JUST TO COMPARE A DIFFERENT APPROACH TO THE DR. JOHNSON RESULTS, USING THE SAME 2003 SCHWARZENBACH TEXT:

- **Using the same B(o)p solubility for a solid, as present in Dr. Johnson's original testimony.**
  \[ C_{sw}^\text{sat}(s) = 1,520 \text{ mg/L} \]

- Also, using his same solubility for B(o)p dissolving from a liquid, per Dr. Johnson's original testimony.
  \[ C_{lw}^\text{sat}(L) = 49.19 \text{ mg/L} \]

- The following assumes (as Dr. Johnson did) that B(o)p is a proxy for all bitumen compounds.

- Using the same values as per page 5 of my 2/27/2012 report, the spent sands will contain around 1.8 parts by weight of d-limonene to 0.84 parts by weight of bitumen (B(o)p as proxy).

Assuming all B(o)p dissolves into the d-limonene the mole fraction can be calculated, using molecular weights of B(o)p = 252.3 g/mol & d-limonene MW = 136.2 g/mol &:

\[
\frac{Z_{L,0}}{252.3} = \frac{0.84}{252.3} + \frac{1 - 0.84}{136.2} = 0.201 = \text{Mol fraction of bitumen (as B(o)p) in solution with d-limonene}
\]
Now, we can calculate the butylen (BP) as proxy concentration in water that is in equilibrium with D-limonene: (Eq 7-21, Schwarzenbach, 2003)

\[ C_{lw} = Z_{x,d-1} \cdot V_{x,d-1} \cdot C_{lw}^{sat}(L) \]

Where \( V_{x,d-1} \) is the activity coefficient of BP in the limonene, which can be approximated as 1.0 (Schwarzenbach, 2003, page 237).

This then yields:

\[ C_{lw} = 0.201 \times 1.0 \times 49.19 \; \mu g/L \]
\[ C_{lw} = 9.89 \; \mu g/L \]

So the solubility increase factor is

\[ \frac{C_{lw}}{C_{lw}^{sat}(s)} = \frac{9.89 \; \mu g/L}{1.652 \; \mu g/L} = 6.051 \]

This is contrasted to the factor of 1500 obtained by Dr. Johnson!!