

# Combining In Situ Chemical Reduction and Big Diameter Vertical Soil Drill as an Alternative Solution for Thermal on a Complex Site Impacted by Chlorinated Solvents (Sao Paulo, Brazil)

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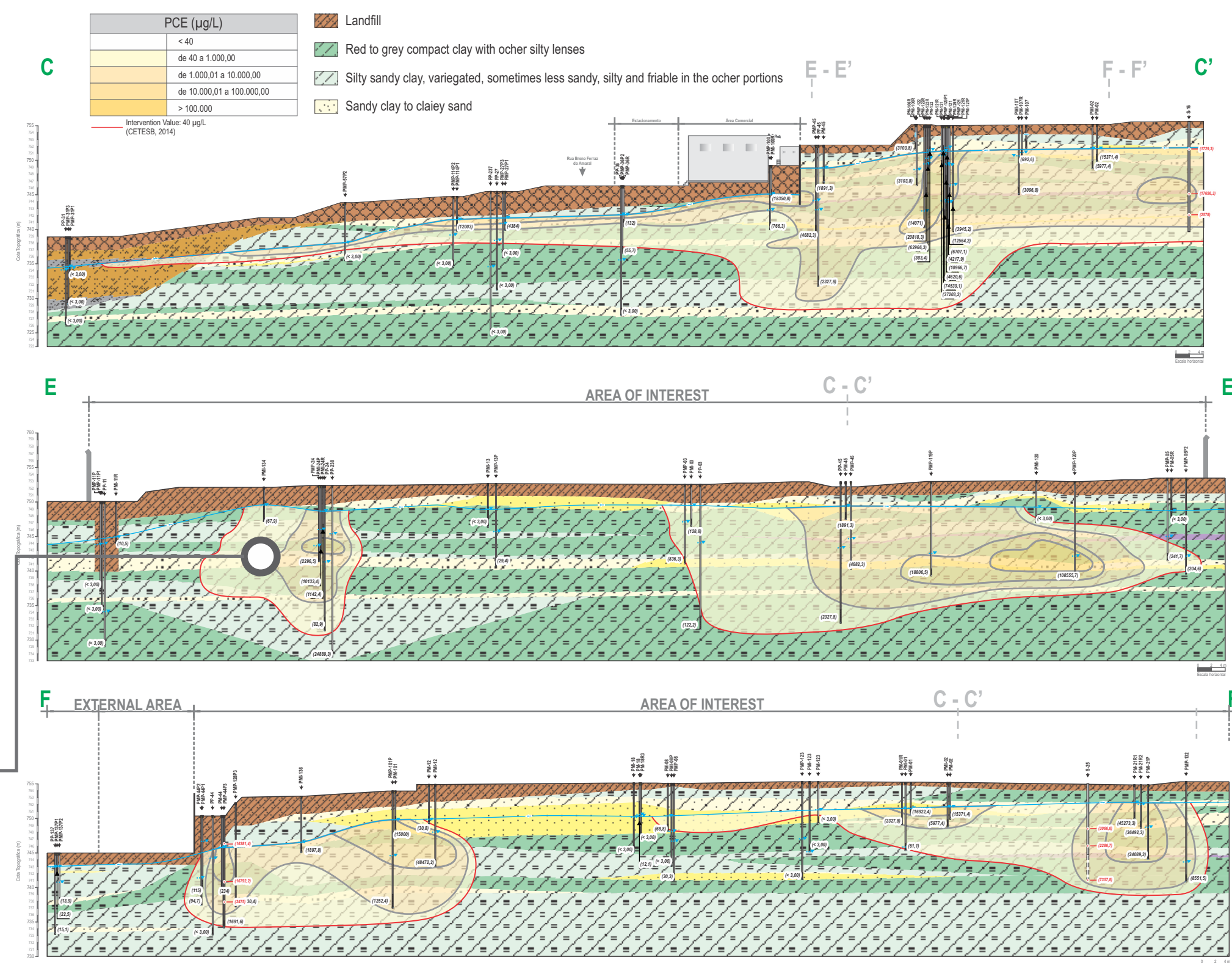
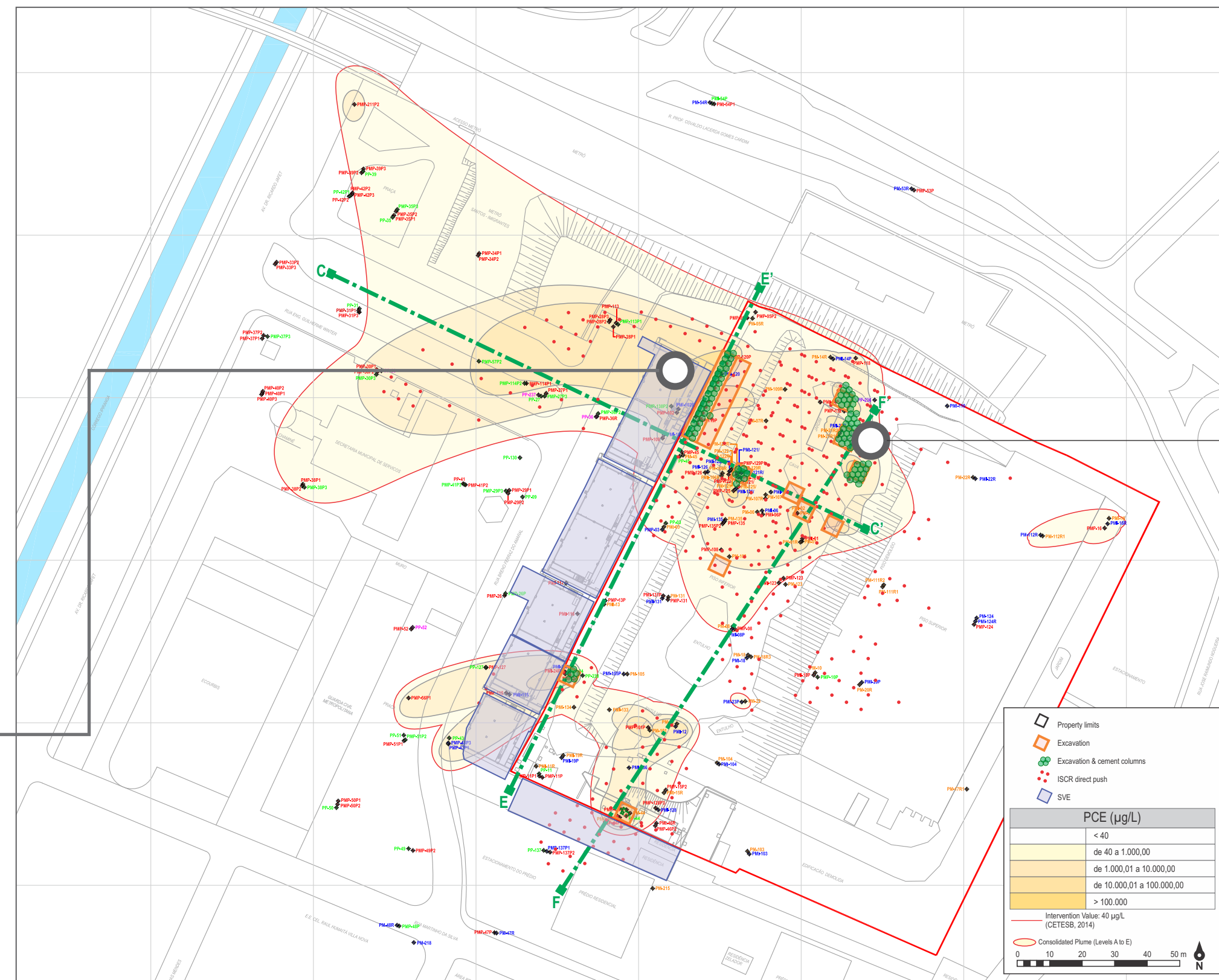
## Background / Objectives

Groundwater in a complex hydrogeology site at former home appliances manufacturing plant located in the city of Sao Paulo (Brazil site), **was impacted with CVOCs** including PCE, TCE, cis-1,2-DCE, VC and 1,1,2,2-TeCA.

PCE levels in groundwater were >200,000 µg/L and in soil was around **26,700,000 µg/kg** in the source areas (multiple sources).

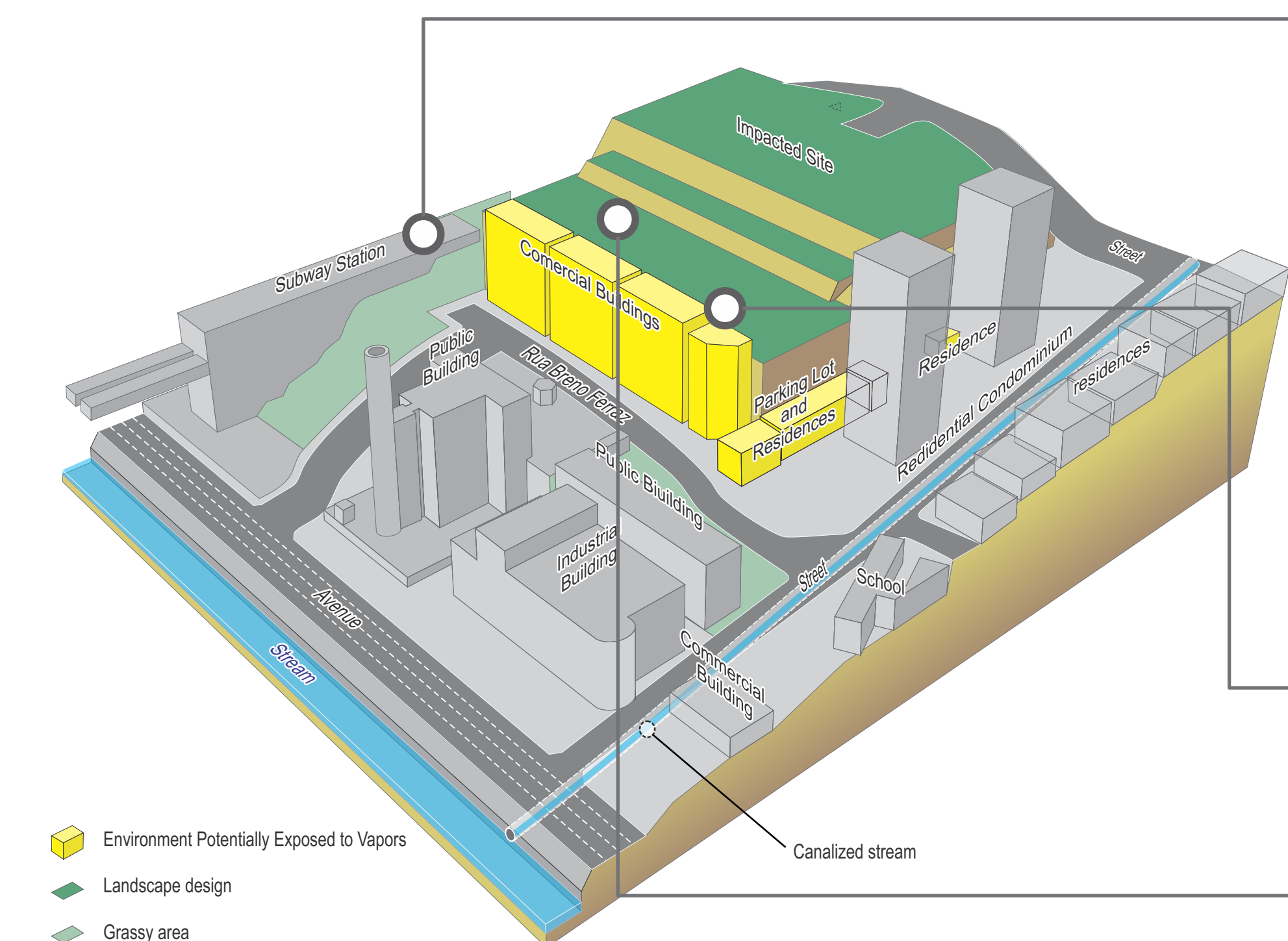
With the CVOC dissolved phase **plumes** covering approximately **115,000 sq ft** reaching **100ft deep** and a **geology comprised mostly by thick compact clay levels with high concentrations** in the source zones and **no space for big excavation pit**, the obvious solution was a **Thermal approach**.

The first step of the project included **understanding the complex hydrogeological model of the area**.



Then the **advantages and disadvantages** of the **thermal approach** were considered. The **main disadvantages**, which made this approach **unviable**, was:

- Existence of a nearby subway station
- Occupied neighboring (vapors concern)
- Elevated costs of the technique in Brazil



## Approach / Activities

Modified large foundation rig



8ft diameter x 100ft depth boreholes



24,300 ton of soil removed



Cement filled boreholes



The remediation was designed through a synergetic **combination of multiple techniques: Big Diameter Vertical Soil Excavation** in the source areas with high contaminant concentrations in the clayey layers, and **In Situ Chemical Reduction (ISCR)** of the impacted groundwater. The excavation was only possible **by modifying an equipment regularly used for big**

**foundations** in the construction industry. The adjusted equipment was able to **vertically remove soil up to 100ft at an 8ft diameter**, allowing the **safe removal of the deep highly contaminated clays** in the source areas **without the need of opening large pits**. This enabled the **ISCR reaction** to take place in the more permeable zones, including the external areas.

## Results / Lessons Learned



The **ISCR** in the dissolved plumes through **injection of 300 ton of Provect-IR®**, distributed in **537 points with multiple injection layers**, was only possible by first removing the impacted soil, and **the costs for the remediation ended up on 50% of the initial thermal estimative**. Fine tune are still needed, since **cis-1,2-DCE and VC are still present** in some monitoring wells in **concentrations above SSTLs** (much lower than baseline), but the latest **results are promising**, and the remediation is expected to **end after 5 years** since its beginning.

The **greatest lesson learned** from this project was that **soil concentrations must not be neglected**, since the contaminants absorbed into this matrix **may harm the remediation progress**.

Also, **compact and thick clayey layers**, which are very common in Brazil, especially in the city of Sao Paulo, may **impose extra challenges to remediation**, as described in this case.

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