# APPENDIX Q

Calculation of Clean-up Time Based on Biodegradation in Hot Spots

# Calculation of Extraction Time

| Monitoring Well | MW241 | MW242 | MW250 | MW253 | MW259 | MW261 |
|---|---|---|---|---|---|---|
| TPH conc. at 2-3m | 338 | 5360 | 2675 | 20 | 52 | 4440 |
| TPH conc. below 3m | 2522 | 29 | 133 | 4061 | 21728 | No data |
| Average conc. of TPH = 3760 mg/kg | | | | | | |

Contaminated area = 59,500 $m^2$ ; Density of soil ($\rho_{soil}$) = 1765 $kg\,m^{-3}$

Mass of vadose zone soil = 59,500 $m^2 \times \rho_{soil} \times 0.5$ (assume 25% of contaminated soil (2m deep) at vadose zone) (based on boring records reported in Technical Report RA24 issued by NCAL)

$= 5.25e^7$ kg

Mass of saturated zone soil = 59,500 $m^2 \times \rho_{soil} \times 1.5$

$= 1.58e^8$ kg

Mass of TPH in vadose zone $= 5.25e^7 kg \times 3760 \frac{mg}{kg} \times \frac{1\,kg}{10^6 mg} = 1.97e^5 kg$

Mass of TPH in saturated zone $= 1.58e^8 kg \times 3760 \frac{mg}{kg} \times \frac{1\,kg}{10^6 mg} = 5.94e^5 kg$

Total = $7.91e^5$ kg

## Time for Biodegradation in Vadose Zone

Assume 56% biodegradation → 4.43 $e^5$ kg
44% volatilisation → 3.48 $e^5$ kg

Mass of TPH in vadose zone × 56% - "allowable mass" (remains after clean up)

$= 1.97e^5 kg \times 56\% - 5.25e^4 kg$

$= 1.10\ e^5 kg - 5.25e^4 kg$

$= 57{,}500\ kg$

Total mass of soil in vadose zone = $5.25e^7$ kg

Vadose zone biodegradation rate

$= 5.25e^7 kg \times \frac{10 mg}{kg/day} \times \frac{kg}{10^6 mg}$

$= 525\ kg/day$

Biodegradation time $= \frac{M_{TPH}}{Bio.rate} = \frac{57{,}500\ kg}{525\ kg/day} = \underline{110\ days}$

# Time for Biodegradation in Saturated Zone

Assume 56% biodegradation → 4.43 $e^5$ kg
44% volatilisation → 3.48 $e^5$ kg

Mass of TPH in saturated zone × 56% – "allowable mass"

$= 5.94\ e^5 kg \times 56\% - 1.58\ e^5 kg$

$= 3.33\ e^5 kg - 1.58\ e^5 kg$

$= 1.75\ e^5 kg = 175{,}000\ kg$

Total mass of soil in saturated zone = $1.58 e^8$ kg

(A) Assume $\frac{1 mg}{kg/day}$ biodegradation rate

Saturated zone biodegradation rate

$= 1.58 e^8 kg \times \frac{1 mg}{kg/day} \times \frac{kg}{10^6 mg}$

$= 158$ kg/day

∴ Biodegradation time $= \frac{M_{TPH}}{\text{Bio. rate}}$

$= \frac{175{,}000\ kg}{158\ kg/day}$

$= 1108$ days

$= \underline{3\ \text{years}}$

Case (B.) Assume $\frac{2 mg}{kg/day}$ biodegradation rate

Saturated zone biodegradation rate

$= 1.58 e^8 kg \times \frac{2 mg}{kg/day} \times \frac{kg}{10^6 mg}$

$= 316$ kg/day

∴ Biodegradation time $= \frac{M_{TPH}}{\text{Bio. rate}}$

$= \frac{175{,}000\ kg}{316\ kg/day}$

$= 554$ days

$= \underline{1.5\ \text{years}}$