Correlation Between Contact Time and NAPL Depletion

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Goal

- To demonstrate that contact time of injected reagant is proportional to the mass of DNAPL that will be depleted for a remedy
  - i.e. as contact time increases for a remedy, the corresponding depletion of DNAPL mass will also increase
- If proven, we don't have to simulate contaminants/DNAPL dissolution (higher uncertainty)

Approach

- Simplified model for now to assess degree of correlation
  - Permanganate injection
  - Rate-limited TCE DNAPL dissolution
  - TCE degradation rate based on permangate concentration

Approach

- Calculate average contact time of oxidant in source zone when changing:
  - Number of injection wells
  - Permanganate (KMnO4) degradation rate
  - Injected solution concentration of KMnO4
  - TCE degradation rate (which should not change contact time but will increase DNAPL dissolution rate)

Approach

- Calculated average contact time in source zone over 30 day period between injections
- Two concentration thresholds:
  - 20 and 200 mg/L $KMnO_4$

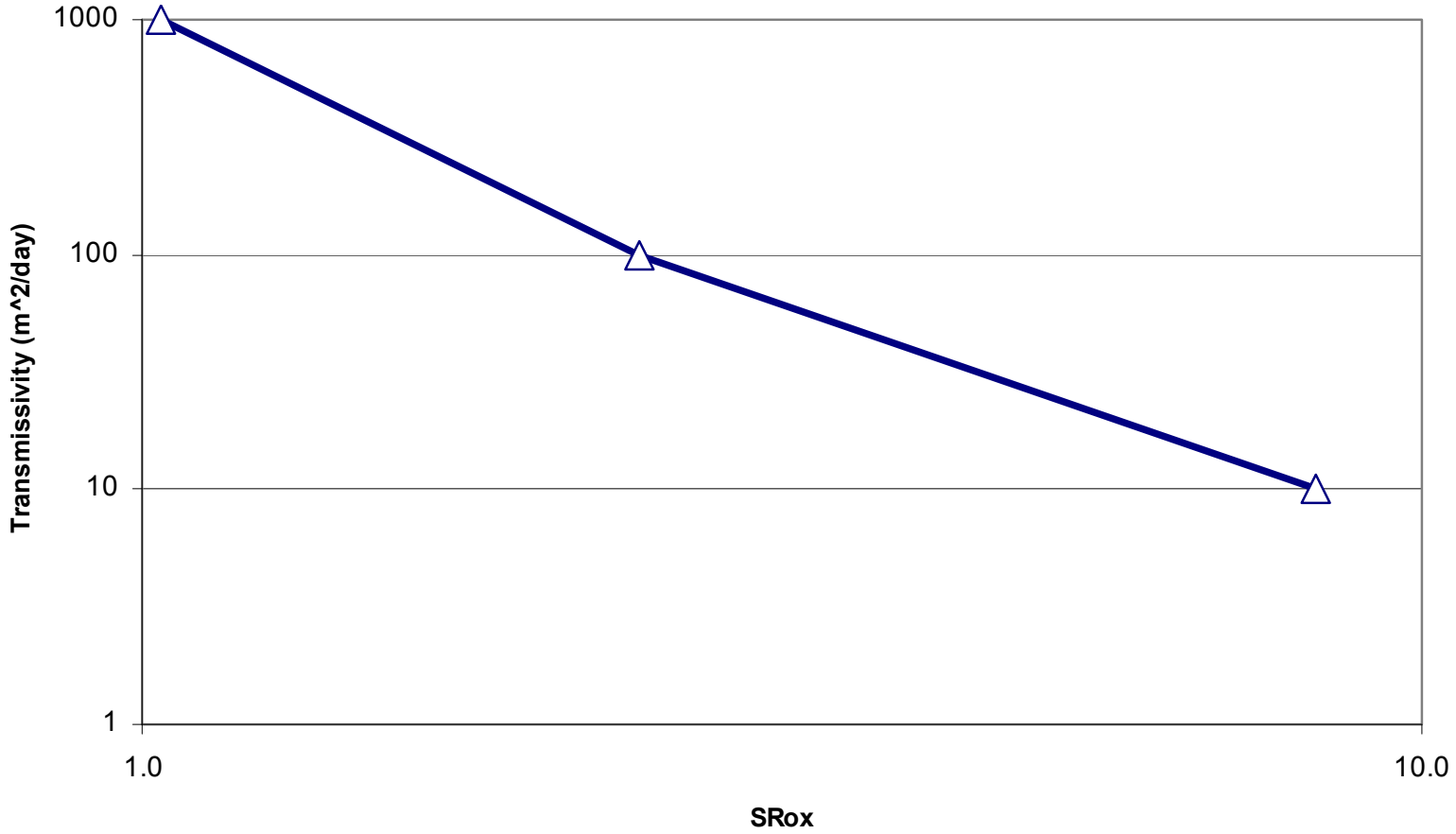
NAPL Mass Depletion

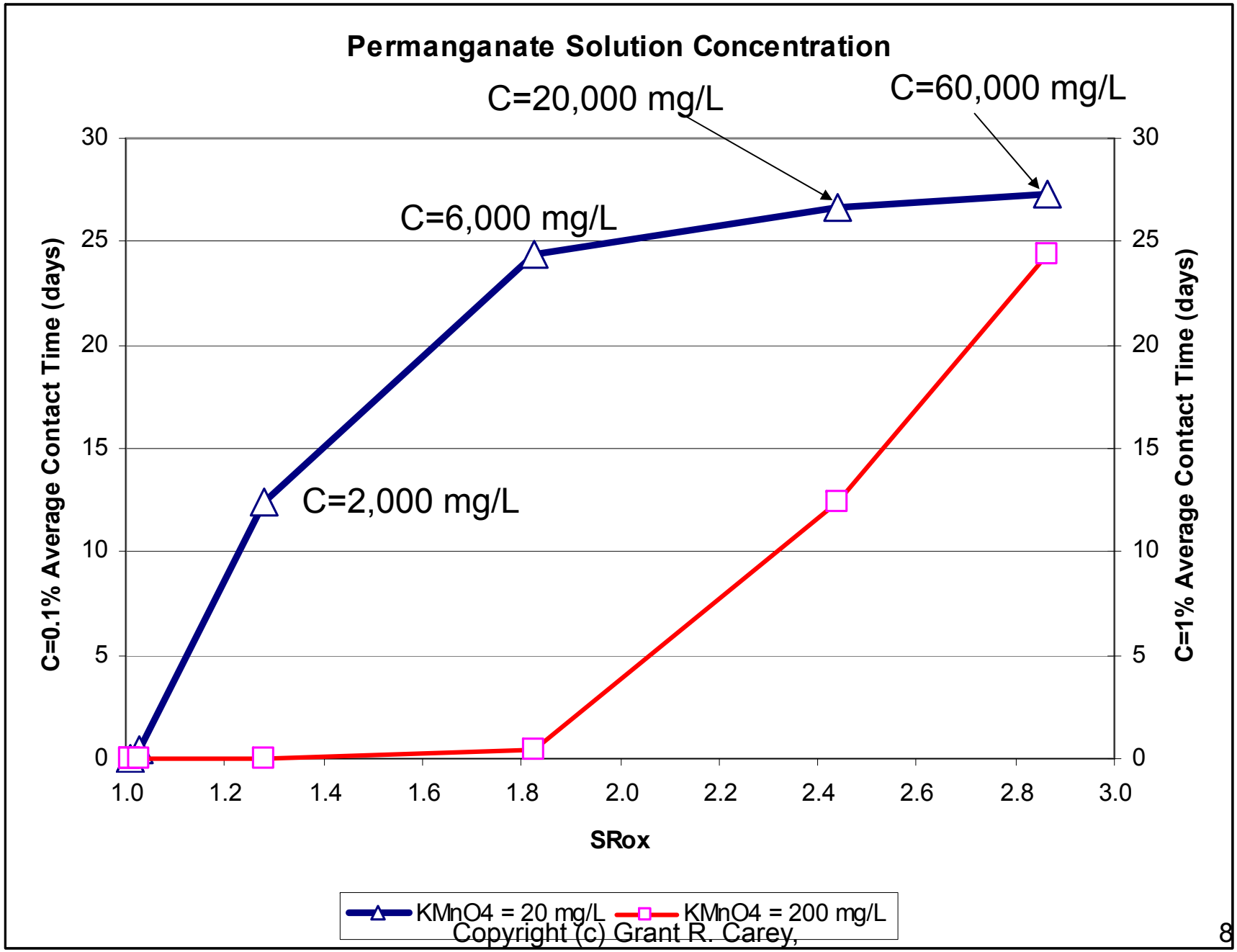
- Compare mass depleted for remedy to mass depleted under no action scenario (i.e. natural dissolution)
  - SRox = $\frac{\text{remedy mass depletion}}{\text{no-action mass depletion}}$

SRox >= 1

Srox = ISCO dissolution enhancement factor

Transmissivity vs. NAPL Depletion



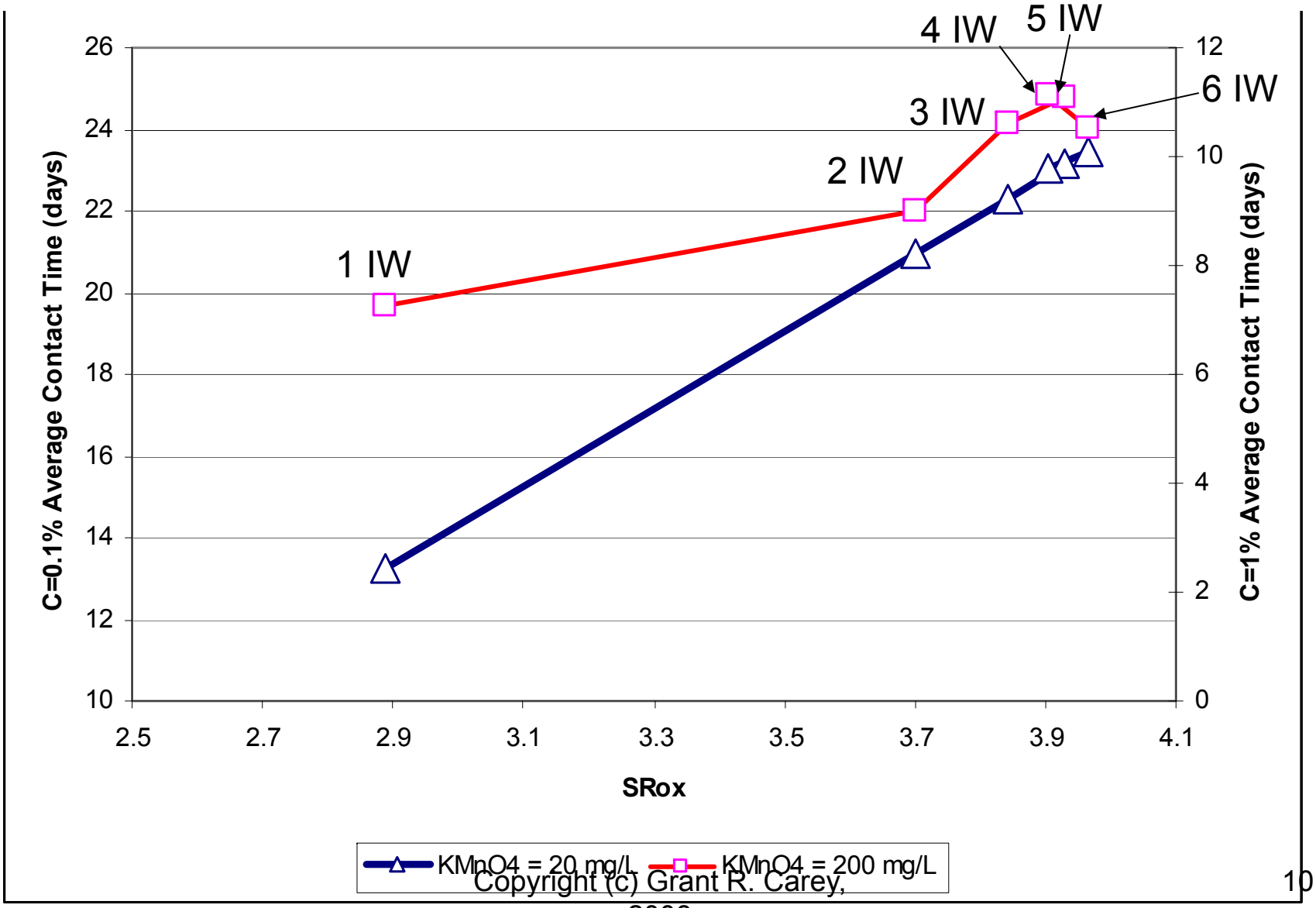


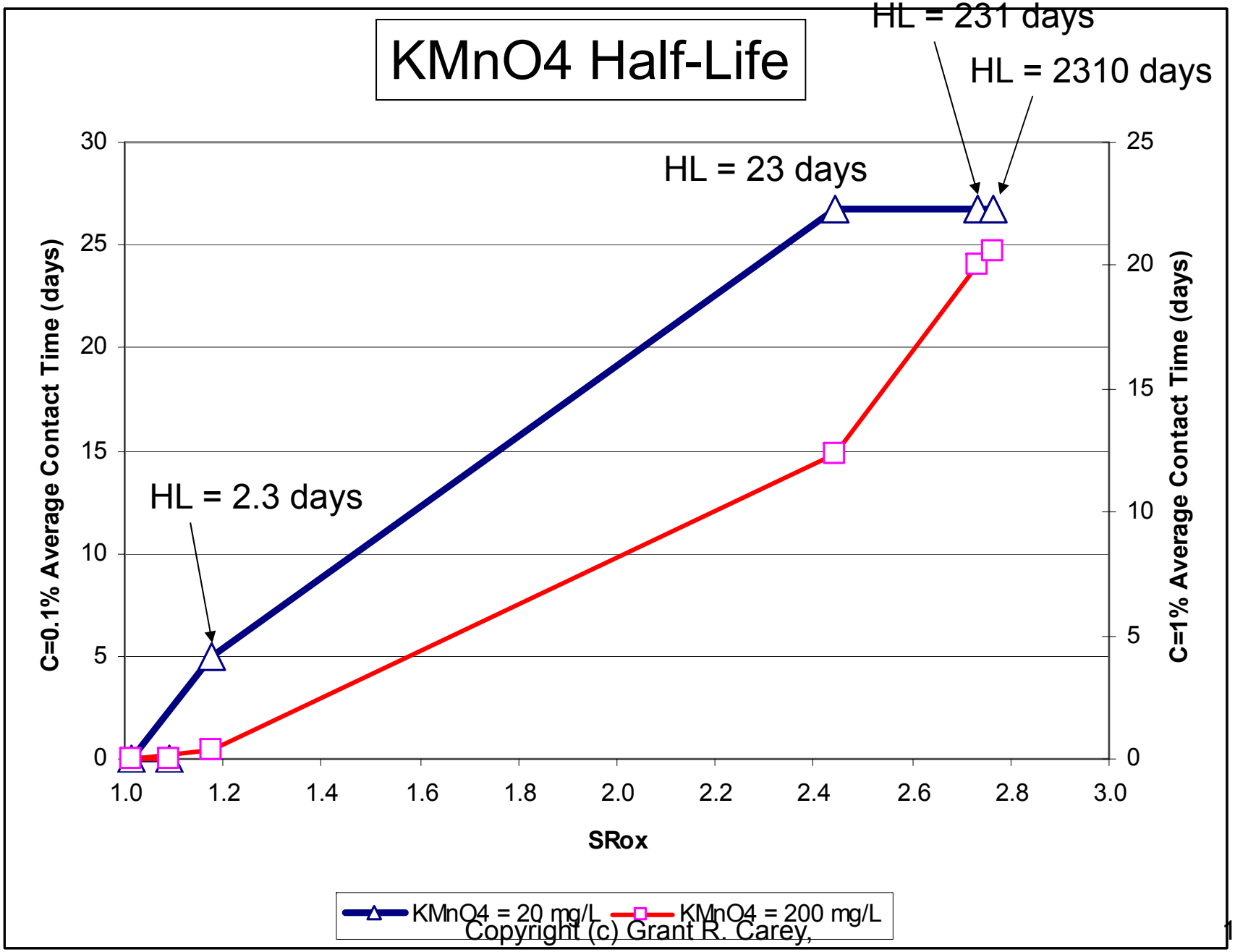
Findings

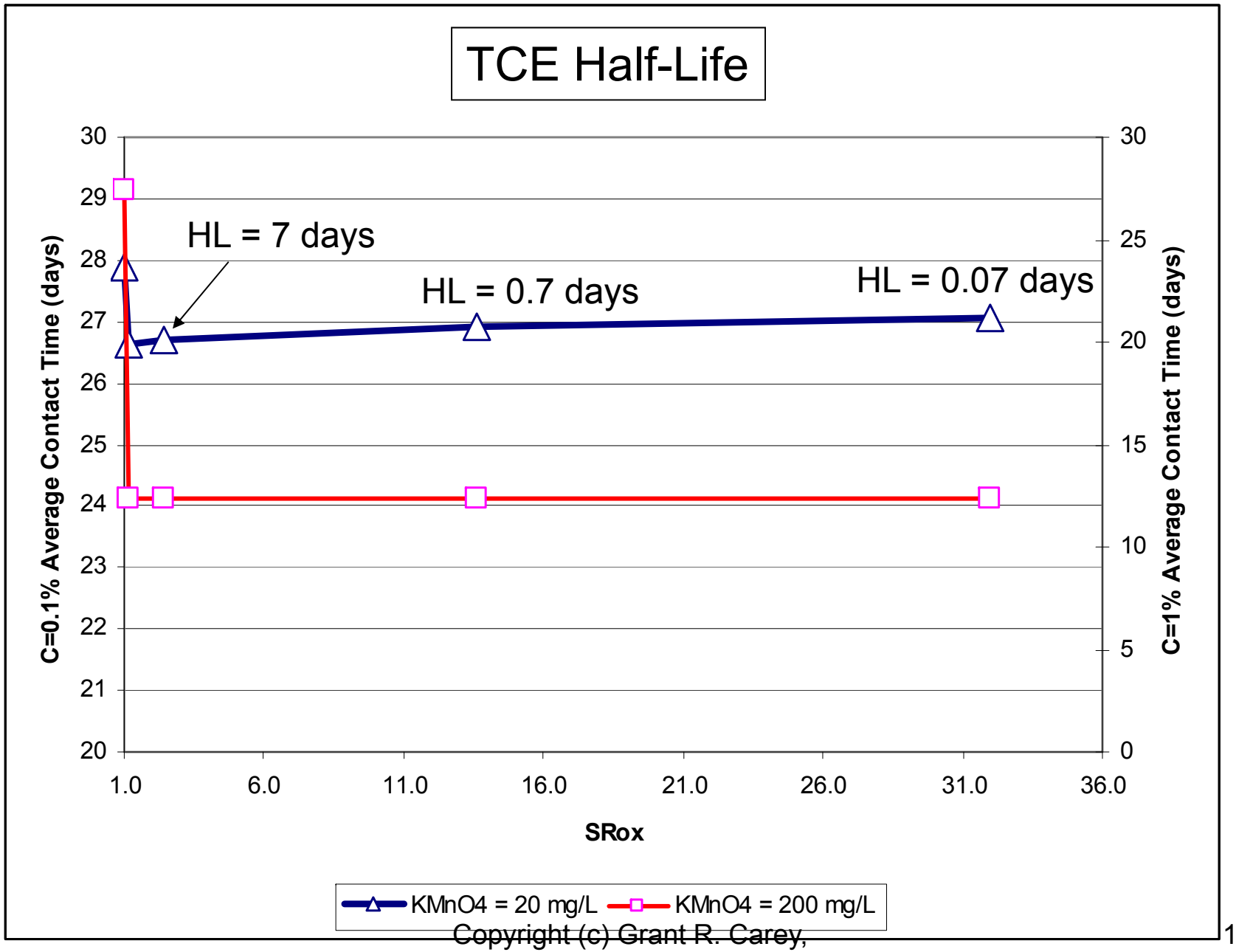
- Results match Petri et al. (2008)
  1. high velocity systems less impacted by ISCO because of higher natural dissolution rate; and
  2. Increasing permanganate concentration increased rate of DNAPL depletion.

- Indicates modeling of NAPL dissolution represents trends observed in lab experiments conducted by Petri et al.

Vary No. of Injection Wells (IW)







Conclusions

- Parameters that result in higher contact time also result in higher DNAPL depletion rate for site conditions
- Contact time is reasonable surrogate for evaluating relative influence of design parameters on DNAPL flushing rate