

SUPPLEMENTARY INFORMATION

A Mass Balance Study of the Phytoremediation of Perchloroethylene-Contaminated Groundwater

C. Andrew James, Gang Xin, Sharon L. Doty, Indulis Muiznieks, Lee Newman, and Stuart E. Strand

Component	Formula		Standard Deviation
Influent and Effluent Water Chloride	$\sum_{i=1}^m C_{w,m} \times Q_m$	$C_{w,m}$ –chloride molar concentration Q_m – volume of water represented by each sample m – number of water samples	±1% ±4% NA
Influent and Effluent Water VOCs	$\sum_{i=1}^m C_{voc,m} \times N_{voc} \times Q_m$	$C_{voc,m}$ – water VOC concentration N_{voc} – moles chlorine per mole VOC	±1% NA
Rain Water Chloride	$\bar{C}_{rain} \times V_{rain}$	\bar{C}_{rain} - average rainwater chloride concentration V_{rain} – volume of rainfall	measured ±5%
Irrigation Water Chloride	$\bar{C}_{irr} \times V_{irr}$	\bar{C}_{irr} - average irrigation water chloride concentration V_{irr} – volume of irrigation water	measured ±5%
Soil Chloride	$\sum_{i=1}^n C_{s,n} \times M_{s,n}$	$C_{s,n}$ - soil chloride concentration M_n - mass of soil represented by each sample n – number of soil samples	±13.1% ±10% NA
VOC Accumulation in tissues	$\bar{C}_{voc,leaf} \times N_{voc} \times M_{leaf}$ $\bar{C}_{voc,trunk} \times N_{voc} \times M_{trunk}$	\bar{C}_{voc} - average measured VOC concentration in leaf or trunk M – total mass of leaf or trunk tissue	measured ±5%
Volatilization	$\bar{\phi}_{voc,leaf} \times N_{voc} \times A_{leaf} \times t$ $\bar{\phi}_{voc,trunk} \times N_{voc} \times A_{trunk} \times t$ $\bar{\phi}_{voc,soil} \times N_{voc} \times A_{soil} \times t$	$\bar{\phi}_{voc}$ - average measured VOC flux from leaf, trunk, or soil A – total surface area of leaf, trunk, or soil t – time	measured ±5% NA

Table S1

Formulae used in calculating components of mass balance. Standard deviation are estimated values determined from analysis of various field measurement methods. “Measured” indicates the actual standard deviation was used from field measurements. NA – not applicable.

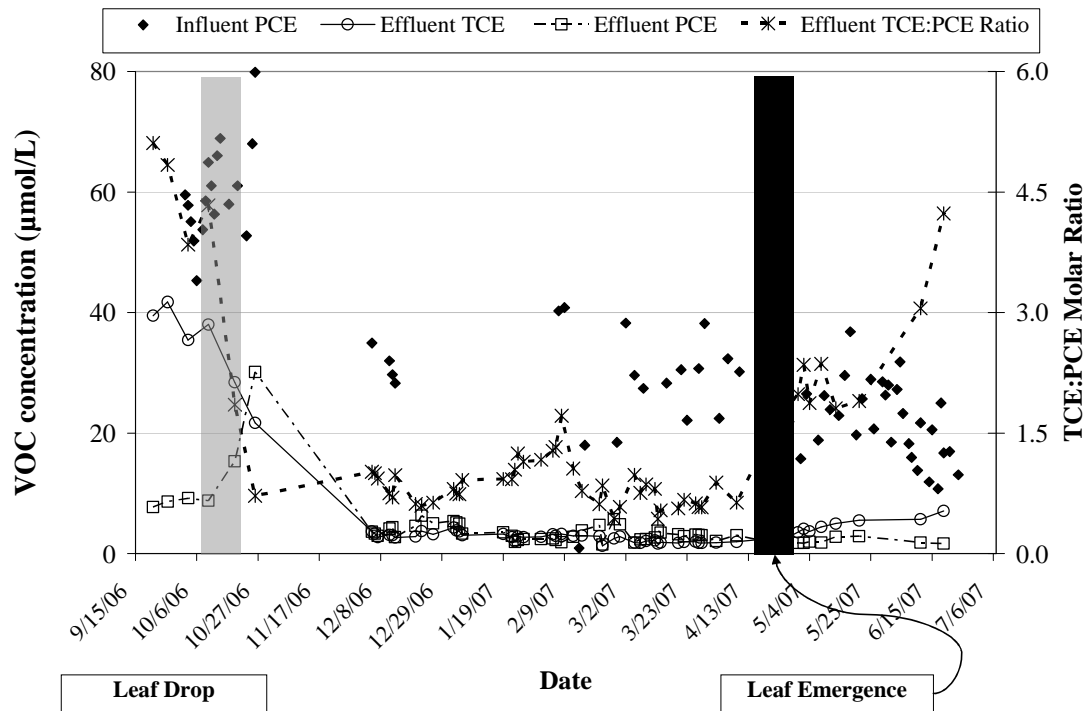


Figure S1

Chlorinated ethene concentration in test bed influent and effluent water and TCE:PCE molar ratio during tree dormant period. Initial decrease in effluent concentration was due to dilution from heavy rainfall during Nov. 2006. During dormant period from December 2006 – April 2007 the average TCE:PCE molar ratio in effluent was 0.8. From April 2007 – June 2007 the TCE:PCE molar ratio averaged 2.3.

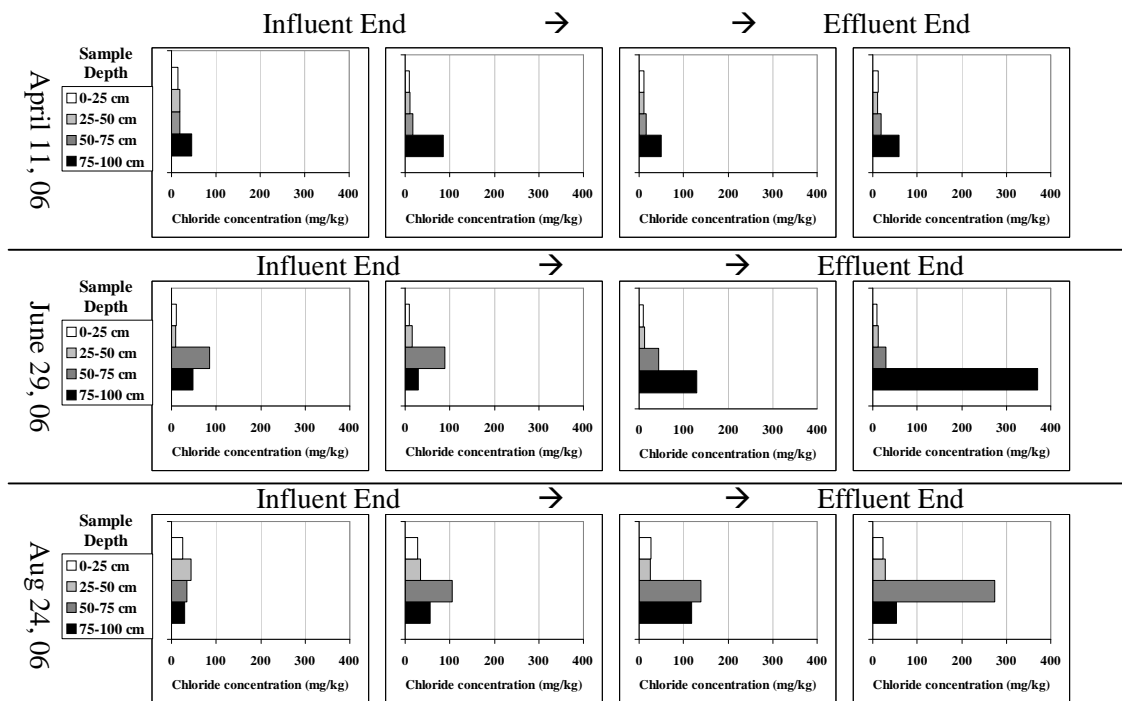


Figure S2

Soil chloride measurements taken at the beginning, middle, and end of the mass balance period (April 11, 2006, June 29, 2006, and August 24, 2006). Samples were collected at locations equally spaced from the influent to the effluent ends of the test bed, and at 4 depths at each location. Individual charts are arranged according to sampling location for each date; results for each depth are shown. The average bed concentration increased from $26 \pm 0.79 \text{ mg kg}^{-1}$ on April 11, to $65 \pm 2.4 \text{ mg kg}^{-1}$ on August 24; these values were significantly different ($P < 0.05$).

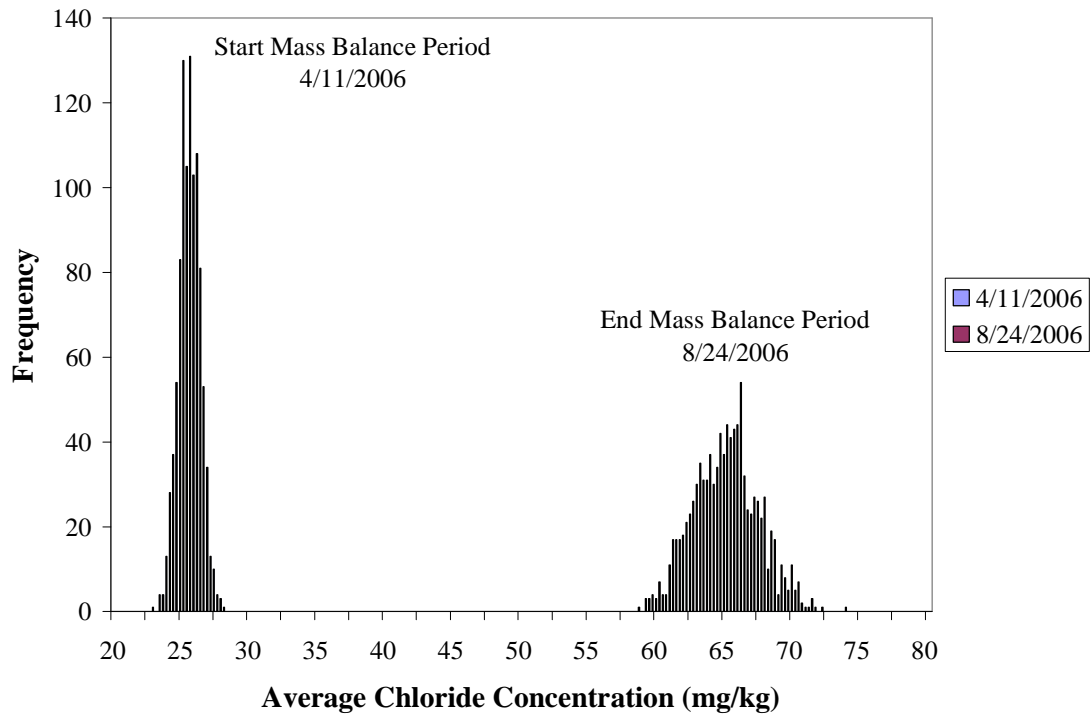


Figure S3

Distribution of average soil chloride concentration based on Monte Carlo analysis of results of sampling performed at the beginning and end of the mass balance period (April 11, 2006 – August 24, 2006). The difference in the distribution sets indicates a significant increase in the soil chloride concentration, and accumulation of chloride in the soil ($P < 0.05$).

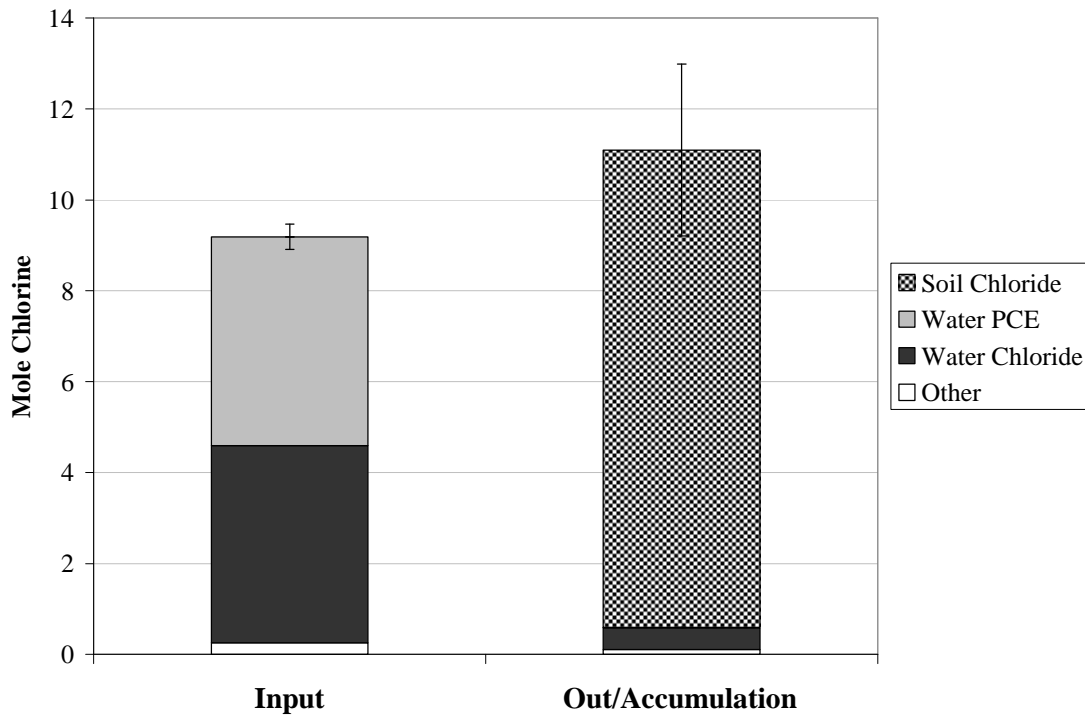


Figure S4

Major components of chloride balance for the mass balance period from April 11, 2006 through August 24, 2006. Error bar indicates ± 1 S.D. and represents the cumulative uncertainty for all measurements.

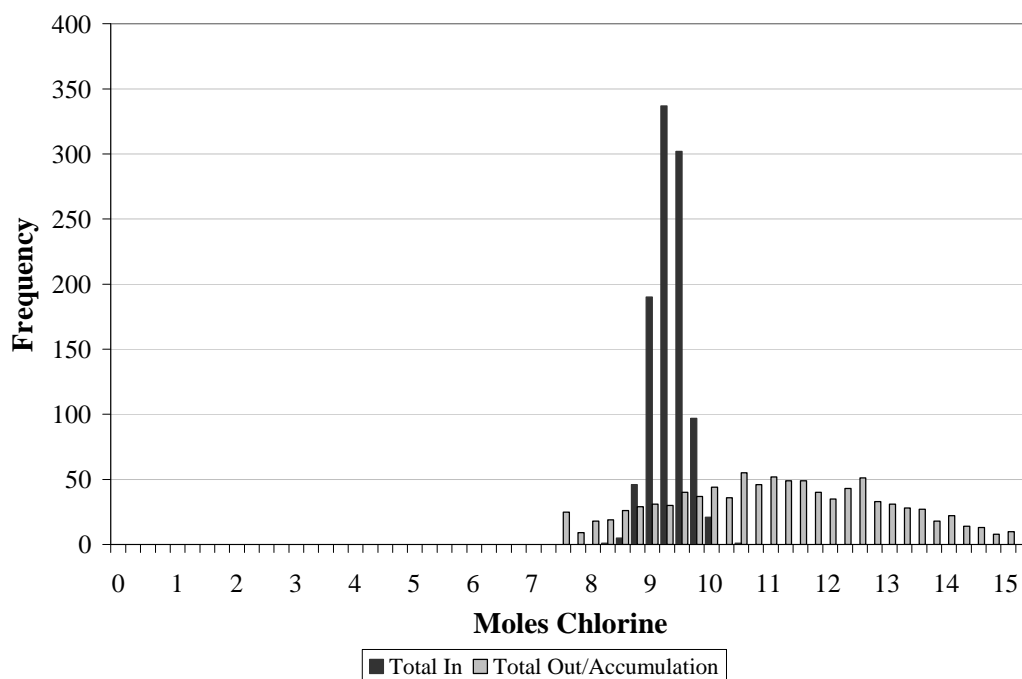


Figure S5

Chlorine balance distribution from Monte Carlo analysis. Shown are separate distributions for the total chlorine inputs and total chlorine outputs/accumulation based on the sum of the individual component distributions. Broad range of Total Out/Accumulation reflects the uncertainty associated mainly with soil chloride measurements.