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A Step by Step Approach for a Complex DNAPL Remediation in Brazil

RemTech – 2019/Ferrara

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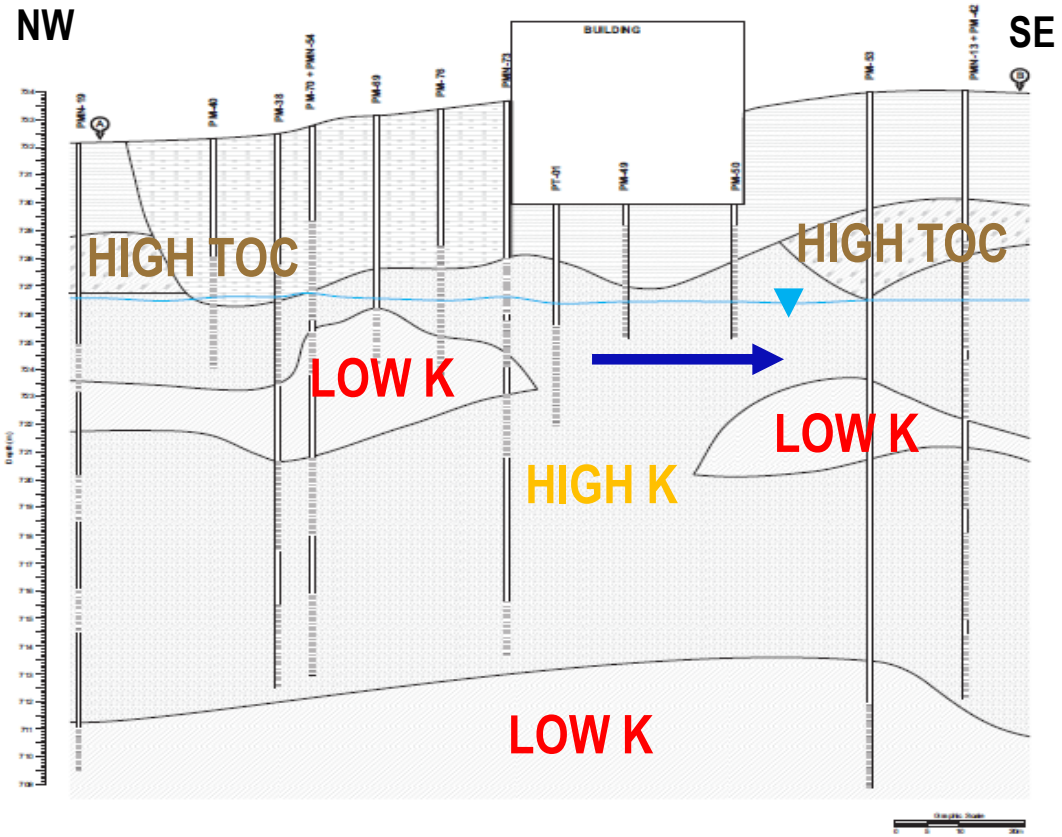
Overview – Land Use

- Former chemical industry in the city of Sao Paulo
- Productive between the 50's and the 80's
- Current use - administrative headquarter
- Current neighborhood's occupation – residential and commercial
- GW explotation, mineral water upgradient in the neighborhood

Overview- Investigations

- Phase 1
- Phase 2
- Phase 3
- HH Risk Assessment
- Numerical GW Modeling

Overview – Hydrogeological Context



GW Flow Direction (10 m/year)

HIGH K 10^{-4} – 10^{-2} cm/s (sandy/silty)

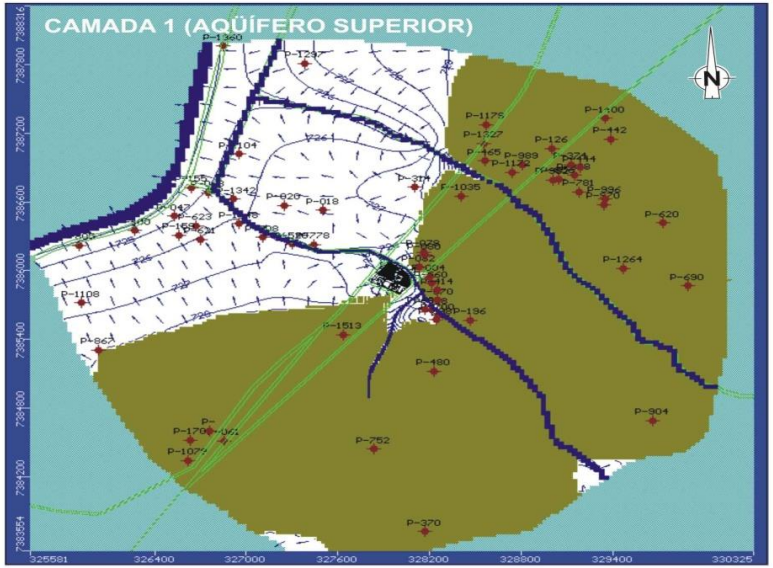
LOW K 10^{-7} – 10^{-5} cm/s (clay)

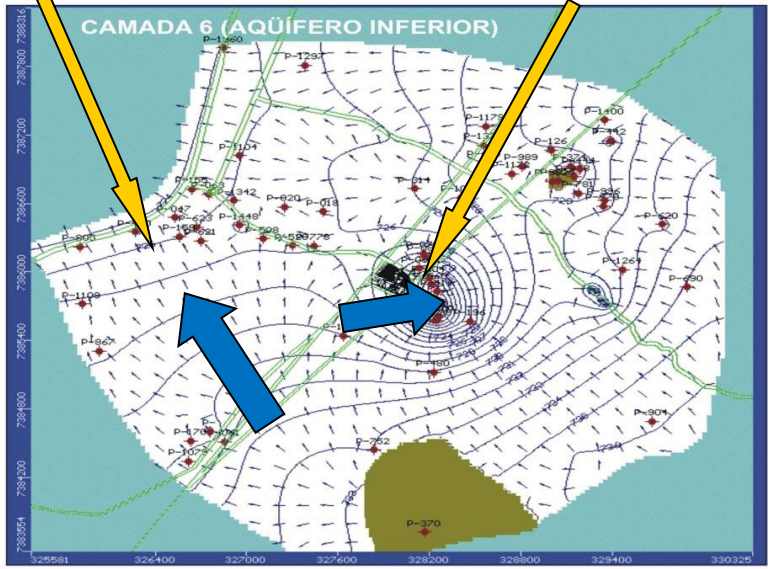
Aluvial sediments, GWL~5m

Overview – Hydrogeological Context

RIVER – REGIONAL DISCHARGE AREA

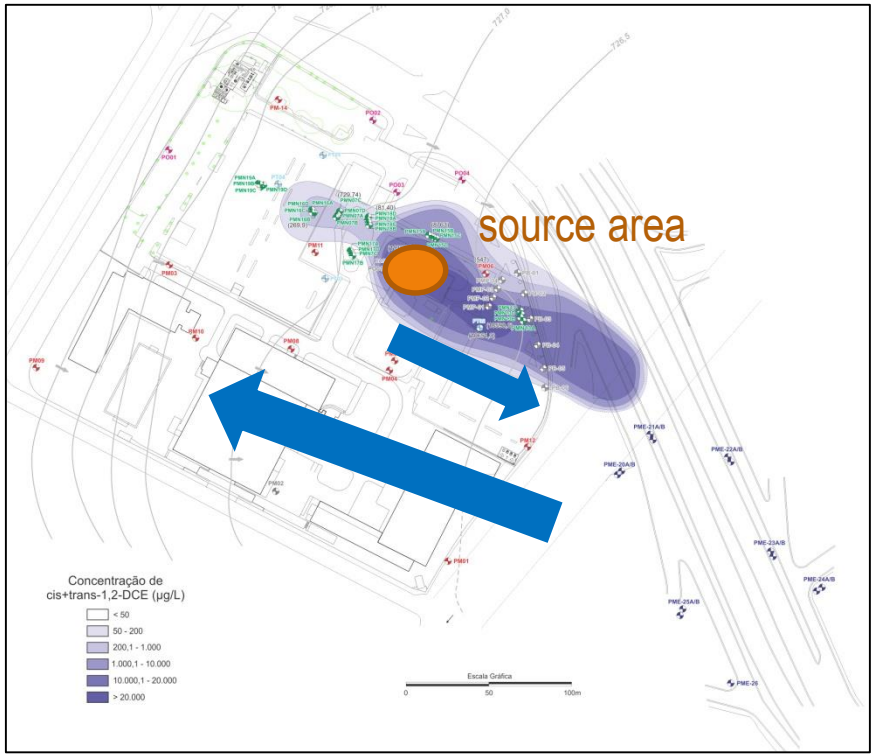
SITE



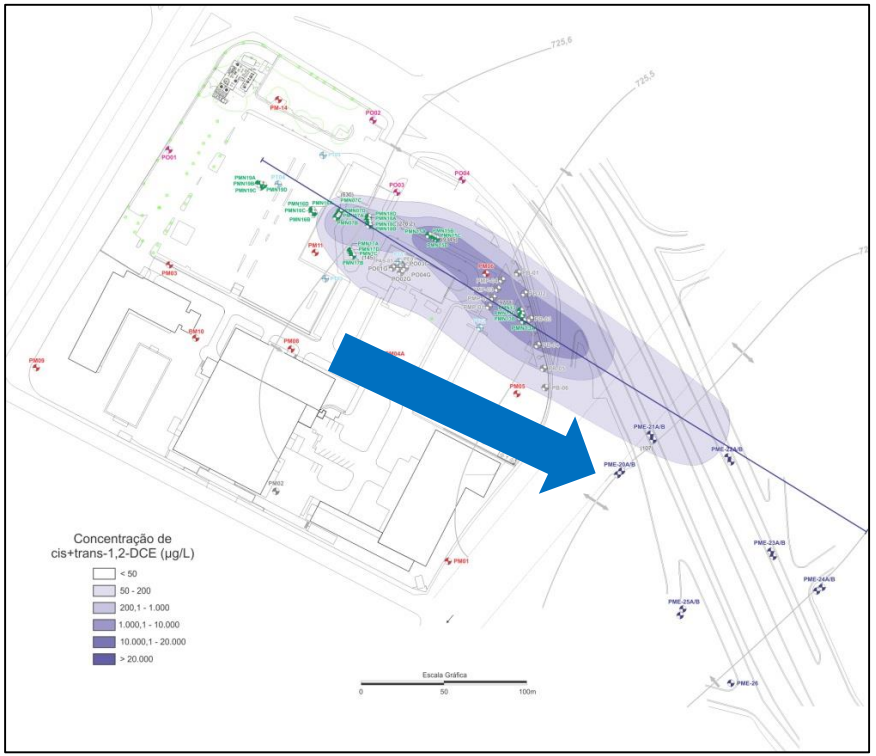


Explotation 30-250m bgs

Overview – GW Dissolved Phase – 1,2 DCE (2007)



6-9 m



14-20 m

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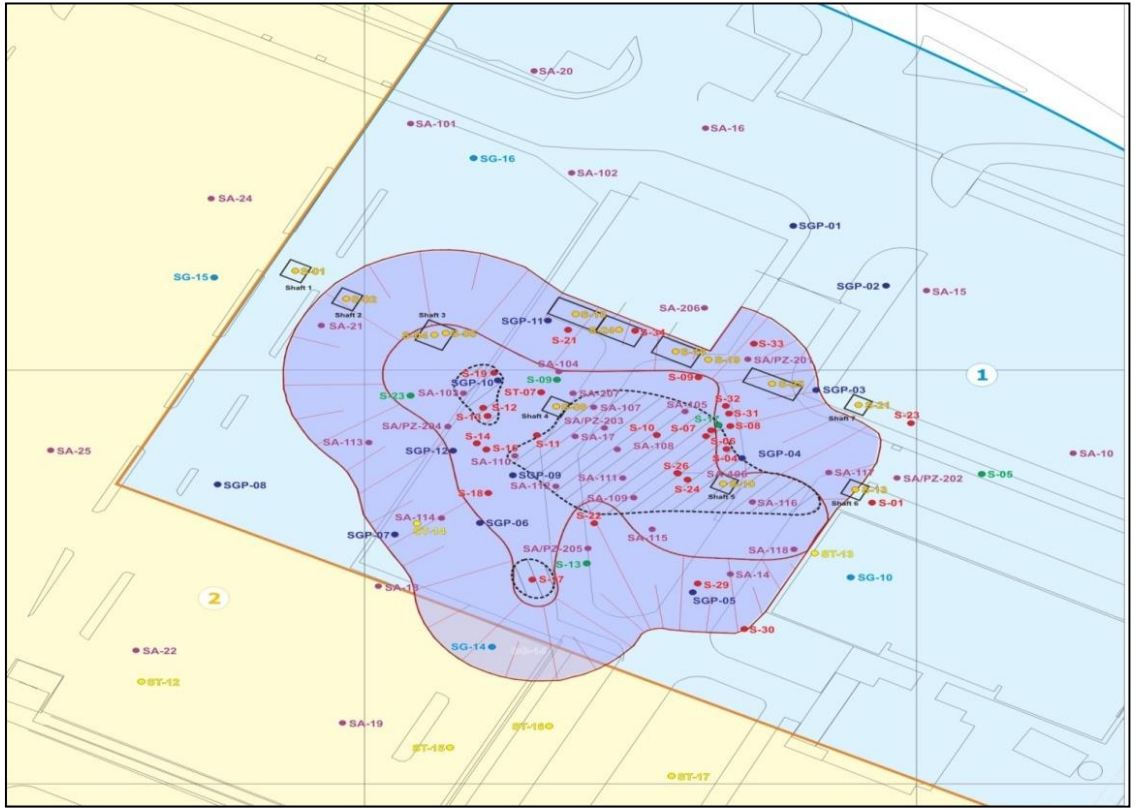
Macro Management Strategy

Step 1	• Risk Control/Mitigation- External and Internal Receptors
Step 2	• Refinement of Conceptual Model - Additional Investigations
Step 3	• Mass Removal

Step 1: Risk Control (2007)

Step 2: Additional Investigations – source area (2009 - 2010)



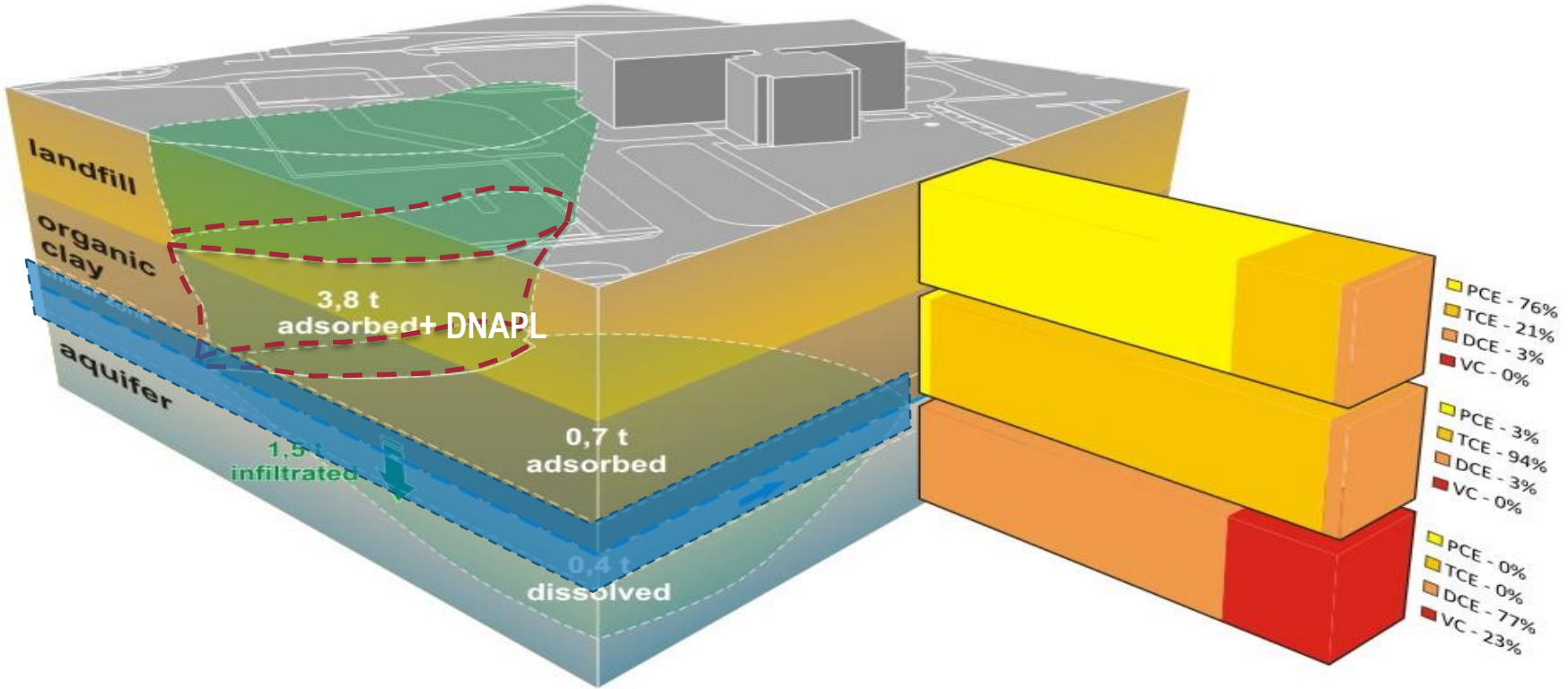
DP boreholes

Soil samples

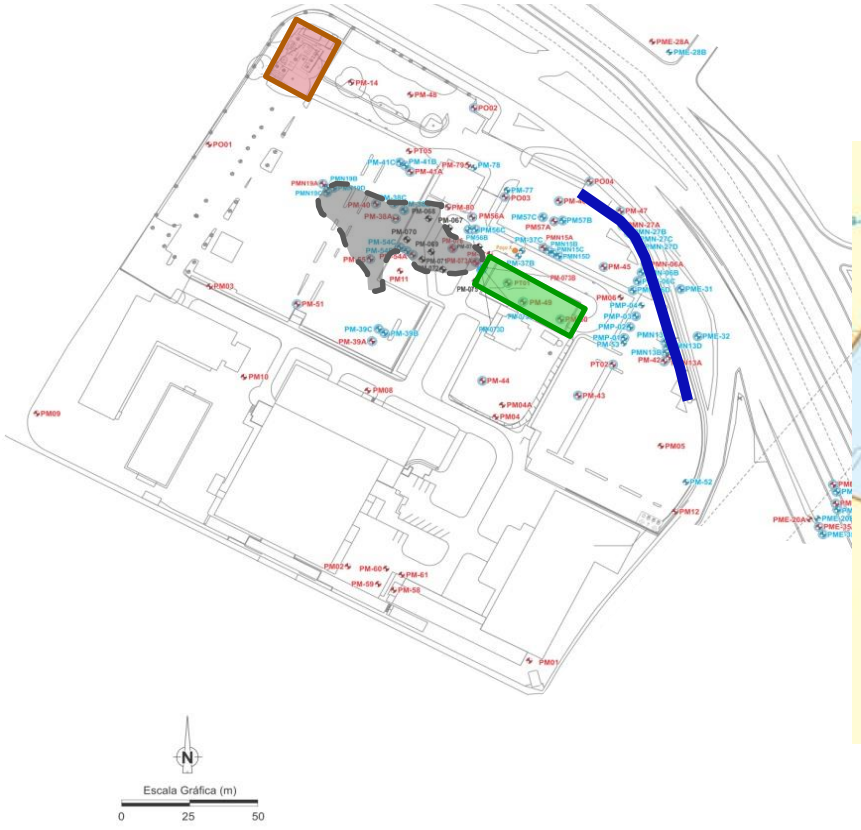
New MW

GW samples

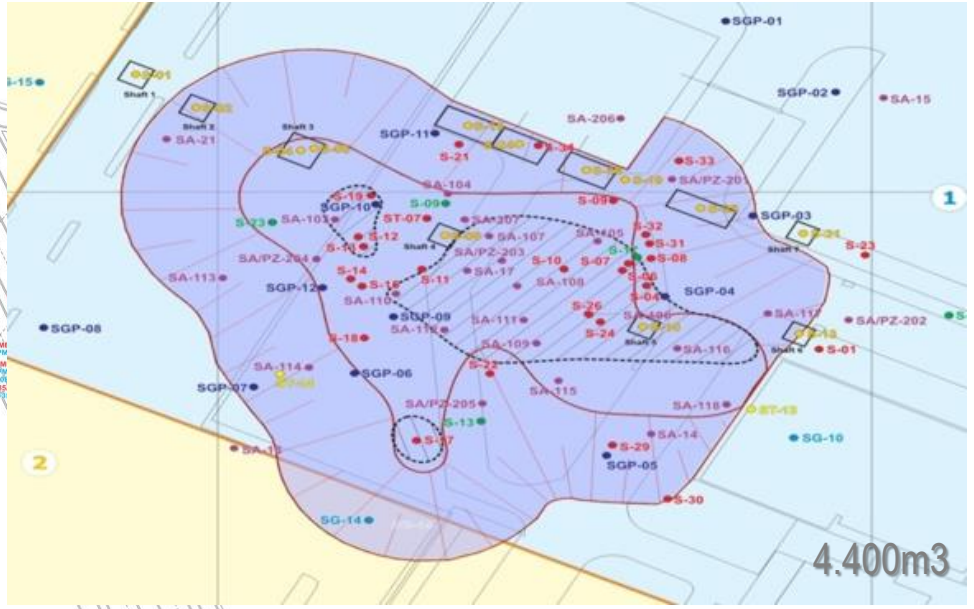
Step 2: Refinement of 3D Conceptual Model (2010)



Step 3: Mass Removal – Source Excavation (2010 - 2011)

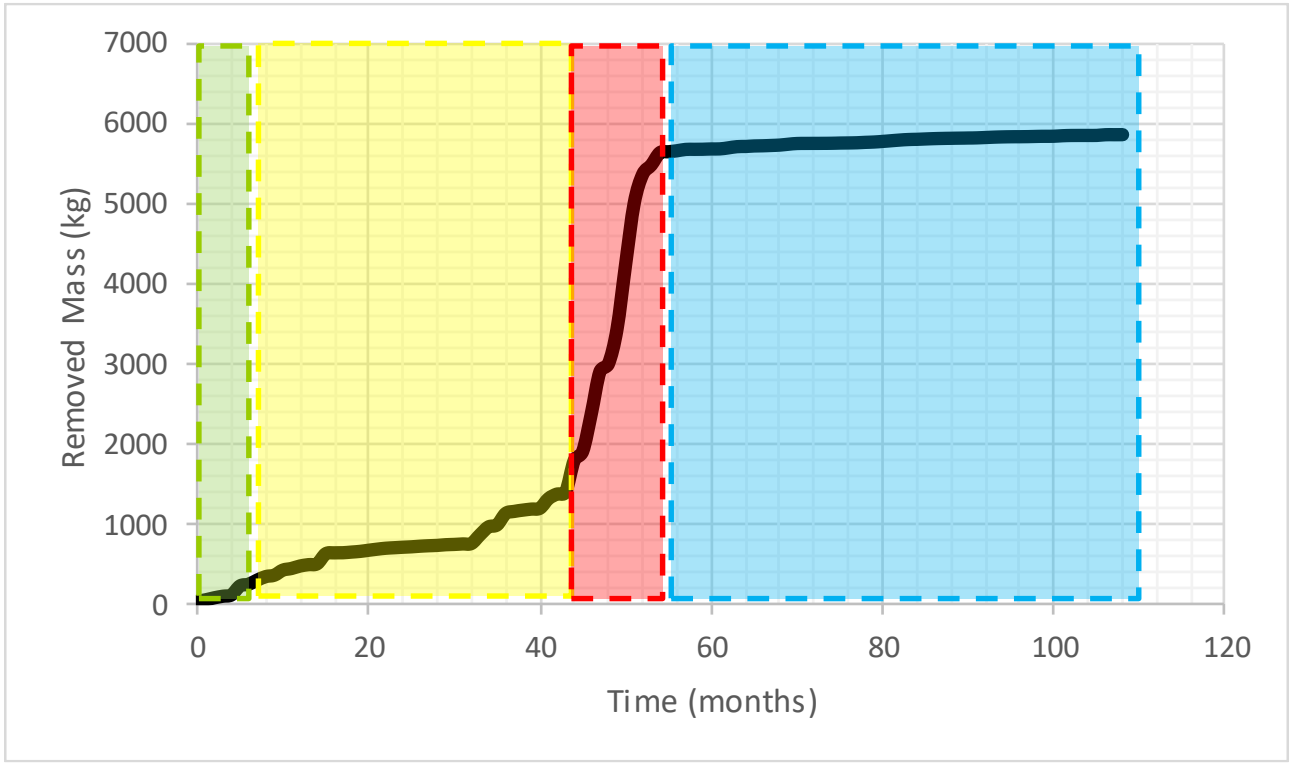


EXCAVATION PIT



Step 3: Mass Removal – Source Excavation (2010 - 2011)

Results: Mass Removal (2007 – 2015)



EXCAVATION + HB

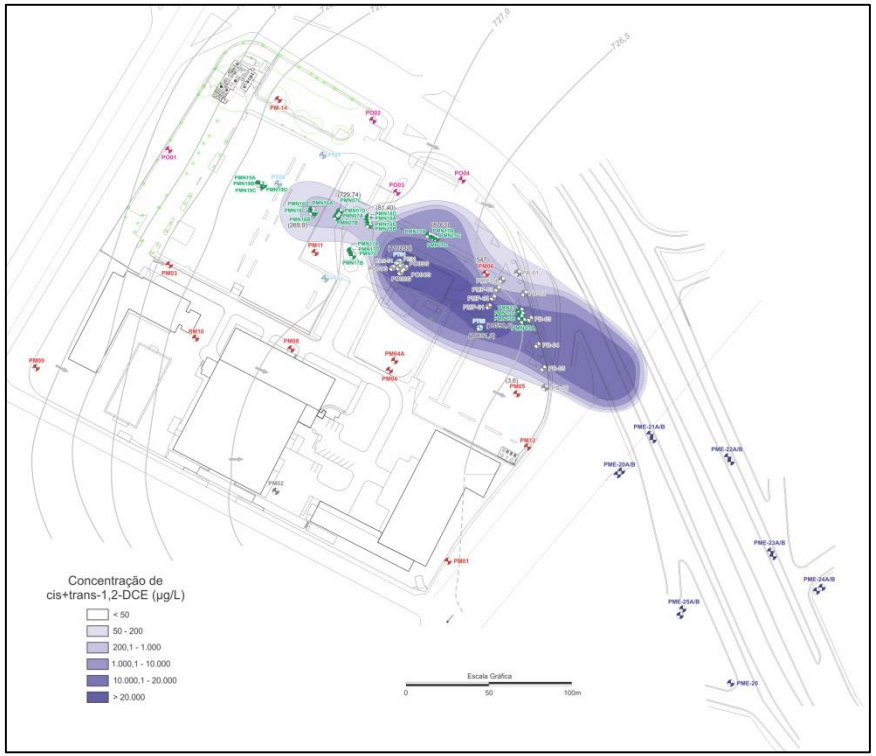
MPE/AS + HB

HB

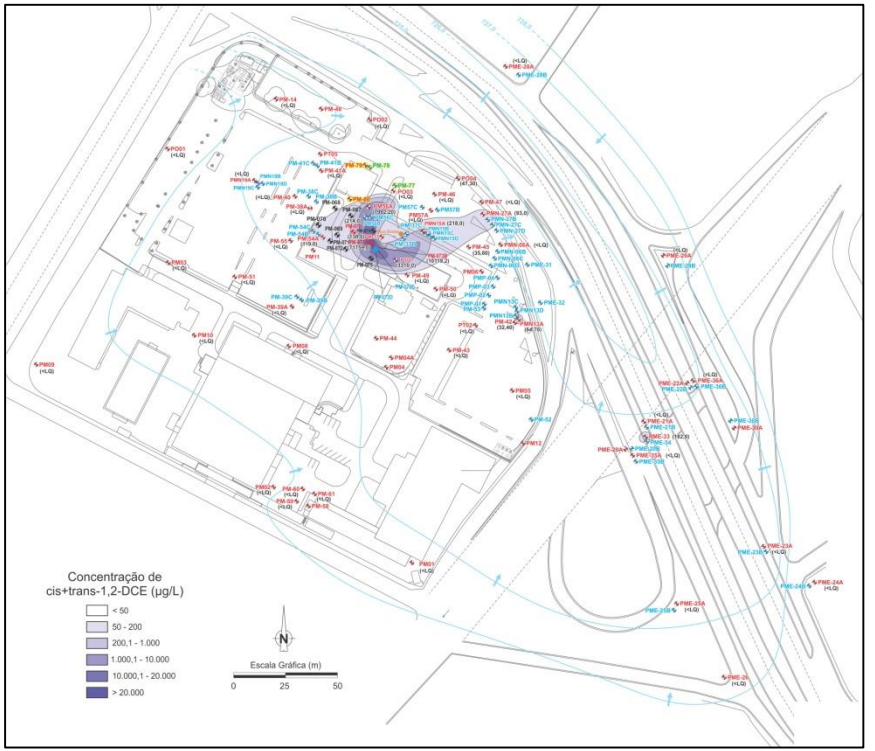
MPE/AS + HB

~95% mass removal

Results: GW Dissolved Phase – 1,2 DCE (6 – 9 m)

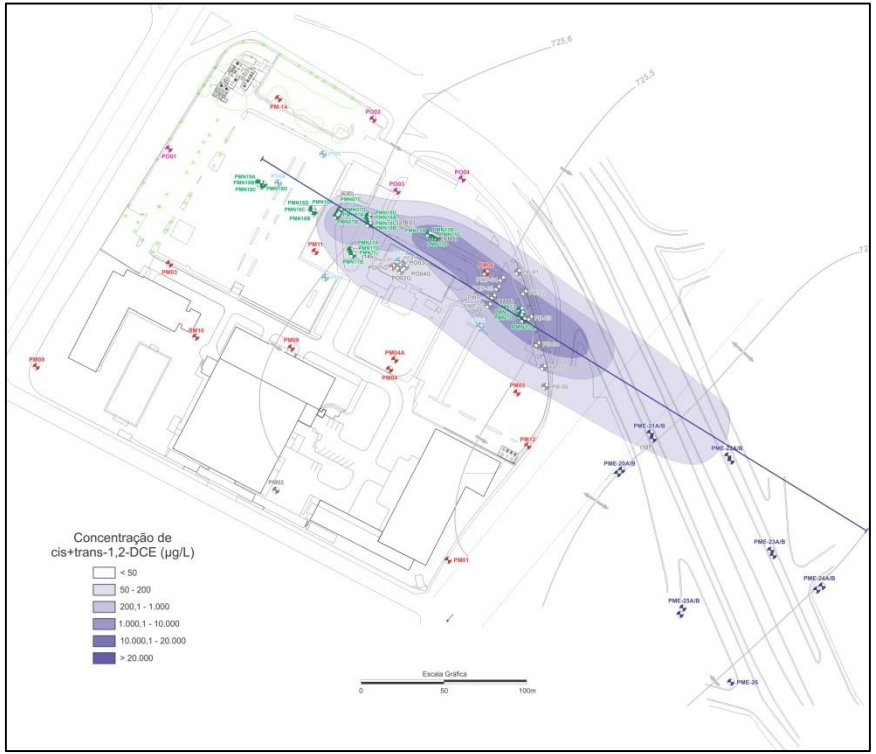


2007

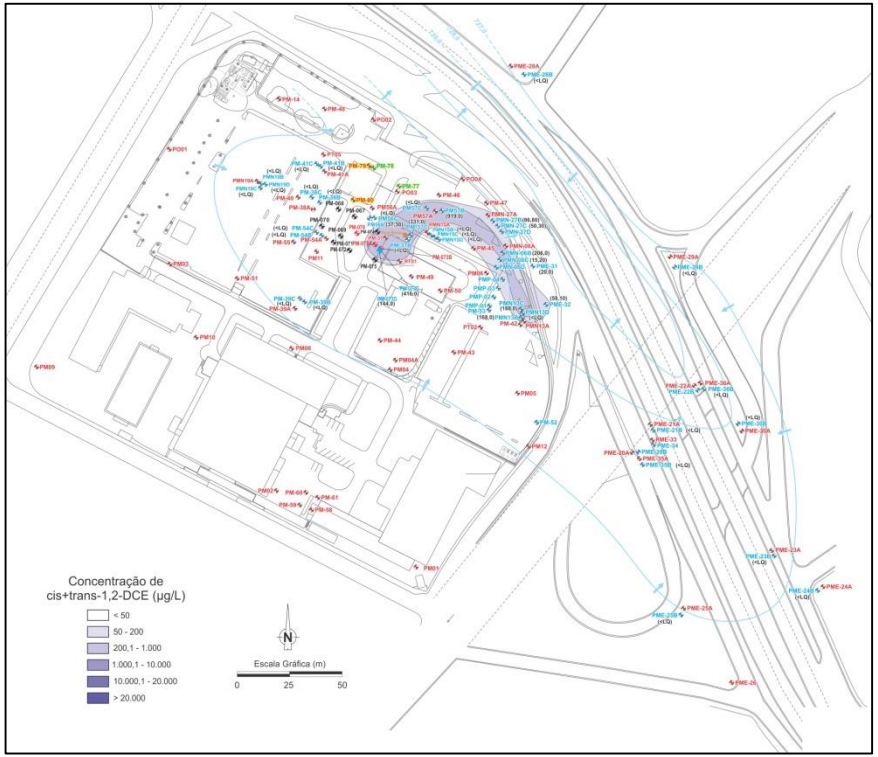


2015

Results: GW Dissolved Phase – 1,2 DCE (14 – 20 m)

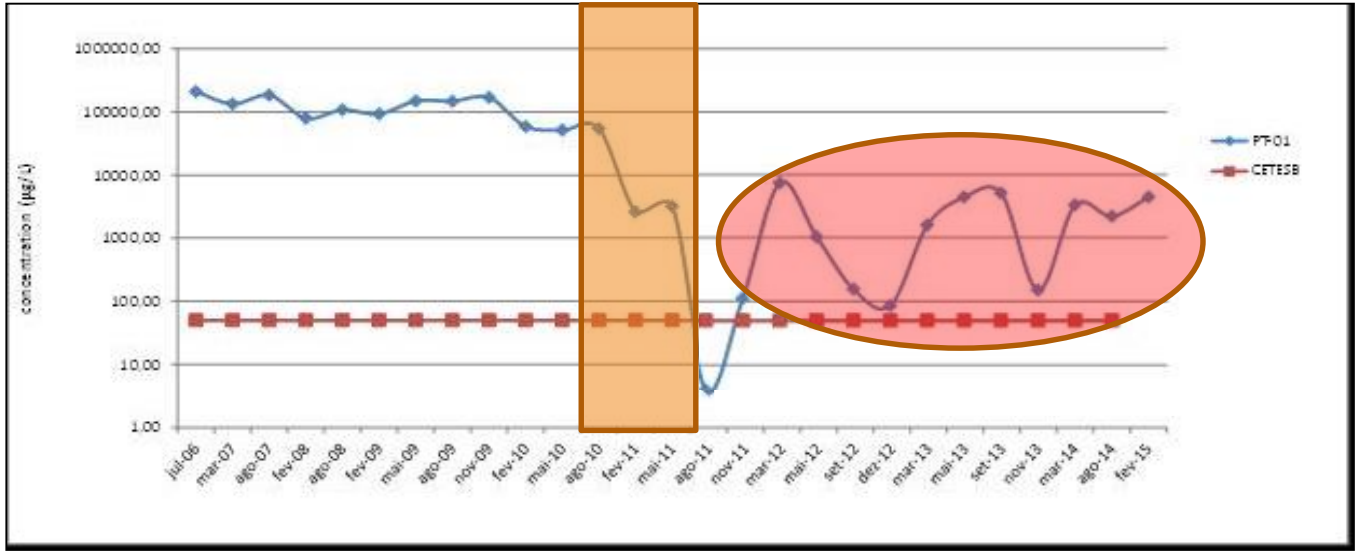


2007



2015

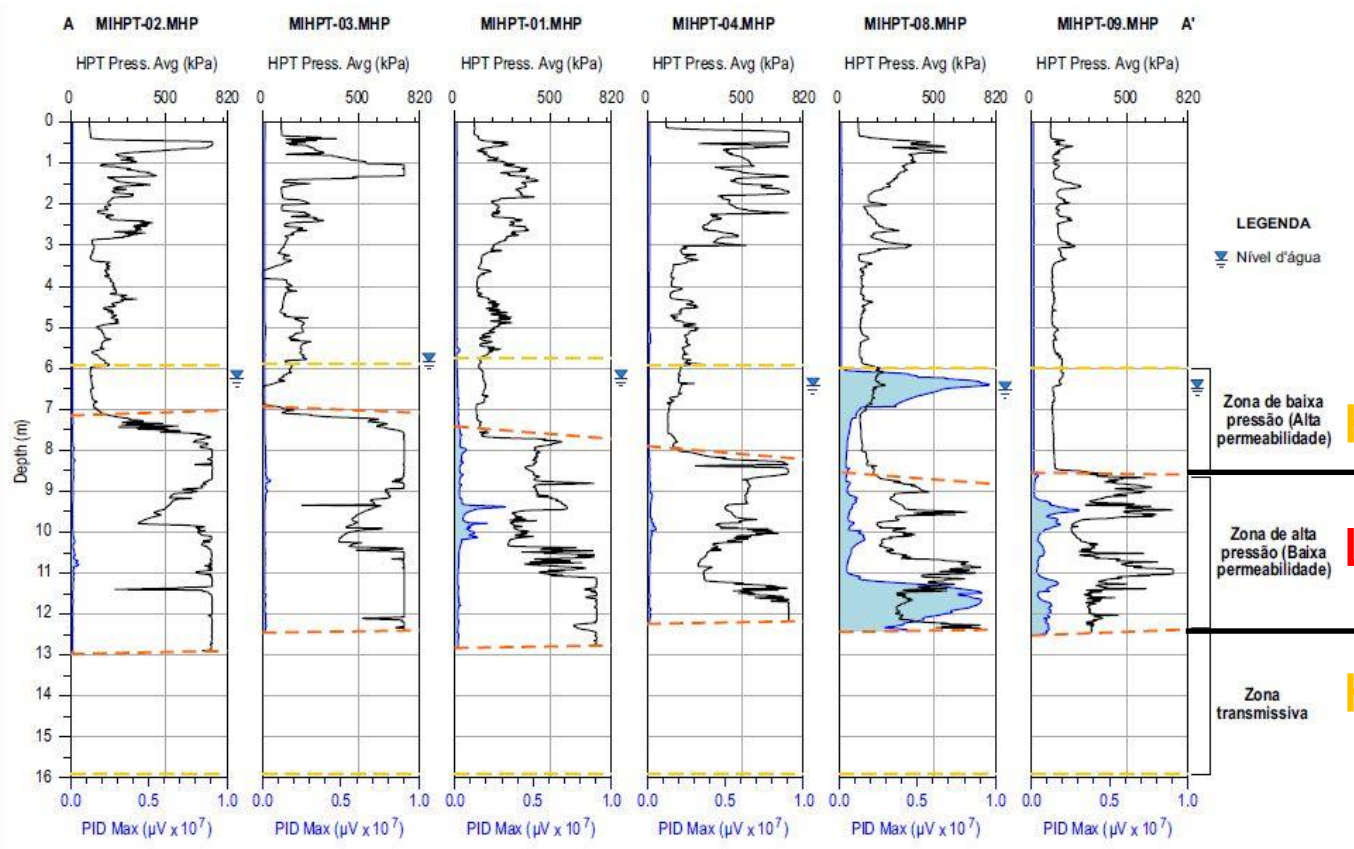
GW Dissolved Phase – 1,2 DCE: Rebound Effect Within Plume Core



Excavation Timeframe

Rebound Effect

Plume Core: HR Mapping (MIP + HPT)



HIGH K = MASS FLUX

LOW K=MASS STORAGE

HIGH K = MASS FLUX

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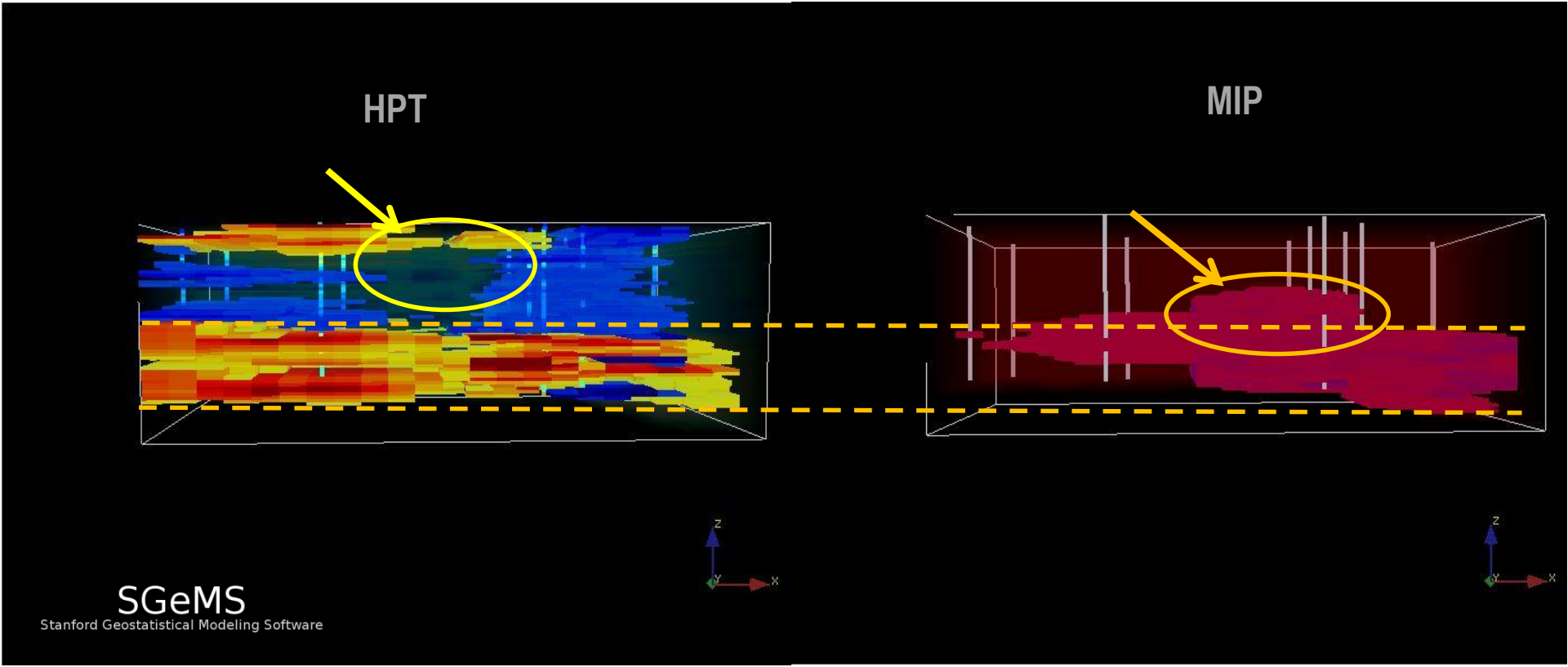
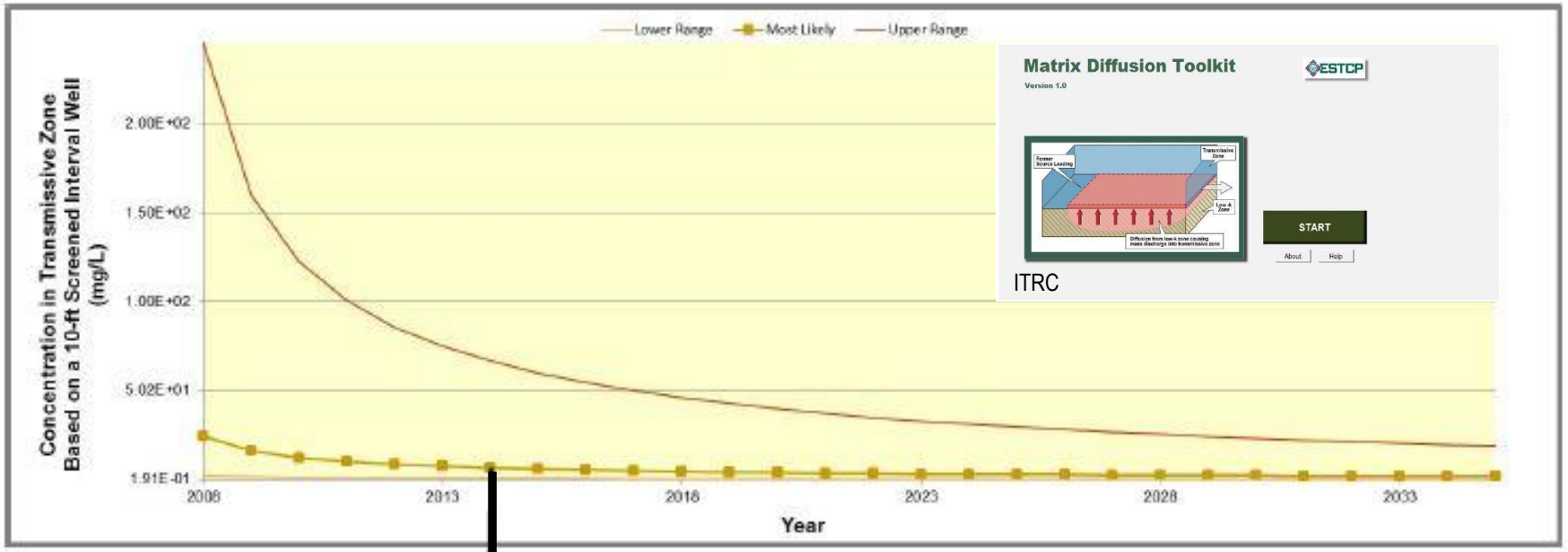
Plume Core: HR 3D Model (MIP + HPT)



Plume Core: Back-Diffusion Modeling



~5 ppm

Next Steps

Step 4	• Attack the remaining mass of contaminants and control the plume core migration
Step 5	• Update transport simulations
Step 6	• Evaluate whether to keep the HB running or not

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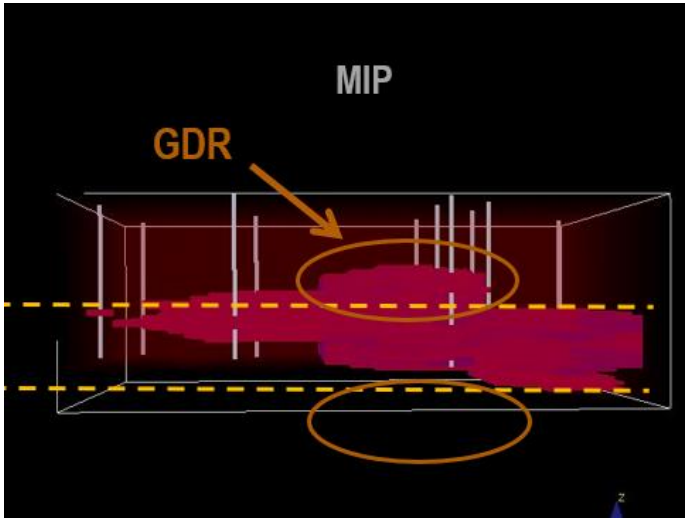
Mass removal and plume control

Client demand: minimum disturbance, use existing infra structure

- GDR (Ground water Directed Recirculation), above & below the clay
- Implementation: 2018 , ~ 5 years
- HB: ongoing, ~ 5 years
- MPE: stopped
- GW extraction 200bgs



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Lessons Learned

- Given that risks were properly identified and understood by all stakeholders, the use of resources has been optimized

- Traditional remediation technologies have been effective in providing risk control and mass removal

- HR tools (MIP) provided valuable information regarding the remaining mass of contaminants


Thank you!
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