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Clarifications

The following items in report 304221.5 DQRA should be replaced with the items in this document

1. Table 8-1 Input parameters and data sources. *Clarification of manganese source concentrations and addition of travel distances for* [redacted] *and* [redacted]
2. Section 8.2 Input parameters, second paragraph, beginning "Two scenarios were modelled, whereby the source concentration was changed for the following scenarios: *Clarification of modelling scenarios*
3. Table 8-4 Level 3 Groundwater modelling results for manganese, Figure 8-1 Level 3 Groundwater modelling results for manganese, and the text in between Table 8-4 and Figure 8-1. *Replacement of results to include distances to* [redacted] *and* [redacted] *change in Table and Figure title to clarify modelling levels. Update of Figure 8.1*

This is to clarify inputs and outputs, and adjust travel distances to [redacted] and [redacted]. There is no material change to the results of the base case or sensitivity analysis, and no change to the conclusions from those reported in 304221.5 DQRA.

Clarification 1

Table 8-1 Input parameters and data sources

Parameter		Base case	Source
Target concentration		0.05 mg/l	DWS for manganese
Initial contaminant concentration	C_0	0.023 mg/l	Average concentration in River Terrace Deposits from first sampling round (21-22 Oct 2020) is 0.244 mg/l, divided by 10.5 to account for dilution in the Chalk. This is conservative as later sampling had a lower manganese concentration (average Mn concentration from all four sampling rounds in SO1-SO6 is 0.154 mg/l)
Half-life for degradation of contaminant in water	$t1_{/2}$	9×10^{99}	No degradation assumed
Width of plume in aquifer at source	Sz	201 m	Warehouse width (Pythagoras)
Plume thickness at source	Sy	12 m	Piling depth
Saturated aquifer thickness	da	60 m	Mott MacDonald (2014)
Bulk density of aquifer materials	r	2.5 g/cm^3	aqua-calc.com: Chalk
Effective porosity of aquifer	n	0.001	TN1.2

Hydraulic gradient[1]	i	0.0012	Average gradient from Chalk boreholes on site (Section 3.3)
Hydraulic conductivity of aquifer	K	70 m/d	Mid range of permeabilities in Table 2-2 and site data (Table 3-5)
Distance to compliance point	x	[redacted]	[redacted]
Soil water partition co-efficient for Mn	Kd	50 l/kg	Manganese Kd for sand. [2]

Clarification 2

Two scenarios were modelled, whereby the source concentration was changed for the following scenarios:

1) Base case (Level 3): Onsite dilution followed by transport in the Chalk to the PWS. The high manganese occurs within the River Terrace Deposits, but not the underlying Chalk. The groundwater recharge through the piled area into the Chalk aquifer was calculated as 12.4 m^3/d using the data in Table 8.2. Given Chalk groundwater flow (119 m^3/d), and assuming that the Mn concentration in the Chalk is zero, the manganese load in the RTD reaching the Chalk was diluted by the Chalk groundwater flow to give an estimated concentration of manganese in the Chalk groundwater of ~~0.0023 mg/l~~ 0.023 mg/l (dilution factor of 10.5). This initial concentration is then further reduced by transport in the Chalk aquifer (case 1a, 1b, 1c for [redacted] respectively). The base case used for later sensitivity analysis (scenario 1a) is for [redacted] but the [redacted] and [redacted] are also modelled.
2) Dilution at PWS (Level 4): The concentration predicted at the borehole in Level 3 (1a, 1b and 1c) was reduced by a factor of the ratio ‘minimum PWS pumping rate: flow rate beneath site’. This assumes that all groundwater flow reaches the abstraction borehole, which is a highly conservative estimate. Using a site flow of 0.119 Ml/d and comparing this to the lowest pumping rate at each PWS, a PWS dilution factor was obtained. The Base case concentration was divided by the PWS dilution factor to obtain an adjusted concentration in the PWS abstraction (Table 8.3).

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[1] From groundwater levels measured at the site in October 2020. The average gradient from baseline monitoring was 0.0015, and from the historic record was 0.0018. Sensitivity analysis included this range of gradients, and the conclusions are therefore considered to stand

[2] Heuel-Fabianek, 2014. Partition Coefficients (Kd) for the Modelling of Transport Processes of Radionuclides in Groundwater, May 2014, Berichtedes Forschungszentrums Jülich 4375; ISSN0944-2952 Division of Safety and Radiation Protection (S)

Clarification 3

Table 8.4 Level 3 and 4 Groundwater modelling results for manganese

Scenario	PWS	Initial site conc in Chalk (mg Mn/l)	Distance from site (m)	Description	PWS conc (mg Mn/l)	
					Steady state	1000 years
1a (Base case)	[redacted]	0.023	[redacted]	No PWS dilution	0.00915	0.00106
2a				PWS dilution	0.00029	0.00003
1b	[redacted]	0.023	[redacted]	No PWS dilution	0.00591	0.00015
2b				PWS dilution	0.00006	1.68E-06
1c	[redacted]	0.023	[redacted]	No PWS dilution	0.00159	2.60E-08
2c	[redacted]			PWS dilution	0.00002	3.02E-10

The base case predicts a manganese concentration in groundwater at [redacted] PWS of 0.009 mg/l at steady state, and 0.001 mg/l after 1000 years, both of which are significantly below the drinking water standard of 0.05 mg/l. Dilution at the PWSs reduces the manganese concentration further, to negligible concentrations: the highest of which, at [redacted] PWS, is 0.00029 mg/l, below normal laboratory detection limits. The measured manganese concentrations at [redacted] are an average of 0.016 mg/l and a maximum of 0.53 mg/l.

The predicted manganese concentrations at [redacted] and [redacted] boreholes are lower than at [redacted] due to their increased distance and higher pumping rate (i.e. dilution). ~~In reality these PWS are also further from the site than~~ [redacted]~~, and concentrations would be further reduced by dilution and dispersion along the pathway.~~

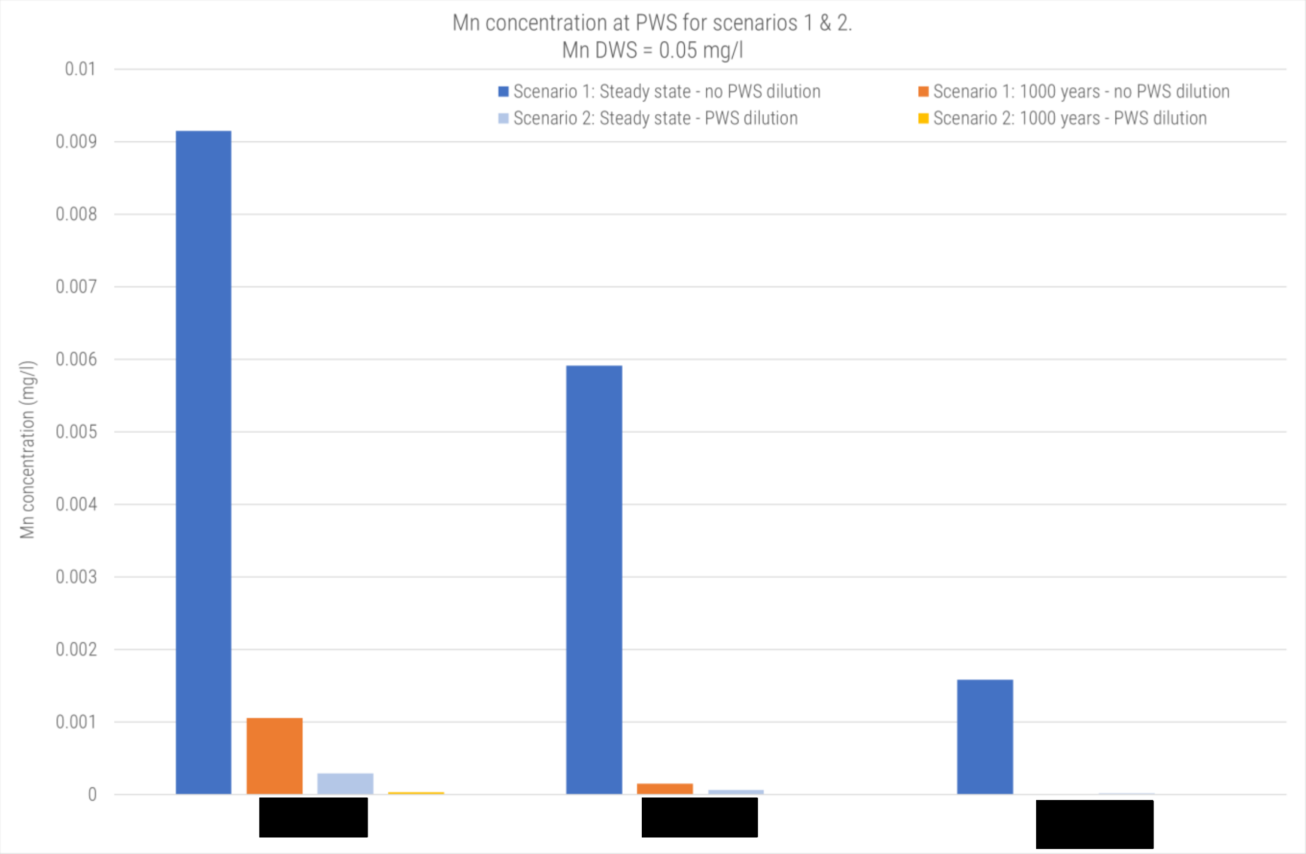

Figure 8-1 Level 3 and 4 Groundwater modelling results for manganese