Investigation into the Incidence of Acute Myeloid Leukaemia at Tollerton Mobile Home Park

September 2008

Rushcliffe Borough Council

Developed by Environment and Waste Management Service

[redacted]

An investigation began following an anonymous report sent to Rushcliffe Borough Council from a member of the public suggesting that four working aged males had been diagnosed recently with acute myeloid leukaemia (AML). These men reportedly lived at the Tollerton Caravan site (NG12 4GD). The information received: one Surname, three Christian names and one address. Utilising these sketchy details information was extracted from the HIS Data Warehouse, Nottingham University Hospitals Admission and Cancer Registry data to identify all recently diagnosed cases of leukaemia living at the postcode NG12 4GD. The individual GP case notes for those subjects who were deceased were also examined to determine cause of death.

Three subjects who had lived at the Tollerton site were identified as having a diagnosis of AML: two males (one deceased) & one female (deceased). One resident had a diagnosis of chronic lymphocytic leukaemia . Their average age at diagnosis was 80 years of age and each subject had lived at the Tollerton site for at least 7 years prior to diagnosis.

The Trent Cancer Registry identified a further resident at the Tollerton site with a diagnosis of other myeloid leukaemia.

Statistical analysis was carried out to determine if this number of AML and other leukaemia cases was greater than would be expected for the population living at Tollerton. The standardised rate ratio for the number of leukaemia cases expected at the Tollerton site was 33.29 (excluding the resident with chronic lymphocytic leukaemia). This figure suggests that there is over a 33 times greater rate of leukaemia diagnosis than would be expected. This figure, although statistically significant should be interpreted with caution. The small number of subjects involved means that the actual expected number of leukaemia cases for the population at Tollerton is less than one. This could result in a more imprecise and overestimated calculation of risk. Analysis comparing the directly age standardised rates of all leukaemia cases in the rest of England and the East Midlands with the Rushcliffe area concluded that the rates observed were similar.

The proportional incidence ratio (PIR) for all leukaemias was also estimated for the Tollerton site. This examined the number of leukaemia cases as a proportion of all known cancers diagnosed in site residents from the early 1980s. The PIR of 10.4 indicates that there appears to be 10 times more diagnosed leukaemia cases than would be expected for the population at Tollerton.

Nevertheless, this data also reflects the low levels of other cancers diagnosed in residents of the Tollerton site over the past 20 plus years. As discussed later in this report, bone sarcoma has been found to be strongly associated with occupational radium exposure, if there was an excess level at Tollerton then increased numbers of this type of cancer could be expected.

Further important aspects, which could account for the higher rates of leukaemia, are other known risk factors not accounted for within this analysis.

In particular, cigarette smoking has been shown to almost double the risk of AML in males and accounts for approximately a quarter of all cases.

If the cases were smokers and this status had been included within the analysis, it could potentially lower the rate. Therefore, although there appears to be an excess number of AML and other leukaemia cases our estimated rate may well be too great.

The caravan site at Tollerton is situated on a decommissioned Royal Air Force Air Base. After the Second World War it was a used as a base to demolish Lancaster bombers. A particularly significant part of this process was the disposal of the luminising dials from the cockpits.

Radium was used universally in the first half of the 20th century in dials, watches, etc. The disposal of the luminised instruments from aeroplanes generally took the form of burning or burial. The migration of radium to the environment from such practices is documented.

This process is dependant on several factors:

- Depth of burial of waste
- The solubility of the radium form used
- Whether the groundwater has a low pH, high total dissolved solids or low redox potential
- The degree of vegetation on the site - potential for plant uptake & radiation entering the environment or food chain
- Accessibility of the site to humans or animals
- Dust transportation - possible but unlikely in the UK climate

Recommendations to prevent radium spread to the environment include:

- Limit potential migration by removing or covering luminising waste
- Prevent or limit the action of burrowing animals and access by members of the public

In adults, studies have linked AML and other leukaemias with several environmental contaminants including: solvents and petroleum products including benzene and ionising radiation. All subjects with leukaemia lived within close proximity on the caravan site. It is uncertain if this could imply a dose response effect of an environmental contaminant or if this is purely a chance event.

A statistical programme was utilised by the Trent Cancer Registry to examine whether the average distance between the homes of the cases was significantly less than would otherwise be expected by chance. The results indicate that the probability of the caravans belonging to the cases being positioned by chance in a cluster towards the right of the caravan park was low.

The quality of the evidence establishing a statistically significant relationship between environmental exposure to radium and leukaemia is weak. Two ecological studies from Florida and Iowa in the USA, do not reach the same conclusions; one finds a strong correlation between AML, other leukaemias and radium contamination and the other none. A more robust cohort study of 'Dial Painters' (using radium) does identify a strong link between radium and bone sarcoma with a 50 times greater relative risk of developing this type of cancer. However, no association with leukaemia was reported despite high levels of exposure. It is know that studies of populations experiencing high dose radiation from the A bomb indicate a higher risk of AML within 5-10 years of exposure. However, it is unclear if this data takes into account the background incidence of AML, which would be expected with an aging population.

Despite doubts over the precision of the statistical analysis, there does appear to be an increased observed number of leukaemia cases at Tollerton. The site was previously used to decommission aircraft that would have contained luminised dials, which has the potential to release radium into the environment. Short wave α emitter particles such as radium would have to be ingested or inhaled to effect tissue damage and there is little evidence that this is the case at Tollerton. Correspondence from the Ministry of Defence (dstl) suggests that a small airfield such as Tollerton would have a low risk of any radioactive contamination being present. There is nevertheless, little or no historical information available regarding the methods used to dispose of aircraft dials at Tollerton and the actual numbers of aircraft involved.

In conclusion, the possibility of residual radium contamination at the Tollerton site exists however; the available scientific evidence does not fully support a causal link between environmental radium and the increased numbers of leukaemia cases reported. The levels of uncertainty involved in this study and public concerns are both high.

The circumstances of this study have been discussed with colleagues from the Ministry of Defence (dstl), Health Protection Agency and their Radiation Protection Division. It was recommended that a radiation survey should be undertaken at the Tollerton site in the first instance to exclude any conspicuous radioactive contamination.

This investigation should include soil and drinking water samples to detect potential increased levels of solvents or petroleum contaminants including benzene to rule out other environmental contaminants.

Radiological Survey

Description of survey

The survey was undertaken by the Health Protection Agency Radiological Division to check for residual radioactive materials arising from the site's previous use. In particular, the survey was designed to check for the presence of radium-226, historically used for luminising dials and other components in aircraft.

The survey consisted of a walk-over survey of:

- the main residential part of the site occupied by static mobile homes; the immediately adjacent parts of the airfield just outside the site perimeter, where direct access is possible from the mobile home site;
- the area at the bottom of the site used to park caravans and other touring vehicles; and
- the car park and approach lane at the entrance to the site.

The bulk of the measurements were made using sensitive scintillation detectors capable of detecting the gamma ray emissions from low level radium-226 contamination. In addition a number of ambient gamma radiation dose rate measurements were made at set locations within the site. Two areas (see below) were found to have elevated levels of gamma radiation; in these areas, additional gamma dose rate and gamma spectrometry measurements were taken.

A full list of the equipment used during the survey is given in Appendix 1.

Survey results and discussion

A full description of the measurement results is given in Appendix 2. The majority of the areas surveyed gave results within the normal range of background radiation levels within the UK.

In terms of above-background readings, two locations were identified (fig.1), as follows:

1. Outside of the site perimeter (Home no. 25) on the adjacent airfield

This consists of a small rectangle (approx 2 metres by 4 metres) of bare ground immediately beyond the site boundary. The gamma spectrometry results indicate the presence of shielded radium-226, i.e. the activity is likely to be buried beneath the surface layer of soil. Elevated levels of gamma radiation are detectable over the entire patch of ground, with a maximum gamma dose rate of 1 μSv/h at the ground surface. The radiation levels reduce rapidly with distance; at the nearest occupied position on the site (the garden decking to the rear of home no. 25) the dose rate is within the normal background range.

2. Caravan parking area at the far end of the site (parking plot 42)

This consists of a small patch (approx 30 cm in diameter) of ground. The gamma spectrometry results indicate the presence of radium-226, and the overall pattern of measurement results suggest that the activity is in the upper few centimetres of the ground. There was nothing obviously visible to the naked eye in the soil and would possibly be a flake of paint.

The maximum dose rate at the surface of the affected patch is 0.7μSv/h, but reduces rapidly with distance, such that radiation levels are close to background at 1 metre away.

Conclusions and recommendations of the radiological survey

The statutory guidance sets out the levels of radioactivity that should be considered as causing harm:

- an effective dose of 3 mSv or more, per year;
- an equivalent dose to the lens of the eye of 15 mSv or more, per year; or
- an equivalent dose to the skin of 50 mSv or more, per year

The results of the survey indicate that there is no evidence of radioactive contamination from radium-226 within the residential area occupied by static mobile homes.

However, two areas of radium-226 contamination were detected outside this area: one in the airfield just outside the perimeter of the site, and one in the caravan parking area. It is stressed that the levels of contamination detected in these locations are not considered sufficient to pose a significant radiation hazard to mobile home residents and the levels detected are well below the 3mSv set out in the statutory guidance.

The Environmental Advisor of the Defence Estates, MoD has reviewed the report and considered that no appreciable dose had been detected at the surface and therefore the risks of exposure are considered to be low.

However, should the use of the land change (in particular should excavations be undertaken) then further investigation works would be warranted.

Radioactive Contaminated Land

The presence of radionucleides on land doesn’t automatically mean that it is ‘radioactive contaminated land’ under the extended Part 2A regime. For land to be determined as radioactive contaminated land a significant pollutant linkage must be present.

A pollutant linkage comprises a radioactive contaminant and a human receptor, with a pathway capable of linking the two. All three elements need to occur on site for a pollution linkage to exist. The pollutant linkage becomes

‘significant’ if it results in harm to human health, or there is significant possibility of such harm occurring.

A significant possibility of harm refers to the probability or frequency of a situation or event occurring which could lead to the sort of exposure levels described above.

At the Tollerton site a theoretical linkage exists but the actual dose levels are well below the effective and equivalent doses recommended in the legislation.

Soil Analysis

Soil samples were taken at a one spade depth, the ground below this being very hard to dig. The samples were dispatched the same day to the National Laboratory Service, Leeds.

The samples were analysed for asbestos, metals, organic compounds including aromatic, aliphatic, polycyclic aromatic hydrocarbons, polychlorinated biphenyls.

Statistical analyses were carried out on those parameters that exceeded the SGV/GAC, Copper, Benzo(a)pyrene and dibenzo(ah)anthracene were found to be of statistical significance.

The elevated concentration of copper in the soil sample taken from the rear of no 28 was considered to be a hot spot. It was also noted that an elevated antimony concentration was also present in the same sample and may indicate that the sample contained some man made metal object rather than a specific contaminant problem. It was reported by some residents of the Park that small metal items such as brake pipes were found in the soil, which may reflect the former use of the site by travellers, and not the activities of the aircraft maintenance work.

Benzo(a)pyrene was found in all samples at an average concentration of 4.54 mg/kg, well above the GAC of 0.82mg/kg, and dibenzo(ah)anthracene concentrations, average concentration of 0.96mg/kg were marginally above the GAC of 0.76mg/kg.

Polycyclic aromatic hydrocarbons were found in all soil samples and may originate from tarmac.

Benzene, solvents, PCBs and petroleum products were not detected.

Asbestos was not detected in any of the soil samples.

Mains Water

Because of the possibility of contaminants leaching through plastic mains water pipes, drinking water samples were taken from two mobile homes, and analysed for aliphatic, aromatic and total petroleum hydrocarbons.

All parameters were below the limit of detection.

Conclusions of the soil and water sampling

Polyclic aromatic hydrocarbons were found in all the soil samples taken with benzo(a)pyrene being well above the LQM/CIEH generic assessment criteria.

An assessment was carried out using the Environment Agencies CLEA software version 1.06 run on basic mode for residential without plant uptake land use with a soil organic matter of 1%. The age criteria value was chosen to reflect the typical age range of the Parks residents.

For residential without plant uptake, the ratio of average daily exposure to oral and inhalation health criteria are both zero.

It is considered that because of the large fraction of hard and vegetative cover and small area and volume of soil and the fact that all the garden areas are purely ornamental, and that the mobile homes are set above the concrete hard standing that there is negligible risks from the PAH contamination in the soil through ingestion, inhalation and dermal pathways.

Appendices 3 and 4 Show the results of the soil and water analysis.


Fig.1. Location of radium hotspots
Caravan storage area hotspot. Parking spot no 42
Perimeter hotspot rear of home no 25

Appendix 1: Radiation survey at Tollerton Mobile Home Park 6 October 2008

List of survey equipment used

- Rotem Ram DA2000 with PM-11 probe
- Bicron Analyst with small probe
- Exploranium GR-135 plus
- Bicron microSievert gamma survey meter
- Mini Instruments Environmental Meter type6.80 with MC71 probe

Appendix 2: Radiation Survey of Tollerton Mobile Home Park 6 October 2008
Measurement results
Gamma dose rates and gamma spectroscopy

1. The main residential part of the site occupied by static mobile homes

Location	Ambient dose rate (µSv/h)
Whole site –walkover survey Set measurement positions between Nos. 3 and 4 between Nos. 9 and 10 between Nos. 16 and 18 in front of No. 34 On decking behind No. 25	0.03 – 0.05 0.04 0.04 0.04 0.05 0.05
Typical UK background (for comparison)	0.02 – 0.05

2. The airfield just beyond the site perimeter (behind No. 25)

Location	Ambient dose rate (μSv/h)
Surface of bare patch of ground	1.0 (maximum reading)
At 1 metre above the ground	0.1 – 0.2
Other adjacent areas	0.03 – 0.04

A gamma spectrometry measurement indicated that the contamination was due to (shielded) radium-226.

3. The area at the bottom of the site used to park caravans

Location	Ambient dose rate (µSv/h)
Parking plot 42 • Surface of small patch of ground • 1 metre above the patch Other areas	 0.7 (maximum reading) 0.07 0.03 – 0.05

A gamma spectrometry measurement indicated that the contamination was due to (shielded) radium-226.

4. The car park and approach lane at the entrance to the site

Location	Ambient dose rate (µSv/h)
Car park Approach lane	0.03 – 0.05 0.03 – 0.05

Appendix 3: Soil sample analysis

SOIL SAMPLES							
	rear of no19	rear of no 28	rear of no 33	front of 10 - 12	base of pear tree 3 - 4		SGV /GAC Residential with plant uptake (mg/Kg)
METALS (mg/kg)						Average	(LQM GAC residential)
Cyanide	1.15	<1.00	<1.00	<1.00	<1.00		34
Antimony	< 10.00	10.4	<10.00	<10.00	<10.00		
Arsenic	19.4	22.4	17.4	28.1	14.6	20.38	32
Cadmium	0.806	3.89	1.4	1.02	0.901	1.6034	1 (pH6) 2 (pH7) 8 (pH8) (GAC residential 3)
Chromium	20.1	42	21.4	23.3	16.4	24.64	130 (GAC Cr III 3000)
Copper	35.1	3430	51.5	30.4	30.1		(GAC 2330)
Lead	88	195	72.1	63.7	52	94.16	450
Mercury	<2.00	<2.00	<2.00	<2.00	<2.00		1
Nickel	21.2	30.8	19.2	18.7	15.5	21.08	130
Zinc	156	1340	156	145	95.5	378.5	(GAC 3750)

ORGANICS (µg/kg)	rear of no19	rear of no 28	rear of no 33	front of 10 - 12	base of pear tree 3 - 4	Average	
Acenapthene	50	342	681	100	40	242.6	(GAC 1% SOM 210)
Acenaphthylene	100	300	521	100	230	250.2	(GAC 1% SOM 170)
Anthanthrene	408	2070	2900	517	240	1227	
Anthracene	230	1630	2090	409	674	1006.6	(GAC 1% SOM 2300)
Benzo(a)anthracene	934	5650	7340	1980	1380	3456.8	(GAC 1% SOM 3.1)
Benzo(a)pyrene	1230	7530	9880	2760	1310	4542	(GAC 1% SOM 0.83)
Benzo(b+k)fluoranthrene	2200	11700	16100	4660	2210	7374	
Benzo(e)pyrene	1090	5230	7180	2230	908	3327.6	
Benzo(ghi)perylene	1060	5430	7540	1930	763	3344.6	(GAC 1% SOM 44)
Chrysene	1120	6880	8780	2290	1400	4094	(GAC 1% SOM 6.0)
Cyclopenta(cd)pyrene	<10.00	<10.00	<10.00	<10.00	60		
Dibenzo(ah)anthracene	300	1760	1910	611	220	960.2	(GAC 1% SOM 0.76)
Fluoranthrene	1880	12500	15300	39901	2770	14470.2	(GAC 1% SOM 260)
Fluorene	70	525	817	100	180	338.4	(GAC 1% SOM 160)
Indeno(1,2,3cd)pyrene	1090	4350	6660	2100	796	2999.2	(GAC 1% SOM 3.2)
Naphthalene	40	<10.00	<10.00	80	80		(GAC 1% SOM 1.5)
Phenanthrene	675	4820	5530	1130	1870	2805	(GAC 1% SOM 92)
Pyrene	1720	11400	14000	3730	2420	6654	(GAC 1% SOM 560)

ORGANICS (µg/kg)	rear of no19	rear of no 28	rear of no 33	front of 10 - 12	base of pear tree 3 - 4
PCB 28	<2.00	<2.00	<2.00	<2.00	<2.00
PCB 52	<1.00	<1.00	<1.00	<1.00	<1.00
PCB 101	<2	<2.00	<2.00	<2.00	<2.00
PCB 118	<1	<1.00	<1.00	<1.00	<1.00
PCB 138	<1	<1.00	<1.00	<1.00	<1.00
PCB 153	<1	<1.00	<1.00	<1.00	<1.00
PCB 180	<1	<1.00	<1.00	<1.00	<1.00

ORGANICS (µg/kg)	rear of no19	rear of no 28	rear of no 33	front of 10 - 12	base of pear tree 3 - 4	Average	
C10-12 Aliphatic	<300.00	>300.00	<300.00	<300	<300.00		
C10-12 Aromatic	<300.00	<300.00	<300.00	<300	<300.00		
C12-16 Aliphatic	<300.00	<300.00	<300.00	<300	<300.00		
C12-16 Aromatic	586	1850	548	1060	844	977.6	(GAC 1% SOM 740 (24)vap)
C16-21 Aliphatic	<300.00	2180	394	<300	<300.00		
C16-21 Aromatic	3440	18800	2320	4870	1390	6164	(GAC 1% SOM 250)
C21-35 Aliphatic	12600	21900	8370	10800	<3000		
C21-35 Aromatic	35400	140000	23400	63000	9950	54350	(GAC 1% SOM 890)
C35-40 Aliphatic	1470	2330	<900.00	1360	<900.00		
C35-40 Aromatic	11500	31000	9600	13600	3400	13820	
Hydrocarbons, Aliphatic extractable C10-C40	14500	26700	9510	12600	<3000.00		
Hydrocarbons, Aromatic extractable C10-C40	51100	192000	36000	82700	15700	75500	
Hydrocarbons, Total extractable C10-C40	65600	219000	45500	93500	17200	88160	
Equiv.Carbon No>6-7 Aliphatic	<2000	<2000	<2000	<2000	<2000.00		
Equiv.Carbon No>7-8 Aliphatic	<300.00	<300	<300	<300	<300.00		
Equiv.Carbon No>7-8 Aromatic	<1.00	<1.00	<1.00	<1.00	<1.00		
Equiv.Carbon No>8-10 Aliphatic	<700	<700.00	<700.00	<700	<700.00		
Equiv.Carbon No>8-10 Aromatic	<10.00	<10.00	<10.00	<10.00	<10.00		
Hydrocarbons Total Volatile C5-C10	<4000	<4000.00	<4000.00	<4000	<4000.00		
Hydrocarbons Aliphatic volatile C5-C10	<4000	<4000	<4000.00	<4000	<4000.00		
Hydrocarbons Aromatic volatile C5-C10	<10	<10.00	<10.00	<10	<10.00		
Equiv.Carbon No> 5-6 Aliphatic	<2000	<2000	<2000.00	<2000	<2000.00		
Equiv.Carbon No> 6-7 Aromatic	<10	<10.00	<10.00	<10	<10.00		

ORGANICS (µg/kg)	rear of no19	rear of no 28	rear of no 33	front of 10 - 12	base of pear tree 3 - 4		
1,1,1,2- Tetrachloroethane	<2.00	<2.00	<2.00	<2.00	<2.00		
1,1,1,- Trichloroethane	<0.200	<0.200	<0.200	<0.200	<0.200		
1,1,2,2,- Tetrachloroethane	<3.00	<3.00	<3.00	<3.00	<3.0		
1,1,2,- Trichloroethane	<0.300	<0.300	<0.300	<0.300	<0.300		
1,1- Dichloroethane	<0.200	>0.200	<0.200	<0.200	<0.3200		
1,1- Dichloroethylene	<1.00	<1.00	<1.00	<1.00	<1.00		
1,1- Dichloropropylene	<0.600	<0.600	<0.600	<0.600	<0.600		
1,2,3- Trichlorobenzene	<3.00	<3.00	20	7	4		(LQM GAC residential 1.0)
1,2,3- Trichloropropane	<1.00	<1.00	<1.00	<1.00	<1.00		
1,2,4- Trichlorobenzene	<5.00	<5.00	5	<5.00	<5.00		(LQM GAC residential 1.8)
1,2,4- Trimethylbenzene	<0.700	<0.700	<0.700	<0.700	<0.700		
1,2- Dibromo-3 chloropropane	<2.00	<2.00	<2.00	<2.00	<2.00		
1,2- Dibromomethane	<3.00	<3.00	<3.00	<3.00	<3.00		
1,2- Dibromobenzene	<2.00	<2.00	<2.00	<2.00	<2.00		
1,2 Dichloroethane	<0.300	<0.300	<0.300	<0.300	<0.300		
1,2 Dichloropropane	<0.500	<0.500	<0.500	<0.500	<0.500		
1,2 Dimethylbenzene (o-Xylene)	<1.00	<1.00	<1.00	<1.00	<1.00		
1,3,5- Trimethylbenzene	<0.500	<.0500	<0.500	<0.500	<0.500		
1,3- Dichlorobenzene	<1.00	<1.00	1	<1.00	<1.00		(LQM GAC residential 0.29)
1,3 - Dichloropropane	<2.00	<2.00	<2.00	<2.00	<32.00		
1,3- Dichloropropylene	<1.700	<1.700	<1.700	<1.700	<1.700		
1,4-Dichlorobenzene	<0.500	<0.500	<0.500	<0.500	<0.500		
2,2-Dichloropropane	<1.00	<1.00	<1.00	<1.00	<1.00		
2-Chlorotoluene	<0.700	<0.700	<0.700	<0.700	<0.700		
4-Chlorotoluene	<1.00	<1.00	<1.00	<1.00	<1.00		

ORGANICS (µg/kg)	rear of no19	rear of no 28	rear of no 33	front of 10 - 12	base of pear tree 3 - 4		
Benzene	<1.00	<1.00	<1.00	<1.00	<1.00		
Bromochloromethane	<0.500	<0.500	<0.500	<0.500	<0.500		
Bromodichloromethane	<0.500	<0.500	<0.500	<0.500	<0.500		
Bromobenzene	<2.00	<2.00	<2.00	<2.00	<2.00		
Bromoform (Tribromomethane)	<2.00	<2.00	<2.0	<2.00	<2.00		
cis-1,2-Dichloroethylene	<1.00	<1.00	<1.00	<1.00	<1.00		
cis-1,3-Dichloropropylene	<1.00	<1.00	<1.00	<1.00	<1.00		
Carbon Tetrachloride (Tetrachloromethane)	<0.200	<0.200	<0.200	<0.200	<0.200		
Chlorobenzene	<1.00	<1.00	<1.00	<1.00	<1.00		
Chloroethane	<5.00	<5.00	<5.00	<5.00	<5.00		
Chloroform (trichloromethane)	<0.500	<0.500	<0.500	<0.500	<0.500		
Chloromethane (Methyl Chloride)	2	6	40	6	<2.00		
Dibromochloromethane	<3.00	<3.00	<3.00	<3.00	<3.00		
Dibromomethane	<0.600	<0.600	<0.600	<0.600	<0.600		
1,3 +1,4- Dimethylbenzene (m&p Xylenes)	<2.0	<2.00	<2.00	<2.00	<2.00		
Ethyylbenzene	>0.500	<0.500	<0.500	<0.5000	<0.500		
Hexachlorobutadiene	<2.00	<2.00	7	4	2		(LQM GAC 0.21)
Isopropylbenzene (Methylethylbenzene)	<0.700	<0.700	<0.700	<0.700	<0.700		

ORGANICS (µg/kg)	rear of no19	rear of no 28	rear of no 33	front of 10 - 12	base of pear tree 3 - 4		
iso propyltoluene	<0.800	<0.800	<0.800	<0.800	<0.800		
MTBE	<4.00	<4.00	<4.00	<4.00	<4.00		
n-Butylbenzene (1-Phenylbutane)	<2.00	<2.00	<2.00	,2.00	<2.00		
n- Propylbenzene (1-pheneylpropane)	<0.600	<0.600	<0.600	<0.600	<0.600		
sec- Butylbenzene	<0.600	<0.600	<0.600	<0.600	<0.600		
Styrene (Vinylbenzene)	<0.500	<0.500	<0.500	<0.500	<0.500		
trans-1,2-Dichloroethene	<1.00	<1.00	<1.00	<1.00	<1.00		
trans-1,3 Dichloropropene	<1.00	<1.00	<1.00	<1.00	<1.00		
tert- Butylbenzene ((1,1-Dimethylethyl) benzene)	<0.800	<0.800	<0.800	<0.800	<0.800		
Tertachloroethylene (Perchloroethylene)	<1.00	<1.00	<1.00	<1.00	<1.00		760
Toluene (Methylbenzene)	<3.00	<3.00	<3.00	<3.00	<3.00		
Trichloroethylene (Trichloroethene)	<0.200	<0.200	<0.200	<0.200	<0.200		13
Trichlorofluoromethane	<0.300	<0.300	<0.300	<00.300	<0.300		
Vinyl Chloride	<2.00	<2.00	<2.00	<2.00	<2.00		
Dry solids	81.5	79.1	81.6	77.9	82.33		
Asbestos	ND	ND	ND	ND	ND		

Appendix 4: Water sample analysis

WATER SAMPLES (µg/l)		
Sample reference number	no17	no 25A
C10-12 Aliphatic	<10	<10
C10-12 Aromatic	<10	<10
C12-16 Aliphatic	<10	<10
C12-16 Aromatic	<10	<10
C16-21 Aliphatic	<10	<10
C16-21 Aromatic	<10	<10
C21-40 Aliphatic	<22	<22
C21-40 Aromatic	<22	<22
Equiv.Carbon No>6-7 Aliphatic	<10	<10
Equiv.Carbon No>7-8 Aliphatic	<10	<10
Equiv.Carbon No>7-8 Aromatic	<10	<10
Equiv.Carbon No>8-10 Aliphatic	<10	<10
Equiv.Carbon No>8-10 Aromatic	<10	<10
Total petroleum hydrocarbons: Aromatic + aliphatic	<100	<100
Total petroleum hydrocarbons: Aliphatic	<50.00	<50.00
Total petroleum hydrocarbons: Aromatic	<50.00	<50.00