
MEMORANDUM

Date: September 5, 2012
To: Marti Sharp
From: Brian Patterson, Ph.D.
cc: Dave Seluga – Golder Associates
Project No.: 123-99720-04
Company: Carson Oil
Email: Brian_Patterson@Golder.com
RE: **MASS BALANCE CALCULATIONS FOR GASOLINE RELEASE –
GOLDENDALE, WASHINGTON**

This memorandum addresses the gasoline release which occurred at 808 South Columbus Avenue in Goldendale, Washington on February 29, 2012. In particular, calculations have been performed comparing the mass of gasoline estimated to have been released to the mass of gasoline contained in the soil and groundwater removed from the site soon after the release occurred. The purpose of this comparison is to determine whether or not the majority of the released gasoline has been cleaned up at the site.

Golder was provided with the following information concerning the release and the soil and groundwater removed:

- Approximately 970 gallons of gasoline were initially released, with approximately 50 gallons recovered from the ground surface immediately after the release. Therefore, approximately 920 net gallons of gasoline were released.
- Approximately 332 tons of soil within the berm surrounding the release area were removed with an average gasoline concentration (measured as Gx) of 9,553 milligrams per kilogram (mg/kg). This is the average Gx concentration of the 12 soil samples collected inside the bermed area after the release, but prior to removal, excluding the one non-detect sample at Location S-Center 54" [see Table 2 in the May 4, 2012 letter from Tim O'Gara (consulting geologist) to Tim Love (Carson Oil Company)].
- Approximately 86.5 tons of soil outside of the berm surrounding the release area were removed with an average gasoline concentration (measured as Gx) of 3,610 mg/kg. This is the average Gx concentration of the two soil samples collected outside the bermed area at Location 7 after the release; this location is representative of the area where soil was later removed [see Table 3 in the May 4, 2012 letter from Tim O'Gara (consulting geologist) to Tim Love (Carson Oil Company)].
- Approximately 38,000 gallons of groundwater were removed from an excavated area within the berm surrounding the release area with an average gasoline concentration (measured as Gx) of 85,850 micrograms per liter (µg/l). This concentration is the average of a 44,700 µg/l

MEMORANDUM

concentration in a water sample collected from the initial pit dug within the bermed area shortly after the release and the maximum boring water concentration of 127,000 µg/l collected outside the bermed area later following the release. This average is expected to best represent the impacted groundwater removed given the available data.

It is also Golder's understanding that gasoline contamination of the soil and groundwater was already present at the site prior to the February 29, 2012 release.

Using this information, the total mass of gasoline contained in the soil and groundwater removed from the site subsequent to the February 29, 2012 release could be calculated. These calculations are provided in Table 1.

Based on these calculations, a net total of approximately 2,603.6 kg of gasoline was released and a net total of 3,179.6 kg of gasoline was contained in the soil and groundwater removed from the site. Therefore, approximately 575.9 kg more gasoline was removed from the site than was released.

These calculations are based on the simplifying assumption that the average concentration of the samples collected represents the actual weighted average concentration of the gasoline contamination in the soil and groundwater removed from the site; this is the only feasible approach to using the available data and should provide a reasonable estimate of the total gasoline removed. Golder believes that there is more uncertainty in the average concentration values associated with the groundwater removed (fewer samples taken associated with the water removed and one sample exceeded the upper range of the analytical equipment), but it appears that only a small fraction of the mass of gasoline removed from the site was in the groundwater, so this uncertainty should not significantly affect the overall conclusion.

There would have also been an unquantified amount of gasoline volatilized at the release site due to evaporation, providing another route of mass removal of the released material.

Based on the available information, it appears that all, or even more than, the amount of gasoline released at the site on February 29, 2012 was subsequently removed in the soil and groundwater shipped offsite.

Table 1
Mass Balance Calculations for Gasoline Spill and Subsequent Removal
Carson Oil, Goldendale, Washington

Gasoline Released:

970 gallons released
 50 gallons recovered immediately
 => 920 gallons net released
 Gasoline density = 2.83 kg/gal
 => **2603.6 kg net gasoline released**

Gasoline Recovered from Soil:

332 tons of soil at 9,553 mg/kg gasoline concentration from within berm
 => (332 tons) x (909.1 kg/ton) x (9,553 mg/kg) x (1E-06 kg/mg)
 = **2883.3 kg gasoline removed**

86.5 tons of soil at 3,610 mg/kg gasoline concentration from outside berm
 => (86.5 tons) x (909.1 kg/ton) x (3,610 mg/kg) x (1E-06 kg/mg)
 = **283.9 kg gasoline removed**

Gasoline Recovered from Water:

38,000 gallons of water removed at 85,850 ug/liter gasoline concentration
 => (38,000 gal) x (3.785 liter/gal) x (85,850 ug/liter) x (1e-09 kg/ug)
 = **12.35 kg gasoline removed**

Overall Mass Balance:

2603.6 kg net gasoline released
3167.2 kg gasoline removed with soil
12.35 kg gasoline removed with water
 (575.9) **net kg gasoline added (subtracted) from site**