



Mass Discharge as a KPI for a Industrial Site Remediation

GEOKLOCK
Consultoria e Engenharia Ambiental

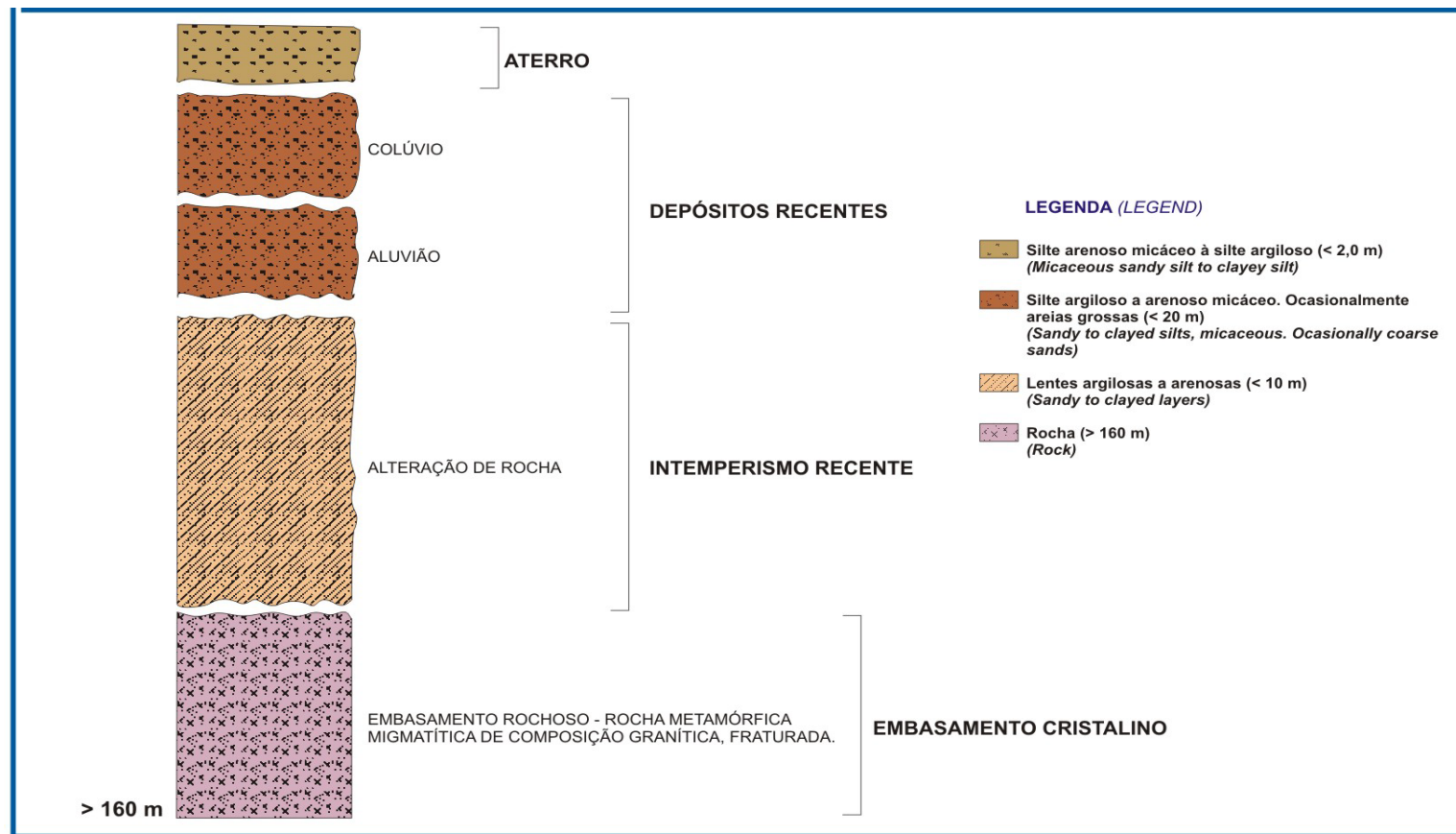
AGENDA

- General Info
- Hydrogeological Setting
- Contamination Scenario
- Risk Assessment
- Remediation Approach
- Mass Discharge
- Final Considerations

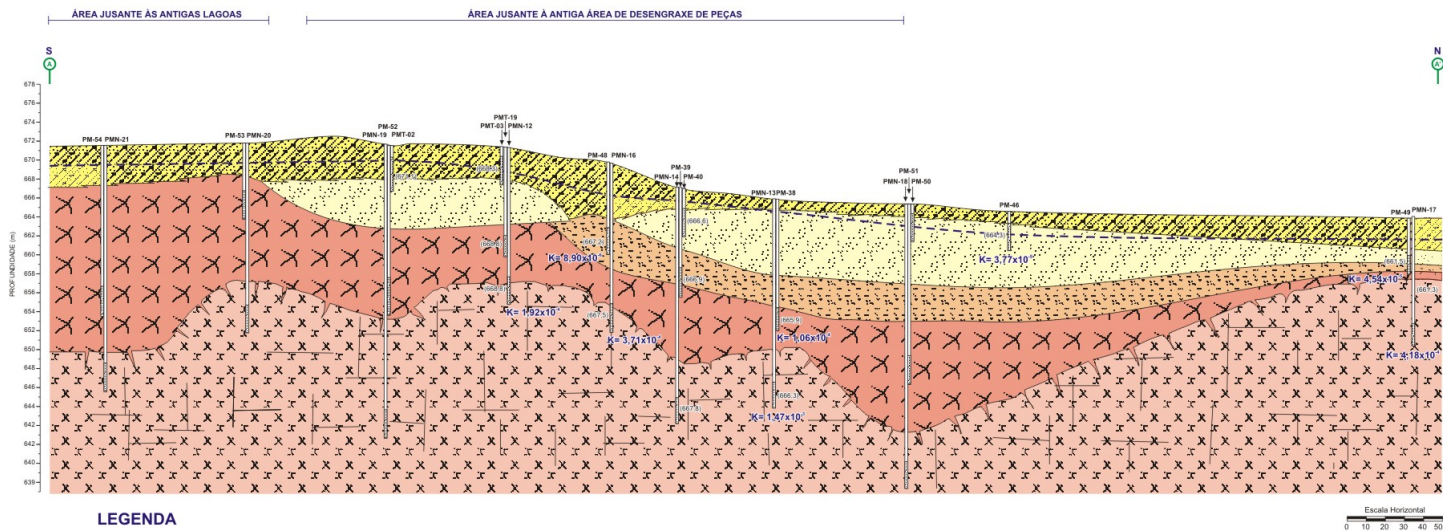
GENERAL INFO

- Industrial Site in Brazil - São Paulo State
- Operating since 1974
- Former use of PCE for degreasing.

HYDROGEOLOGICAL SETTING



HYDROGEOLOGICAL SETTING



LEGENDA

Sedimentos Aluvionares

- Sedimentos arenosos, de granulometria fina a grosseira, com pouca contribuição argilosa, cor cinza a avermelhada
- Sedimentos argilo-siltosos, localmente argilo-arenosos, cor cinza a ocre

Elúvio

- Solo de alteração arenoso, de composição quartzo-feldspático, cor creme, ciza e rósea

Saprolito

- Alternância de bandamentos arenosos (quartzo-feldspático) e micáceos (biotita, muscovita, flogopita e hornblenda), localmente com fragmentos de rocha sã, cor creme esbranquiçada nos bandamentos arenosos e cinza esverdeado nos micáceos

Rocha

- Gnaisses e migmatitos, localmente anfibolito

(685,2) Carga hidráulica (m)

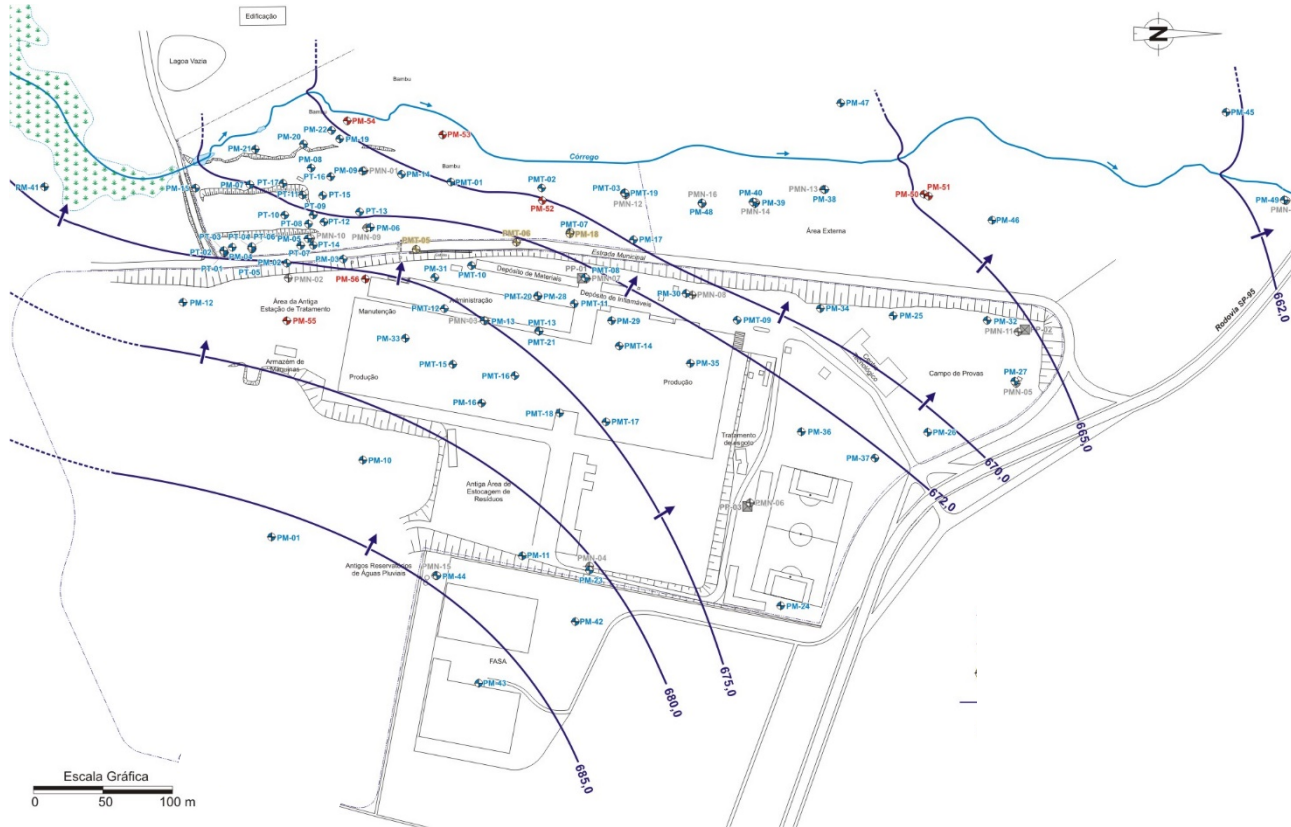
--- Nível d'água subterrâneo

K Condutividade hidráulica (cm/s)

┘ Fraturas

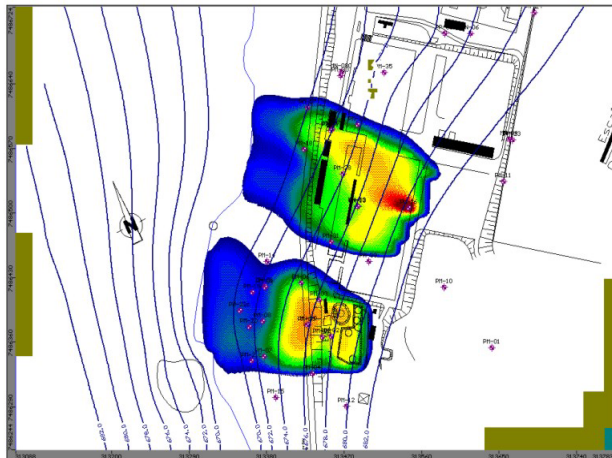


HYDROGEOLOGICAL SETTING

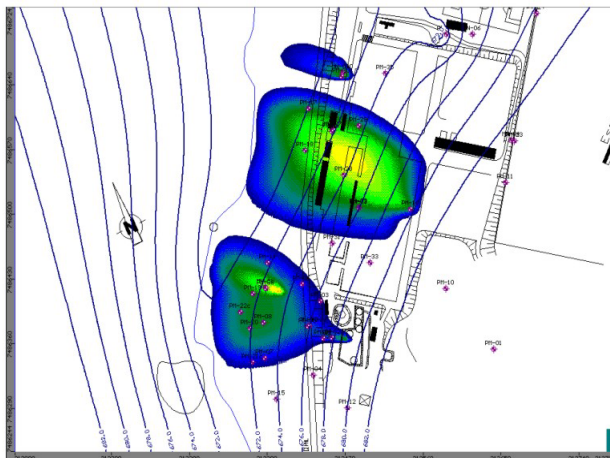


CONTAMINATION SCENARIO

Aquífero Raso (Shallow Aquifer)



Aquífero Profundo (Deep Aquifer)



LEGENDA (LEGEND)

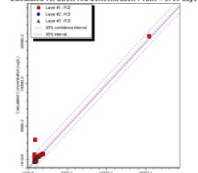
CONCENTRAÇÕES DE PCE (µg/L)
(PCE CONCENTRATION (µg/L))

15000	500
10000	250
2500	100
1000	40

PREMISSAS (PREMISES)

Fator Retardamento = 2 a 5,6
(Factor of Retardation = 2 to 5.6)
Tempo 1/2 vida = 2,5 a 3 anos
(Half-life = 2.5 to 3 years)

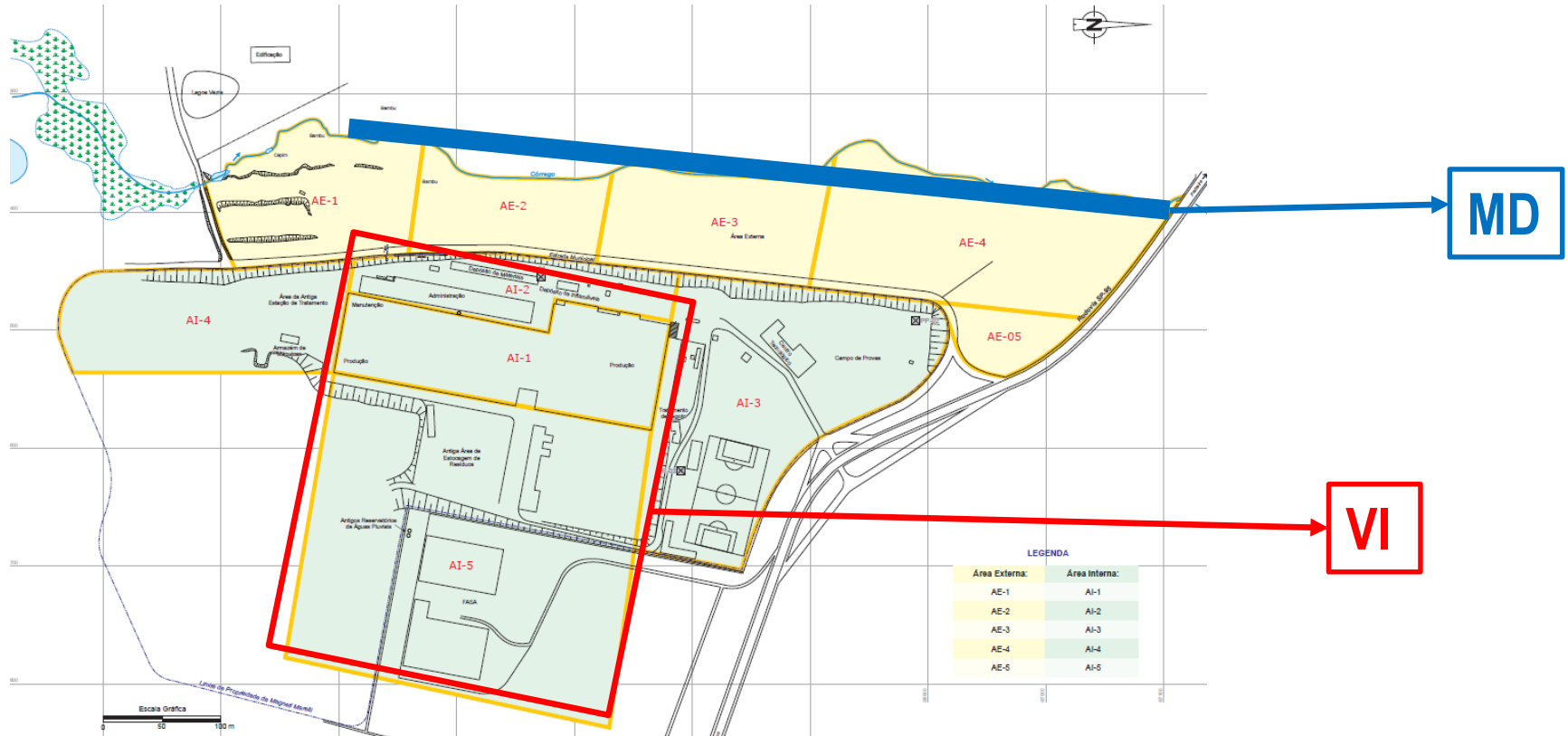
Calculated vs. Observed Concentration : Time = 8760 days



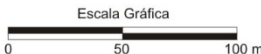
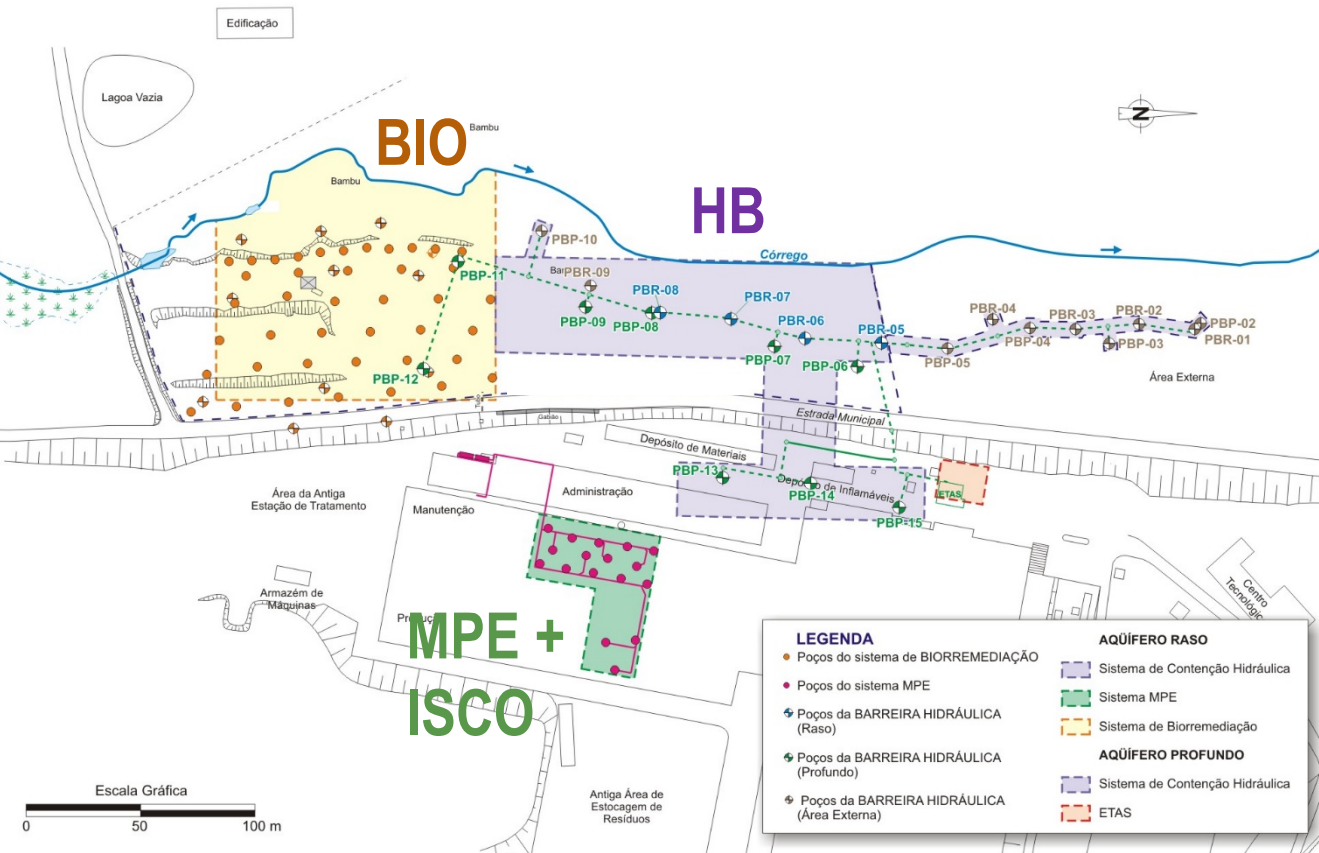
Name of Data Points: (1)
 Min. Observed: 400.00 (µg/L) at P10-01A
 Max. Observed: 1000.00 (µg/L) at P10-01A
 Min. Calculated: 100.00 (µg/L) at P10-01A
 Max. Calculated: 200.00 (µg/L) at P10-01A
 Min. Absolute Error: 100.00 (µg/L)
 Max. Absolute Error: 100.00 (µg/L)

Standard Error of the Estimate: 104.76 (µg/L)
 Root Mean Square: 100.00 (µg/L)
 Normalized RMSE: 20.00 (%)
 Coefficient of Correlation: 0.98

RISK ASSESSMENT

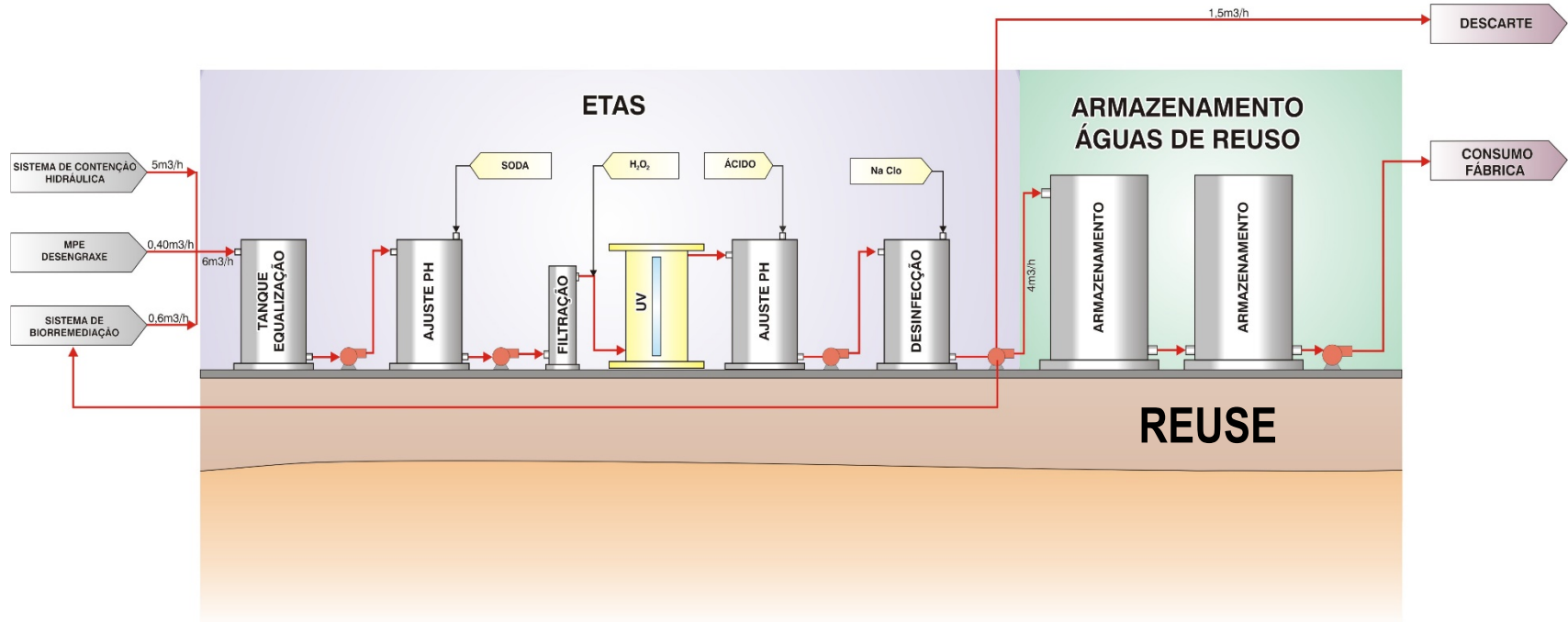


REMEDIATION APPROACH

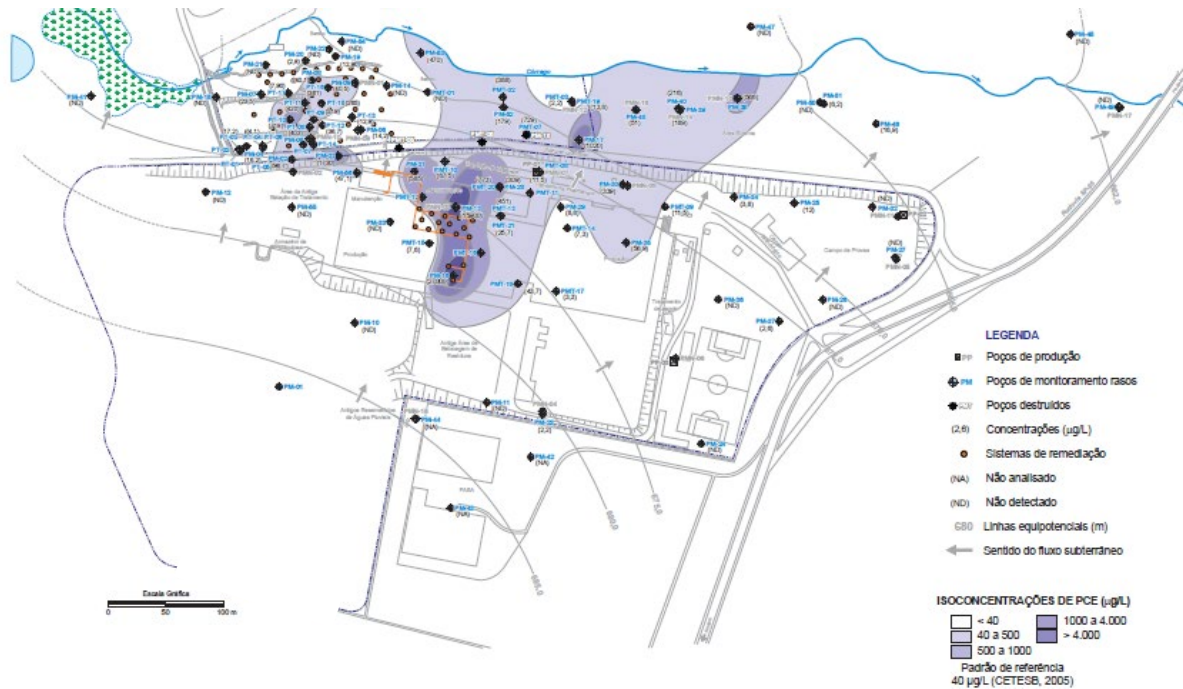


LEGENDA	
● Poços do sistema de BIORREMEDIÇÃO	■ Sistema de Contenção Hidráulica
● Poços do sistema MPE	■ Sistema MPE
⚡ Poços da BARREIRA HIDRÁULICA (Raso)	■ Sistema de Biorremediação
⚡ Poços da BARREIRA HIDRÁULICA (Profundo)	AQUÍFERO PROFUNDO
⚡ Poços da BARREIRA HIDRÁULICA (Área Externa)	■ Sistema de Contenção Hidráulica
	■ ETAS

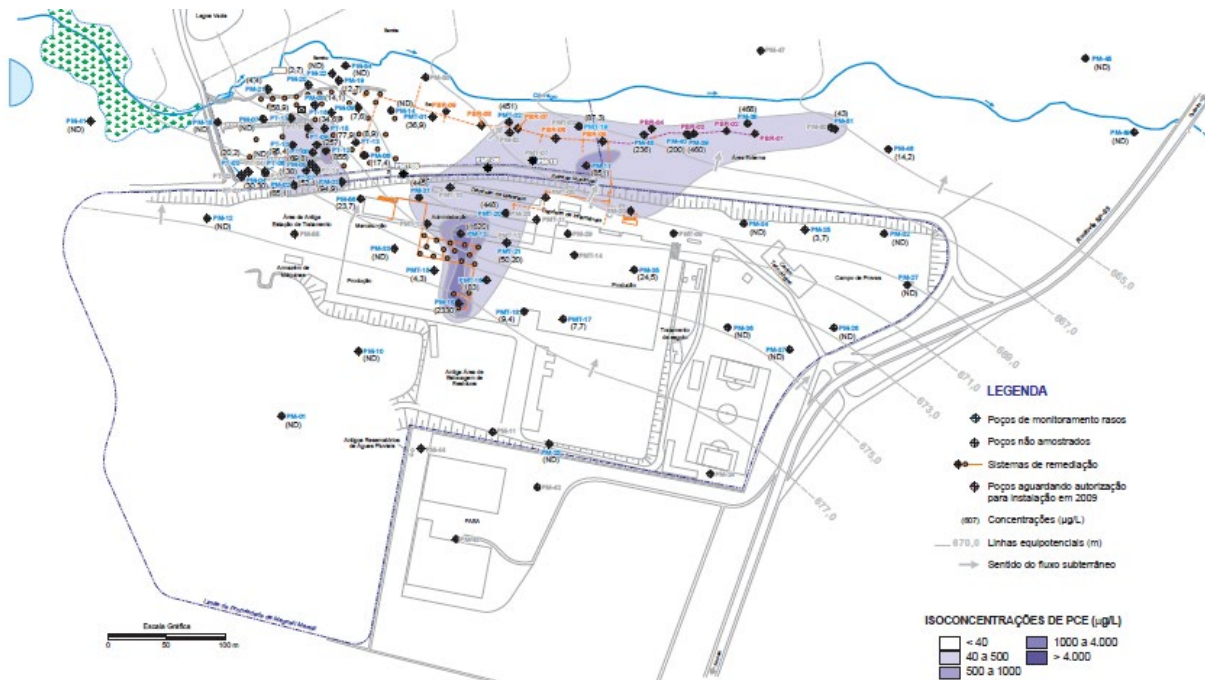
REMEDIATION APPROACH



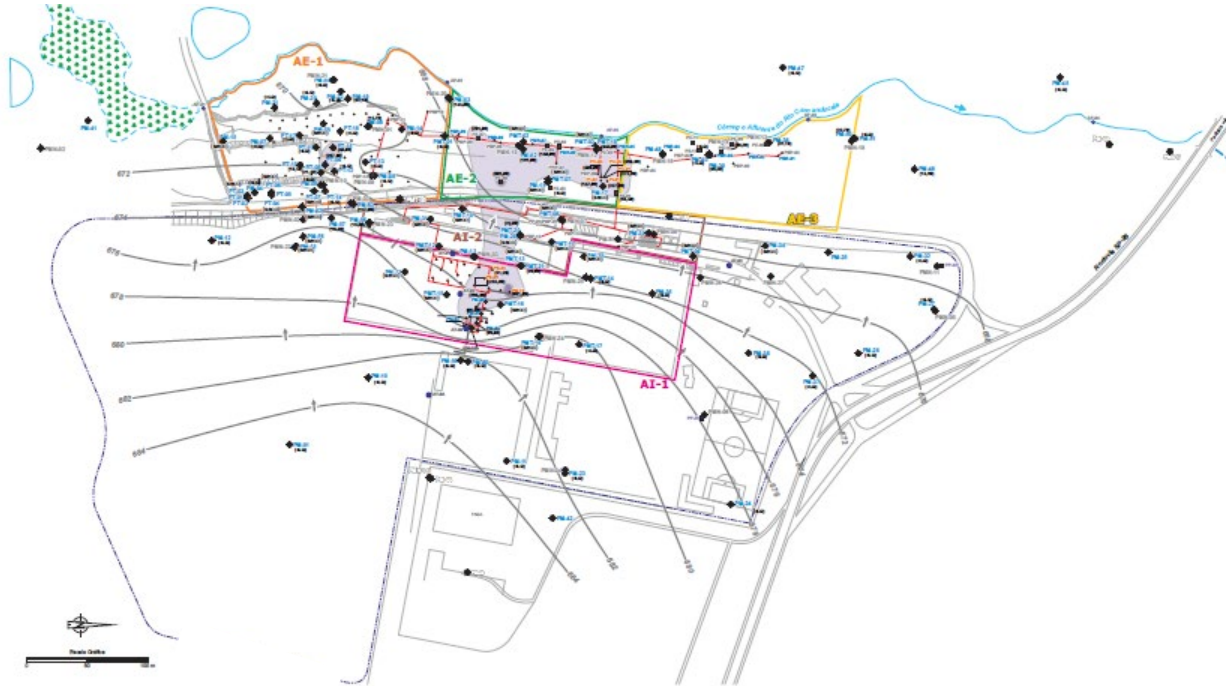
BASELINE - 2007



HB + MPE + BIO – 2009



HB + MPE + BIO + ISCO - 2015

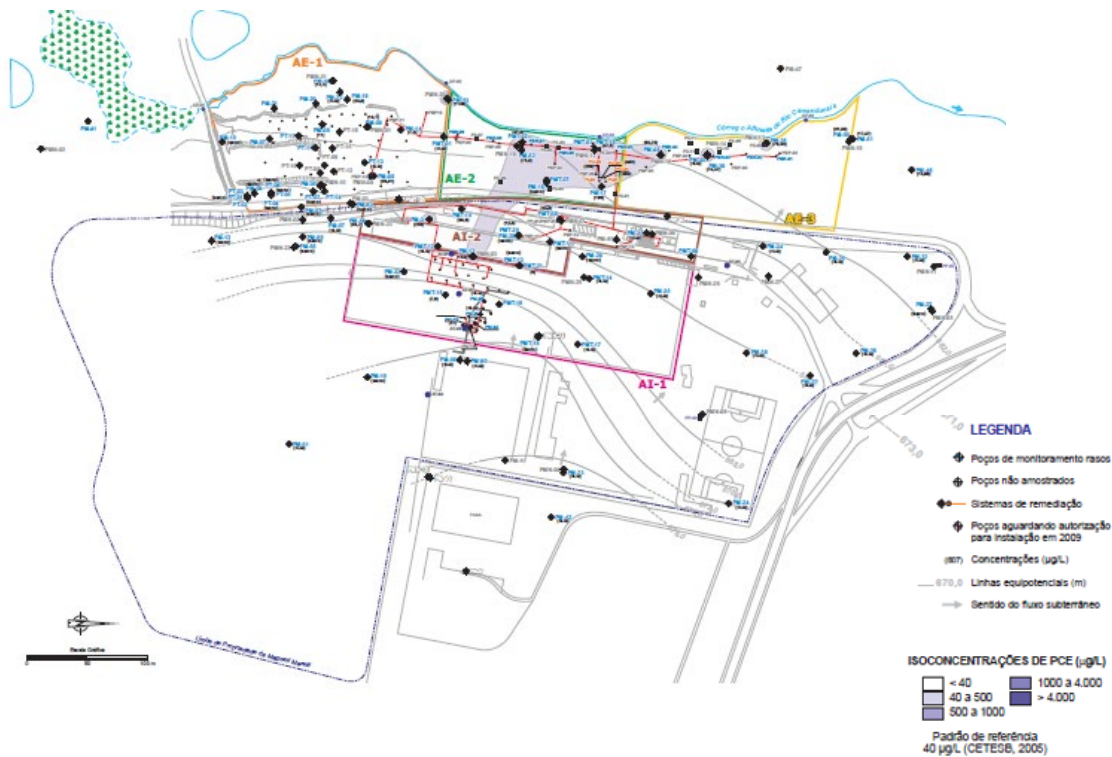


Padrão de referência
40 µg/L (CETESB, 2005)

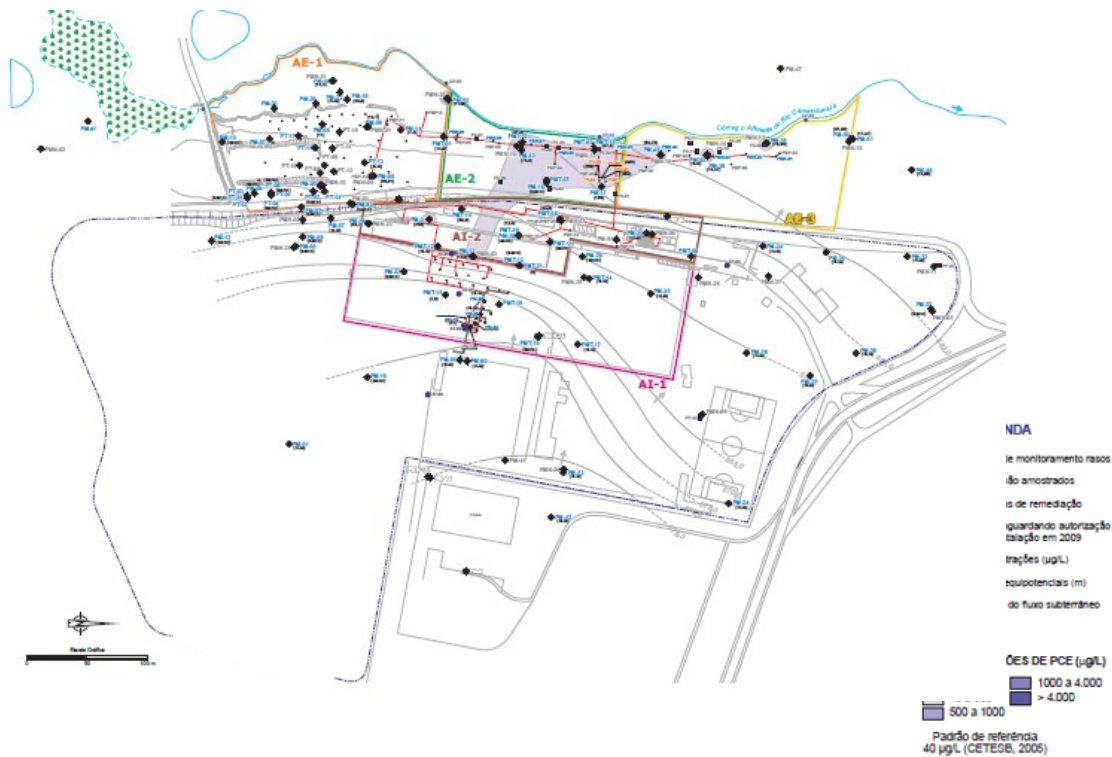
REMEDIATION SHUTDOWN - 2015



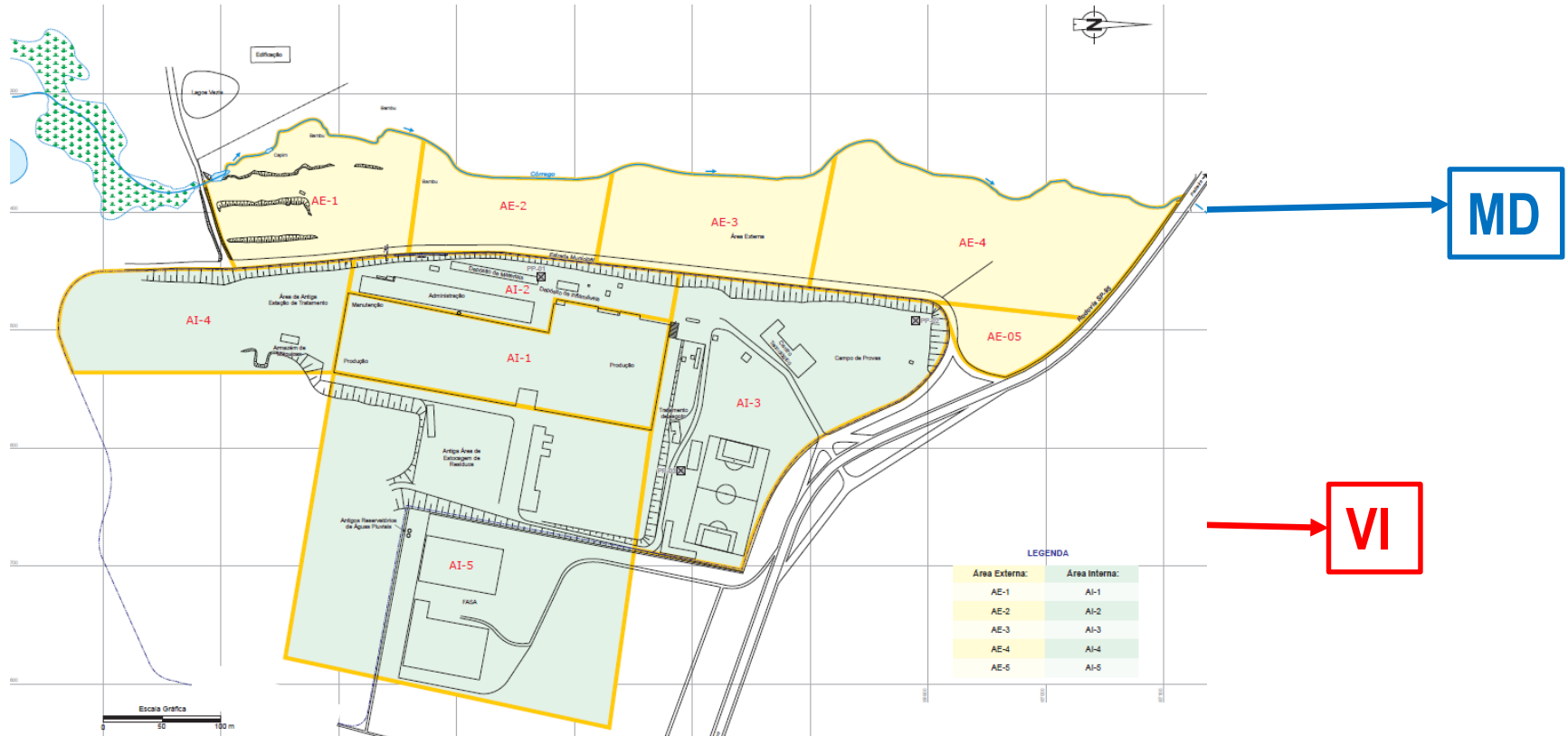
POST REMEDIATION - 2016



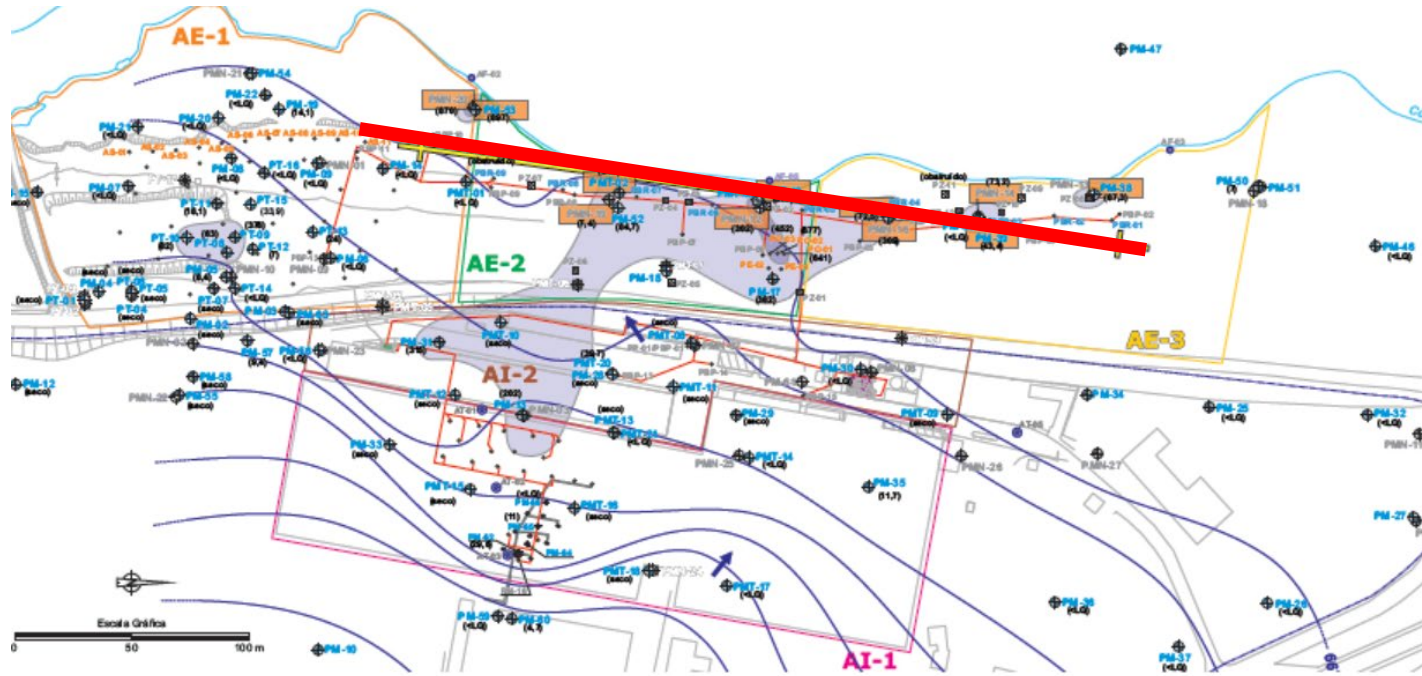
POST REMEDIATION - 2016



RISK ASSESSMENT



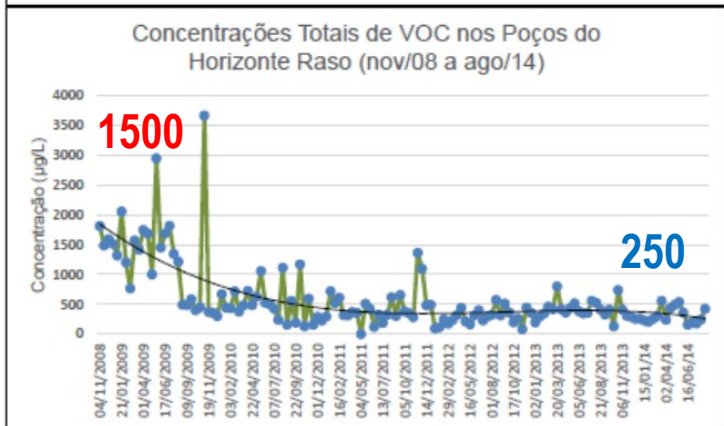
MASS DISCHARGE CALCULATION - TRANSECT



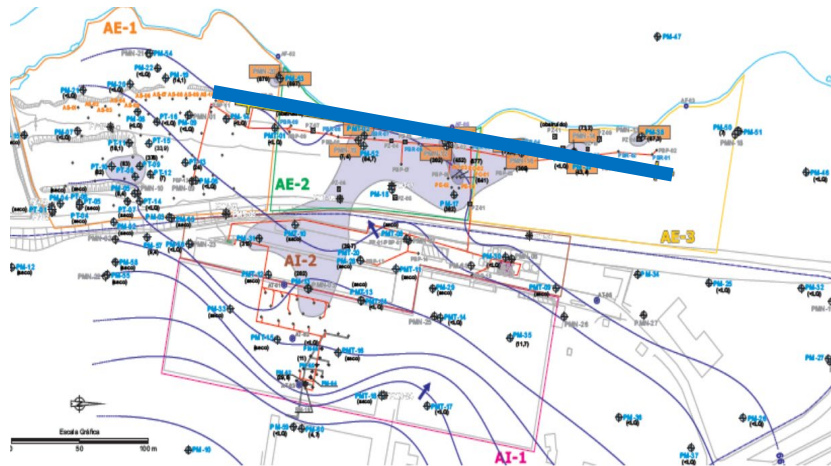
MEASURED MASS DISCHARGE (Under HB Influence)



VOC Mass
(kg/month)

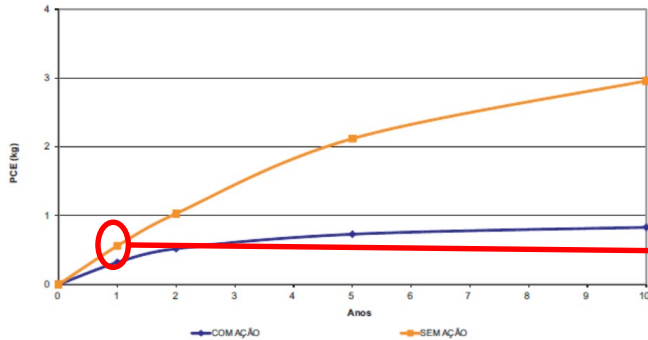
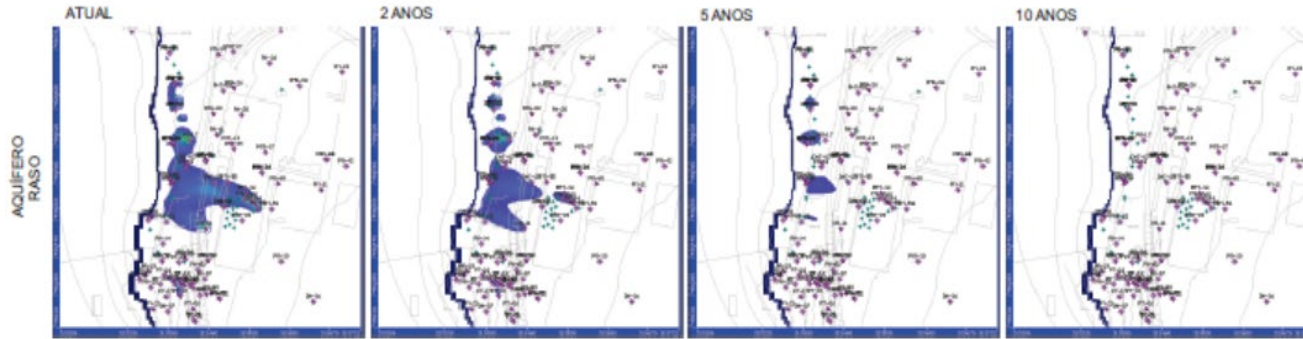


VOC Concentration
(ppb)



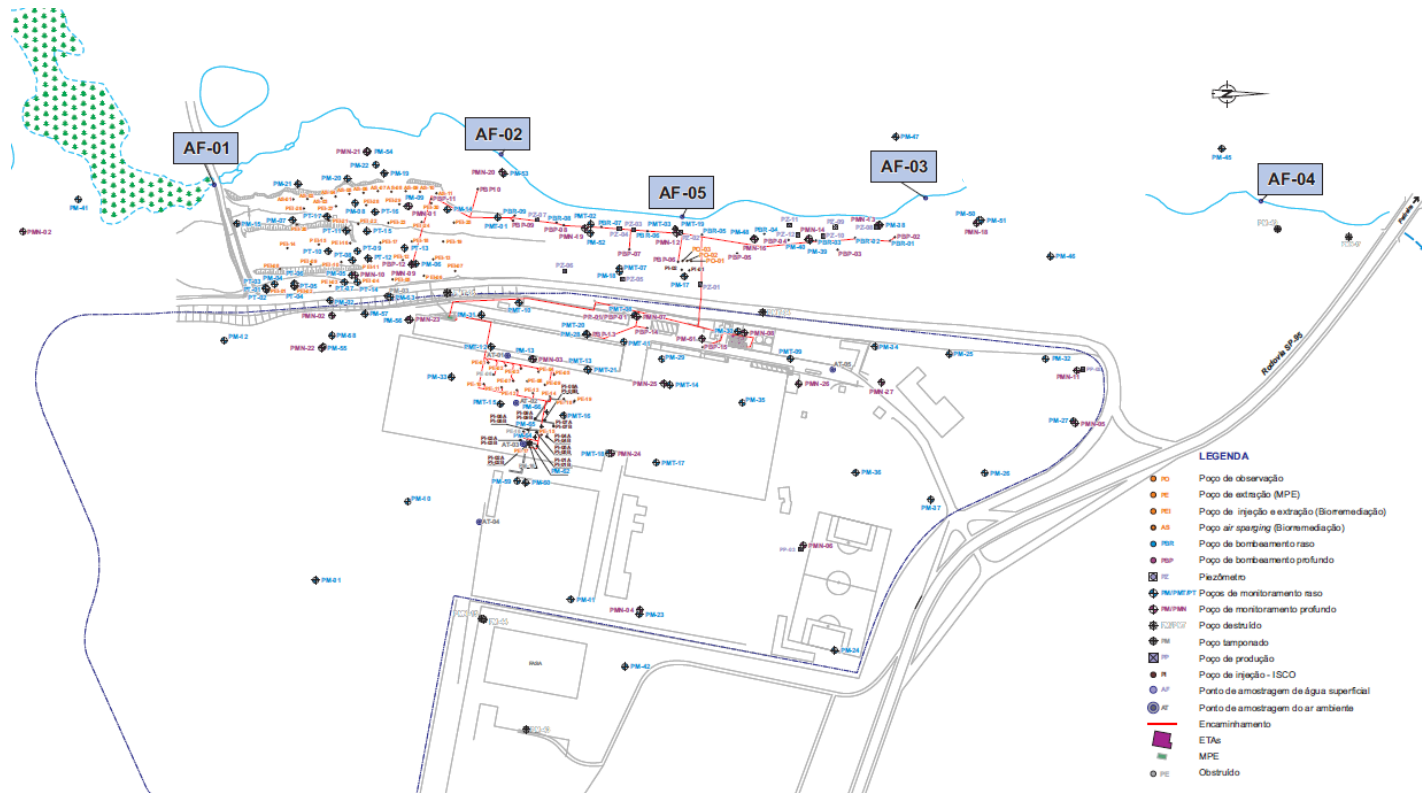
SIMULATED MASS DISCHARGE

PCE (MT3D)



~0,6 kg/year

SURFICIAL WATERS – MONITORING



Post HB Shutdown
 36 sampling rounds without PCE detection

FINAL CONSIDERATIONS

- The remediation approach was effective in reducing PCE concentrations
- The SSTL for indoor air inhalation was achieved
- Different methods were applied to estimate the potential PCE mass discharge into a creek. All of them pointed out to a safe condition, supporting the HB shutdown decision
- Based on results of post remediation monitoring rounds , the local environmental agency (CETESB) issued a clean-up certification for industrial use.



Thanks!!

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