SERDP & ESTCP

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Technical Symposium & Workshop

28-30 November 2000

Treatment of Perchlorate and Other Contaminates to Produce Drinking Water

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Aerojet Environmental Site Remediation

Treatment History
Aerojet Site (Sacramento CA)

- Soil & Groundwater contamination primarily VOCs, perchlorate and n-nitrosodimethylamine (NDMA)
- Aerojet is currently operating 5 Groundwater Extraction and Treatment (GET) Facilities

  Treatment systems utilize air strippers and air stripper / UV oxidation / Bio combinations

- GET Facilities currently treating ~ 12 million gallons per day (47 billion gallons treated to date)

Aerojet's GET E/F Treatment Plant

- Treatment plant influent is groundwater pumped from GET E/F extraction wells
- Flow rate of 4000 gpm as-built with additional 4000 gpm expansion capacity
- Includes
  - Fluidize Bed Reactor — Perchlorate / Nitrate
  - UV/OX system — VOCs / NDMA
  - Air Stripping Towers — VOCs

Aerojet's Full Scale Perchlorate Treatment Plant

- Continuous flow, granular activated carbon (GAC) fluidized bed reactor (FBR)
- Construction completed in December 1998
- Substrate - Ethanol
- Nutrient - Nitrogen/Phosphorus
- Sand bed filters remove biomass solids from FBR effluent stream

Aerojet's
Full Scale Perchlorate Treatment Plant

- 4 Fluidized Bed Reactors available
- Each reactor has a design capacity of
  - 1800 gpm Fluidization Rate
  - 900 gpm Feed Rate
- 4 reactors currently in use with combined feed rate of ~3500 gpm (~875 gpm each)
- Treating ~ five million gallons per day

Aerojet's Full Scale Perchlorate Treatment Plant

Bed Reactor	Influent	Effluent
– Dissolved O_2	5.3 ppm	<0.5 ppm
– CLO4	~3500 ppb	<4.0 ppb
– TCE	1500 ppb	1500 ppb
– NDMA	110 ppt	110 ppt
– Nitrate-N	1.5 ppm	<0.11 ppm
– Nitrite-N	<0.076 ppm	<0.076 ppm
– Sulfate-S	6.0 ppm	6.0 ppm
– Ethanol	NA	<1.0 ppm
– pH	~7.5	~7.5

Baldwin Park Operable Unit Pilot Study

- Constructed at Aerojet's Sacramento Facility adjacent to GET E/F Treatment Plant
- Conduct a technology demonstration project that produces potable drinking water
- Evaluate complete treatment train
  - Multiple contaminants
  - Various treatment technologies in series

Pilot Study Objectives

- Construct and operate a pilot treatment system that will demonstrate process performance in a size and configuration applicable to a full scale water treatment system
- Confirm destruction and removal efficiencies for nitrate, perchlorate, VOCs, NDMA, and 1,4-dioxane
- Establish operating parameters to assure optimal, reliable, and consistent treatment performance
- Determine unit process requirements to meet drinking water standards
- Obtain technology approval from DHS for use of the treatment train to produce drinking water in the San Gabriel Basin

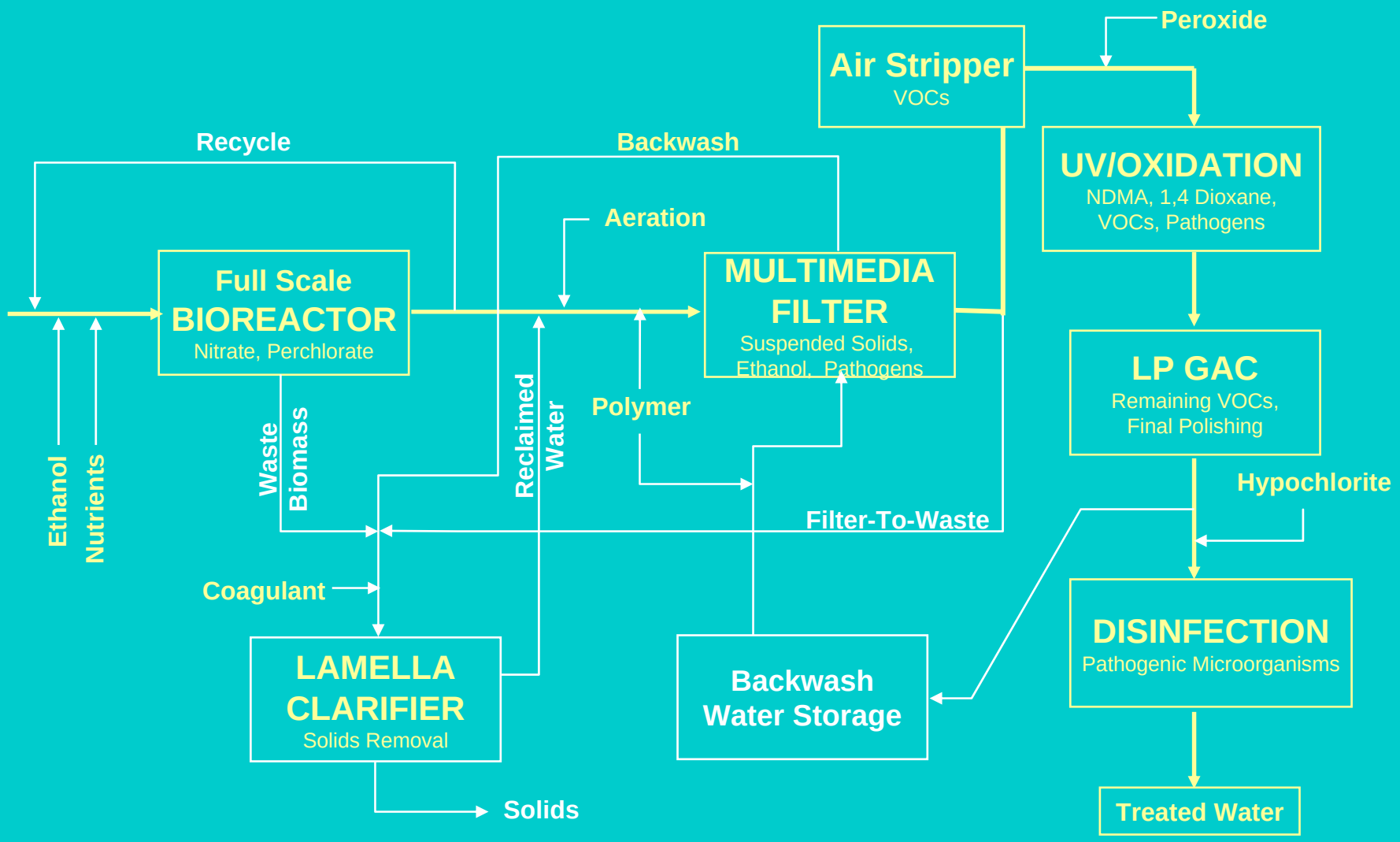
Pilot Study Design

- GAC/FB Bioreactor (Full Scale Plant)
- Multimedia Filters
- Air Stripper
- UV/Chemical Oxidation (UV/OX)
- Liquid-Phase Granular Activated Carbon Adsorption (LP GAC)
- Disinfection

Pilot Study Design

Unit Process	Flow Rate	Target Contaminants
GAC/FB Bioreactor	900 - 1500 gpm	Nitrate, Perchlorate
Multi-Media Filter	350 gpm	Suspended Solids, Ethanol, Pathogens
Air Stripper	100 gpm	VOCs
UV/OX System	100 gpm	NDMA, 1,4-Dioxane, VOCs, Pathogens
Liquid Phase GAC	100 gpm	VOCs, Polishing
Disinfection	10 gpm	Pathogens
Lamella Clarifier	25-50 gpm	Biosolids

Process Flow Diagram

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Pilot Study Requirements

- Biological GAC/FB with Multimedia Filtration
  - Bioreactor effluent classified as Surface Water by DHS
  - Does bioreactor effluent contain pathogens?
  - Process stability for regaining performance after an upset event
  - Ethanol utilization efficiency and breakdown products
  - Process consistency in day to day operations
  - Using ORP as a control parameter
  - Biomass characterization
  - Minimum nutrient requirements
  - Cell yield (biological solids production), reaction rates
  - Lowering analytical detection limit for ethanol

Pilot Study Requirements

- Multimedia Filter
  - Biologically active
  - Removal of ethanol breakdown products
  - Pathogen removal
  - Loading rate
  - Influent and effluent turbidity
  - Influent and effluent particle counts

Pilot Study Requirements

- Air Stripper
  - Verify removal efficiencies
  - Removal of VOCs, TCE and Chloroform
  - Air/Water loading rate

Pilot Study Requirements

- UV/Oxidation System
  - Low energy design
  - Optimize peroxide dose
  - Interactions of peroxide, UV absorbance, and NDMA, 1-4 dioxane, and VOC removal
  - Correlation between water quality and system performance
  - Formation of DBP precursors

Pilot Study Requirements

- Liquid Phase GAC
  - Removal of any remaining adsorbable compounds
  - Final polishing step
  - Biological removal of UV/OX breakdown products

Pilot Study Requirements

- Disinfection
  - Sodium Hypochlorite
  - THMs and DBPs
  - CT requirements
  - Microbial water quality and potential for biological regrowth
  - NDMA reformation

Pilot Study Requirements

- Reclamation System
  - Lamella clarifier
  - Type of coagulant and dose
  - Loading rate
  - Solids production
  - Clarified water reintroduced into main treatment train upstream of filter

Pilot Study Sampling Points

Groundwater
FBR4 Influent
FBR4 @ 1 ft
FBR4 @ 3 ft
FBR4 @ 6 ft
FBR4 Effluent
AT Effluent
Filter Influent
Filter Effluent
Air Stripper Influent
Air Stripper Effluent
UV Influent

UV Effluent
GAC Influent
GAC 1/4
GAC 1/2
GAC 3/4
GAC Effluent
Chlorine 0 min
Chlorine 2.5 min
Chlorine 7 min
Chlorine 12 min
Chlorine 17 min
Chlorine 22 min

Waste Biomass
Spent Backwash
Clarifier Influent
Clarifier Effluent
Clarifier Effluent Tank
Clarifier Sludge

Pilot Study Sampling Analytes

Perchlorate
Chlorate/Chlorite
Nitrate
Nitrite
Ammonia
Phosphorus
Sulfate
Sulfite
Sulfur
Sulfide
NDMA
1,4-Dioxane
VOCs
TSS
VSS
TVS
Ethanol
Methanol
TOC
DOC
AOC
BDOC
BOD
COD
F&T Coliforms
Giardia/Crypto
Virus
Coliphage
Plate Count
Aldehydes
Halos/THMs/CP
THMFP
Acetic Acid
Hardness
Alkalinity
UV Absorbance
Bromide
Bromate
TOX
Complete Drinking Water

Pilot Study Schedule

- Construction Start — Dec 99
- System Start-up — Feb 00
- Pilot Plant Operation — Mar-Dec 00
- Reporting — Monthly
- Final Report
  - to EPA and CA DHS — Jan 01

Conclusion

- Every site will have unique challenges associated with treatment options
- The intrinsic value of drinking water supplies will necessitate a critical evaluation of treatment options and water reuse issues
- These challenges can be met with a methodical and thorough scientific process

Acknowledgments

- Harding Lawson and Associates
- Envirogen
- Expert Peer Review Panel
  - Perry McCarty Stanford University
  - Rhodes Trussell Montgomery Watson
  - Robert Clark USEPA / NRMRL
  - Michael McGuire McGuire & Associates
  - Rick Sakaji and Gary Yamamoto CA DHS
  - Wayne Praskins EPA Region 9

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