the proposed plan reaches the least stringent of USEPAs Primary Remediation Goals. Furthermore, when more realistic assumptions are used, including 2.5% resuspension of sediments and a 10 year dredging period are assumed, for all proposed dredging areas, these scenarios can not be distinguished from one another.

PT188 Evaluation of Dredging as Remediation at a DDT-contaminated Site in San Francisco Bay. Weston, D.P.[1], Jarman, W.E.[2] and Cabana, G.[3] [1]University of California, Berkeley, CA. [2]University of Utah, Salt Lake City, UT. [3]University of Quebec, Quebec. The Lauritzen Canal and adjacent lands were heavily contaminated with DDT and other pesticides as a result of operation of a pesticide formulator. Throughout the 1990's, several investigations documented elevated concentrations of pesticides in sediment, water and biota, sediment toxicity and altered structure of the macrobenthic community. These studies led to removal of contaminated sediments by dredging in 1996 and 1997, with the removal of over 100,000 metric tons of sediment containing 3 tons of DDT. Despite these efforts, DDT concentrations in surficial sediments 4 months after the completion of dredging were indistinguishable from pre-dredging levels. The source of this contaminated material is believed to be subtidal deposits that were not dredgable due to pilings, wharfs and similar obstructions. Dredging activities led to a dramatic increase in DDT body burdens of all 10 fish and invertebrates monitored, presumably due to exposure and resuspension of previously buried sediments. Body burdens in the monitored species increased 3 to 70-fold after dredging. Approximately 1.5 yr after dredging, approximately 80% of the species had DDT body burdens at or above pre-dredging concentrations. These high concentrations were due to continued exposure to the contaminated sediments remaining in Lauritzen Canal, rather than slow elimination of the dredging-induced pulse in DDT body burdens. Despite the abrupt spatial gradients in contamination, the relatively small amount of contaminated material to be removed, and other factors which gave the impression of a relatively straightforward approach to remediation, success was not unequivocal.

PT189 Abandoned Mercury Production Sites at Mt. Amiata (Tuscany, Italy): Remediation Strategies. Bacci, E.[1], Gaggi, C.[1], Ferrozzi, S.[1], Baroni, D.[1] and Giunti, M.[1] [1]Dipartimento di Scienze Ambientali - Universitâ degli Studi di Siena. In the Mt. Amiata area more than one century of cinnabar extraction in eleven metallurgic sites led to a production of about 100,000 metric tons of metallic mercury. All the activities ceased during the first half of the '80s, after the "mercury crisis". Production sites were studied during the last five years to evaluate the residual mercury contamination due to soluble mercury salts and metallic mercury. The main obstacle to prepare a remediation project, before 1996: mercury in cinnabar, by law, was as toxic and dangerous as methylmercury! Remediation standards, introduced by Regione Toscana in 1993, considered contaminated a soil with a concentration of total Hg higher than 0,5 mg/kg (agricultural use). When a cinnabar anomaly rises the Hg concentration in soil up to 100-1,000 mg/kg, it becomes very hard to try a remediation action. A new rule was launched by Regione Toscana in March 1996 and this rule is still in force, after the approval of a national regulation on soil remediation. The new approach is based on a separation between mining and metallurgical sites, which are characterised by different forms of mercury. In the former: mainly cinnabar, in the latter: soluble salts and metallic mercury. Then, no standard has been set for soil, displacing concentration limits to water and air compartments: the presence of metallic mercury leads to air and water contamination, soluble salts (essentially sulfate) contaminate water. So, regulation in force introduced standards for air (300 ng per cubic meter) and water (0,001 mg per liter). On these basis remediation projects were prepared and approved by Governmental Authorities. At the Miniera del Siele (the second site by mercury production), the remediation action is near to the end. The remediation and restoration action was carried out looking first at the environmental quality and then taking care of conservation of historical memory. One century old ovens and stack, as well as other important parts of the facilities, were saved without significant residual release of mercury.

PT190 Contaminated Military Sites on National Wildlife Refuges of Southwestern Alaska. Stout, J.H.[1] [1]US Fish & Wildlife Service. Military activities represent one of the longest-term and most geographically widespread contaminants-related issues in the state of Alaska. Significant military buildup occurred in Alaska during WWII and a strong presence continues even today. Though today's military activities are concentrated near Anchorage and Fairbanks, dozens of active, closing or closed facilities are located in remote areas within or adjacent to National Wildlife Refuge lands managed by the US Fish & Wildlife Service. Contamination from these sites poses a significant challenge to Refuge managers and their staff when managing the resources with which they are entrusted. Adak and Amchitka Islands are just two examples of current cleanup efforts at contaminated military sites on Alaskan Refuges.

PT191 Pilot Scale *In-situ* Bioremediation of Perchlorate-contaminated Soils at the Longhorn Army Ammunition Plant in Karnack, Texas. Nzengung, V.A.[1], Das, K.C.[2], Kastner, J.R.[2] and Browder, A.G.[1] [1]Geology Department, University of Georgia. [2]Biological and Agricultural Engineering, University of Georgia. Contamination of soils, surface, and ground water has occurred at military and industrial facilities involved in the manufacture, testing and use of ammonium perchlorate. A 1998 Preliminary Assessment and Site Investigation (PA/SI) for the Longhorn Army Ammunition Plant (LHAAP) in Karnack, Texas, indicated that perchlorate has seriously impacted surface, groundwater and soils at the site. In October 2000, an *in-situ* bioremediation study for perchlorate-contaminated soils was initiated at the LHAAP. Based on the results of our laboratory screen tests, chicken manure, horse manure, and ethanol were selected as suitable carbon sources for the field demonstration. Optimum doses and efficient modes of application of each amendment to achieve desired treatment endpoints at different depths in the subsurface (vadose zone) were determined using column tests. Six identical treatment cells (4.57 x 2.74 m) and one control cell (5.5 x 5.5 m) were sectioned off (isolated) using plastic liners. Tensiometers were installed to monitor moisture at depth. Duplicate cells were treated with the same predetermined concentration of each nutrient amendment. No amendment was added to the control cell. Water was added to all 7 cells to achieve complete saturation only at desired treatment depths. The maximum concentration of perchlorate in the selected treatment plots at the start of the pilot study was 400 mg/kg. After six months, including four winter months, we observed 60 - 90% reduction of perchlorate in the treated cells and no reduction in the control cell. The results of this pilot study demonstrate that perchlorate-contaminated soils can be treated *in-situ* by applying the cost-effective techniques we have developed to deliver nutrients amendments to desired depths.

PT192 Evaluation of pH as a Limiting Factor for TCE Dechlorination in Savannah River Site Sediment. Rust, C.M.[1], Aelion, C.M.[1] and Flora, J.R.[1] [1]University of South Carolina, Columbia, SC. *In situ* pH control may be a viable method for enhancing remediation of contaminated groundwater and sediment. pH can limit certain anaerobic subsurface microbes employed in bioremediation efforts. Investigations into pH control must begin with an evaluation of the effect of pH on microbes actively metabolizing contaminants in sediment from a potential site. The Department of Energy's Savannah River Site (SRS) was chosen as a possible site for in situ pH control due to extensive contamination of the groundwater with TCE (trichloroethylene). Limited success has been reported at this site for removal of TCE from the groundwater and sediment via the reductive dechlorination pathway. Near neutral pH has been shown to optimize TCE reductive dehalogenase activity in purified enzyme solutions, cell extracts, and cell suspensions, though this pH effect has not been tested in subsurface sediment. The groundwater at SRS ranges in pH from 4.5 to 5.5. Sediment obtained from a TCE-contaminated aquifer at SRS was packed into 160-

ml serum bottles and spiked with 0.2 mg/kg TCE and nutrients. The pH in the sediment slurry was adjusted to different set points (4.0, 5.5, 7.0, 8.5, 10.0) using 0.5 M NaOH or HCl. TCE and its metabolites, cis-dichloroethylene and vinyl chloride, and methane were analyzed by GC-FID for 50 days. Carbon and nutrient analyses were performed on sediment extracts. Metabolites were formed at low concentrations (3 μg/L) without methanogenesis. Statistically, maximum vinyl chloride production occurred at a pH of 4 ($p<0.0001$). The results implied that a pH of 7 will not necessarily optimize TCE dechlorination in sediment even if it does so in enrichment cultures such as cell suspensions. Though pH appeared to have an effect on TCE dechlorination, the low production of reduced metabolites indicated that in situ pH control would not be efficacious for promoting reductive dechlorination at SRS.

PT193 Reductive Dechlorination of Polychlorinated Biphenyls (PCBs) in Twelve Mile Creek/Lake Hartwell Watershed. Pakdeesusuk*, U.[1], Lee, C.M.[1], Coates, J.T.[1] and Freedman, D.L.[1] [1]Clemson University, Clemson, SC 29634-0919. Twelve Mile Creek/Lake Hartwell watershed, SC, was placed on the National Priority List for Superfund site by EPA as a result of contamination by polychlorinated biphenyls (PCBs). The final Record of Decision selected was monitored natural attenuation via natural capping of PCB-contaminated sediment with the continued deposition of clean sediment. This study proposes to evaluate the role of another natural attenuation process via *in situ* reductive dechlorination of PCBs in Twelve Mile Creek/Lake Hartwell sediment. The primary tools used to evaluate the presence of this process are microcosm study, and comparative analysis of contaminated sediment data from 1998 to the historic data at equivalent depth. Microcosm study is used to evaluate the presence of indigenous PCB dechlorinating organisms. Comparative analysis of existing sediment data is used to evaluate the presence of *in situ* reductive dechlorination of PCBs. The microcosm study data indicate that Twelve Mile Creek/Lake Hartwell sediments contained microorganisms that have the ability to degrade commercial PCBs mixture, Aroclor 1254, and a single PCB congener, PCB 132. Analysis of sediment data in 1998 reveals the likely presence of *in situ* reductive dechlorination based on the decrease of the higher chlorinated PCB congeners along with the accumulation of the lower chlorinated PCB congeners especially, the *ortho*-substituted dechlorination products. However, comparative analysis of the 1998 data to the 1988 data reveals that *in situ* reductive dechlorination of PCBs may be at a plateau level since 1988. Combined with the continued presence of PCBs in surface sediment layers, and fish samples, the preliminary findings suggest that monitored natural attenuation via both the natural capping of contaminated sediment and biodegradation may require much longer cleanup time than originally predicted.

PT194 Geostatistical Assessment of Natural Transformation of Dioxins in Estuarine Sediments. Barabas, N.[1], Adriaens, P.[1] and Goovaerts, P.[1] [1]The University of Michigan, Ann Arbor, Michigan. Contaminated sediments are an urgent environmental issue worldwide. Because remediation is expensive, assessment of the presence and spatial distribution of natural attenuation processes is an important strategy. However, signals of transformation processes are often masked by a complex mix of pollution sources and transport processes. Statistical and geostatistical tools can be used to separate contributions of different factors to the total variability in the observations. Previously, statistical analysis was used to map the relative contributions of different sources to the concentrations, however, not all identified patterns could be assigned to particular sources. A possible explanation is the transformation of dioxins by abiotic and biotic processes. The goal of this study is to use multivariate geostatistical modeling to analyze spatio-temporal patterns and scales of variation of 2378-substituted polychlorinated dibenzo-p-dioxins in the sediments of the Passaic River. To assess the hypothesis of dioxin transformation in the field, specific congener ratios will be evaluated for their suitability as indicators of variability due to biological activity as opposed to variability due to other sources. Three-dimensional semivariogram analysis and factorial kriging analysis of such indicators will allow an assessment of the spatial distribution patterns and prevalence of dechlorination activity in the sediments. In the field, variability of the ratio 2378Cl4CDD/Total 2378ClnCDD is greatest in the vertical direction, implying that time-varying (transformation and long-term sedimentation processes) rather than horizontally varying processes (short-term transport and pollution source locations) are the more important determinants of the spatial variation of this ratio.

PT195 Post Mortem Risk Assessment of a Closed NPL Site in Coastal Louisiana. Parker, K.A.[1] and Portier, R.J.[1] [1]Louisiana State University. The Cleve Reber site is located in Ascension Parish, Louisiana. Originally used as a borrow pit for the construction of a local highway, it was subsequently used as a landfill for municipal and industrial waste. An estimated 6,400 drums were buried on this 25 acre site. In 1974, the site was abandoned and in 1979 declared an abandoned hazardous waste site. After a comprehensive field investigation, the USEPA determined that all significant contamination was restricted to the site. The primary hazard of concern was associated with the buried drums and bulk sludges with hexachlorobenzene as the primary constituent of concern. It has a high affinity for the local clays and a small groundwater gradient, which lead officials to believe that to date, contaminant migration has not spread beyond the site. In March 1987, EPA signed the Record of Decision (ROD) outlining the selected remedy for the site. It included excavation and onsite incineration of buried drums and sludges; drainage and backfilling of ponds; capping the site; and groundwater monitoring. Remedial action activities were completed in May 1996. The site was deleted from the National Priorities List (NPL) in December 1997. Nevertheless, the ROD was signed before the original promulgation of the Risk Evaluation Corrective Action Program (RECAP) by the State of Louisiana. RECAP is a program for addressing past and present uncontrolled constituent releases. The standards put forth in the ROD are not concurrent with the standards set by the state today. A RECAP investigation at the Cleve Reber site was conducted to determine if the remedy selected in the ROD was effective in protecting human health and the environment and to establish a protocol for evaluating other NPL sites that were cleaned up before the promulgation of RECAP.

PT196 Kinetics of PCB Dechlorination by Hudson River Sediment Microorganisms and Dechlorinating Microbial Populations in Natural Sediments. Cho, Y.[1], Sokol, R.C.[2], Frohnhoefer, R.C.[1] and Rhee, G.[1,3] [1]Wadsworth Center, New York State Department of Health, Albany, NY 12201. [2]Center for Environmental Health, New York State Department of Health, Troy, NY 12180. [3]School of Public Health, State University of New York at Albany, Albany, NY 12201. The kinetics of polychlorinated biphenyl (PCB) dechlorination by Hudson River sediment microorganisms were investigated using Aroclor 1242 at 10 concentrations ranging from 0 to 900 ppm. The time course of PCB dechlorination and population growth were determined by congener-specific analysis and the most probable number (MPN) technique, respectively, over a 44-week incubation period. Dechlorination rate (nmol Cl removed/g sediment/d) was a linear function of PCB concentrations similar to the dechlorination of Aroclor 1248 by sediment microorganisms from the St. Lawrence River found in our earlier study. However, the rate was much slower, with the linear slope only 24% of St. Lawrence's value. The intercept of the linear slope, which indicates a threshold concentration below which no dechlorination occurs, was 85 ± 14 ppm, three times higher than that for the dechlorination of Aroclor 1248. The maximum extent of dechlorination was greater at higher Aroclor concentrations. The lag phase before dechlorination appeared to be longer at lower Aroclor 1242 concentrations. Dechlorinating microorganisms did not show any significant growth until late in the lag phase, and their maximum was greater at higher initial Aroclor 1242 concentrations. Although dechlorination rates were significantly lower with the Hudson River inoculum, when normalized to the maximum number of dechlorinating organisms, they were not significantly different from those for Aroclor 1248 by St. Lawrence River microorganisms. These results further support that PCB dechlorination is tightly linked to the growth of dechlorinating microorganisms. When dechlorinating microorganisms were estimated by the MPN technique

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ABSTRACT BOOK

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SETAC 22ND ANNUAL MEETING
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