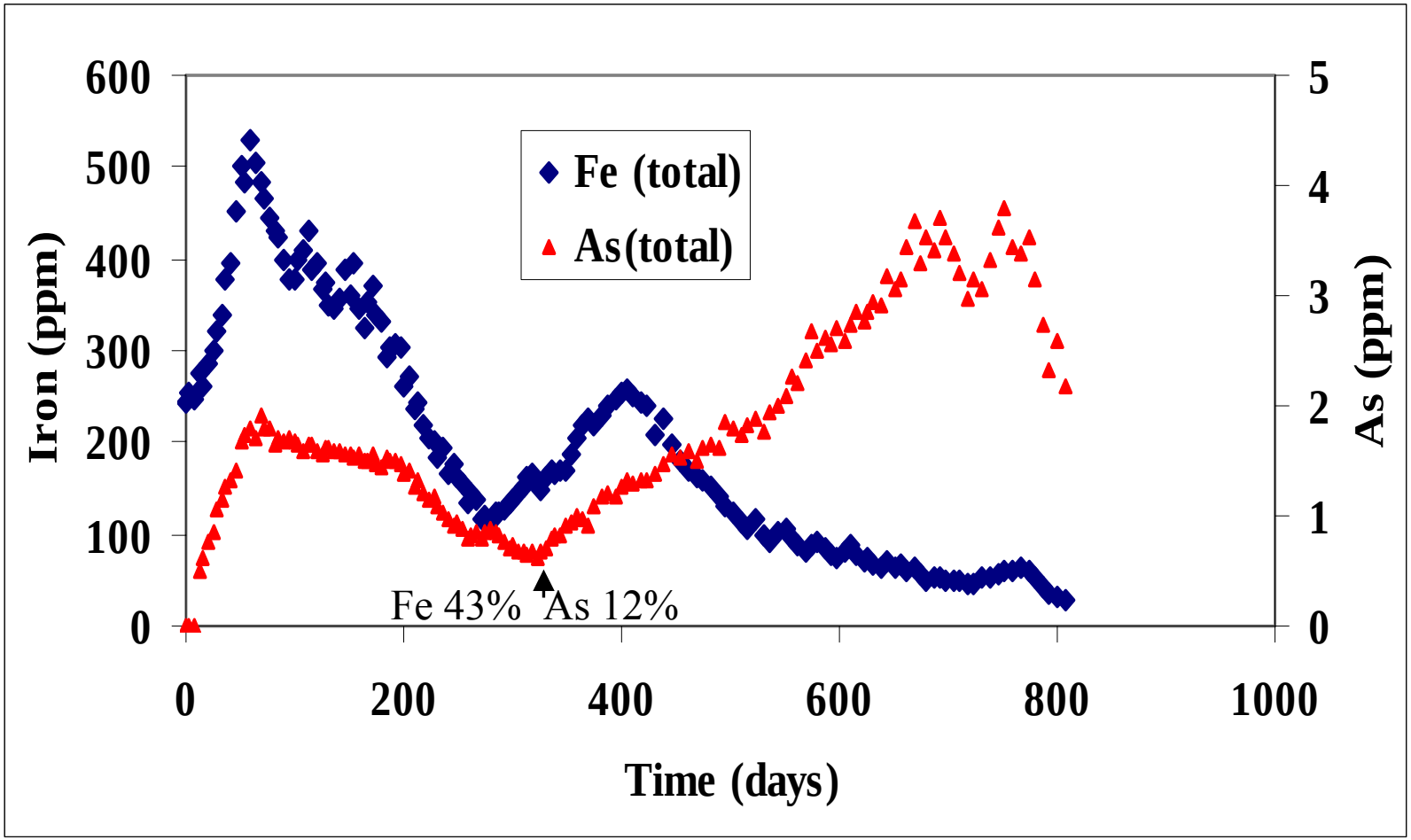
Ferric Precipitate (AFH) Leaching



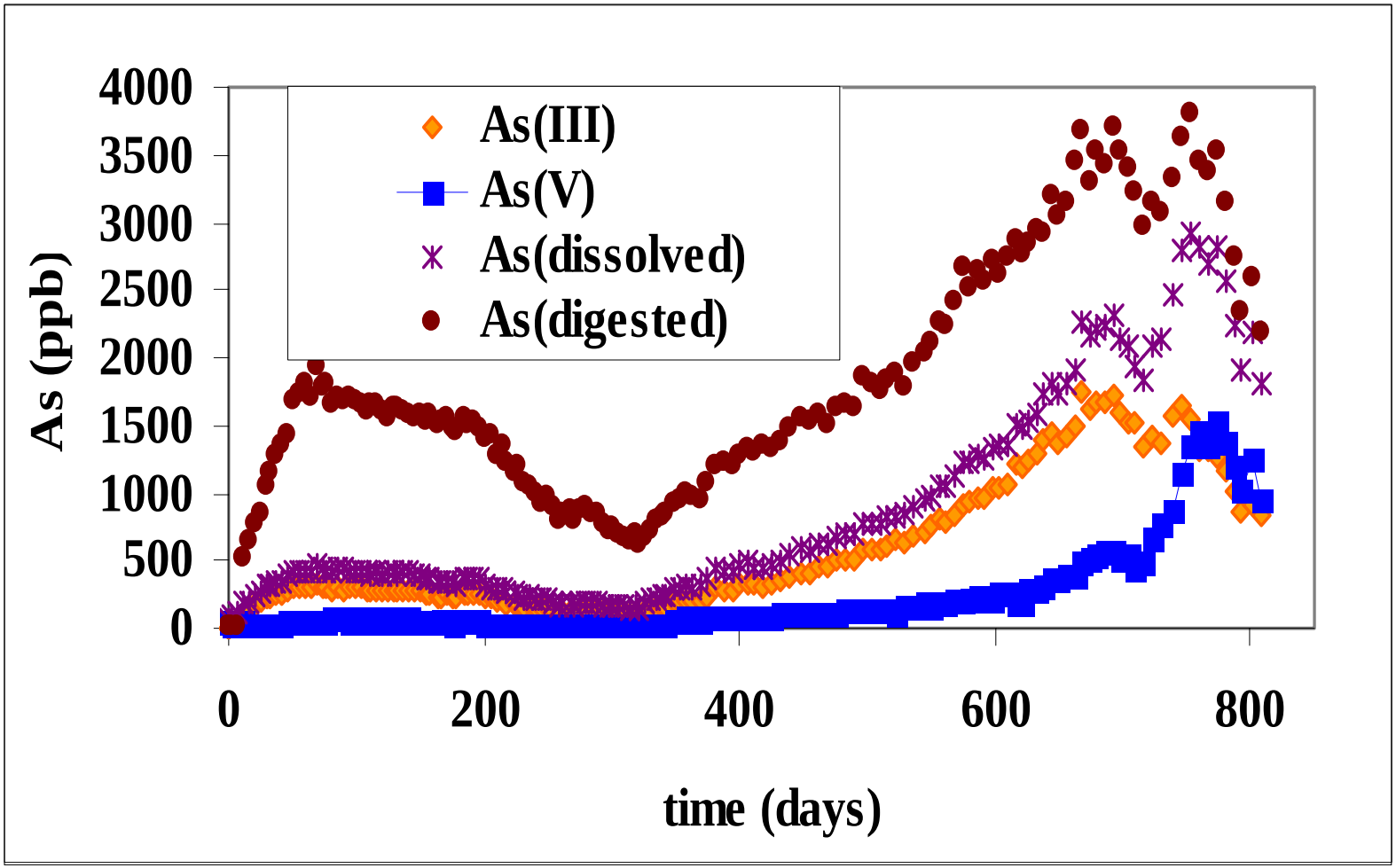
Landfill Simulation Columns



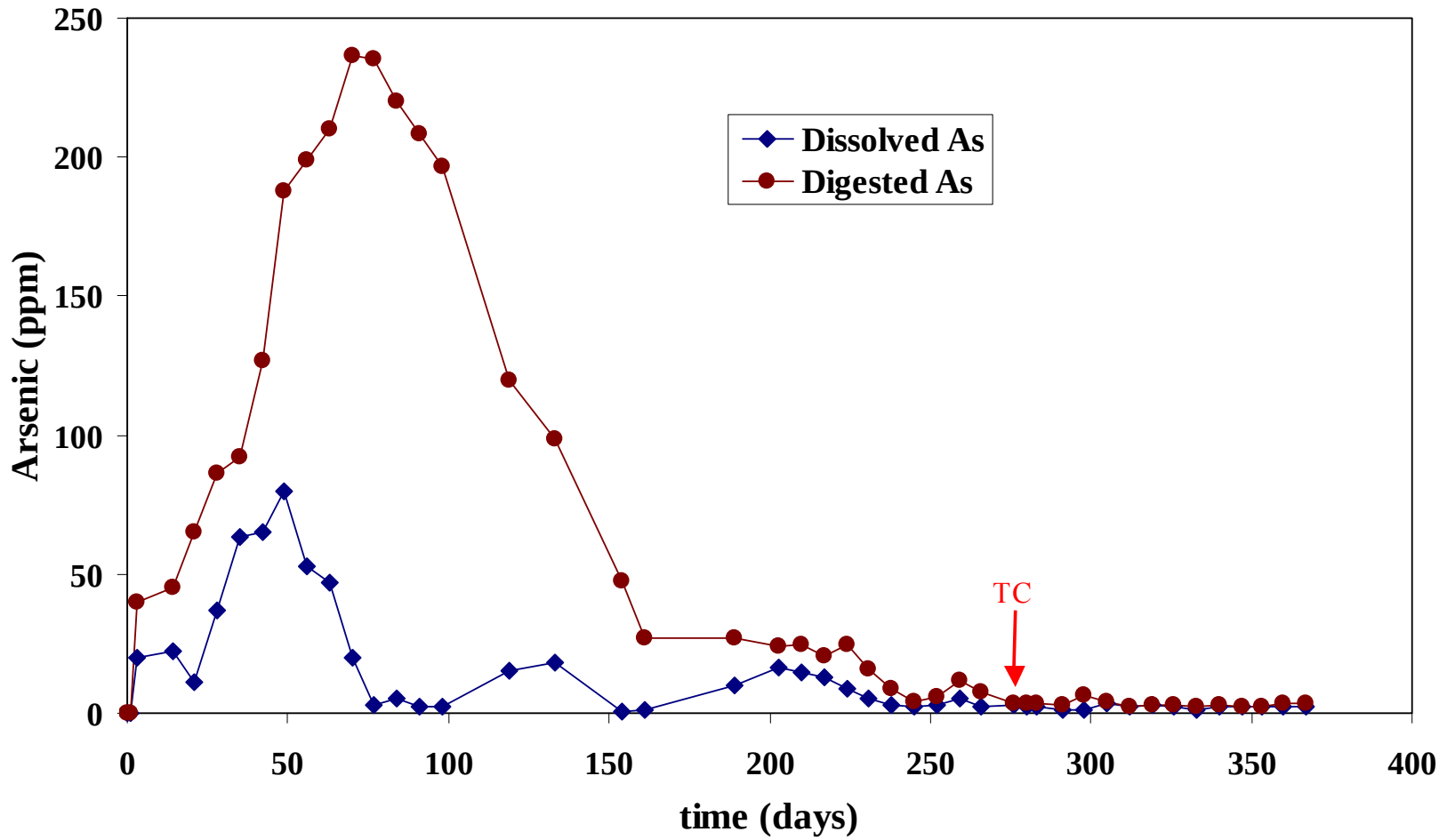
GFH Column Effluent Totals



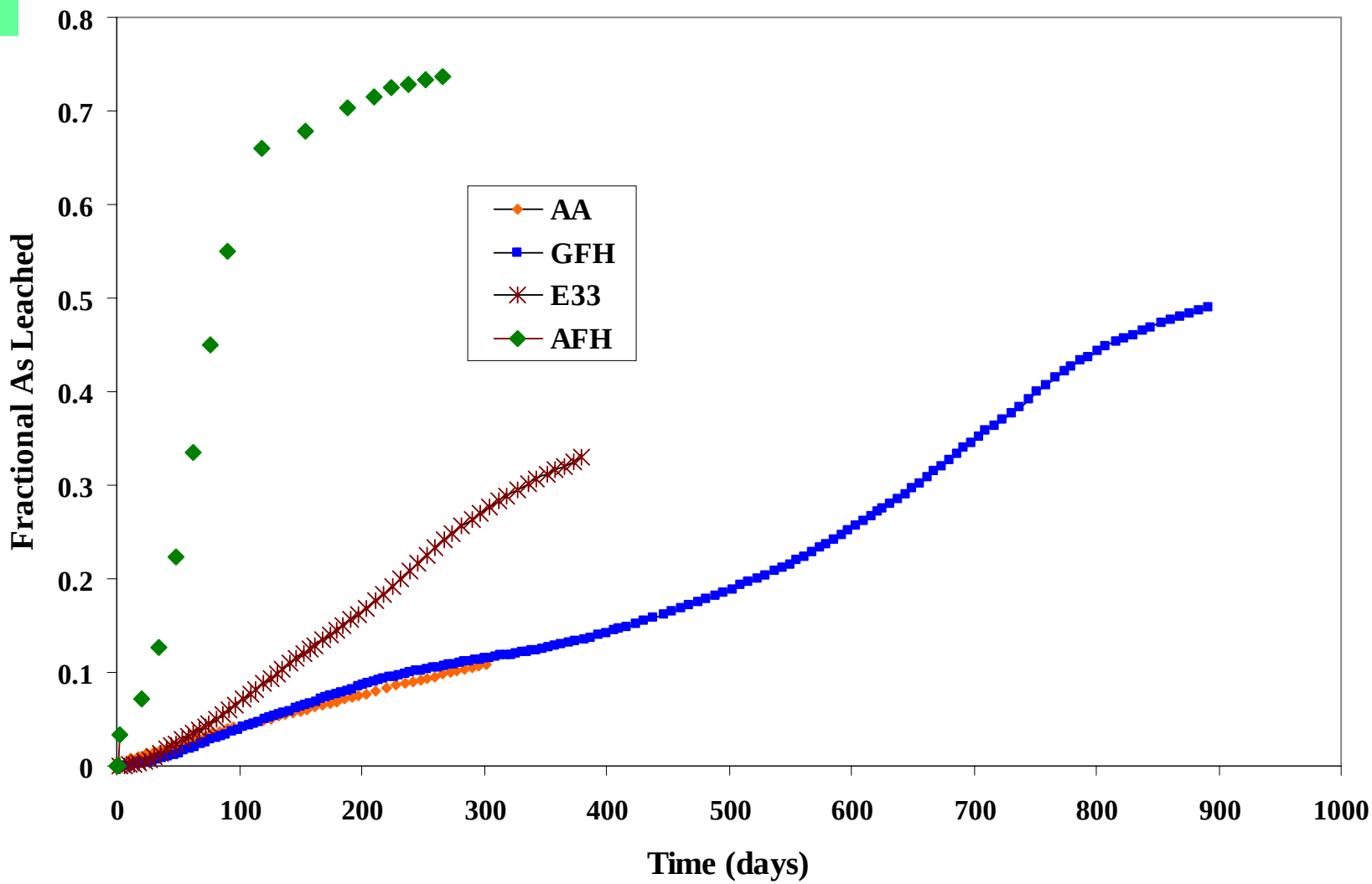
GFH Column Effluent Arsenic



AFH Column Effluent Arsenic

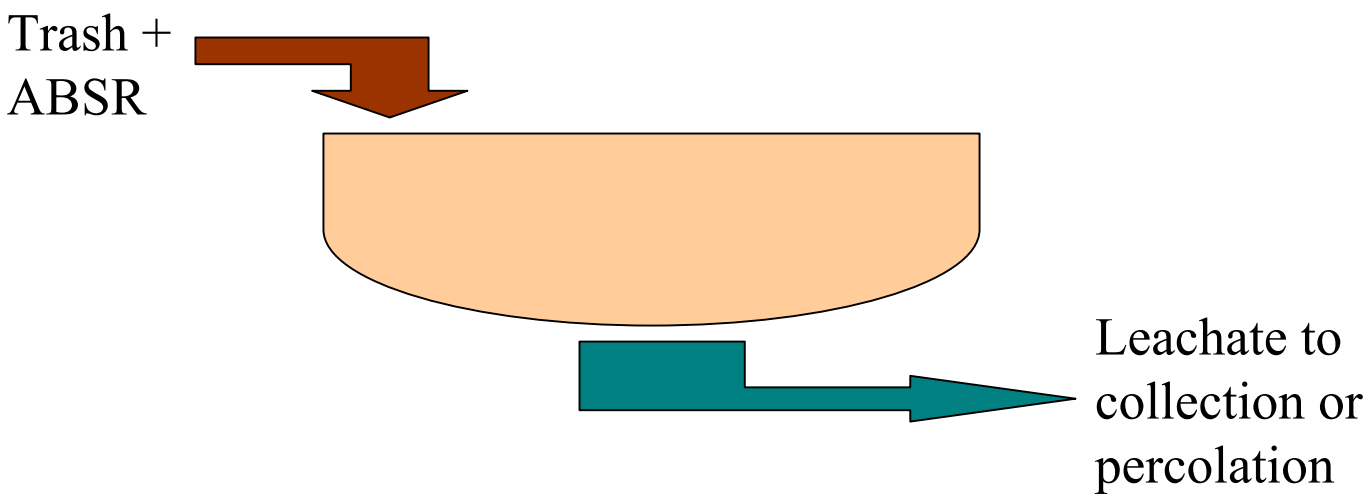


Cumulative As Leaching



Simple Blackbox Mass Balance

- Steady State ($ABSR_{As}$ In = $Leachate_{As}$ Out) after residuals dumping in landfill for **3-7?** years.

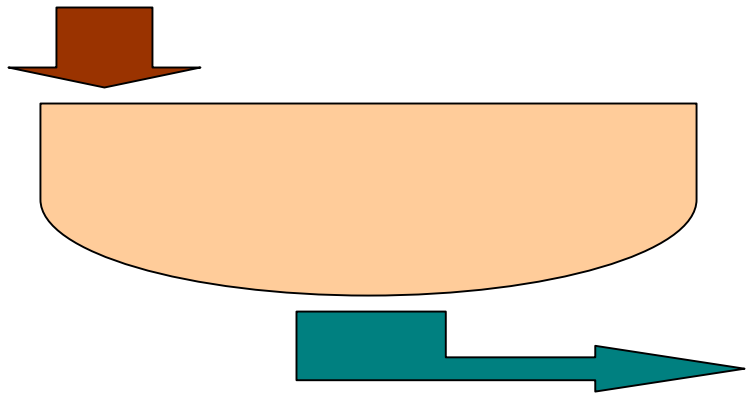


Blackbox Assumptions

- Final drinking water arsenic concentration of 8.0 ppb
- Range of leachate production rates
  ($0.15 – 1.60\ L_{leachate}/kg_{waste}$)
- ABSR are only source of arsenic to landfill
- Source water concentration and population impacted follows EPA final rule estimates
- Landfill only services population impacted by new MCL

Simple Blackbox Estimate

- **2.24 g_{As}/cap•yr**
- **560 kg_{waste}/cap•yr**
- **0.15 – 11 $L_{leachate}$/kg_{waste}**



26.7 – 0.36 ppm

ABSR Solid Fraction

Small-Scale Simulation Columns, Day 285

	Fe Leached (mg)	Percent Fe Leached	As Leached (mg)	Percent As Leached (**Estimated**)
a) 276 g (abiotic)	146	0.10	3.46	0.29
b) 276 g dry GFH (biotic)	1262	0.81	9.72	0.80
c) 52 g dry GFH (biotic)	1182	5.5	13.9	12
d) 7.5 g dry GFH (biotic)	908	22	10.8	61

Unlined Landfills

"...led the majority of participants to agree with the advice that it is imprudent to dispose of ABSR in unlined landfills. This is not to say, that immediate regulatory changes are indicated or that this necessarily impacts a large number of landfills, but merely that it is low cost, reasonable, precautionary guidance in light of the evidence and uncertainties."

Rio Rico Workshop Report, 2006

Lined Landfill Leachate

Background Arsenic

	MSW Landfills (200 surveyed)	Non-Haz. Industrial (21 surveyed)	Subtitle C (Haz.) (17 surveyed)
5th Percentile (ppb)	4.0	3.5	9.0
Median (ppb)	20	40	1500
Mean (ppb)	441	212	42,800
95th Percentile (ppb)	260	830	173,000

EPA 2000 Data - Adapted from Helms, Rio Rico Report, 2006

New Arsenic

CCA Treated Timber: 500 tonne (as As) per year

ABSR: 14 tonne (as As) per year

Arsenic Release Potential (Based on 30 yr disposal horizon):

1 tonne ABSR $\approx$ 58 – 130 tonne CCA

Lined Landfills: Potential Leachate Dominos

- Landfill biota toxicity
- WWTP Slug
  - Water reclamation/reuse
  - Bioreactor performance
  - Biosolids land application
- Drying Ponds
- Dedicated Leachate Treatment Plant

Toxicity to Methanogens

50% Inhibitory Concentrations

Compound	Substrate	IC50 (μM)	IC50 (ppm)
As(III)	acetate	15.5	1.16
As(III)	H_2	27.1	2.03
As(III)	lactate	4.4	0.33
As(V)	acetate	>500.0	
As(V)	H_2	>500.0	
MMA(III)	acetate	9.1	0.68
MMA(V)	acetate	>5,000.0	
DMA(V)	acetate	>5,000.0	

Sierra-Alvarez et al. 2004 AEM 70:5688

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Questions and Comments