TOLUENE REMEDIATION USING LOW VACUUM DUAL-PHASE EXTRACTION

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Overview

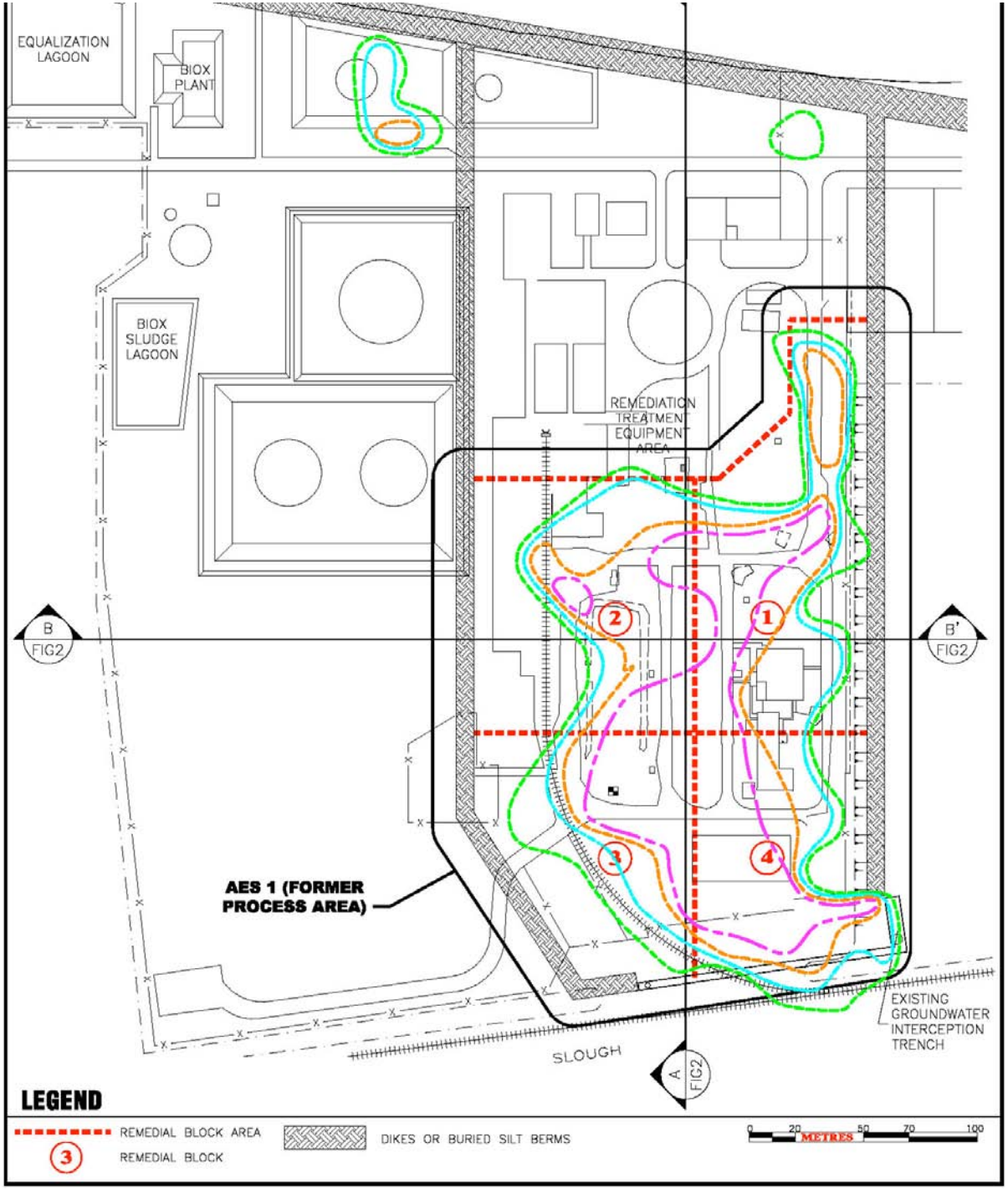
- Background
- Remedial Objectives and Approach
- Additional Investigations
- System Design
- Operational Experience
- Progress to Date
- Questions

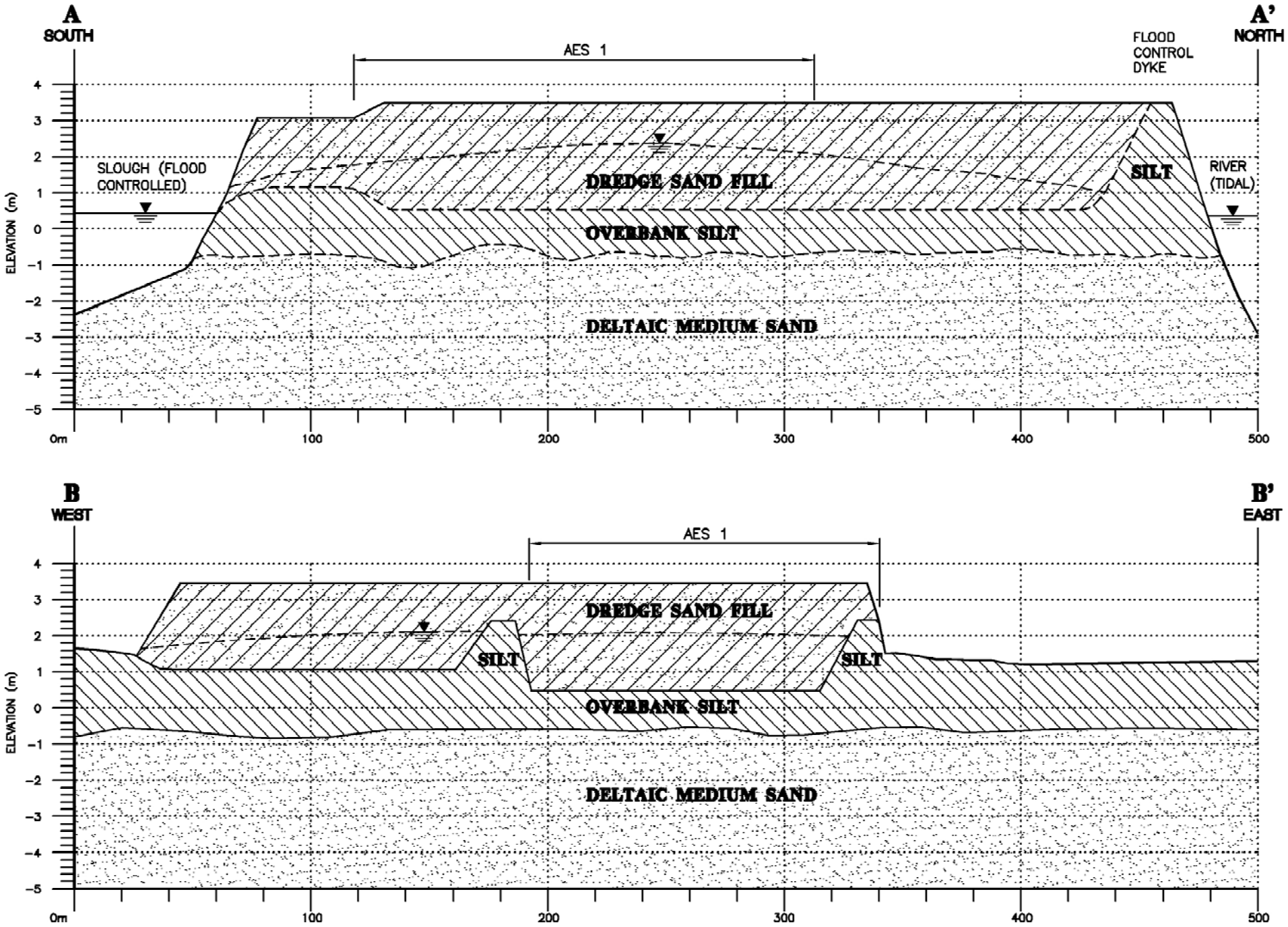
Background

- Petrochemical plant operated 1961-1990
- Produced benzoic acid by catalytic oxidation of toluene
- Focus of talk is former Main Process Area (AES 1), approximately 11 acres
- COCs 520,000 kg aromatics:
  - 65% toluene, 20% benzene, 15% m-xylene

Background

- Located on bank of major estuary
- 3 m to 3.6 m of uniform medium sand fill ($2x10^{-4}$ m/s) over 1 m of overbank clayey silts over deltaic medium sand
- Recharge from 1.1 m rainfall October-May
- Shallow flow north to tidal river, south to slough and vertically downwards to deeper tidal aquifer


EQUALIZATION LAGOON
BIOX PLANT
BIOX SLUDGE LAGOON
REMEDIATION TREATMENT EQUIPMENT AREA
B
FIG2
B'
FIG2
A
FIG2
1
2
3
4
AES 1 (FORMER PROCESS AREA)
SLOUGH
EXISTING GROUNDWATER INTERCEPTION TRENCH
LEGEND
REMEDIAL BLOCK AREA
REMEDIAL BLOCK
DIKES OR BURIED SILT BERMS
0 20 50 70 100
METRES


A
SOUTH
A'
NORTH
AES 1
FLOOD
CONTROL
DYKE
SLOUGH (FLOOD
CONTROLLED)
DREDGE SAND FILL
SILT
RIVER
(TIDAL)
OVERBANK SILT
DELTAIC MEDIUM SAND
ELEVATION (m)
4
3
2
1
0
-1
-2
-3
-4
-5
0m
100
200
300
400
500
B
WEST
B'
EAST
AES 1
DREDGE SAND FILL
SILT
SILT
OVERBANK SILT
DELTAIC MEDIUM SAND
ELEVATION (m)
4
3
2
1
0
-1
-2
-3
-4
-5
0m
100
200
300
400
500

Remedial Objectives

- Risk based; vapour and groundwater flow to aquatic environment

Unit	Compound	Soil	Water
Fill	Benzene:	30 mg/kg	3 mg/L
	Toluene:	100 mg/kg	3 mg/L
	Xylene:	100 mg/kg	-
SILT	-	-	-
SAND	-	-	-

Conceptual Remedial Plan

- Groundwater depression / SVE
  - 9 treatment blocks with separate GW depression and SVE wells in grids
  - No apparent need for perimeter barrier
  - Thermal or catalytic oxidation for vapour stream
  - Utilize existing permitted biox water treatment plant; 225 L/min capacity plus holding lagoon

Additional Investigations

- 3 major data gaps:
  - Depth, nature, and continuity of silt
  - Groundwater flow/dewatering requirements
  - SVE design parameters

Additional Investigations

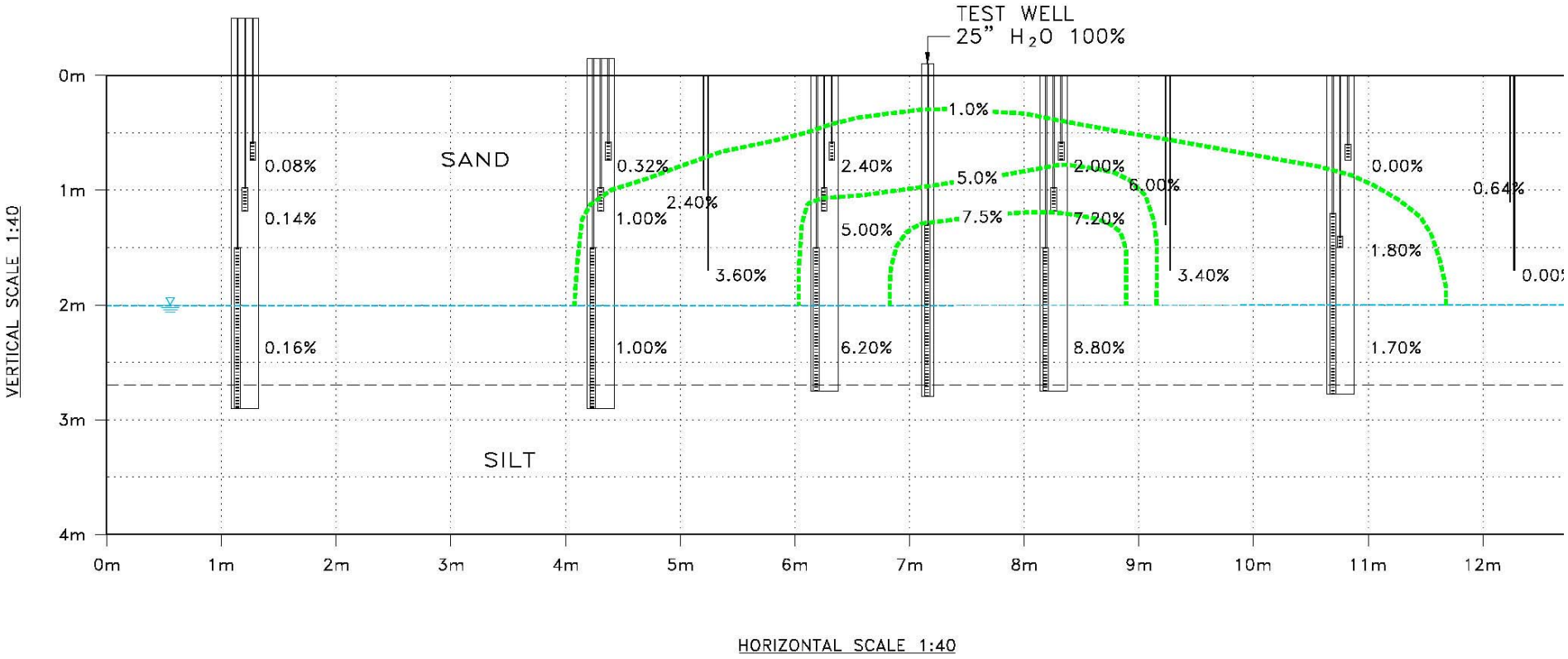
- Depth, nature and continuity of silt layer
  - Drilling and Shelby tube sampling program
  - Grid CPT to accurately define location & nature
- Conclusions:
  - Silt unit locally over-excavated, varied from >1.5 m clayey silt to 0.3 m silty sand; possibly absent in areas

Additional Investigations

- Groundwater flow/dewatering modeling:
  - Three sources of water: rainfall, lateral inflow, vertical upflow through silt
- Conclusions:
  - Could handle up to 3 acres remediation blocks (4 total)
  - Need both perimeter and interior dewatering

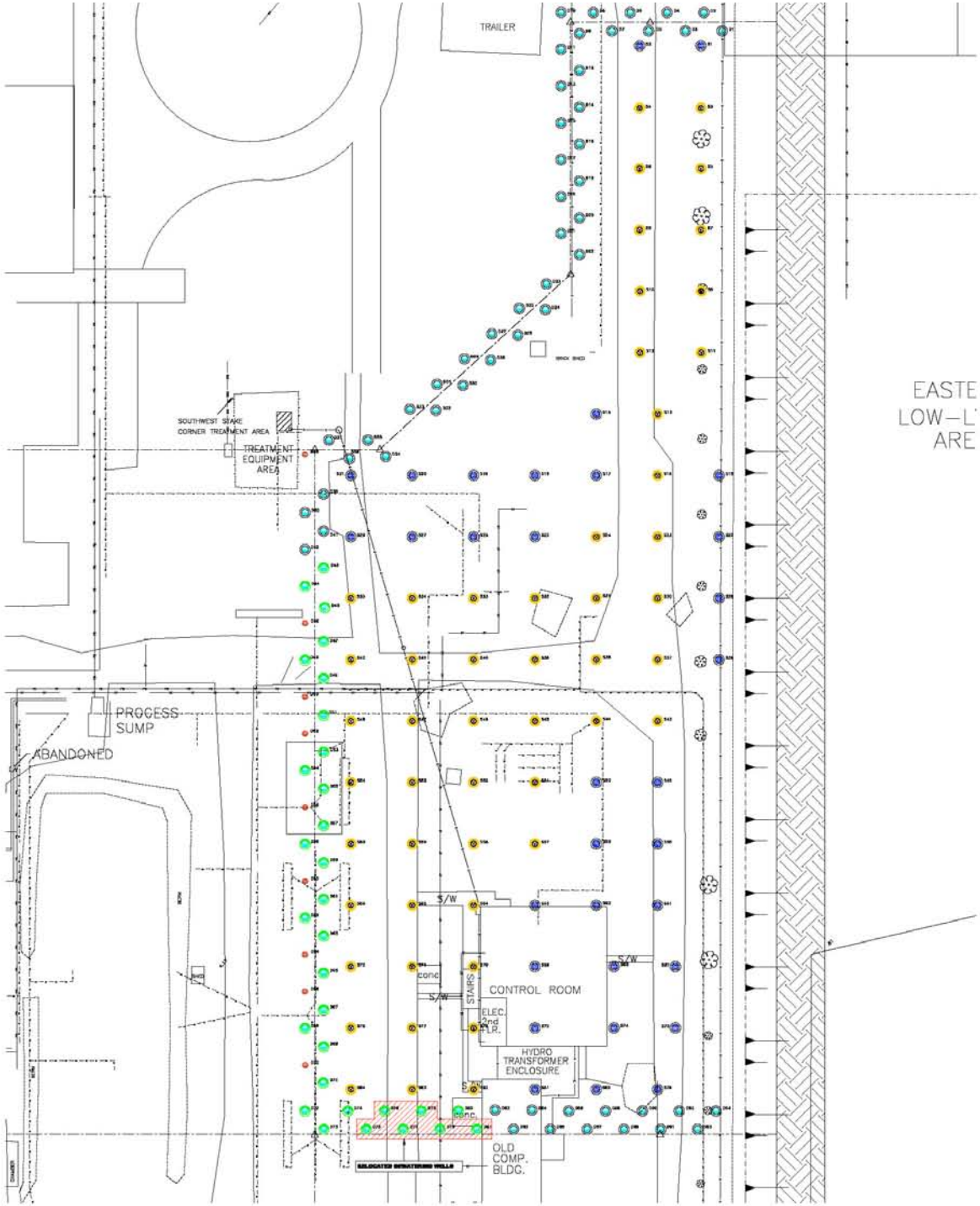
Additional Investigations

- SVE design parameters
  - SVE pilot test and modeling
- Conclusions:
  - Long period of high vapour concentrations
  - Relatively short asymptotic tails consisting mainly of xylene
  - 180 days or less to clean-up at 10 m x 10 m grid, 35 cfm/well


TEST WELL
25" H_2O 100%
SAND
SILT
0.08%
0.14%
0.16%
0.32%
1.00%
2.40%
3.60%
1.00%
2.40%
5.00%
6.20%
1.0%
5.0%
7.5%
2.00%
6.00%
7.20%
3.40%
8.80%
0.00%
1.80%
1.70%
0.64%
0m
1m
2m
3m
4m
5m
6m
7m
8m
9m
10m
11m
12m
VERTICAL SCALE 1:40
HORIZONTAL SCALE 1:40

Remedial Design

- Low-vacuum dual-phase approach selected
  - Dual purpose wells
  - Maximize dewatering efficiency
  - Minimize mounding & capillary saturation (10 m spacing)
- Perimeter dewatering wells
  - Double row of conventional eductor well points
- Four remediation blocks


TRAILER
SOUTHWEST SEAKE
CORNER TREATMENT AREA
TREATMENT
EQUIPMENT
AREA
EASTE
LOW-L
ARE
PROCESS
SUMP
ABANDONED
S/W
S/W
S/W
conc
STAIRS
CONTROL ROOM
ELEC.
Eng.
FLR.
HYDRO
TRANSFORMER
ENCLOSURE
OLD
COMP.
BLDG.

Design Parameters
SVE System

- 88 SVE wells (stainless/PVC)
- 43” H_2O vacuum
- 35 cfm/3” diam well; 20 cfm/2” diam well
- 10 gpm total groundwater flow (30% of total)
- 2 – 1000 cfm rotary lobe bowers @ 15 hp each

Design Parameters
SVE System

Design Parameters
Eductor System

- 94 dewatering wells
- 0.9 L/min/well; 85 L/min total
- Max depth 5 m below eductor
- Total motive flow 220 L/min @ 50 psi
- 2.4 L/min/eductor
- 2 – 5 hp submersible pumps in recirculation tank

Design Parameters
Eductor System

Design Parameters Oxidizer

- Convertible catalytic/thermal
- 2000 cfm capacity upgrade potential to 3000 cfm
- 99.9% destruction efficiency in both catalytic and thermal modes necessary to meet local discharge requirements

Design Parameters
Oxidizer

Design Parameters
Piping

- Design losses approximately 1” H_2O/100ft
- 0.5% slope in SVE pipe toward KO tank
- Adjustable slurp tube height

Design Parameters
Piping

Operational Issues

- >100 dBA measured 10 m from SVE blower discharge
- Failure of oxidizer plenum and heat exchanger tubes
- Solution:
  - Vibration dampeners installed at blower discharge

Operational Issues

Operational Issues

- Water carryover through knockout tank to rotary lobe blowers
- Solution:
  - Install secondary knockout tank

Operational Issues

Operational Issues

- Greater groundwater recovery rate in SVE wells than anticipated (insufficient vacuum available)
- Solution:
  - Upgrade motors to 40 hp

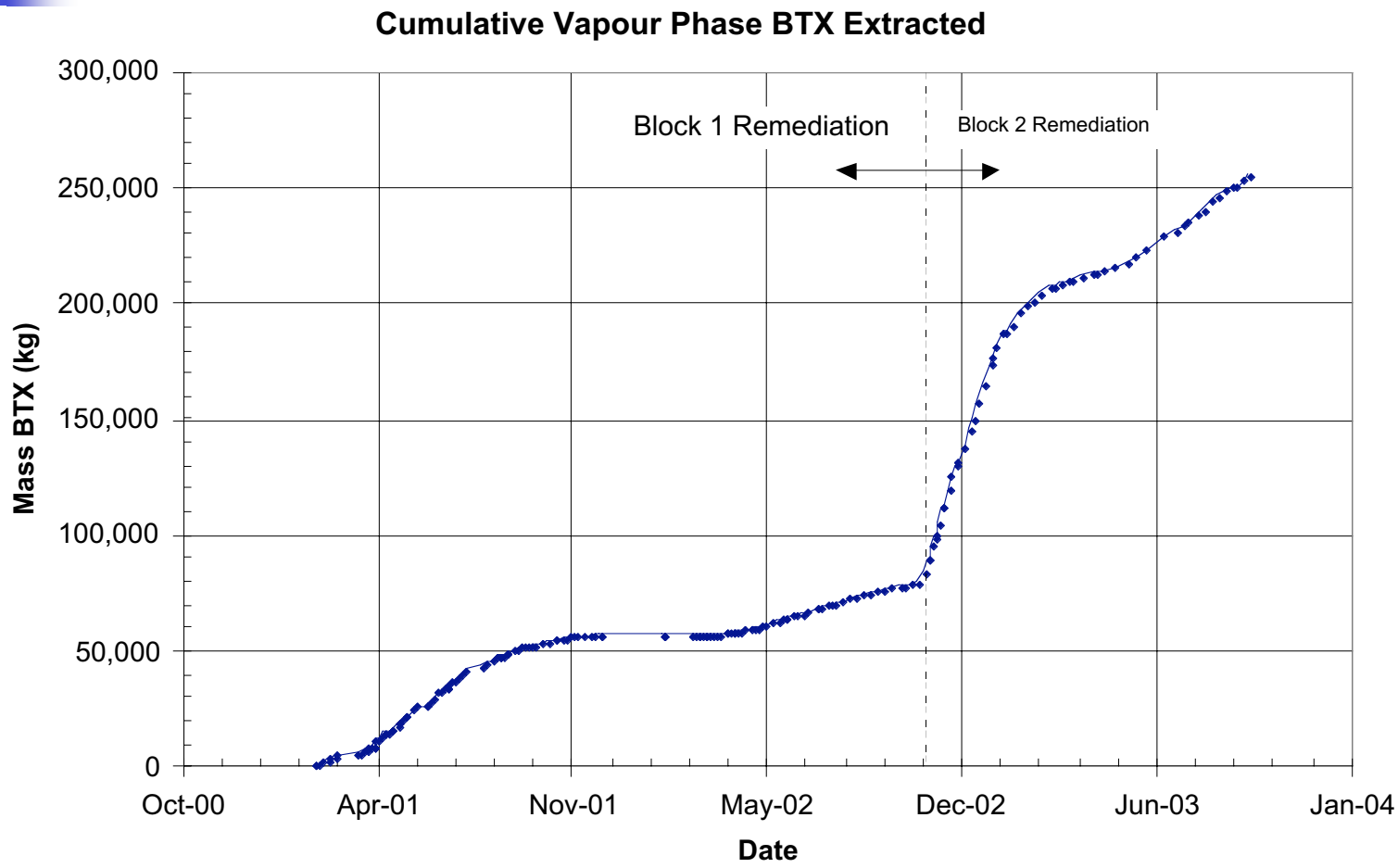
Operational Issues

- Fouling of wellheads with ferrous iron and benzoic acid
- Solution:
  - Periodic well jetting

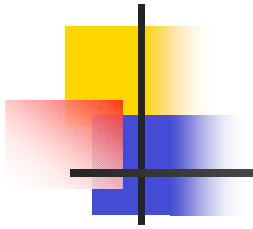
Remediation Success

- Estimated 230,000 kg BTX removed in vapour phase (Sept 2003)
- 85% toluene, 6% benzene, 9% m-xylene
- 50,000 m^3 groundwater treated through Biox plant
- 15,000 kg BTX removed in water phase

Remediation Success



MORROW
FOCUSED ON SOLUTIONS



Questions and Answers