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OPUS JOYNES PIKE

HA/2008/104056/02

CAB/J-BK093 (R003a)

Environment Agency
Planning Liaison
Guildbourne House
Chatsworth Road
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West Sussex
BN11 1LD

ARUN DISTRICT COUNCIL				
No.	W	354	08	

For the attention of Hannah White, Planning Liaison

Dear Hannah,

Re: Travis Perkins, Pier Road/New Road, Littlehampton

Detailed Quantitative Risk Assessment: Controlled Waters

Introduction

Opus Joynes Pike (OJP) have undertaken a Geo-Environmental Desk Study and Ground Investigation of the above site. It is proposed to divide the existing site and redevelop it in two separate phases, a northern phase and a southern phase, for two separate commercial developments. Hence, the ground investigation has been presented in two separate reports to reflect these two phases, referenced CAB/J-BK093 (R002a) and CAB/J-BK093 (R002b) respectively, and both dated September 2008.

The ground conditions beneath the site typically comprise up to 1.40m of Made Ground overlying drift deposits of clays, interpreted as representing Alluvium, to a depth of approximately 2.00m below existing ground level (begl) beneath the north of the site and to depths exceeding 5.00m begl beneath the south. The Alluvium is underlain by silty sands, interpreted as representing Raised Beach Deposits, to depths exceeding 5.00m begl beneath the centre of the site. The Raised Beach Deposits have been proven to be absent beneath the north of the site, but not proven to be either absent or present beneath the south to 5.00m begl. The Chalk bedrock has been proven at depths between 2.75m begl and 4.80m begl beneath the north of the site, but again not proven beneath the south to 5.00m begl. The upper boundaries of both the Raised Beach Deposits and the Chalk appear to deepen towards the south-southeast beneath the site.

The water table is present at depths between approximately 0.50m begl (1.50m AOD) beneath the southwest of the site and 2.00m begl (0.50m AOD) beneath the northeast. This essentially lies within the Made Ground beneath the southwest of the site, within the Alluvium beneath the centre and on the upper boundary of the Raised Beach Deposits/Chalk beneath the northeast.



The recorded groundwater levels are considered to represent a piezometric surface, which appears to be present at a depth of approximately 2.00m begl (0.50m AOD) beneath the entire site. This lies within the Alluvium beneath the majority of the site, but on the upper boundary of the Raised Beach Deposits/Chalk in the northeast of the site. The piezometric surface indicates that the water table within the Made Ground in the southwest of the site may represent perched water resting upon the Alluvium. The piezometric surface appears to deepen towards the north-northeast of the site.

The ground conditions, water table and piezometric surface are shown on the appended Drawing Numbers J-BK093/504, J-BK093/505 and J-BK093/506.

During the ground investigation, a localised area of petroleum hydrocarbon contamination was detected in one soil sample and one groundwater sample taken from beneath the centre of the site. This essentially comprises aromatic TPH fractions C10-C12, C12-C16, C16-C21 and C21-C35. In addition to this, elevated arsenic concentrations were detected in groundwater samples taken from beneath the site.

This report presents a Detailed Quantitative Risk Assessment (DQRA) to derive soil and groundwater Remedial Target Values (RTV's) for the four detected aromatic TPH carbon bands and arsenic to be protective of 'controlled waters'.

Contamination Source Area

TPH

A TPH (C5-C35) concentration of 410mg/kg was detected in a shallow Made Ground sample (<1.00m begl) beneath the centre of the site (WS7). This concentration essentially comprised medium-heavy TPH aromatic fractions C10-C35.

The available historical plans of the site show the presence of a large, rectangular tank (assumed to be an above-ground tank) between 1912 and 1932 in the centre of the site. Reference to the plans shows that the footprint of the historical tank was approximately 25m long (orientated west-east) and approximately 10m wide (orientated north-south).

WS7 was located at the western end of the historical footprint of the tank. The petroleum hydrocarbon contamination in WS7 is assessed to potentially be due to historical leaks/spills of fuel oils/timber preservatives from the tank, and subsequent percolation into the Made Ground beneath and around the tank. No elevated phenol concentrations, generally regarded as being indicative of the presence of timber preservatives, were detected in the WS7 sample.

A TPH (C5-C35) concentration of 270µg/l was detected in a sample of groundwater beneath the centre of the site (WS6), which also comprised medium-heavy TPH aromatic fractions C10-C35.

WS6 was located adjacent to the eastern end of the historical footprint of the tank. The petroleum hydrocarbon contamination in WS6 is assessed to potentially be due to dissolution of the adjacent Made Ground contamination into the groundwater. Again, no elevated phenol concentrations were detected in the WS6 sample.

Arsenic

Arsenic concentrations of between 28µg/l (WS1A) and 73µg/l (WSB) were detected in samples of groundwater taken across the site. No elevated arsenic concentrations were detected in any soil samples.

Water-based Copper-Chromium-Arsenic (CCA) solutions are one of several types of solutions used as timber preservatives. CCA solutions within the groundwater may potentially be a source for the elevated arsenic concentrations, however, no elevated copper or chromium concentrations, or phenol concentrations, were detected in the samples of groundwater.

The only known potential area of timber preservation at the site is the historical tank in the centre of the site, however, the arsenic concentrations appear to decline in a northerly direction across the site. Hence, timber preservatives are unlikely to be responsible for the elevated arsenic concentrations in the samples of groundwater, and their source remains uncertain.

On this basis, it would be reasonable to assume that an appropriate contaminant source area is the footprint of the historical tank.

Receptors and Compliance Point

The nearest aquifer to the site is the Chalk (Major Aquifer), which underlies drift deposits of Alluvium and Raised Beach Deposits at depths of between approximately 2.75m begl and >5.00m begl beneath the site.

The nearest surface watercourse to the site is the River Arun, which lies over 50m to the west of the site at its closest point. The River Arun is tidal along the stretch near the site. The English Channel is located approximately 500m to the south of the site.

The findings of the ground investigation indicated that groundwater flow appeared to be to the southwest-south beneath the site, towards the River Arun. However, OJP undertook a levelling exercise at the site in October 2008 to derive additional site-specific data for the DQRA. The surface covers of the six monitoring standpipes (WS1A, WS3, WS6, WS8, WSB and WSD) were levelled to provide an accurate representation of groundwater levels relative to ordnance datum, and groundwater flow directions, beneath the site. The findings of the levelling exercise have revealed that the groundwater levels are relatively consistent with ordnance datum, however, the groundwater flow direction appears to be to the north-northeast beneath the site, away from the River Arun.

Further research has revealed two possible scenarios to justify the north-northeast groundwater flow direction beneath the site, away from the River Arun, which are described below.

Tidal Cycle

Groundwater beneath the site is assessed to be in direct hydraulic continuity with the River Arun. The River Arun is tidal along the stretch near the site. Hence, the groundwater beneath the site could be anticipated to be influenced by 'outflow' towards the River Arun (southwest-south) around low tides and 'inflow' away from the River Arun (north-northeast) around high tides. However, the degree of inflow/outflow would be determined by the surface water level in the river channel relative to the groundwater levels in its surrounding banks.

Spring tide levels in the River Arun are believed to be around 2.80m AOD at high tide and around -2.00m AOD at low tide, while neap tide levels are believed to be around 1.80m AOD at high tide and around -1.20m AOD at low tide. The piezometric surface appears to be present at an elevation of approximately 0.50m AOD beneath the site. Bearing this in mind, the surface water level in the river channel is higher than the piezometric surface around high tides, but lower around low tides. Groundwater discharge from the site to the river channel could therefore only conceivably occur twice a day for a period of approximately 6 hours (ie. 12 hours per day).

In addition to the above, the fall in the elevation of the piezometric surface from 0.50m AOD beneath the site to 0.00m AOD at the midpoint between high tide and low tide over the distance of 50m between the site and the River Arun represents a very slight hydraulic gradient. This would therefore reduce groundwater flow to the southwest-south, towards the River Arun.

Groundwater Abstractions

Groundwater beneath the site is also assessed to be in direct hydraulic continuity with the Chalk. The Envirocheck database report indicated that there are no recorded groundwater abstractions within 500m of the site. The nearest active groundwater abstraction is held by ARC Ltd for aggregate washing at a location over 800m to the northwest of the site. However, a further 12 active groundwater abstractions are recorded at locations between 1.7km and 2km to the north and northeast of the site, which are held by several horticultural nurseries for spray irrigation.

All of the local groundwater abstractions are likely to be derived from the Chalk (Major Aquifer). Hence, the groundwater abstractions are anticipated to locally drawdown groundwater levels in the Chalk beneath the horticultural nurseries, and ultimately form a 'cone of depression' radiating outwards through the surrounding catchment zone. Although the groundwater abstractions are between 1.7km and 2km to the north and northeast of the site, horticultural nurseries are known to use a significant amount of water for spray irrigation, which means that the 'cone of depression' may conceivably extend as far as the Chalk beneath the site. This would therefore explain the groundwater flow to the north-northeast, away from the River Arun.

Taking the two above scenarios into account, both the River Arun and the groundwater abstraction points are potential sensitive receptors. However, the River Arun is significantly closer to the site (50m) than the groundwater abstraction points (between 1.7km and 2km). The primary 'controlled water' receptor is therefore considered to be surface water in the River Arun. The groundwater abstraction points at the horticultural nurseries are considered to be a secondary 'controlled water' receptor.

On this basis, it would be reasonable to assume that an appropriate compliance point for the DQRA is a point 50m from the contaminant source area, which would be between any potential contaminant plume beneath the site and both receptors. The contaminant source area is over 10m from the western site boundary. Hence, the distance between the contaminant source area and the River Arun is over 60m, which means that the compliance point falls far short of the river channel as well as the groundwater abstraction points.

Detailed Quantitative Risk Assessment

The Detailed Quantitative Risk Assessment (DQRA) has been undertaken for TPH and arsenic in accordance with the Environment Agency's publication entitled 'Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination', dated 2006, using the revised Remedial Targets Worksheet release 3.1, October 2006 (RTW).

Elevated concentrations of aromatic TPH fractions C10-C12, C12-C16, C16-C21 and C21-C35 have been detected in the WS7 Made Ground sample and the WS6 sample of groundwater. Only these four TPH carbon bands have been selected for the DQRA as the other 10 TPH carbon bands were not present above laboratory detection limits in these two samples.

The WS7 soil sample containing elevated concentrations of aromatic TPH fractions was Made Ground and the WS6 sample of groundwater containing elevated concentrations was present within the Alluvium (clays). The Raised Beach Deposits (silty sands) were encountered beneath the contaminant source area at a depth of 4.55m begl, which is 2.55m below the piezometric surface. However, as the piezometric surface within the Alluvium is in direct hydraulic continuity with the Raised Beach Deposits, and ultimately the Chalk, typical values for sandy soils have been selected for several parameters for the DQRA.

Level 1, 2 and 3 assessments have been undertaken for soils for the DQRA to derive RTV's for soils above the water table within the contaminant source area, and a Level 3 assessment for groundwater to derive RTV's for groundwater within the contaminant source area.

Target Concentrations

The compliance point target concentration for TPH has been obtained from the Imperative Values for dissolved and emulsified hydrocarbons defined in the Surface Water Abstractions Directive (SWAD) (75/440/EEC). The SWAD defines three Imperative Values; 50µg/l for Class A1 (Untreated) surface waters, 200µg/l for Class A2 (Partially Treated) surface waters and 1000µg/l for Class A3 (Fully Treated) surface waters. The Imperative Value of 50µg/l has been adopted as the compliance point target concentration for the DQRA. The Imperative Value has been divided evenly between the four detected aromatic TPH fractions to give a target concentration of 12.5µg/l for each fraction at the compliance point.

The compliance point target concentration for arsenic has been obtained from the Environmental Quality Standard (EQS) for coastal and estuarine waters listed in the Dangerous Substances Directive (76/464/EEC). This is 25µg/l.

Key Marker Compounds

Several hydrocarbon compounds present in the TPHCWG fractions are considered to pose more significant risks to the water environment than others. Hence, Key Marker Compounds (KMC's) have been selected to represent the four detected aromatic TPH fractions for the DQRA.

KMC's have been selected from Volume 3 of the TPH Criteria Working Group (TPHCWG) Series of publications, 'Selection of Representative TPH Fractions Based on Fate and Transport Considerations'. These are listed in Table 1 below.

Table 1

TPHCWG Fraction	KMC
Aromatic C10-C12	Naphthalene
Aromatic C12-C16	Acenaphthene
Aromatic C16-C21	Benzo(a)pyrene
Aromatic C21-C35	Benzo(ghi)perylene

The KMC for TPH aromatic fractions C10-C12 and C12-C16 has a carbon number corresponding to the lowest carbon band representing that fraction (e.g. naphthalene, with a carbon number of 10, represents the aromatic C10-C12 fraction).

Benzo(a)pyrene (carbon number 20) has been selected as the KMC for TPH aromatic C16-C21 fraction as it is a stronger carcinogen than fluoranthene (carbon number 16).

Benzo(ghi)perylene (carbon number 22) has been selected as the KMC for TPH aromatic C21-C35 fraction as no data is available within the TPHCWG Series for aromatic compounds with a carbon number of 21.

Initial Source Concentrations

The TPH aromatic fraction C10-C35 concentrations detected in the WS7 Made Ground sample have been adopted to represent the initial source concentrations in soils in the contaminant source area. These are listed in Table 2 below.

Table 2

TPHCWG Fraction	Soil Concentration (mg/kg)
Aromatic C10-C12	12
Aromatic C12-C16	12
Aromatic C16-C21	64
Aromatic C21-C35	320

The TPH aromatic fraction C10-C35 concentrations detected in the WS6 sample of groundwater have been adopted to represent the initial source concentrations in groundwater in the contaminant source area. These are listed in Table 3 below.

Table 3

TPHCWG Fraction	Groundwater Concentration (µg/l)
Aromatic C10-C12	49
Aromatic C12-C16	84
Aromatic C16-C21	41
Aromatic C21-C35	97

The highest detected arsenic concentration in the samples of groundwater taken from across the site of 73µg/l (WSB) has been adopted to represent the initial source concentration in groundwater in the contaminant source area.

Henry's Law Constants (H) and Organic Carbon Partition Coefficient (K_{oc})

The Henry's Law constants and organic carbon partition coefficients of the four detected aromatic TPH fractions have been obtained from Volume 3 of the TPH Criteria Working Group (TPHCWG) Series of publications, 'Selection of Representative TPH Fractions Based on Fate and Transport Considerations', but with the Henry's Law constants adjusted to 10 degrees Centigrade.

Henry's Law constants and organic carbon partition coefficients are not applicable to non-organic compounds (ie. arsenic).

Half Life for Degradation in Water

There are no available degradation rates for the TPH fractions or their adopted KMC's in the TPHCWG Series of publications. Hence, the degradation rates published in Howard 'Handbook of Environmental Degradation Rates' have been used as a suitable alternative instead.

The revised EA methodology is conservative as the published half lives are divided by the retardation factor to simulate degradation in the dissolved phase only. This results in the K_d value being cancelled out and has no further effect on the calculation of the Tier 3 Groundwater RTV's. This is conservative as the K_d value affects retardation, which allows more degradation to take place. However, there are no site-specific degradation rates available, so we have adopted the conservative approach.

The half life values are listed in Table 4 below.

Table 4

KMC	Half Life (Days)
Naphthalene	258
Acenaphthene	204
Benzo(a)pyrene	1060
Benzo(ghi)perylene	1300

Half lives are not applicable to non-organic compounds (ie. arsenic).

Fraction of Organic Carbon (F_{oc})

A fraction of organic carbon value of 0.002 has been obtained from typical published values for sandy soils (CONSIM files).

Fraction of organic carbon is not applicable to non-organic compounds (ie. arsenic).

Soil-Water Partition Coefficient (K_d)

The soil-water partition coefficients of the four detected aromatic TPH fractions have been obtained by multiplying the respective K_{oc} by the respective F_{oc} .

Soil-water partition coefficients are not applicable to non-organic compounds (ie. arsenic).

Infiltration Rate

The average annual rainfall for the nearest Met Office rainfall observation station to the site (Bognor Regis) is 717mm per year. Assuming that the annual effective rainfall (potential rainfall infiltration) is 5% of the average annual rainfall, the annual effective rainfall for the region is 35.85mm per year, which equates to 0.098mm per day.

The proposed commercial developments at the site are to essentially comprise hardstanding surfaces served by a dedicated surface water drainage system. There are very limited proposed areas of soft landscaping, none of which overlie the contaminant source area. Assuming that the drainage system is 95% effective, the infiltration rate for the site is 0.0049mm per day, which equate to 4.9×10^{-6} m per day.

Length, Width and Area of Contaminant Source Area

The footprint of the historical tank has been selected as the contaminant source area. The footprint was approximately 25m long (orientated west-east) and approximately 10m wide (orientated north-south). Therefore, the length of the contaminant source zone, parallel to groundwater flow, has been selected as 25m, and the width, perpendicular to groundwater flow, has been selected as 10m, which equates to an area of the contaminant source zone of 250m².

Saturated Aquifer Thickness

The saturated aquifer thickness has been selected as 3.11m. This has been obtained with reference to the borehole log for WS6, and is based on the difference between the mean piezometric surface (1.89m begl) taken from the four groundwater monitoring visits and the depth of the borehole (5.00m begl).

Plume Thickness at Source

The plume thickness has been selected as 3.01m. This has also been obtained with reference to the borehole log for WS6, and is based on the difference between the mean piezometric surface (1.89m begl) and the depth of the clayey sands between the silty sands and the Chalk (4.90m begl). The clayey sand is likely to retard downward contaminant migration from the silty sands to the Chalk. Hence, the TPH and arsenic concentrations in the silty sands surrounding the WS6 standpipe are likely to be significantly higher than those in the Chalk.

Hydraulic Conductivity

A hydraulic conductivity value of 0.2333m per day has been calculated from the mean of the results of two falling head tests undertaken in the WS6 standpipe.

Hydraulic Gradient

A hydraulic gradient value of 0.0242 has been calculated from the difference in elevation of the mean piezometric surface between the WS6 and WS8 standpipes, as shown on the appended Drawing Number J-BK093/504.

Bulk Density

The bulk density value has been selected as 1.60kg/m³, which is the CLEA model default for sandy soils.

Air and Water Porosity

The air and water porosity values have been selected as 0.30 and 0.24 respectively, which are the CLEA model defaults for sandy soils.

Effective Porosity

The effective porosity value has been selected as 0.30, which is approximately 80% of the RBCA model default value for the total porosity of clayey sands, and a value recommended by the Environment Agency.

Remedial Target Values

The calculated Level 3 RTV's are summarised in Table 5 below. The key input parameters are target concentrations in line with SWAD for TPH (50µg/l) and EQS for coastal and estuarine waters for arsenic (25µg/l), a compliance point between the site and the River Arun (50m) and an allowance for degradation. The worksheet printouts are presented on the enclosed CD (Appendix 'A').

Table 5

Key Marker Compound	Target Concentration at Compliance Point µg/l	Maximum Soil Concentration mg/kg	Maximum Groundwater Concentration µg/l	Level 3 Soil RTV mg/kg	Level 3 Groundwater RTV µg/l
Aromatic TPHCWG Fractions					
Naphthalene C10-C12	12.5	12	49	1,270	3,610
Acenaphthene C12-C16	12.5	12	84	16,600	9,060
Benzo(a)pyrene C16-C21	12.5	64	41	35,500	132
Benzo(ghi)perylene C21-C35	12.5	320	97	42,800	103
TPH	50	410	270	96,170	12,905
Arsenic	25	30	73	909	58.5

Sensitivity Analysis

A sensitivity analysis has been undertaken on several key input parameters adopted for the DQRA. This has involved adjusting key input parameters as follows:

- Omitting Degradation
- Decreasing the Hydraulic Conductivity by 50% to reflect the fact that groundwater discharge from the site to the river channel only conceivably occurs twice a day for a period of 6 hours (ie. 12 hours per day)

- Changing the Target Concentrations in line with the Drinking Water Standards (DWS) defined in the Water Supply (Water Quality) Regulations 1989 and 2000 for TPH (10µg/l) and arsenic (10µg/l) and increasing the Compliance Point from 50m to 250m to reflect the potential secondary 'controlled water' receptor (groundwater abstraction points at the horticultural nurseries)
- Decreasing and increasing the Effective Porosity of clayey sands by a fraction of 0.05 to 0.25 and 0.35 respectively, which is approximately 70% and 90% of the default value for the total porosity of clayey sands

Omitting Degradation

The calculated Level 3 RTV's derived by omitting degradation are summarised in Table 6 below, and the worksheet printouts (Version 1.11) are presented on the enclosed CD (Appendix 'A').

Table 6

Key Marker Compound	Level 3 Soil RTV mg/kg	Level 3 Groundwater RTV µg/l
Aromatic TPHCWG Fractions		
Naphthalene C10-C12	10.6	29.2
Acenaphthene C12-C16	55.5	29.2
Benzo(a)pyrene C16-C21	7,940	29.2
Benzo(ghi)perylene C21-C35	12,300	29.2

Degradation is not applicable to arsenic.

Decreasing Hydraulic Conductivity by 50%

The calculated Level 3 RTV's derived by decreasing the hydraulic conductivity by 50% are summarised in Table 7 below, and the worksheet printouts (Version 1.12) are presented on the enclosed CD (Appendix 'A').

Table 7

Key Marker Compound	Level 3 Soil RTV mg/kg	Level 3 Groundwater RTV µg/l
Aromatic TPHCWG Fractions		
Naphthalene C10-C12	3.05E+5	1.87E+6
Acenaphthene C12-C16	9.68E+6	1.15E+7
Benzo(a)pyrene C16-C21	2.17E+5	1,660
Benzo(ghi)perylene C21-C35	1.85E+5	913

Hydraulic conductivity is not applicable to arsenic as it is not degradable.

Changing Target Concentrations to DWS and increasing Compliance Point to 250m

The calculated Level 3 RTV's derived by changing the target concentrations to DWS and increasing the compliance point to 250m are summarised in Table 8 below, and the worksheet printouts (Version 1.13) are presented on the enclosed CD (Appendix 'A').

Table 8

Key Marker Compound	Level 3 Soil RTV mg/kg	Level 3 Groundwater RTV µg/l
Aromatic TPHCWG Fractions		
Naphthalene C10-C12	1.25E+10	3.6E+10
Acenaphthene C12-C16	1.24E+12	6.9E+11
Benzo(a)pyrene C16-C21	7.86E+7	288,000
Benzo(ghi)perylene C21-C35	4.24E+7	100,000
Arsenic	6,850	419

Decreasing and increasing the Effective Porosity of clayey sands by a fraction of 0.05

The calculated Level 3 RTV's derived by decreasing and increasing the Effective Porosity of clayey sands by a fraction of 0.05 are summarised in Table 9 below, and the worksheet printouts (Versions 1.14 and 1.15) are presented on the enclosed CD (Appendix 'A').

Table 9

Key Marker Compound	Decreased Effective Porosity		Increased Effective Porosity	
	Level 3 Soil RTV mg/kg	Level 3 Groundwater RTV µg/l	Level 3 Soil RTV mg/kg	Level 3 Groundwater RTV µg/l
Aromatic TPHCWG Fractions				
Naphthalene C10-C12	682	1,930	2,280	6,510
Acenaphthene C12-C16	8,090	4,390	32,700	17,900
Benzo(a)pyrene C16-C21	28,400	105	44,200	165
Benzo(ghi)perylene C21-C35	35,400	85	51,400	124

Effective porosity is not applicable to arsenic as it is not degradable.

Conclusion and Recommendations

TPH

The DQRA shows that none of the soil and groundwater concentrations of the aromatic TPH fractions C10-C12, C12-C16, C16-C21 and C21-C35 detected beneath the centre of the site exceed their corresponding RTV's, and that there would be no impact to 'controlled waters' at a compliance point 50m from the contamination source area. This is further confirmed by the lack of detectable concentrations of the above four aromatic TPH fractions in other samples of groundwater taken from surrounding standpipes, several of which are located within 50m of the contamination source area.

The sensitivity analysis indicates that omitting degradation decreases the RTV's. However, these RTV's are over-conservative values as they make no allowance for degradation (volatilisation, dissolution or sorption) which typically acts upon petroleum hydrocarbon contamination in the subsurface environment. In addition, contaminant migration beneath the site is considered to be significantly influenced by the tidal cycles. Inflow of groundwater is anticipated to occur twice a day for a period of about 6 hours. This means that the time period for any outflow of groundwater and discharge into the River Arun is effectively 50% of the hydraulic conductivity values used in the DQRA (ie. 12 hours per day rather than 24 hours). The tidal cycle is likely to retard contaminant migration, and therefore, degradation and dilution rates may potentially be significantly faster, and hydraulic conductivity may potentially be significantly slower, than those used in the DQRA. This is shown through the sensitivity analysis whereby a decrease of the hydraulic conductivity value by 50% increases the RTV's.

The sensitivity analysis also indicates that there would be no impact from TPH contamination beneath the site to the potential secondary 'controlled water' receptor (groundwater abstraction points at the horticultural nurseries).

Arsenic

The DQRA shows that none of the soil concentrations of arsenic detected beneath the site exceed the corresponding soil RTV. Four concentrations of arsenic (28µg/l in WS1A, 30µg/l in WS3, 45µg/l in WS6 and 56µg/l in WS8) detected in the samples of groundwater taken from standpipes within the north and centre of the site, including the contamination source area, also lie below the groundwater RTV of 58.5µg/l. However, the remaining two concentrations of arsenic (73µg/l in WSB and 67µg/l in WSD) detected in the samples of groundwater taken from standpipes within the south of the site lie marginally above the groundwater RTV, and would therefore potentially impact 'controlled waters' at a compliance point 50m from the contamination source area.

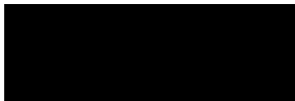
Despite the above, the arsenic concentrations in the six samples of groundwater appear to increase in a southerly direction beneath the site rather than in a westerly direction. This means that if this increase in arsenic concentrations in groundwater continues further to the south, then not only is the site unlikely to be the potential source, but the English Channel, which is located approximately 500m to the south of the site, is likely to be the potential 'controlled water' receptor rather than the River Arun. Taking this tenfold increase in distance into account, there would be no impact to 'controlled waters'.

The sensitivity analysis indicates that there would be no impact from arsenic contamination beneath the site to the potential secondary 'controlled water' receptor (groundwater abstraction points at the horticultural nurseries).

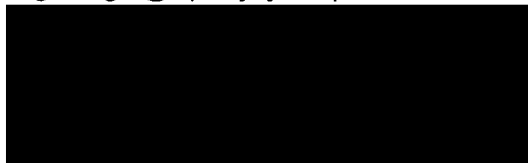
Remediation

Although subject to confirmation by the Environment Agency, based on the outcome of the DQRA, it is anticipated that no remedial works would be required at the site to be protective of 'controlled waters'. However, if ground conditions should differ significantly from those encountered during the ground investigation, including the discovery of any significant petroleum hydrocarbon contamination beneath the footprint of the historical tank within the centre of the site, the Principal Contractor should suspend site redevelopment works within the subject area(s) immediately and inform the site developer. The suspect material should then be inspected and assessed by a Geo-Environmental Engineer, and rectified accordingly.

Yours sincerely



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