FAST-TRACK BIOREMEDIATION WITH INDIGENOUS MICROBES

Summary Report

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During the renovation of a laboratory building at a Midwest facility, soil below the basement floor was found to contain polynuclear aromatic hydrocarbons (PAHs) exceeding applicable state standards, particularly for benzo(a) pyrene, a known carcinogen. The facility decided to undertake a voluntary cleanup of the contamination with the following objectives:

- *Protect workers and the environment from exposure to PAHs,*
- *Reduce or eliminate potential future environmental liability associated with the building, and*
- *Construct a remedial system quickly so as to restore the building to productive use within two months.*

The cost for excavation and disposal would have exceeded $1 million and was deemed too expensive. Instead, a bioremediation remedy was designed and successfully implemented within 24 months for under $300,000. Indigenous microbes from the site were used together with a proprietary database of microbes and feed stock to design the inoculating liquid. The delivery system used the existing exposed trenches. The soil sampling network, for remedy confirmation, was designed to allow the occupation of the laboratory during the cleanup.

The facility was in the process of decommissioning some of their buildings when contamination beneath a floor in one building was discovered. The contamination threatened to delay the renovation of the building, which was scheduled to be turned into much-needed offices within the next two months. Contaminant levels were high enough to pose a potential risk to building inhabitants if they remained in the soils. Furthermore, the facility was planning to release the buildings at some future date and wanted to do so without restriction.

The remedy selection was driven by the renovation schedule. In the universe of remedies available to address the newly-discovered polycyclic aromatic hydro-carbons (PAHs), only soil excavation could have remediated the problem in the required two months. However, cost estimates for excavation ranged well over $1 million. What was needed was a remedy that could be applied during and after renovation that would not pose a potential risk to workers or building inhabitants yet would eliminate future liability associated with the contaminated soils without interfering with building renovation.

The facility faced the following issues regarding their decision to remediate these soils. They could:

1. excavate the soils, thereby moving the liability and quickly completing cleanup,
2. reconstruct the floor and maintain the liability into the future, decreasing the building's worth and limiting its future use,
3. implement a remedial technology that could prove successful, but could interfere with building renovation schedule because of its long duration, or
4. implement a remedy that could be performed during and after the renovation.

The final option, which consisted of in-situ bioremediation, was selected with an understanding of its risk. Bioremediation using enhanced indigenous microbes was likely to be able to remediate the soils within a reasonable time. However, this conclusion could only be drawn after a treatability study, taking valuable time. A decision was made based on the assumption of success. This decision meant the remedial system needed to be designed and installed prior to completing the treatability study. Negative results from the study would mean time and money wasted. Positive results would mean a minimized schedule.

Laboratory testing for PAHs showed that contamination did not exceed approximately three feet below the trench floors. Therefore, the target for soil remediation was limited to a depth of three feet below the trench bottoms.

Laboratory results for ground water showed that neither well contained detectable concentrations of pesticides or PAHs. Therefore, no ground water was targeted for cleanup. However, ground water quality was monitored throughout the remediation and these data supported an exemption from ground water discharge permitting by the State. Nothing was detected in soils outside of the building foundations at a depth of five feet (SB-3). Therefore, the soils outside the building did not constitute a remedial target.

The tactical goal of this remedial action was to expose contaminated soils to treatment by transmitting the inoculum to an area larger than that believed to be contaminated. Contaminated wastewater is thought to have leaked from the drain lines in the trench. The remedial action sought to provide a larger hydraulic head than that which existed during the release scenario, thereby increasing soil penetration.

PAHs have been found in soils in the trench bottoms and at similar depths (approximately 4 feet below the floor) outside the trench walls; concentrations fall below generic screening criteria at a depth of approximately 3 feet below the floor.

The basic concept for the ecological restoration of the finite resources of soil and water, that are the mainstays of Earth's unique biosphere, is firmly grounded in proven natural laws. When faced with environmental stress, organisms respond by migrating, adapting, or dying off.

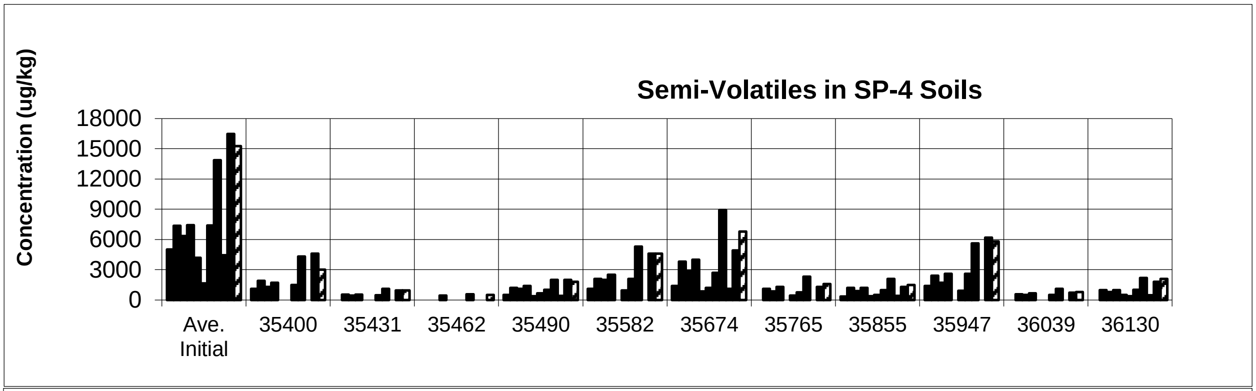
Site-specific microbes were enhanced in a balanced matrix of bacteria, fungi, algae and protozoa in the laboratory. The process was conformed to fit the environment. One application in the contaminated areas re-balanced and maintained the system, while targeting specific contaminants. The entire concept is elegant in its simplicity, as nature intended it to be.

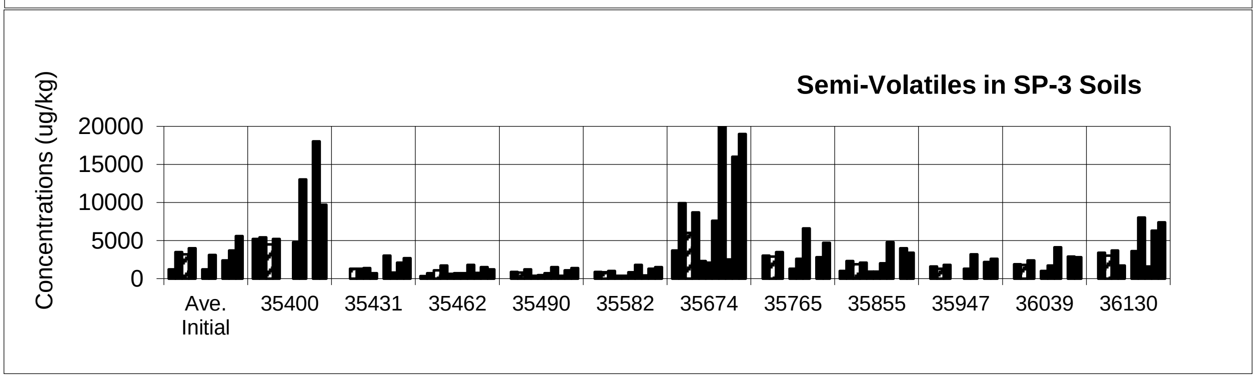
The contaminants in the soils beneath the basement floor in Building 1 consisted of PAHs. The soils were exposed in trenches that had been excavated to remove buried floor drains. The plan was to use these pre-existing trenches as part of the remedial design in an effort to minimize costs and compress the cleanup schedule.

As a first step in the remediation, the trenches were partially backfilled with clean gravel, designed to have a much higher hydraulic conductivity than the surrounding soils and to accept a discharge of over 200 gallons per minute. A four-inch, perforated horizontal piping was placed on the gravel bed along the upper one-third of all of the trenches.

Soil and ground water sampling was conducted monthly in each soil port and monitoring well for four months, then quarterly for 18 months until the soils reach concentrations below the soil screening criteria. The samples were analyzed for semi-volatile organic compounds by GC/MS by a state-certified laboratory. Representative results are presented below. Although specific constituents cannot be identified from this figure (other than benzo(a) pyrene), the general distribution and magnitude of the contaminants can be seen.

A linear regression analysis was performed on these data. The remedy was successful in reducing all PAHs below the target concentrations with the exception of SP-6. The concentrations of benzo(a) pyrene remain elevated at this location. The tenacity of the contaminants there was unexpected and did not respond to re-inoculation. This was finally explained by the latest sampling in which what appeared to be chunks of asphalt were found in the soil sample.





This study illustrates several important concepts about the use of indigenous microbes for bioremediation. The most fundamental point is that natural systems can be fine-tuned to successfully remediate contaminants without upsetting the natural balance of matter and energy flow. Using indigenous microbes and the concept of negative feedback reduces those factors that inhibit the degradation of a given chemical mix, reinforcing the use of balance to degrade contaminants by exploiting fairly passive techniques. In systems that have been stressed during remediation (e.g., pump and treat, highly oxidized bioremediation, and other aggressive extraction processes), once the stress has been removed, the system will try to readjust and contaminants often reappear from the smear zone or beyond the area of treatment.

Paralleling the natural biological system to destroy contaminants is the use of physical limitations to set the logistical parameters of cleanup design. Delivery and operation of the cleanup must be structured around the limitations of the site. This remediation was designed to allow the renovation of the laboratory with minimal disruption to site operations while cleanup was ongoing. This was possible through innovative staging and design of the injection and sampling system, as well as the selection of a passive remedial technology.

Successful fast-track bioremediation can be accomplished at many sites, as long as the remedy takes into account the strengths and attributes of the natural system and harnesses them to help destroy the contaminants. Success also depends on the ability of the consultant to work with the client to implement a cleanup that achieves a wide variety of objectives, not all of them technical or regulatory, while reducing future environmental liabilities

