

3.6 PHASE 3 - SAMPLING OF SOILS, GROUNDWATER, SURFACE WATER, & LANDFILL GAS

3.6.1 Soils Sampling Results

A total of 4 no soil samples were taken for analysis. The analytical parameters included those specified in the EPA Landfill monitoring Table d.1 guideline minimum reporting values.

The soil samples taken from trial holes TH11, TH13, TH18 & TH21 (Baseline) were sampled and analysed for the following:

- Inorganics
- Metals
- Mineral Oil / Oils & Greases
- Extractable Petroleum Hydrocarbons (EPH)
- Polyaromatic Hydrocarbons (PAHs)
- Volatile Organic Compounds (VOCs)

The laboratory test results are included and summarised in Tables 4 - 9. The Tables include the limits for Dutch Reference and intervention values and each soil sample was compared to these.

Dutch Standards are environmental pollutant reference values (i.e. concentrations in environmental medium) used in environmental remediation, investigation and cleanup. ^[1] Barring a few exceptions, the target values are underpinned by a risk analysis wherever possible and apply to individual substances. In most cases, Target values for the various substances are related to a national Background Concentration that was determined for the Netherlands.

The soil remediation intervention values indicate when the functional properties of the soil for humans, plants and animals is seriously impaired or threatened. They are representative of the level of contamination above which a serious case of soil contamination is deemed to exist. The Target values for soil are adjusted for the organic matter (humus) content and soil fraction.

TH11 exceeded the Dutch Reference value for soils with regard to Copper, Nickel and Zinc. TH13 exceeded the Dutch Intervention Reference value for Copper, Lead, Nickel and Zinc. TH11 also exceeded the Dutch Intervention value for PAH. TH18 exceeded the Dutch intervention values for Copper and Zinc.

Extractable Petroleum Hydrocarbons (EPH) >C10 – C40 results for TH11 (2050mg/kg), TH13 (2820mg/kg), TH18 (2610mg/kg) were significantly higher than the TH21 (162mg/kg) the baseline soil sample.

The United States Environmental Protection Agency (USEPA) has designated 16 PAH compounds as priority pollutants, this is known as Polyaromatic hydrocabons Total USEPA 16. Polyaromatic hydrocarbon (PAH) occur in oil, coal, and tar deposits, and are produced as byproducts of fuel burning (whether fossil fuel or biomass). As a pollutant, they are of concern because some compounds have been identified as carcinogenic, mutagenic, and teratogenic.

TH11 exceeded Dutch intervention PAH values with a result of 79.10mg/kg. TH13 and TH18 had a result of 6.11mg/kg and 4.30mg/kg respectively. TH21 which was used as the baseline had a result of <0.118mg/kg. PAHs such as Fluoranthene were detected in TH11, TH13, TH18 in levels well exceeding TH21 baseline sample. The results could indicate the presence of Bitumen/Tar in TH11, TH13 and 18.

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Legend:

	Result exceeds Dutch Intervention Values (Reference Value)
	Result exceeds Dutch Intervention Values (Intervention Value)
	Result does not exceed Dutch Intervention or Reference Values

Table 4: Inorganics - Soils Samples Results For Trial Holes TH11, TH13, TH18 & TH21 (Baseline)

Parameter	TH11	TH13	TH18	TH21	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Ammoniacal Nitrogen, exchangeable as NH4	347	117	219	<15	n/a	n/a
Ammoniacal Nitrogen as N	270	91.1	170	<15	n/a	n/a
pH	7.79	7.44	7.3	6.91	n/a	n/a
Alkalinity, Total as CaCO3	1130	840	1080	<10	n/a	n/a
Conductivity @ 20 deg.C	2.37	2.45	2.49	1.88	n/a	n/a

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Table 5: Metals - Soils Samples Results For Trial Holes TH11, TH13, TH18 & TH21 (Baseline)

Parameter	TH11	TH13	TH18	TH21	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Copper	50.3	83.6	681	23.3	36.0	190
Iron	39400	25400	34900	26700	n/a	n/a
Lead	66	328	247	6.88	85.0	530
Manganese	620	410	377	414	n/a	n/a
Mercury	<0.14	<0.14	<0.14	<0.14	0.3	10.0
Nickel	41.2	42	27.4	-	35.0	210
Phosphorus	1230	1170	1110	759	n/a	n/a
Zinc	283	330	915	50.8	140	720
Sodium	337	810	293	102	n/a	n/a
Magnesium	8310	5950	5270		n/a	n/a
Potassium	1760	1420	1110	1670	n/a	n/a

Table 6: Mineral Oil / Oils & Greases Soil Sample Results For Trial Holes TH11, TH13, TH18 & TH21 (Baseline)

Parameter	TH11	TH13	TH18	TH21	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Mineral oil >C10-C40	302	802	558	11.7	n/a	5000

Table 7: Extractable Petroleum Hydrocarbons (EPH) Soil Sample Results For Trial Holes TH11, TH13, TH18 & TH21 (Baseline)

Parameter	TH11	TH13	TH18	TH21	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Interpretation	Bitumen/Tar	Bitumen/Tar	PAHS Acids	Humic Acids	n/a	n/a
EPH Range >C10 - C40	2050	2820	2610	162	n/a	n/a

Table 8: Polyaromatic Hydrocarbons (PAHs) USEPA Soil Sample Results For Trial Holes TH11, TH13, TH18 & TH21 (Baseline)

Parameter	TH11	TH13	TH18	TH21	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Naphthalene	0.553	0.448	0.349	<0.009	n/a	n/a
Acenaphthylene	0.391	0.053	0.0489	<0.012	n/a	n/a
Acenaphthene	1.350	0.0778	0.188	<0.008	n/a	n/a
Fluorene	1.090	0.237	0.256	<0.01	n/a	n/a
Phenanthrene	4.360	0.744	0.619	<0.015	n/a	n/a
Anthracene	2.100	0.231	0.203	<0.016	n/a	n/a
Fluoranthene	17.900	0.805	0.600	<0.017	n/a	n/a
Pyrene	14.900	0.864	0.548	<0.015	n/a	n/a
Benz(a)anthracene	5.970	0.520	0.247	<0.014	n/a	n/a
Chrysene	4.380	0.609	0.233	<0.010	n/a	n/a
Benzo(b)fluoranthene	7.800	0.553	0.227	<0.015	n/a	n/a
Benzo(k)fluoranthene	2.730	0.164	0.110	<0.014	n/a	n/a
Benzo(a)pyrene	6.930	0.322	0.239	<0.015	n/a	n/a
Indeno(1,2,3-cd)pyrene	3.490	0.166	0.144	<0.018	n/a	n/a
Dibenzo(a,h)anthracene	0.907	0.0676	<0.023	<0.023	n/a	n/a
Benzo(g,h,i)perylene	4.190	0.246	0.188	<0.024	n/a	n/a
Polyaromatic hydrocarbons, Total USEPA 16	79.100	6.110	4.300	<0.118	n/a	40

Table 9: Volatile Organic Compounds (VOCs) Soil Sample Results For Trial Holes TH11, TH13, TH18 & TH21 (Baseline)

Parameter	TH11	TH13	TH18	TH21	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Dichlorodifluoromethane	<0.004	<0.004	<0.004	<0.004	n/a	n/a
Chloromethane	<0.007	<0.007	<0.007	<0.007	n/a	n/a
Vinyl Chloride	<0.01	<0.01	<0.01	<0.01	n/a	n/a
Bromomethane	<0.013	<0.013	<0.013	<0.013	n/a	n/a
Chloroethane	<0.014	<0.014	<0.014	<0.014	n/a	n/a
Trichlorofluoromethane	<0.006	0.00236	<0.006	<0.006	n/a	n/a
1.1-Dichloroethene	<0.01	<0.01	<0.01	<0.01	-	0.3
Carbon Disulphide	0.106	0.131	0.516	<0.007	n/a	n/a
Dichloromethane	<0.01	<0.01	<0.01	<0.01	-	3.9
Methyl Tertiary Butyl Ether	<0.011	<0.011	<0.011	<0.011	n/a	n/a
trans-1-2-Dichloroethene	<0.011	<0.011	<0.011	<0.011	n/a	n/a
1.1-Dichloroethane	<0.08	<0.08	<0.08	<0.08	-	15
cis-1-2-Dichloroethene	<0.005	<0.005	<0.005	<0.005	n/a	n/a
2.2-Dichloropropane	<0.012	<0.012	<0.012	<0.012	n/a	n/a
Bromochloromethane	<0.014	<0.014	<0.014	<0.014	n/a	n/a
Chloroform	<0.008	<0.008	<0.008	<0.008	-	5.6
1.1.1-Trichloroethane	<0.007	<0.007	<0.007	<0.007	-	15
1.1-Dichloropropene	<0.011	<0.011	<0.011	<0.011	n/a	n/a
Carbontetrachloride	<0.014	<0.014	<0.014	<0.014	n/a	n/a
1.2-Dichloroethane	<0.005	<0.005	<0.005	<0.005	-	6.4
Benzene	0.0612	0.0354	<0.009	<0.009	n/a	n/a

Parameter	TH11	TH13	TH18	TH21	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Trichloroethene	<0.009	<0.009	<0.009	<0.009		2.5
1.2-Dichloropropane	<0.012	<0.012	<0.012	<0.012	n/a	n/a
Dibromomethane	<0.009	<0.009	<0.009	<0.009	n/a	n/a
Bromodichloromethane	<0.007	<0.007	<0.007	<0.007	n/a	n/a
cis-1-3-Dichloropropene	<0.014	<0.014	<0.014	<0.014	n/a	n/a
Toluene	0.0601	0.0786	0.0636	<0.005	n/a	320
trans-1-3-Dichloropropene	<0.014	<0.014	<0.014	<0.014	n/a	n/a
1.1.2-Trichloroethane	<0.01	<0.01	<0.01	<0.01	n/a	n/a
1.3-Dichloropropane	<0.007	<0.007	<0.007	<0.007	n/a	n/a
Tetrachloroethene	0.0238	<0.005	<0.005	<0.005	-	8.8
Dibromochloromethane	<0.013	<0.013	<0.013	<0.013	n/a	n/a
1.2-Dibromoethane	<0.012	<0.012	<0.012	<0.012	n/a	n/a
Chorobenzene	<0.005	<0.005	<0.005	<0.005	n/a	n/a
1.1.1.2-Tetrachloroethane	<0.01	<0.01	<0.01	<0.01	n/a	n/a
Ethylbenzene	0.0227	0.0226	0.0141	<0.004	n/a	n/a
p/m-Xylene	0.0438	0.257	0.0344	<0.014	n/a	n/a
o-Xylene	0.0323	0.029	<0.010	<0.010	n/a	n/a
Styrene	<0.01	<0.01	<0.01	<0.01	n/a	n/a
Bromoform	<0.01	<0.01	<0.01	<0.01	n/a	n/a
Isopropylbenzene	0.014	<0.005	<0.005	<0.005	n/a	n/a
1.1.2.2-Tetrachloroethane	<0.01	<0.01	<0.01	<0.01	n/a	n/a
1.2.3-Trichloropropane	<0.017	<0.017	<0.017	<0.017	n/a	n/a

Parameter	TH11	TH13	TH18	TH21	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Bromobenzene	<0.01	<0.01	<0.01	<0.01	n/a	n/a
Propylbenzene	<0.011	<0.011	<0.011	<0.011	n/a	n/a
2-Chlorotoluene	<0.009	<0.009	<0.009	<0.009	n/a	n/a
1.3.5-Trimethylbenzene	0.0396	<0.009	0.0211	<0.009	n/a	n/a
4-Chlorotoluene	<0.012	<0.012	<0.012	<0.012	n/a	n/a
tert-Butylbenzene	<0.012	<0.012	<0.012	<0.012	n/a	n/a
1.2.4-Trimethylbenzene	0.179	0.181	0.0878	<0.009	n/a	n/a
sec-Butylbenzene	0.0252	<0.01	<0.01	<0.01	n/a	n/a
4-Isopropyltoluene	0.213	<0.011	<0.011	<0.011	n/a	n/a
1.3-Dichlorobenzene	<0.006	<0.006	<0.006	<0.006	n/a	n/a
1.4-Dichlorobenzene	<0.005	<0.005	<0.005	<0.005	n/a	n/a
n-Butylbenzene	<0.01	<0.01	<0.01	<0.01	n/a	n/a
1.2-Dichlorobenzene	<0.012	<0.012	<0.012	<0.012	n/a	n/a
1.2-Dibromo-3-chloropropane	<0.014	<0.014	<0.014	<0.014	n/a	n/a
Tert-amyl methyl ether	<0.015	<0.015	<0.015	<0.015	n/a	n/a
1.2.4-Trichlorobenzene	<0.006	<0.006	<0.006	<0.006	n/a	n/a
Hexachlorobutadiene	<0.012	<0.012	<0.012	<0.012	n/a	n/a
Naphthalene	<0.013	<0.013	<0.013	<0.013	n/a	n/a
1.2.3-Trichlorobenzene	<0.006	<0.006	<0.006	<0.006	n/a	n/a

3.6.2 Groundwater Results

The groundwater samples were analysed for a range of organic and inorganic parameters specified in the EPA Landfill monitoring Table d.1 guideline minimum reporting values.

The full laboratory test report is in Appendix C and the results are summarised in Tables 10 - 21. Included in the Table are draft Interim Guideline Values (IGV) published by the Environmental Protection Agency (EPA). The EPA IGV limits are proposed water quality standards and are set out in the EPA publication "Towards Setting Guideline Values For Protection of Groundwater In Ireland" – Interim Report. The IGVs are based on likely requirements for water quality that will come into force under amendments to the EU Water Framework Directive in the form of a Groundwater Directive which will have to be adopted by all member states. Groundwater samples were also compared to the Dutch reference and intervention values.

Dutch Standards are environmental pollutant reference values (i.e., concentrations in environmental medium) used in environmental remediation, investigation and cleanup. Groundwater target values provide an indication of the benchmark for environmental quality in the long term, assuming that there are negligible risks for the ecosystem.

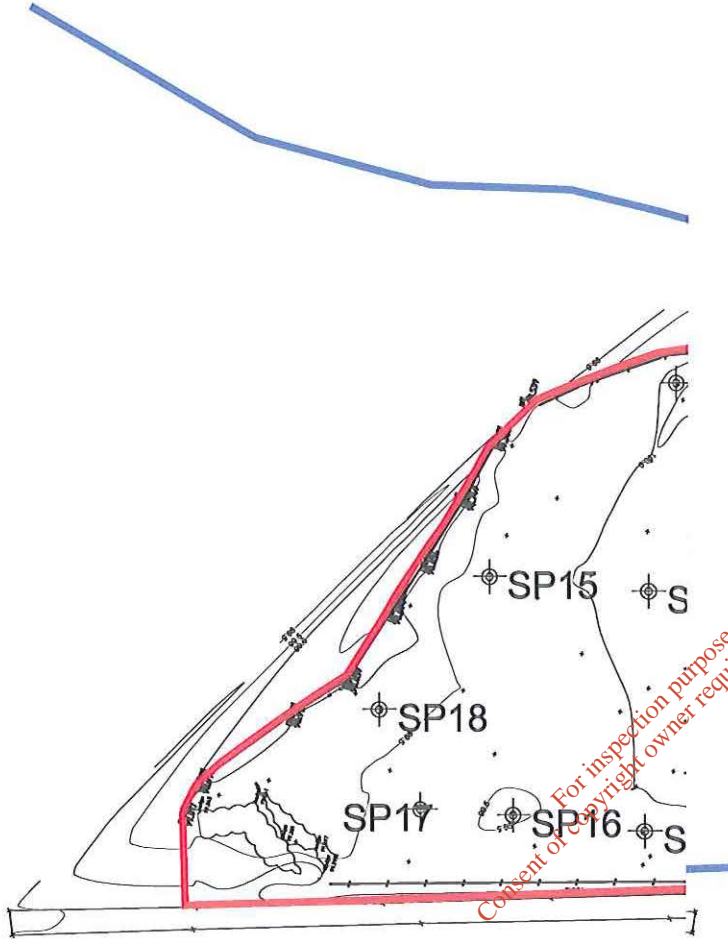
Ammoniacal Nitrogen as N exceeded IGV values for TH3, TH6, TH8, TH11, TH15, TH18, TH21. Conductivity exceeded the IGV limit for TH3, TH8 and TH11. Chloride exceeded the IGV limit for TH15 and TH18. Manganese exceeded the IGV limit for all trial holes with the highest Manganese result achieved in TH11. Nickel exceeded the Dutch reference value for TH13. Chromium exceeded the Dutch Reference value for TH11, TH15 and TH18.

Phenols and Cresols exceeded the Dutch reference values for TH11. Mineral oil >C10 C40 (aq) exceeded the Dutch Intervention value for TH3, TH6, TH8, TH11, TH13 and TH18. EPH Range >C10 - C40 (aq) exceeded the Dutch Reference values for TH3, TH8, TH13, TH15 and Dutch intervention value for TH6 and TH11.

The United States Environmental Protection Agency (USEPA) has designated 16 PAH compounds as priority pollutants, this is known as Polyaromatic hydrocabons Total USEPA 16. They are naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]flouranthene, benzo[a]pyrene, dibenz(ah)anthracene, benzo[ghi]perylene, and indeno(1,2,3-cd)pyrene.

Naphthalene (aq) exceeded the Dutch reference value in TH 6. IGV limit was exceeded in TH11. Fluoranthene (aq) exceeded the Dutch intervention value for TH8 and TH11. Dutch reference values exceeded in TH13 and TH15. Anthracene exceeded Dutch intervention value in TH11. Chrysene exceeded the Dutch reference value in TH6, TH8 and TH15 and intervention values in TH11. Benzo (a) anthracene (aq) exceeded the Dutch intervention value in TH11 and reference values in TH13 and TH15. Benzo (b) Fluoranthene (aq) exceeded the dutch intervention values for TH8 and TH11 and the IGV limit for TH6. Benzo (a) pyrene (aq) exceeded the Dutch Reference values in TH3 and TH13 and TH15. Dutch intervention values were exceeded in TH6, TH8 and TH11. Benzo(g,h,i) perylene exceeded the dutch intervention values for TH6, TH8 and TH11. Indeno (1,2,3-cd) pyrene (aq) exceeded dutch intervention value for TH6, TH8, TH11. Polyaromatic hydrocabons Total USEPA 16 exceeded the IGV limits for TH3, TH6, TH8, TH11, TH13, TH15 and TH18. The analytical data suggests that the waste material on site has not had a negative impact on the groundwater downgradient of the site as shown in TH21.

NOTES



- OPEN DRAINS
- SITE BOUNDARY
- ⊗ SP1 GROUND WATER SAMPLING POINT
- GROUND WATER FLOW DIRECTION

GROUND WATER SAMPLING POINTS
SCALE 1:1000

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REV.	DATE	DESCRIPTION	APPROVED

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CLIENT
CAVAN COUNTY COUNCIL

PROJECT TITLE
SITE INVESTIGATION & RISK ASSESSMENT OF EXISTING HISTORIC LANDFILL SITE AT RANTAVAN, MULLAGH, CO CAVAN

DRAWING TITLE
GROUNDWATER MONITORING LOCATIONS

SCALE	DRAWN	CHECKED	APPROVED
1:1000	PAURIC LOUGHLIN	PADRAIG JORDAN	NEVIN TRAYNOR
	DATE	DATE	DATE
	NOVEMBER 2010	NOVEMBER 2010	NOVEMBER 2010

DRAWING No.	REV.
10-198-013	

Groundwater Results Legend

	Result Exceeded Interim Guideline Value (IGV)
	Result Exceeded Dutch Intervention Values Reference Value
	Result Exceeded Dutch Intervention Values Intervention Value
	Result did not exceed IGV or Dutch Intervention Values

Table 10: Total Organic Carbon – Groundwater Samples Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Total Organic Carbon	17.6	55.6	22.8	107	17.8	19.3	19.1	35.7	No change	n/a	n/a

Table 11: Inorganics – Groundwater Samples Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Alkalinity, Total as CaCO ₃	500	394	488	597	445	296	242	109	No change	n/a	n/a
BOD, unfiltered	2.65	36.4	1.99	89.6	2.05	1.99	<1	1.31	n/a	n/a	n/a
Ammoniacal Nitrogen as N	18.5	5.13	17.9	28	14.6	2.84	3.89	0.544	0.15mg/l	n/a	n/a
Ammonia, Free / unionised as N	0.953	0.339	0.924	1.86	0.752	0.312	0.371	<0.2	0.15mg/l	n/a	n/a
Fluoride	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.0mg/l	n/a	n/a
Conductivity @ 20 deg.C	1.04	0.697	1.14	1.08	0.931	0.594	0.497	0.264	1.00 mS/cm	n/a	n/a
Dissolved solids, Total (meter)	847	576	925	875	765	483	401	211	1000mg/l	n/a	n/a
Sulphate	<3	<3	28.7	16.1	<3	6.5	<3	41	30 mg/l	n/a	n/a
Chloride	16.3	6.6	11.3	12.5	16.7	34.6	34.4	2.8	30 mg/l	n/a	n/a

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Phosphate (ortho) as PO4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	n/a	n/a	n/a
Total Oxidised Nitrogen as N	0.551	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	n/a	n/a	n/a
Cyanide, Total	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.01mg/l	5 mg/l	1.50 mg/l
pH	8.16	8.18	8.08	8.13	8.12	8.51	8.39	7.96	≥ 6.5 and ≤ 9.5	n/a	n/a

Table 12: Filtered (Dissolved) Metals Groundwater Sample (mg/l) Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Arsenic (diss.filt)	0.0012	0.0011	0.0013	0.0024	0.000806	0.00064	0.00057	0.00149	0.01mg/l	0.01 mg/l	0.06 mg/l
Boron (diss.filt)	0.247	0.0346	0.247	0.125	0.259	0.126	0.0914	0.0286	1.0mg/l	n/a	n/a
Cadmium (diss.filt)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.005mg/l	0.0004 mg/l	0.006 mg/l
Copper (diss.filt)	0.00145	0.0018	0.000884	<0.00085	<0.00085	0.00146	<0.0008	0.0257	0.03mg/l	0.015 mg/l	0.075 mg/l
Lead (diss.filt)	0.000037	<0.00002	<0.00002	0.000349	<0.00002	0.000214	0.000076	0.000308	0.01mg/l	0.015 mg/l	0.075 mg/l
Manganese (diss.filt)	0.611	1.030	1.470	2.800	0.839	0.658	0.912	2.020	0.05mg/l	n/a	n/a
Nickel (diss.filt)	0.00838	0.00461	0.0107	0.0102	0.0176	0.00461	0.00384	0.00422	0.02mg/l	0.015 mg/l	0.075 mg/l
Zinc (diss.filt)	0.00974	0.00312	0.0163	0.0158	0.00528	0.0292	0.00937	0.00142	0.1mg/l	0.065 mg/l	0.80 mg/l
Mercury (diss.filt)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.000014	0.001	0.00005 mg/l	0.0003 mg/l
Calcium (diss.filt)	0.163	0.138	0.217	0.139	0.166	0.108	0.0811	0.0325	200mg/l	n/a	n/a
Sodium (diss.filt)	0.0322	0.013	0.0184	0.0411	0.0144	0.0165	0.0181	0.00813	150mg/l	n/a	n/a
Magnesium (diss.filt)	0.0205	0.0109	0.0191	0.025	0.0162	0.00826	0.0074	0.0126	50mg/l	n/a	n/a
Potassium (diss.filt)	0.0257	0.0094	0.0239	0.0289	0.0188	0.00645	0.00463	<0.00234	5mg/l	n/a	n/a
Iron (diss.filt)	<0.000019	<0.000019	<0.000019	0.00515	<0.000019	0.000387	0.00148	0.000166	0.2mg/l	n/a	n/a

Table 13: Unfiltered (Total) Metals Groundwater Sample (mg/l) Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Chromium (tot.unfilt)	0.00339	0.00348	0.00546	0.0269	<0.003	0.00459	0.0041	0.00131	0.03mg/l	0.001 mg/l	0.03 mg/l

Table 14: Phenols (mg/l) Groundwater Sample (mg/l) Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Phenol	<0.002	<0.002	<0.002	0.05	<0.002	<0.002	<0.002	<0.002	0.0005 mg/l	0.0002 mg/l	2.0 mg/l
Cresols	<0.006	<0.006	<0.006	0.01	<0.006	<0.006	<0.006	<0.006	n/a	0.0002 mg/l	0.20 mg/l
Xylenols	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	n/a	n/a	n/a
2,3,5-Trimethylphenol	<0.003	<0.003	<0.003	0.01	<0.003	<0.003	<0.003	<0.003	n/a	n/a	n/a
2-Isopropylphenol	<0.006	<0.006	<0.006	0.2	<0.006	<0.006	<0.006	<0.006	n/a	n/a	n/a
Phenols, Total 5 speciated	<0.025	<0.025	<0.025	0.27	<0.025	<0.025	<0.025	<0.025	n/a	n/a	n/a

Table 15: Mineral Oil / Oils & Greases Groundwater Samples (mg/l) Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Mineral oil >C10 C40 (aq)	0.923	1.740	0.0953	3.660	0.795	<0.01	0.800	<0.01	0.01mg/l	0.05 mg/l	0.06 mg/l

Table 16: Extractable Petroleum Hydrocarbons (EPH) Groundwater Samples (mg/l) Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
EPH Range >C10 - C40 (aq)	1.390	2.490	0.241	2.860	1.460	0.303	1.350	<0.046	n/a	0.0002 mg/l	2.0 mg/l

Table 17: Polyaromatic Hydrocarbons (PAHs) Groundwater Samples (mg/l) Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Naphthalene (aq)	<0.0001	0.000176	<0.0001	0.00364	<0.0001	<0.0001	0.000119	0.000109	0.001mg/l	0.00001 mg/l	0.07 mg/l
Acenaphthene (aq)	0.000056	0.000039	0.000024	0.000631	0.000088	<0.000015	<0.00015	<0.000015	n/a	n/a	n/a
Acenaphthylene (aq)	<0.000011	0.000025	<0.000011	0.00026	<0.000011	<0.000011	<0.000011	<0.000011	n/a	n/a	n/a
Fluoranthene (aq)	0.000021	0.000087	0.000173	0.00128	0.000044	0.000041	<0.000014	<0.000014	n/a	0.000007 mg/l	0.0001 mg/l
Anthracene (aq)	<0.000015	0.000023	<0.000015	0.000228	<0.000015	<0.000015	<0.000015	<0.000015	10 mg/l	0.0000007 mg/l	0.00005 mg/l
Phenanthrene (aq)	0.000032	0.000121	0.000029	0.000976	0.000026	<0.000022	<0.000022	<0.000022	n/a	n/a	n/a
Fluorene (aq)	0.000039	0.000199	0.000015	0.000905	0.000061	<0.000014	<0.000014	<0.000014	n/a	n/a	n/a
Chrysene (aq)	<0.000013	0.000061	0.000092	0.000892	<0.000013	0.000025	<0.000013	<0.000013	n/a	0.000003 mg/l	0.0002 mg/l
Pyrene (aq)	0.00003	0.000106	0.000213	0.00126	0.000056	0.000051	0.00008	<0.000015	n/a	n/a	n/a
Benzo(a)anthracene (aq)	0.00002	0.000069	0.000138	0.000694	0.000028	0.000038	0.000036	<0.000017	n/a	0.0000001 mg/l	0.0005 mg/l
Benzo(b)fluoranthene (aq)	<0.000023	0.000049	0.00015	0.000944	<0.000023	<0.000023	<0.000023	<0.000023	0.0005mg/l	0.0000004 mg/l	0.00005 mg/l
Benzo(k)fluoranthene (aq)	<0.000027	0.000117	0.00016	0.000809	<0.000027	<0.000027	<0.000027	<0.000027	n/a	n/a	n/a
Benzo(a)pyrene (aq)	0.000011	0.000113	0.000186	0.00102	0.000023	0.000027	0.000012	<0.000009	0.00001mg/l	0.0000005 mg/l	0.00005 mg/l
Dibenzo(a,h)anthracene (aq)	<0.000016	<0.000016	0.000037	0.000263	<0.000016	<0.000016	<0.000016	<0.000016	n/a	n/a	n/a
Benzo(g,h,i)perylene (aq)	<0.000016	0.000053	0.000134	0.000968	0.000018	0.000027	0.000026	<0.000016	0.00005mg/l	0.0000003 mg/l	0.00005 mg/l
Indeno(1,2,3-cd)pyrene (aq)	<0.000014	0.000057	0.000127	0.000817	0.000015	0.00002	0.000022	<0.000014	0.00005mg/l	0.0000004 mg/l	0.00005 mg/l
Polyaromatic hydrocarbons, Total USEPA 16 (aq)	0.000208	0.00129	0.00148	0.0156	0.000359	0.000243	0.000293	0.000109	0.0001mg/l	n/a	n/a

Table 18: Semi-Volatile Organic Compounds (SVOC), Groundwater Samples (mg/l) Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
1,2,4-Trichlorobenzene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0004 mg/l	n/a	n/a
1,2-Dichlorobenzene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01 mg/l	n/a	n/a
1,3-Dichlorobenzene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01 mg/l	n/a	n/a
1,4-Dichlorobenzene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01 mg/l	n/a	n/a
2,4,5-Trichlorophenol (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0004 mg/l	n/a	n/a
2,4,6-Trichlorophenol (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
2,4-Dichlorophenol (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
2,4-Dimethylphenol (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
2,4-Dinitrotoluene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
2,6-Dinitrotoluene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
2-Chloronaphthalene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
2-Chlorophenol (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.2 mg/l	n/a	n/a
2-Methylnaphthalene (aq)	<0.001	<0.001	<0.001	0.0013	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
2-Methylphenol (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
2-Nitroaniline (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
2-Nitrophenol (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
3-Nitroaniline (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
4-Bromophenylphenylether (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
4-Chloro-3-methylphenol (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
4-Chloroaniline (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
4-Chlorophenylphenylether (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
4-Methylphenol (aq)	<0.001	<0.001	<0.001	0.00236	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
4-Nitrophenol (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
4-Nitroaniline (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Azobenzene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Acenaphthylene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Acenaphthene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Anthracene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
bis(2-Chloroethyl)ether (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
bis(2-Chloroethoxy)methane (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
bis(2-Ethylhexyl) phthalate (aq)	<0.002	<0.002	<0.002	<0.002	<0.003	<0.002	<0.005	<0.002	n/a	n/a	n/a
Benzo(a)anthracene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	0.0000001mg/l	0.00005 mg/l
Butylbenzyl phthalate (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Benzo(b)fluoranthene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Benzo(k)fluoranthene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	0.0000004 mg/l	0.00005 mg/l
Benzo(a)pyrene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	0.0000005mg/l	0.00005 mg/l
Benzo(g,h,i)perylene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	0.0000003 mg/l	0.00005 mg/l
Carbazole (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Chrysene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	0.000003 mg/l	0.0002 mg/l
Dibenzofuran (aq)	<0.001	<0.001	<0.001	0.00116	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
n-Dibutyl phthalate (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Diethyl phthalate (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Dibenzo(a,h)anthracene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Dimethyl phthalate (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
n-Dioctyl phthalate (aq)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	n/a	n/a	n/a
Fluoranthene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Fluorene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Hexachlorobenzene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.00003 mg/l	n/a	n/a
Hexachlorobutadiene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01 mg/l	n/a	n/a
Pentachlorophenol (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002 mg/l	n/a	n/a
Phenol (aq)	<0.001	<0.001	<0.001	0.0527	<0.001	<0.001	<0.001	<0.001	0.0005 mg/l	0.0002 mg/l	2.0 mg/l
n-Nitroso-n-dipropylamine (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Hexachloroethane (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Nitrobenzene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Naphthalene (aq)	<0.001	<0.001	<0.001	0.00335	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Isophorone (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Hexachlorocyclopentadiene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Phenanthrene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Indeno(1,2,3-cd)pyrene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Pyrene (aq)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a

Table 19: Volatile Organic Compounds (VOCs) Groundwater Samples (mg/l) Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Dibromofluoromethane**	114	106	102	103	102	101	102	102	n/a	n/a	n/a
Toluene-d8**	99.5	100	99.1	98.4	98.8	98.3	99.4	99.9	n/a	n/a	n/a
4-Bromofluorobenzene**	102	103	99	97.8	98.8	97.6	98.9	99.7	n/a	n/a	n/a
Dichlorodifluoromethane	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	n/a	n/a	n/a
Chloromethane	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	n/a	n/a	n/a
Vinyl chloride	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	n/a	n/a	n/a
Bromomethane	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	n/a	n/a	n/a
Chloroethane	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	n/a	n/a	n/a
Trichlorofluoromethane	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	n/a	n/a	n/a
1,1-Dichloroethene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	n/a	n/a	n/a
Carbon disulphide	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	n/a	n/a	n/a
Dichloromethane	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037	n/a	0.00001 mg/l	1.00 mg/l
Methyl tertiary butyl ether (MTBE)	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	n/a	n/a	n/a
trans-1,2-Dichloroethene	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	n/a	n/a	n/a
1,1-Dichloroethane	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	n/a	0.007 mg/l	0.9 mg/l
cis-1,2-Dichloroethene	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	n/a	n/a	n/a
2,2-Dichloropropane	<0.0038	<0.0038	<0.0038	<0.0038	<0.0038	<0.0038	<0.0038	<0.0038	n/a	n/a	n/a
Bromochloromethane	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	n/a	n/a	n/a
Chloroform	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	n/a	0.006 mg/l	0.4 mg/l
1,1,1-Trichloroethane	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	n/a	0.00001 mg/l	0.3 mg/l
1,1-Dichloropropene	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	n/a	n/a	n/a

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Carbontetrachloride	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014	n/a	n/a	n/a
1,2-Dichloroethane	<0.0033	<0.0033	<0.0033	<0.0033	<0.0033	<0.0033	<0.0033	<0.0033	n/a	0.007 mg/l	0.4 mg/l
Benzene	0.00175	0.0142	<0.0013	0.00987	<0.0013	<0.0013	<0.0013	<0.0013	n/a	n/a	n/a
Trichloroethene	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	n/a	0.006 mg/l	0.5 mg/l
1,2-Dichloropropane	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	n/a	n/a	n/a
Dibromomethane	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	n/a	n/a	n/a
Bromodichloromethane	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	n/a	n/a	n/a
cis-1,3-Dichloropropene	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	n/a	n/a	n/a
Toluene	<0.0014	<0.0014	<0.0014	0.00303	<0.0014	<0.0014	<0.0014	<0.0014	n/a	n/a	n/a
trans-1,3-Dichloropropene	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	n/a	n/a	n/a
1,1,2-Trichloroethane	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	n/a	0.00001	0.13
1,3-Dichloropropane	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	n/a	n/a	n/a
Tetrachloroethene	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	n/a	n/a	n/a
Dibromochloromethane	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	n/a	n/a	n/a
1,2-Dibromoethane	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	n/a	n/a	n/a
Chlorobenzene	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	n/a	n/a	n/a
1,1,1,2-Tetrachloroethane	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	n/a	n/a	n/a
Ethylbenzene	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	n/a	n/a	n/a
m,p-Xylene	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	n/a	n/a	n/a
o-Xylene	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	n/a	n/a	n/a
Styrene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	n/a	n/a	n/a

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Bromoform	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	n/a	n/a	n/a
Isopropylbenzene	0.00158	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014	n/a	n/a	n/a
1,1,2,2-Tetrachloroethane	<0.0052	<0.0052	<0.0052	<0.0052	<0.0052	<0.0052	<0.0052	<0.0052	n/a	n/a	n/a
1,2,3-Trichloropropane	<0.0078	<0.0078	<0.0078	<0.0078	<0.0078	<0.0078	<0.0078	<0.0078	n/a	n/a	n/a
Bromobenzene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	n/a	n/a	n/a
Propylbenzene	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	n/a	n/a	n/a
2-Chlorotoluene	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	n/a	n/a	n/a
1,3,5-Trimethylbenzene	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	n/a	n/a	n/a
4-Chlorotoluene	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	n/a	n/a	n/a
tert-Butylbenzene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	n/a	n/a	n/a
1,2,4-Trimethylbenzene	<0.0017	<0.0017	<0.0017	0.00272	0.00233	<0.0017	<0.0017	<0.0017	n/a	n/a	n/a
sec-Butylbenzene	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	n/a	n/a	n/a
4-iso-Propyltoluene	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	n/a	n/a	n/a
1,3-Dichlorobenzene	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	n/a	n/a	n/a
1,4-Dichlorobenzene	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	n/a	n/a	n/a
n-Butylbenzene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	n/a	n/a	n/a
1,2-Dichlorobenzene	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037	n/a	n/a	n/a
1,2-Dibromo-3-chloropropane	<0.0098	<0.0098	<0.0098	<0.0098	<0.0098	<0.0098	<0.0098	<0.0098	n/a	n/a	n/a
1,2,4-Trichlorobenzene	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	n/a	n/a	n/a
Hexachlorobutadiene	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	n/a	n/a	n/a
tert-Amyl methyl ether (TAME)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Naphthalene	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	n/a	n/a	n/a
1,2,3-Trichlorobenzene	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	n/a	n/a	n/a
1,3,5-Trichlorobenzene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	n/a	n/a	n/a

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Table 20: Phenoxy Acid Herbicides Groundwater Samples (mg/l) Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Phenoxyacetic acid (PAA)	<0.000031	0.000033	<0.000031	0.000176	<0.00003	<0.000031	<0.000031	<0.000031	n/a	n/a	n/a
Dicamba	<0.00033	<0.000033	<0.00033	<0.00033	<0.00003	<0.000033	<0.000033	<0.000033	n/a	n/a	n/a
Phenoxypropionic acid (PPA)	<0.000023	<0.000023	<0.000023	<0.00002	<0.00002	<0.000023	<0.000023	<0.000023	n/a	n/a	n/a
4-Chlorophenoxyacetic acid (4-CPA)	<0.000037	<0.000037	<0.000037	<0.00003	<0.00003	<0.000037	<0.000037	<0.000037	n/a	n/a	n/a
4-Phenoxybutyric acid	<0.000019	<0.000019	<0.000019	<0.00001	<0.00001	<0.000019	<0.000019	<0.000019	n/a	n/a	n/a
Bentazone	0.000018	0.000018	0.000018	0.000018	0.000018	0.000018	0.000018	0.000018	n/a	n/a	n/a
Bromoxynil	<0.000022	<0.000022	<0.000022	<0.00002	<0.00002	<0.000022	<0.000022	<0.000022	n/a	n/a	n/a
2,4-Dichlorophenoxy acetic acid (2,4-D)	<0.000026	<0.000026	<0.000026	<0.00002	<0.00002	<0.000026	<0.000026	<0.000026	n/a	n/a	n/a
2-methyl-4 Chlorophenoxyacetic acid (MCPA)	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	n/a	n/a	n/a
2-methyl-4,6-Dinitrophenol	<0.000041	<0.000041	<0.000041	<0.00004	<0.00004	<0.000041	<0.000041	<0.000041	n/a	n/a	n/a
Triclopyr	<0.000022	<0.000022	<0.000022	<0.00002	<0.00002	<0.000022	<0.000022	<0.000022	n/a	n/a	n/a
loxynil	<0.000017	<0.000017	<0.000017	<0.00001	<0.00001	<0.000017	<0.000017	<0.000017	n/a	n/a	n/a
2,4-Dichlorophenoxy acetic acid (2,4-DP)	0.000045	0.000046	0.000016	0.00025	0.000017	<0.000015	<0.000015	<0.000015	n/a	n/a	n/a
2,4,5-Trichlorophenol (2,4,5-T)	<0.000029	<0.000029	<0.000029	<0.00002	<0.00002	<0.000029	<0.000029	<0.000029	n/a	n/a	n/a
Mecoprop (MCPP)	0.00206	0.000103	0.00106	0.0018	0.00626	0.000224	0.000029	<0.000025	n/a	n/a	n/a
4-(2,4-Dichlorophenoxy) butyric acid (2,4-D)	<0.000022	<0.000022	<0.000022	<0.00002	<0.00002	<0.000022	<0.000022	<0.000022	n/a	n/a	n/a
4-(4-Chloro-o-tolyloxy) butyric acid (MCPB)	<0.000029	<0.000029	<0.000029	<0.00002	<0.00002	<0.000029	<0.000029	<0.000029	n/a	n/a	n/a
2-(2,4,5-Trichlorophenoxy) propionic acid	<0.000024	<0.000024	<0.000024	<0.00002	<0.00002	<0.000024	<0.000024	<0.000024	n/a	n/a	n/a
Dinoseb	<0.000027	<0.000027	<0.000027	<0.00002	<0.00002	<0.000027	<0.000027	<0.000027	n/a	n/a	n/a
Pentachlorophenol	<0.000032	<0.000032	<0.000032	<0.00003	<0.00003	<0.000032	<0.000032	<0.000032	n/a	0.00004 mg/l	0.003 mg/l

Table 21: Combined Pesticides / Herbicides Grounwater Samples (mg/l) Results

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Atrazine	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.09mg/l	n/a	n/a
Simazine	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n/a	n/a	n/a
Dichlorvos	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Mevinphos	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Tecnazene	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Hexachlorobenzene	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Trifluralin	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
alpha-Hexachlorocyclohexane (HCH / Lindane)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Quintozene (PCNB)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Diazinon	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Triallate	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Etrimphos	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
gamma-Hexachlorocyclohexane (HCH / Lindane)	0.000293	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.005mg/l	n/a	n/a
Disulfoton	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000001	n/a	n/a
Propetamphos	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Heptachlor	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Chlorpyriphos methyl	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Dimethoate	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	n/a	n/a
Aldrin	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Chlorothalonil	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a

Parameter	TH3	TH6	TH8	TH11	TH13	TH15	TH18	TH21	Interim Guideline Value	Dutch Intervention Values Reference Value	Dutch Intervention Values Intervention Value
Pirimiphos-methyl	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
beta-Hexachlorocyclohexane (HCH / Lindane)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Endosulphan II	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
p,p-DDT	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000061	<0.00001	<0.00001	n/a	n/a	n/a
Carbophenothion	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
o,p-Methoxychlor	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Triazophos	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
p,p-Methoxychlor	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Endosulphan sulphate	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Permethrin	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.02 mg/l	n/a	n/a
Phosalone	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Permethrin II	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Azinphos-methyl	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a
Azinphos-ethyl	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	n/a	n/a	n/a

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3.6.3 Surface Water Sampling Results

The watercourse/drain, which flows along the boundary, is between 3m and 4m deep at the highest point on site below the waste fill area.

Given the direction of groundwater flow from northwest to southeast there is the potential for leachate to enter the river either via shallow groundwater recharge, or as surface water run-off from the landfill to the adjacent streams.

Surface water samples were taken in the stream at 4No. Locations on 13th October 2010. SW-1 sampling location was located north of the site and SW-2 sampling point was taken upstream of the historic landfill. SW-3 sampling point was taken downstream of the waste body itself and the drain that feeds into it. SW4 was taken downstream of the site after the historic landfill. Location of the sampling points can be seen on Drawing No. 10-198-014. Farmyards, wastewater treatment systems/septic tanks and diffuse sources appear to be discharging into the watercourse/drain upstream of the landfill site and could mask the impact of any leachate arising on site.

The surface water samples were collected in accordance with Traynor Environmental sampling protocols and were placed in laboratory prepared containers and stored in a cooler. Field measurement and observations recorded at the time of sampling are presented in Table 22. The samples were sent for analysis to Alcontrol Laboratories.

The samples were analysed for a range of organic and inorganic parameters that included pH, electrical conductivity, dissolved oxygen, ammonia, nitrite, nitrate, orthophosphate, potassium, sodium, chloride, sulphate, heavy metals to include (arsenic, antimony, barium, cadmium, chromium, copper, Fluoride, mercury, manganese, molybdenum, nickel, lead, selenium and zinc), cyanide, Volatile Organic Compounds (VOC), Total Petroleum Hydrocarbons (Diesel Range Organics(DRO), MTBE, Petrol Range Organics (PRO)), Phenols, total pesticides.

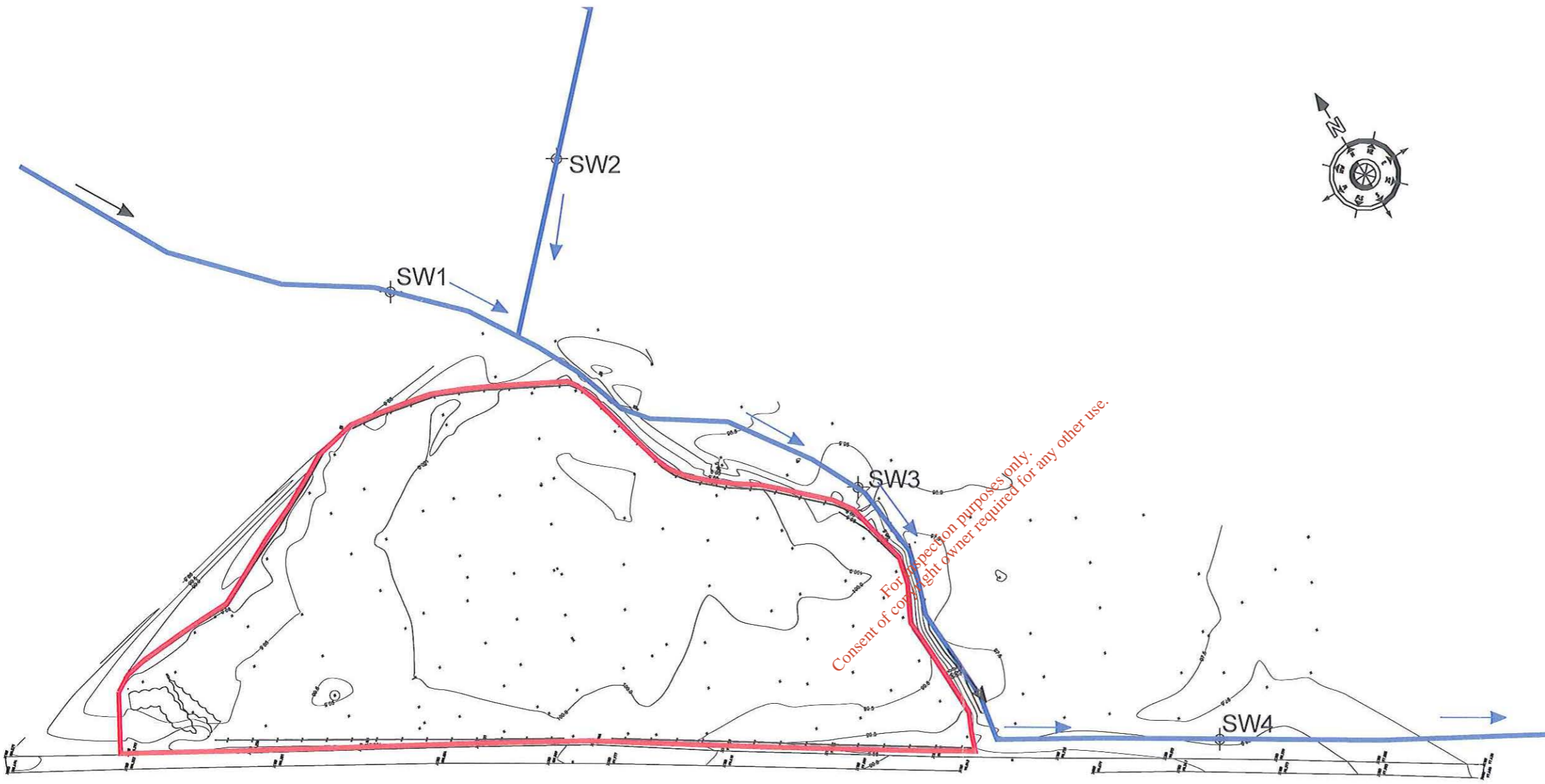
The laboratory test report is contained in Appendix C and the results are summarised in Tables 22-34. The tables include for comparative purposes Environmental Quality Standards (EQS) published by the EPA. The EQS limits are proposed water quality standards and are derived from the EU Directive on Drinking Water Quality 80/778/EEC and the Directive on the Protection of Groundwater against pollution caused by certain dangerous substances 80/66/EEC.

pH results varied in the different sampling locations. pH readings varied between 6.42 (SW-1) and 8.04 (SW-4). BOD prior to the site at SW-1 was 7.13mg/l, upgradient of the site (SW-2) 29.9mg/l and alongside the site (SW3) 69.40 mg/l. BOD result down-gradient of the site at SW-4 was very low with a result of 4.29mg/l.

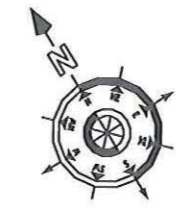
Manganese exceeded the EQS for surface water monitoring locations SW-2 and SW-3 with results of 0.484mg/l and 2.690mg/l respectively. Chromium exceeded the EQS for surface water monitoring location SW-3. Cresols was detected in Sw2 at a low level.

All other parameter analysed for were below their respective EQS or method detection limits. The results would indicate that the historic landfill is having a negligible impact on the water quality downstream of the site.

NOTES



- OPEN DRAINS
- SITE BOUNDARY
- ⊕ SW1 SURFACE WATER MONITORING POINT
- SURFACE WATER FLOW DIRECTION



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SURFACE WATER MONITORING POINTS
SCALE 1:1000

REV.	DATE	DESCRIPTION	APPROVED

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CLIENT
CAVAN COUNTY COUNCIL

PROJECT TITLE
SITE INVESTIGATION & RISK ASSESSMENT OF EXISTING HISTORIC LANDFILL SITE AT RANTAVAN, MULLAGH, CO CAVAN

DRAWING TITLE
SURFACEWATER MONITORING POINTS

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	DATE	DATE	DATE
	NOVEMBER 2010	NOVEMBER 2010	NOVEMBER 2010

DRAWING No.	REV.
10-198-014	

Table 22: Surface Water Monitoring Field Measurements

Surface Water Sampling Point	SW-1	SW-2	SW-3	SW-4
pH	7.60	6.42	7.04	8.04
Electrical Conductivity	0.223	0.193	0.275	0.39
Colour	Light brown	Clear	Dark Brown/Orange	Clear

Table 23: Organic Carbon (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Organic Carbon, Total	28.7	51.7	38.9	23	-

Table 24: Inorganics (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Alkalinity, Total as CaCO ₃	66	48.5	111	18	-
BOD, unfiltered	7.13	29.9	69.4	4.29	-
Ammonia, Free / unionised as N	<0.2	<0.2	<0.2	<0.2	0.02 NH ₃
Fluoride	<0.5	1.3	1.38	<0.5	5.0mg/l
Conductivity @ 20 deg.C	0.223	0.193	0.275	0.39	1.0 mS/cm
Dissolved solids, Total (meter)	180	155	205	313	-
Sulphate	19.2	<3	5.6	3.9	250 mg/l
Chloride	17	38.9	33.2	20.7	250 mg/l
Phosphate (ortho) as PO ₄	0.547	0.084	0.371	<0.05	-
Total Oxidised Nitrogen as N	3.46	<0.1	<0.1	2.46	-
Cyanide, Total	<0.05	<0.05	<0.05	<0.05	0.01mg/l
pH	7.6	6.42	7.04	8.04	6.5 and 9.5

Table 25: Filtered (Dissolved) Metals – (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Arsenic (diss.filt)	0.00133	0.00144	0.00192	0.00084	0.025mg/l
Boron (diss.filt)	0.0191	0.0177	0.0273	0.0443	2.0mg/l
Cadmium (diss.filt)	<0.0001	<0.0001	<0.0001	<0.0001	0.005mg/l
Copper (diss.filt)	0.00458	0.00184	0.00172	0.00151	0.03mg/l
Lead (diss.filt)	0.000188	0.00181	0.00207	0.000081	0.01mg/l
Manganese (diss.filt)	0.0111	0.484	2.690	0.012	0.3mg/l
Nickel (diss.filt)	0.00392	0.00186	0.00326	0.00261	0.05mg/l
Zinc (diss.filt)	0.00268	0.00316	0.0034	0.000795	0.1mg/l
Mercury (diss.filt)	<0.00001	0.0000117	<0.00001	<0.00001	0.001mg/l
Calcium (diss.filt)	28.4	17.3	26	53.1	-
Sodium (diss.filt)	14.6	19.4	18	17.5	-
Magnesium (diss.filt)	4.55	4.27	5.37	12.3	-
Potassium (diss.filt)	7.09	2.52	6.07	6.58	-
Iron (diss.filt)	0.55	10.8	17.5	0.435	-

Table 26: Unfiltered (Total) Metals (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Chromium (tot.unfilt)	0.0101	-	0.0327	0.00362	0.03mg/l

Table 27: Phenols (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Phenol	<0.002	<0.002	<0.002	<0.002	-
Cresols	<0.006	0.01	<0.006	<0.006	-
Xylenols	<0.008	<0.008	<0.008	<0.008	-
2,3,5-Trimethylphenol	<0.003	<0.003	<0.003	<0.003	-
2-Isopropylphenol	<0.006	<0.006	<0.006	<0.006	-
Phenols, Total 5 speciated	<0.025	<0.025	<0.025	<0.025	-

Table 28: Mineral Oil / Oils & Greases (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Mineral oil >C10 C40 (aq)	<0.010	<0.010	<0.010	<0.010	0.01mg/l

Table 29: Extractable Petroleum Hydrocarbons (EPH) (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
EPH Range >C10 - C40 (aq)	<0.046	<0.046	<0.046	<0.046	0.01mg/l

Table 30: Polyaromatic Hydrocarbons (PAHs) (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Naphthalene (aq)	<0.0001	<0.0001	<0.0001	<0.0001	n/a
Acenaphthene (aq)	<0.000015	<0.000015	<0.000015	<0.000015	n/a
Acenaphthylene (aq)	<0.000011	<0.000011	<0.000011	<0.000011	n/a
Fluoranthene (aq)	<0.000015	<0.000014	<0.000014	<0.000014	n/a
Anthracene (aq)	<0.000015	<0.000015	<0.000015	<0.000015	n/a
Phenanthrene (aq)	<0.000022	<0.000022	<0.000022	<0.000022	n/a
Fluorene (aq)	<0.000014	<0.000014	<0.000014	<0.000014	n/a
Chrysene (aq)	0.0000144	<0.000013	<0.000013	<0.000013	n/a
Pyrene (aq)	0.0000177	<0.000015	<0.000015	<0.000015	n/a
Benzo(a)anthracene (aq)	0.0000263	<0.000017	<0.000017	<0.000017	n/a
Benzo(b)fluoranthene (aq)	<0.000023	<0.000023	<0.000023	<0.000023	n/a
Benzo(k)fluoranthene (aq)	<0.000027	<0.000027	<0.000027	<0.000027	n/a
Benzo(a)pyrene (aq)	0.0000152	<0.000009	<0.000009	<0.000009	n/a
Dibenzo(a,h)anthracene (aq)	<0.000016	<0.000016	<0.000016	<0.000016	n/a
Benzo(g,h,i)perylene (aq)	<0.000016	<0.000016	<0.000016	<0.000016	n/a
Indeno(1,2,3-cd)pyrene (aq)	<0.000014	<0.000014	<0.000014	<0.000014	n/a
Polyaromatic hydrocarbons, Total USEPA 16 (aq)	<0.0001	<0.0001	<0.0001	<0.0001	0.0002 mg/l

Table 31: Semi-Volatile Organic Compounds (SVOCs) (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
1,2,4-Trichlorobenzene (aq)	<0.001	<0.001	<0.001	<0.001	0.0004 mg/l
1,2-Dichlorobenzene (aq)	<0.001	<0.001	<0.001	<0.001	0.01 mg/l
1,3-Dichlorobenzene (aq)	<0.001	<0.001	<0.001	<0.001	0.01 mg/l
1,4-Dichlorobenzene (aq)	<0.001	<0.001	<0.001	<0.001	0.01 mg/l
2,4,5-Trichlorophenol (aq)	<0.001	<0.001	<0.001	<0.001	0.0004 mg/l
2,4,6-Trichlorophenol (aq)	<0.001	<0.001	<0.001	<0.001	n/a
2,4-Dichlorophenol (aq)	<0.001	<0.001	<0.001	<0.001	n/a
2,4-Dimethylphenol (aq)	<0.001	<0.001	<0.001	<0.001	n/a
2,4-Dinitrotoluene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
2,6-Dinitrotoluene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
2-Chloronaphthalene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
2-Chlorophenol (aq)	<0.001	<0.001	<0.001	<0.001	n/a
2-Methylnaphthalene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
2-Methylphenol (aq)	<0.001	<0.001	<0.001	<0.001	n/a
2-Nitroaniline (aq)	<0.001	<0.001	<0.001	<0.001	n/a
2-Nitrophenol (aq)	<0.001	<0.001	<0.001	<0.001	n/a
3-Nitroaniline (aq)	<0.001	<0.001	<0.001	<0.001	n/a
4-Bromophenylphenylether (aq)	<0.001	<0.001	<0.001	<0.001	n/a
4-Chloro-3-methylphenol (aq)	<0.001	<0.001	<0.001	<0.001	n/a
4-Chloroaniline (aq)	<0.001	<0.001	<0.001	<0.001	n/a
4-Chlorophenylphenylether (aq)	<0.001	<0.001	<0.001	<0.001	n/a
4-Methylphenol (aq)	<0.001	<0.001	<0.001	<0.001	n/a
4-Nitrophenol (aq)	<0.001	<0.001	<0.001	<0.001	n/a
4-Nitroaniline (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Azobenzene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Acenaphthylene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Acenaphthene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Anthracene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
bis(2-Chloroethyl)ether (aq)	<0.001	<0.001	<0.001	<0.001	n/a
bis(2-Chloroethoxy)methane (aq)	<0.001	<0.001	<0.001	<0.001	n/a

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
bis(2-Ethylhexyl) phthalate (aq)	<0.002	<0.002	<0.002	<0.002	n/a
Benzo(a)anthracene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Butylbenzyl phthalate (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Benzo(b)fluoranthene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Benzo(k)fluoranthene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Benzo(a)pyrene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Benzo(g,h,i)perylene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Carbazole (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Chrysene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Dibenzofuran (aq)	<0.001	<0.001	<0.001	<0.001	n/a
n-Dibutyl phthalate (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Diethyl phthalate (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Dibenzo(a,h)anthracene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Dimethyl phthalate (aq)	<0.001	<0.001	<0.001	<0.001	n/a
n-Dioctyl phthalate (aq)	<0.005	<0.005	<0.005	<0.005	n/a
Fluoranthene (aq)	<0.001	<0.001	<0.0001	<0.001	n/a
Fluorene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Hexachlorobenzene (aq)	<0.001	<0.001	<0.001	<0.001	0.00003 mg/l
Hexachlorobutadiene (aq)	<0.001	<0.001	<0.001	<0.001	0.01 mg/l
Pentachlorophenol (aq)	<0.001	<0.001	<0.001	<0.001	0.002 mg/l
Phenol (aq)	<0.001	<0.001	<0.001	<0.001	0.0005 mg/l
n-Nitroso-n-dipropylamine (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Hexachloroethane (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Nitrobenzene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Naphthalene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Isophorone (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Hexachlorocyclopentadiene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Phenanthrene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Indeno(1,2,3-cd)pyrene (aq)	<0.001	<0.001	<0.001	<0.001	n/a
Pyrene (aq)	<0.001	<0.001	<0.001	<0.001	n/a

Table 32: Volatile Organic Compounds (VOCs) (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Dichlorodifluoromethane	<0.007	<0.007	<0.007	<0.007	n/a
Chloromethane	<0.009	<0.009	<0.009	<0.009	n/a
Vinyl chloride	<0.0012	<0.0012	<0.0012	<0.0012	n/a
Bromomethane	<0.002	<0.002	<0.002	<0.002	n/a
Chloroethane	<0.0025	<0.0025	<0.0025	<0.0025	n/a
Trichlorofluoromethane	<0.0013	<0.0013	<0.0013	<0.0013	n/a
1,1-Dichloroethene	<0.0012	<0.0012	<0.0012	<0.0012	n/a
Carbon disulphide	<0.0013	<0.0013	<0.0013	<0.0013	n/a
Dichloromethane	<0.0037	<0.0037	<0.0037	<0.0037	n/a
Methyl tertiary butyl ether (MTBE)	<0.0016	<0.0016	<0.0016	<0.0016	n/a
trans-1,2-Dichloroethene	<0.0019	<0.0019	<0.0019	<0.0019	n/a
1,1-Dichloroethane	<0.0012	<0.0012	<0.0012	<0.0012	n/a
cis-1,2-Dichloroethene	<0.0023	<0.0023	<0.0023	<0.0023	n/a
2,2-Dichloropropane	<0.0038	<0.0038	<0.0038	<0.0038	n/a
Bromochloromethane	<0.0019	<0.0019	<0.0019	<0.0019	n/a
Chloroform	<0.0018	<0.0018	<0.0018	<0.0018	n/a
1,1,1-Trichloroethane	<0.0013	<0.0013	<0.0013	<0.0013	n/a
1,1-Dichloropropene	<0.0013	<0.0013	<0.0013	<0.0013	n/a
Carbontetrachloride	<0.0014	<0.0014	<0.0014	<0.0014	n/a
1,2-Dichloroethane	<0.0033	<0.0033	<0.0033	<0.0033	n/a
Benzene	<0.0013	<0.0013	<0.0013	<0.0013	n/a
Trichloroethene	<0.0025	<0.0025	<0.0025	<0.0025	n/a
1,2-Dichloropropane	<0.003	<0.003	<0.003	<0.003	n/a
Dibromomethane	<0.0027	<0.0027	<0.0027	<0.0027	n/a
Bromodichloromethane	<0.0009	<0.0009	<0.0009	<0.0009	n/a
cis-1,3-Dichloropropene	<0.0019	<0.0019	<0.0019	<0.0019	n/a
Toluene	<0.0014	<0.0014	<0.0014	<0.0014	n/a
trans-1,3-Dichloropropene	<0.0035	<0.0035	<0.0035	<0.0035	n/a
1,1,2-Trichloroethane	<0.0022	<0.0022	<0.0022	<0.0022	n/a
1,3-Dichloropropane	<0.0022	<0.0022	<0.0022	<0.0022	n/a
Tetrachloroethene	<0.0015	<0.0015	<0.0015	<0.0015	n/a
Dibromochloromethane	<0.0017	<0.0017	<0.0017	<0.0017	n/a
1,2-Dibromoethane	<0.0023	<0.0023	<0.0023	<0.0023	n/a

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Chlorobenzene	<0.0035	<0.0035	<0.0035	<0.0035	n/a
1,1,1,2-Tetrachloroethane	<0.0013	<0.0013	<0.0013	<0.0013	n/a
Ethylbenzene	<0.0025	<0.0025	<0.0025	<0.0025	n/a
m,p-Xylene	<0.0025	<0.0025	<0.0025	<0.0025	n/a
o-Xylene	<0.0017	<0.0017	<0.0017	<0.0017	n/a
Styrene	<0.0012	<0.0012	<0.0012	<0.0012	n/a
Bromoform	<0.003	<0.003	<0.003	<0.003	n/a
Isopropylbenzene	<0.0014	<0.0014	<0.0014	<0.0014	n/a
1,1,2,2-Tetrachloroethane	<0.0052	<0.0052	<0.0052	<0.0052	n/a
1,2,3-Trichloropropane	<0.0078	<0.0078	<0.0078	<0.0078	n/a
Bromobenzene	<0.002	<0.002	<0.002	<0.002	n/a
Propylbenzene	<0.0026	<0.0026	<0.0026	<0.0026	n/a
2-Chlorotoluene	<0.0019	<0.0019	<0.0019	<0.0019	n/a
1,3,5-Trimethylbenzene	<0.0018	<0.0018	<0.0018	<0.0018	n/a
4-Chlorotoluene	<0.0019	<0.0019	<0.0019	<0.0019	n/a
tert-Butylbenzene	<0.002	<0.002	<0.002	<0.002	n/a
1,2,4-Trimethylbenzene	<0.0017	<0.0017	<0.0017	<0.0017	n/a
sec-Butylbenzene	<0.0017	<0.0017	<0.0017	<0.0017	n/a
4-iso-Propyltoluene	<0.0026	<0.0026	<0.0026	<0.0026	n/a
1,3-Dichlorobenzene	<0.0022	<0.0022	<0.0022	<0.0022	n/a
1,4-Dichlorobenzene	<0.0027	<0.0027	<0.0027	<0.0027	n/a
n-Butylbenzene	<0.002	<0.002	<0.002	<0.002	n/a
1,2-Dichlorobenzene	<0.0037	<0.0037	<0.0037	<0.0037	n/a
1,2-Dibromo-3-chloropropane	<0.0098	<0.0098	<0.0098	<0.0098	n/a
1,2,4-Trichlorobenzene	<0.0023	<0.0023	<0.0023	<0.0023	n/a
tert-Amyl methyl ether (TAME)	<0.001	<0.001	<0.001	<0.001	n/a
Naphthalene	<0.0035	<0.0035	<0.0035	<0.0035	n/a
1,2,3-Trichlorobenzene	<0.0031	<0.0031	<0.0031	<0.0031	n/a
1,3,5-Trichlorobenzene	<0.01	<0.01	<0.01	<0.01	n/a

Table 33: Phenoxy Acid Herbicides (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Phenoxyacetic acid (PAA)	0.000385	<0.000031	0.000107	0.000783	n/a
Dicamba	<0.000033	0.000033	0.000033	0.000033	n/a
Phenoxypropionic acid (PPA)	<0.000023	<0.000023	<0.000023	<0.000023	n/a
4-Chlorophenoxyacetic acid (4-CPA)	0.000133	<0.000037	<0.000037	<0.000037	n/a
4-Phenoxybutyric acid	<0.000019	<0.000019	<0.000019	<0.000019	n/a
Bentazone	<0.000018	<0.000018	<0.000018	<0.000018	n/a
Bromoxynil	<0.000022	<0.000022	<0.000022	<0.000022	n/a
2,4-Dichlorophenoxy acetic acid (2,4-D)	<0.000026	<0.000026	<0.000026	<0.000026	n/a
2-methyl-4-Chlorophenoxyacetic acid (MCPA)	<0.00003	<0.00003	<0.00003	<0.00003	n/a
2-methyl-4,6-Dinitrophenol	<0.000041	<0.000041	<0.000041	<0.000041	n/a
Triclopyr	<0.000022	<0.000022	<0.000022	<0.000022	n/a
loxynil	<0.000017	<0.000017	<0.000017	<0.000017	n/a
2,4-Dichlorophenoxy acetic acid (2,4-DP)	<0.000015	<0.000015	<0.000015	<0.000015	n/a
2,4,5-Trichlorophenol (2,4,5-T)	<0.000029	<0.000029	<0.000029	<0.000029	n/a
Mecoprop (MCP)	<0.000025	<0.000025	0.0000375	0.000231	n/a
4-(2,4-Dichlorophenoxy) butyric acid (2,4-D)	<0.000022	<0.000022	<0.000022	<0.000022	n/a
4-(4-Chloro-o-tolyloxy) butyric acid (MCPB)	<0.000029	<0.000029	<0.000029	<0.000029	n/a
2-(2,4,5-Trichlorophenoxy) propionic acid	<0.000024	<0.000024	<0.000024	<0.000024	n/a
Dinoseb	<0.000027	<0.000027	<0.000027	<0.000027	n/a
Pentachlorophenol	<0.000032	<0.000032	<0.000032	<0.000032	n/a

Table 34: Combined Pesticides / Herbicides (mg/l) Surface water Samples Results

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Atrazine	<0.001	<0.001	<0.001	<0.001	0.001mg/l
Simazine	<0.001	<0.001	<0.001	<0.001	0.01mg/l
Dichlorvos	<0.00001	<0.00001	<0.00001	<0.00001	0.000001 mg/l
Mevinphos	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Tecnazene	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Hexachlorobenzene	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Trifluralin	<0.00001	<0.00001	0.0000306	<0.00001	n/a
alpha-Hexachlorocyclohexane (HCH / Lindane)	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Quintozene (PCNB)	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Diazinon	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Triallate	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Etrimphos	<0.00001	<0.00001	<0.00001	<0.00001	n/a
gamma-Hexachlorocyclohexane (HCH / Lindane)	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Disulfoton	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Propetamphos	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Heptachlor	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Chlorpyriphos methyl	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Dimethoate	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Aldrin	<0.00001	<0.00001	<0.00001	<0.00001	0.00001 mg/l
Chlorothalonil	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Pirimiphos-methyl	<0.00001	<0.00001	<0.00001	<0.00001	n/a
beta-Hexachlorocyclohexane (HCH / Lindane)	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Chlorpyriphos	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Telodrin	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Methyl parathion	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Isodrin	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Malathion	0.0000116	<0.00001	<0.00001	<0.00001	n/a
Fenthion	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Fenitrothion	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Heptachlor epoxide	<0.00001	<0.00001	<0.00001	<0.00001	n/a

Parameter	SW-1	SW-2	SW-3	SW-4	EQS for Surface Waters
Triadimefon	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Pendimethalin	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Parathion	<0.00001	<0.00001	<0.00001	<0.00001	n/a
o,p-DDE	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Chlorfenvinphos	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Endosulphan I	<0.00001	<0.00001	<0.00001	<0.00001	0.000001 mg/l
Trans-chlordane	<0.00001	<0.00001	<0.00001	<0.00001	n/a
cis-Chlordane	<0.00001	<0.00001	<0.00001	<0.00001	n/a
p,p-DDE	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Dieldrin	<0.00001	<0.00001	<0.00001	<0.00001	0.00001 mg/l
o,p-TDE (DDD)	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Endrin	<0.00001	<0.00001	<0.00001	<0.00001	n/a
o,p-DDT	<0.00001	<0.00001	<0.00001	<0.00001	n/a
p,p-TDE (DDD)	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Ethion	<0.00001	<0.00001	<0.00004	<0.00001	n/a
Endosulphan II	<0.00001	<0.00001	<0.0002	<0.00001	n/a
p,p-DDT	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Carbophenothion	<0.00001	<0.00001	<0.00001	<0.00001	n/a
o,p-Methoxychlor	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Triazophos	<0.00001	<0.00001	<0.00001	<0.00001	n/a
p,p-Methoxychlor	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Endosulphan sulphate	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Permethrin I	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Phosalone	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Permethrin II	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Azinphos-methyl	<0.00001	<0.00001	<0.00001	<0.00001	n/a
Azinphos-ethyl	<0.00001	<0.00001	<0.00001	<0.00001	n/a

3.6.4 Landfill Gas Monitoring

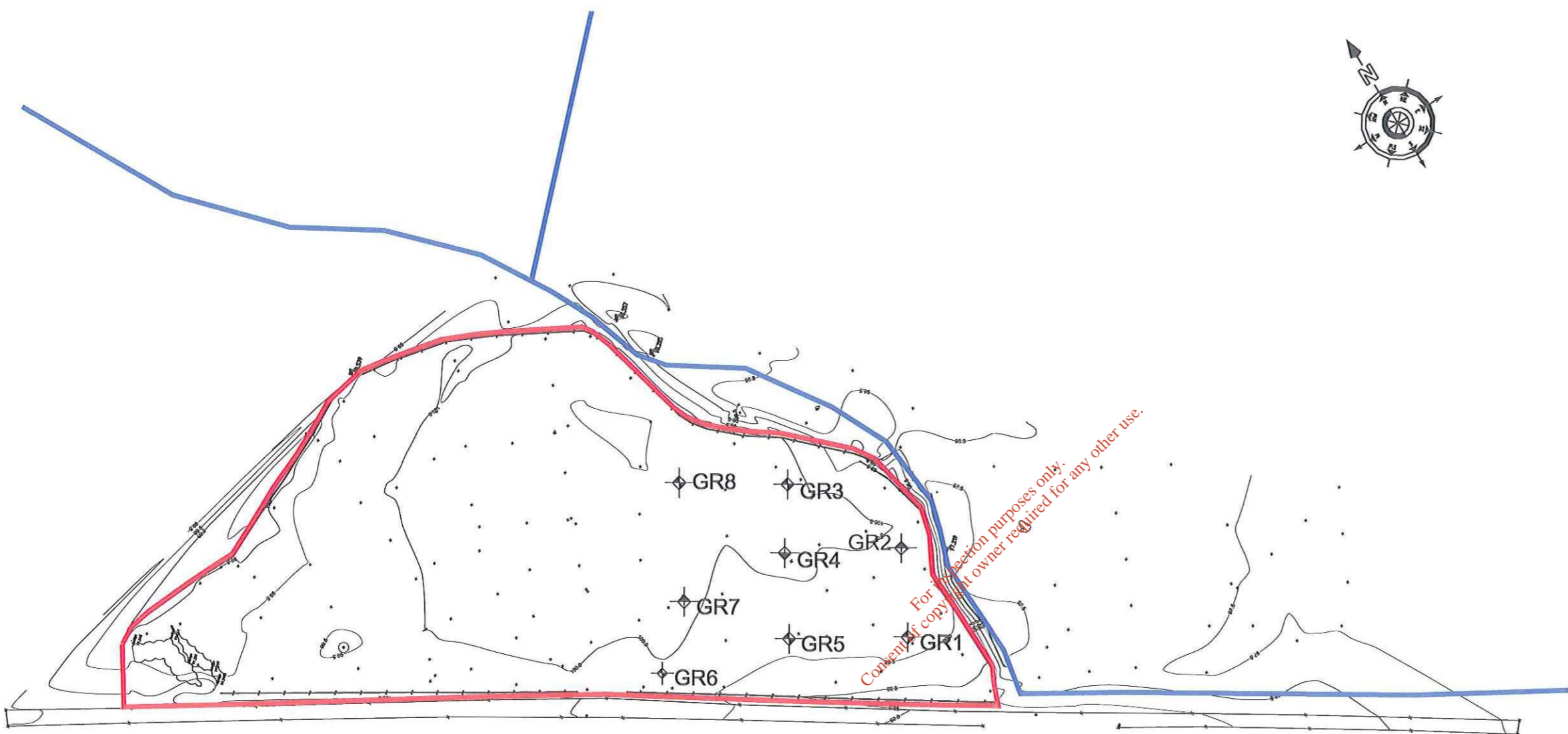
8 No. trial holes were monitored for landfill gas. After monitoring the 8 No. trial holes it was decided to cease gas monitoring due to the low levels of gas detected in the first 8 trial holes. The gas monitoring programme included the measurement of methane and carbon dioxide. The meter was calibrated before use. Based on the negligible landfill gas levels detected Traynor Environmental Ltd considers that the risk posed by landfill gas to be insignificant.

Table 35: Gas Monitoring at Mullagh Historic Landfill

Parameter	Result (%)				Comments
	Methane (CH ₄)	Carbon Dioxide (CO ₂)	Oxygen (O ₂)	Nitrogen Dioxide (NO ₂)	
GR1	0.01	0.01	21.6	78.2	No notable odour detected
GR2	0.01	ND*	21.5	78.3	Oil odour detected
GR3	ND*	ND*	21.4	78.5	Burnt / Oily odour detected
GR4	0.01	0.01	21.4	78.4	Burnt odour detected
GR5	0.01	ND*	21.3	78.5	Oily odour detected
GR6	0.01	ND*	21.3	78.5	Burnt odour detected
GR7	ND*	ND*	21.4	78.5	Oil odour detected
GR8	0.01	0.01	21.3	78.5	Strong oil odour detected

* ND - Not Detected

NOTES



- OPEN DRAINS
- SITE BOUNDARY
- ◆ GR1 GAS RECORDING POINT

GAS RECORDING POINTS
SCALE 1:1000

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CLIENT		CAVAN COUNTY COUNCIL	
PROJECT TITLE SITE INVESTIGATION & RISK ASSESSMENT OF EXISTING HISTORIC LANDFILL SITE AT RANTAVAN, MULLAGH, CO CAVAN			
DRAWING TITLE GAS RECORDING POINT			
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10-198-015			

3.7 ECOLOGICAL ASSESSMENT OF SITE

An ecological survey of the historic landfill site at Rantavan was carried out on October 15th 2010 by Noreen McLoughlin, MSc. MIEEM on behalf of Traynor Environmental Ltd. This survey included a Q assessment of the small stream that runs along the perimeter of the site.

3.7.1 Survey Methods

Prior to the site visit, the websites of the National Parks and Wildlife Service (NPWS), the National Biodiversity Data Centre and the EPA were consulted for information on nature conservation areas and records of notable species within the area.

The ecological survey included a Q assessment of the small stream that runs along the perimeter of the site.

Three biological water samples were taken for the purpose of Q value rating, the locations of which are listed in Table 36.

Table 36: Location of Q Value Rating Surface Water Sampling

Station No.	Location
1	Main Stream within Site
2	Drain feeding Stream
3	~ 70m Downstream of Site

The EPA recommends that for a standard Q assessment, a two minute kick sample and stone wash is undertaken. This method was used at station 3. However, at stations 1 and 2 the conditions of the watercourse/drain did not allow a standard sampling methodology. Both stations were heavily silted with low flow and there were no suitable riffle areas to sample from. Although not ideal, the water and surrounding vegetation was swept for two minutes with a Freshwater Biological Association approved hand held sweep net with a mesh diameter of 500µm. Samples were removed and later assessed by determining the abundances of various indicator groups of macro-invertebrates that were obtained in the sweep. Based on the relative abundance of these indicator species, a biotic index (Q rating) was determined for the sites in accordance with the biological assessment procedure used by the Environmental Protection Agency (Toner *et al.* 2005). All indicator species are assigned to one of five different groups based on their tolerance to pollution. Group A are the most sensitive invertebrates and Group E are the least sensitive.

3.7.2 Description of the Existing Environment

Designated Areas

The site of the historic landfill lies approximately 0.8km North of Killyconny Bog SAC 000006. This is a raised bog habitat of approximately 191 hectares. The site comprises a core of uncut high bog occurring as two distinct lobes, joined by a narrow strip of bog. This intact area is surrounded by cutover raised bog surfaces. The uncut high bog dome covers an area of approximately 85 hectares (Derwin et al., 2002) and contains a well developed raised bog flora.

Habitats

The main habitat on the site of the disused landfill is grassland (now disturbed). Habitats adjacent to the site include wet grassland, birch woodland and drains. A significant area of raised bog occurs on the opposite side of the road to the landfill. Overall, the areas surrounding the site are quite natural and have a moderately high level of biodiversity that is important on a local level. However, biodiversity within the footprint of the old landfill site is low.

The stream that runs along the north-eastern boundary of the site was assessed and a Q rating was obtained at two points along its course. This stream flows in a south-easterly direction, flowing adjacent to the Killyconny Bog SAC. Beyond the SAC, there is an extensive network of streams and drains, so tracing this stream proved difficult. However, it is possible that it eventually joins the Moynalty (Owenroe) River.

The results for the Q rating obtained are presented in Table 37 below. A full list of species obtained can be seen in Appendix I.

Table 37: Summary of Q Value Assessment Findings

Station	Location	Q Rating	Status	Quality
1	Main Stream within Site	Q2	Seriously Polluted	Poor
2	Drain feeding Stream	Q2-3	Moderately Polluted	Poor
3	~ 70m Downstream of Site	Q3	Moderately Polluted	Poor

Station 1 had extremely high levels of sediment visible. There was also a foul odour and a type of sewage fungus visible on the surface. Diversity at this station was low and the sample was dominated by the small freshwater mussel Sphaeriidae, a Group D taxa that is tolerant of relatively high levels of pollution. Other tolerant Group D taxa present included leeches and the water louse *Asellus aquaticus*. Oil has a toxic effect on freshwater organisms, particularly to fish. Station 1 was determined to be seriously polluted.

Station 2 was taken from a drain which joined the main stream. This drain had a high sediment level and there in-stream aquatic vegetation was abundant. There was no foul smell from this watercourse. This station was dominated by Group C taxa, which are moderately tolerant of pollution. Midge larvae from the family Chironomidae were most common. The more tolerant Group D taxa were numerous and mostly represented by *Asellus aquaticus*. Station 2 was determined to be moderately polluted and it is likely that the pollution is due to eutrophication from run off from agricultural land.

Station 3 was taken approximately 70m downstream of the site and here the water quality had recovered slightly. The sediment load was low and the water was quite clear. Flow was extremely low here though, with the water depth barely reaching 5cm in some parts. Overall, the number of invertebrates in this sample was low – 28 organisms in total and the majority of these were the freshwater shrimp *Gammarus duebeni*, a Group C taxon that is moderately tolerant of organic pollution. While the water quality at this point is better than Station 1, it is still unsatisfactory. It is likely that it suffers from diffuse organic pollution from the surrounding agricultural land.

3.7.3 Ongoing Impacts and Assessment

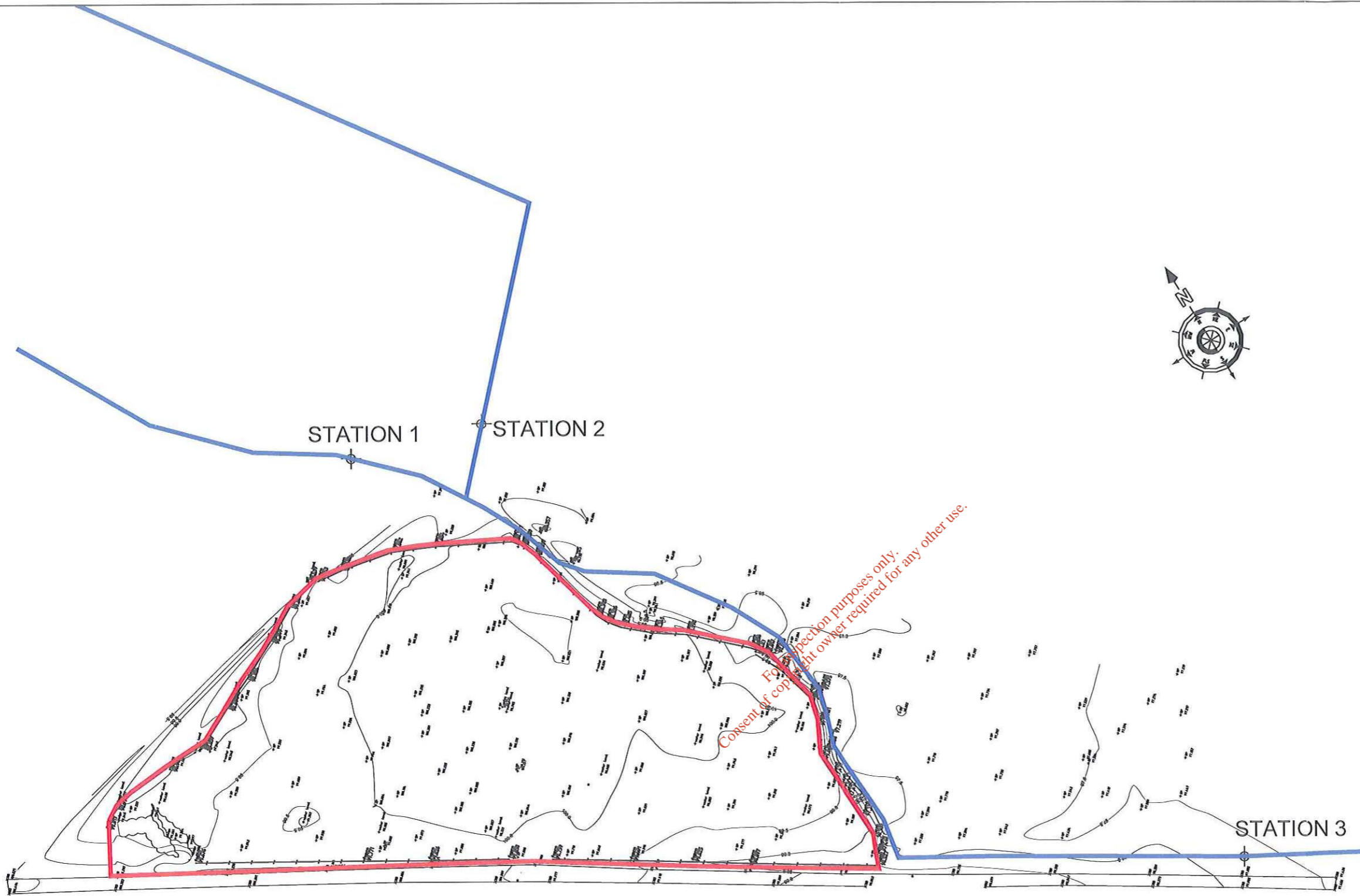
The site of the old landfill is directly connected to Killyconny Bog SAC via the small stream. At the present time, there are no ongoing impacts from the old landfill that are resulting in the direct loss of habitats or species within the Killyconny Bog SAC.

It is possible that leachate from the landfill site may be impacting upon the groundwater of the historic landfill site. Raised bogs are ombrotrophic systems, which means that they are dependent on precipitation rather than groundwater. Therefore, it is unlikely that if the groundwater is contaminated it is having an impact upon Killyconny Bog SAC.

Leachate from the historic landfill is having an impact on the watercourse/drain that runs along its perimeter. It is seriously polluted along this particular stretch but it does recover somewhat downstream of the site. It is likely that water quality in this stream is also being reduced by diffuse agricultural run-off.

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NOTES



- OPEN DRAINS
- SITE BOUNDARY
- STATION 1 Q VALUE MONITORING POINT

Q-VALUE MONITORING POINTS
SCALE 1:1000

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CLIENT
CAVAN COUNTY COUNCIL

PROJECT TITLE
SITE INVESTIGATION & RISK ASSESSMENT OF EXISTING HISTORIC LANDFILL SITE AT RANTAVAN, MULLAGH, CO CAVAN

DRAWING TITLE
Q - VALUE MONITORING POINTS

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10-198-016	

4.0 REFINEMENT OF CONCEPTUAL SITE MODEL (CSM)

4.1 DESCRIPTION

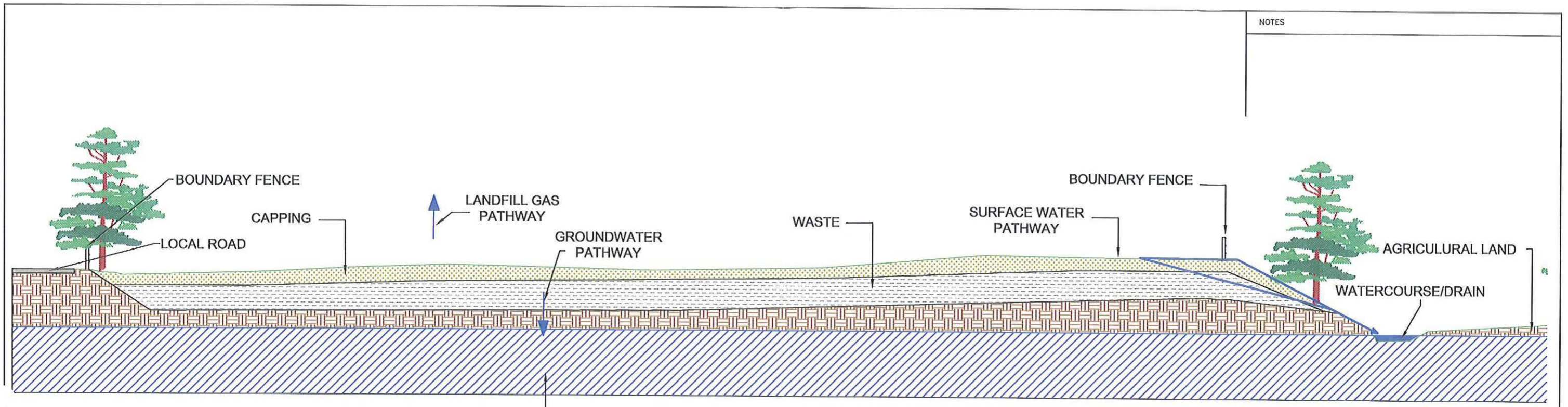
The Code of Practice requires the Conceptual Site Model (CSM) developed during Tier 1 should be refined after completion of the Tier 2 site investigations. Where a site is deemed to pose a high or moderate risk to the environment or human health then a Quantitative Risk Assessment (QRA) should then be undertaken.

Traynor Environmental Ltd, using the information obtained in the site investigation, refined the CSM in the Tier 1 Assessment. The most recently landfilled waste is estimated to be approximately >20 years old with much of the waste emanating from the 1970s and 1980s. The waste is covered by relatively free draining soils.

The natural subsoils (Peat) beneath the waste appear to be of low permeability and will retard the downward movement of infiltrating rainfall. It is likely that most of the rainfall reaching the base of the waste ultimately discharges laterally along the base of the waste into the surrounding surface water drainage system, with a small amount reaching the water table and ultimately entering the adjacent watercourse/drain as shallow baseflow.

The groundwater monitoring results from Trial Hole TH21 (Baseline) located down-gradient of the landfill indicate that the waste body is having little or no impact on the underlying aquifer. The watercourse/drain adjacent to the site is seriously polluted with the water quality improving downstream of the site.








Landfill gas generation at the site is very low and due to the free draining nature of the waste can vent freely to atmosphere.



NOTES

CONCEPT MODEL
SCALE 1:200

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-  LANDFILL WASTE SOURCE
-  PATHWAY
-  EVIDENT PATHWAY
-  RECEPTOR (GROUNDWATER)
-  RECEPTOR (STREAM)
-  CAPPING
-  EXISTING SUBSOIL

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PROJECT TITLE
 SITE INVESTIGATION & RISK ASSESSMENT
 OF EXISTING HISTORIC LANDFILL SITE AT
 RANTAVAN, MULLAGH, CO CAVAN

DRAWING TITLE
 CONCEPT MODEL OF THE SITE

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4.2 SOURCE/HAZARDS

4.2.1 Waste Types

The waste encountered comprised plastic and glass bottles, occasional empty flattened steel drums, empty plastic drums, steel, papers, tyres, timber and trees. Waste oil was encountered in all trial holes with the exception of the trial holes excavated outside of the landfill site. Hydraulic parts were encountered on site. The nature of waste observed is typical of municipal waste that has been buried for more than 20 years and which has undergone considerable biodegradation.

4.2.2 Waste Area

The lateral extent of the waste body on site is shown on the Northeastern extents of the waste body. They are defined by a line of trees, a fence and watercourse located on the boundary. The Southwestern extent of the waste material is defined by the local road.

The investigation proved that thickness of the waste ranged from 0.3m to 2.2m, with an average thickness of 1.25m. The area covered by the waste body is 8,589m². It is estimated, that approximately 18,900 tonnes of waste is deposited at the site.

4.2.3 Leachate

The natural subsoils beneath the waste appear to be of low permeability and appear to retard the movement of infiltrating rainfall. It is likely that most of the rainfall reaching the base of the waste ultimately discharges laterally along the base of the waste into the surrounding surface water drainage system with a small amount reaching the water table and ultimately entering the adjacent watercourse as shallow baseflow.

4.2.4 Landfill Gas

The landfill gas monitoring has established that the waste is not a significant source of landfill gas. Gas monitoring was carried out on 8 No. trial hole. Negligible amounts of methane and carbon dioxide concentrations were evident. This is consistent with the type of waste observed, its age and relatively shallow thickness. The site investigation did not identify the presence of discrete layers of daily cover material placed over the waste, with the exception of the final cover. It is probable that when the site was operational daily cover was not regularly applied. This would have encouraged the aerobic breakdown of the organic waste fraction. These conditions would have reduced the risk of build up of gas pressure, which is the primary driver of landfill gas migration.

4.3 MIGRATION PATHWAYS

4.3.1 Groundwater Vulnerability

The GSI has categorised the aquifer vulnerability of area occupied by the site as Moderate to High. The site investigation data confirmed this rating. The waste is saturated and water was encountered in the majority of the trial holes. The waste is underlain by a layer of peat which would greatly retard the downward movement of any leachate resulting in preferential flow to the surface water system.

4.3.2 Groundwater Flow Regime

The bedrock aquifer is characterised by the GSI as a Poor Aquifer that is productive only in local zones. This means that groundwater flow paths are short probably 10s to 100s of metres. Groundwater flow direction appears to be Northwest to Southeast.

4.3.3 Landfill Gas Pathways

The Clay cover material over the waste is free draining and landfill gas vents freely to atmosphere. The site is surrounded by a surface water drain which essentially prevents the migration off-site of landfill gas.

4.4 MIGRATION RECEPTORS

4.4.1 Human Presence

There is one well located >300m Southeast of the site and has been identified by Cavan County Council.

4.4.2 Aquifer Category

The bedrock aquifer is classified as Poor aquifer (PI). Based on the results of the downgradient groundwater monitoring trial hole (TH21 - baseline) the landfill is not having an impact on the underlying aquifer.

4.4.3 Surface Water Bodies

The watercourse/drain runs along the Northeastern site boundary. The watercourse/drain runs along the northeastern boundary of the landfill. Q value monitoring around the site has been carried out. The watercourse/drain upstream of the landfill site has a Q Value rating of Q2-3 indicating moderate pollution possibly from Agricultural sources and/or private wastewater treatment systems. The watercourse/drain running along the northeastern boundary has a Q2 rating indicating serious pollution. A Q value of Q3 was achieved for Monitoring station located down gradient of the site and the quality was deemed as poor but of better quality than monitoring Station 2. Based on this assessment programme the discharge from the Waste site is a cause of the poor quality of the watercourse/drain however there is other sources of pollution and not solely the landfill.

4.5 LANDFILL GAS RECEPTORS

4.5.1 Human Presence

There are two private dwellings located >200m North and Southeast of the landfill. The risk posed by landfill gas to off-site receptors is considered to be negligible.

4.6 RISK ASSESSMENT

The COP provides a scoring matrix where points are assigned, based on a source-pathway receptor (SPR) model, to assess risk. There are eleven (11) possible SPRs, which are based on a range of hazard sources (leachate, landfill gas) pathways (soils, surface water and groundwater) and receptors (humans, ecosystems, groundwater supplies).

The point scores for the individual parameters are derived from the Tables in the Code of Practice. The scores are normalised to 1 -100. High risk sites are those with a score \Rightarrow 70 for any one SPR. Moderate risk are sites scoring between 40 - 70. Low risk sites, which are considered not to pose a significant risk to the environment or human health, are those with a score below 40. In the Tier 1 assessment the site score was 50.

While the site investigation has confirmed that some wastes in the historic landfill are hazardous and present a high risk, there is no mechanism in the scoring matrix to reflect this.

With regard to the risk ranking; SPR Linkage number 8 highlights leachate migration through surface waters.

The waste footprint for Mullagh Landfill is < 1 hectare and thus the scoring matrix assigns a value of 5 for both municipal and industrial waste. If the site was >1 hectare the scoring matrix will assign a value of 7 thus changing the site from a moderate risk site to a high risk site. Even though the site is deemed hazardous, the percentage linkage score for number 8 is ultimately dependent on the size of the site (refer to examples below).

Prior to Trial Holes Excavation (< 1 hectare – Municipal Waste)

$$\begin{aligned} \text{SPR 8} &= 1a \times 2c \times 3e \\ &= 5 \times 2 \times 3 = 30 \text{ (Score)} \end{aligned}$$

50% linkage score (**moderate risk**)

Post Trial Holes Excavation (<1 hectare – Industrial/Hazardous Waste)

$$\begin{aligned} \text{SPR 8} &= 1a \times 2c \times 3e \\ &= 5 \times 2 \times 3 = 30 \text{ (Score)} \end{aligned}$$

50% linkage score (**moderate risk**)

>1 Hectare in Size (>1 Hectare – Industrial/Hazardous Waste)

$$\begin{aligned} \text{SPR 8} &= 1a \times 2c \times 3e \\ &= 7 \times 2 \times 3 = 42 \text{ (Score)} \end{aligned}$$

70% linkage score (**high risk**)

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4.7 RISK SCREENING & PRIORITISATION CALCULATIONS AFTER TIER 2 RISK ASSESSMENT

Table 1a LEACHATE: Source/hazard Scoring Matrix			
Waste Type	Waste Footprint (ha)		
	≤ 1ha	> 1 ≤ 5ha	≥ 5ha
C&D	0.5	1	1.5
Municipal	5	7	10
Industrial	5	7	10
Pre 1977 sites	1	2	3

1a =	5
-------------	----------

Table 1b LANDFILL GAS: Source/hazard Scoring Matrix			
Waste Type	Waste Footprint (ha)		
	≤ 1ha	> 1 ≤ 5ha	≥ 5ha
C&D	0.5	0.75	1
Municipal	5	7	10
Industrial	3	5	7
Pre 1977 sites	0.5	0.75	1

1b =	5
-------------	----------

Table 2a LEACHATE MIGRATION: Pathways	
Groundwater Vulnerability (Vertical Pathway)	Points
Extreme Vulnerability	3
High Vulnerability	2
Moderate Vulnerability	1
Low Vulnerability	0.5
High – Low Vulnerability	2

2a =	2
-------------	----------

Table 2b LEACHATE MIGRATION: Pathways	
Groundwater Flow Regime (Horizontal Pathway)	Points
Karstified Groundwater Bodies (Rk)	5
Productive Fissured Bedrock Groundwater Bodies (Rf & Lm)	3
Gravel Groundwater Bodies (Rg & Lg)	2
Poorly Productive Bedrock Groundwater Bodies (LI, PI, Pu)	1

2b =	1
-------------	----------

Table 2c LEACHATE MIGRATION: Pathways	
Surface Water Drainage (Surface Water Pathway)	Points
Is there direct connection between drainage ditches associated with the waste body and adjacent surface water body? Yes	2
If no direct connection.	1

2c =	2
-------------	----------

Table 2d LANDFILL GAS: Pathways	
Landfill Gas Lateral Migration Potential	Points
Sand and Gravel, Made ground, urban, karst	3
Bedrock	2
All other Tills (including limestone, sandstone etc – moderate permeability)	1.5
All Namurian or Irish Sea Tills (low permeability)	1
Clay, Alluvium, Peat	1

2d =	1.5
-------------	------------

Table 2e LANDFILL GAS: Pathways (receptor above source)	
Landfill Gas Lateral Migration Potential	Points
Sand and Gravel, Made ground, urban, karst	3
Bedrock	2
All other Tills (including limestone, sandstone etc – moderate permeability)	1.5
All Namurian or Irish Sea Tills (low permeability)	1
Clay, Alluvium, Peat	1
(As Table 2e applies to situations where buildings, structures or other enclosed spaces are present above the waste body a value of 0 has been assigned)	

2e =	0
-------------	----------

Table 3a LEACHATE MIGRATION: Receptor	
Human Presence (presence of a house indicates potential private wells)	Points
On or within 50m of the waste body	3
Greater than 50m but less than 250m	2
Greater than 250m but less than 1km	1
Greater than 1km of the waste body	0

3a =	0
-------------	----------

Table 3b LEACHATE MIGRATION: Receptors	
Protected Areas (SWDTE & GWDTE)	Points
Within 50m of the waste body	3
Greater than 50m but less than 250m of the waste body	2
Greater than 250m but less than 1km of the waste body	1
Greater than 1km of the waste body	0
Undesignated sites within 50m of the waste body	1
Undesignated sites greater than 50m but less than 250m of the waste body	0.5
Undesignated sites greater than 250m of the waste body	0

3b =	1
-------------	----------

Table 3c LEACHATE MIGRATION: Receptors	
Aquifer Category (resource potential)	Points
Regionally Important Aquifers (Rk, Rf, Rg)	5
Locally Important Aquifers (Ll, Lm, Lg)	3
Poor Aquifer (Pl, Pu)	1

3c =	1
-------------	----------

Table 3d LEACHATE MIGRATION: Receptors	
Public Water Supplies (other than private wells)	Points
Within 100m of the site boundary	7
Greater than 100m but less than 300m or within the in inner SPA for GW supplies	5
Greater than 300m but less than 1km or within outer SPA for GW supplies	3
Greater than 1km (karst aquifer)	3
Greater than 1km (no karst)	0

3d =	0
-------------	----------

Table 3e LEACHATE MIGRATION: Receptors	
Surface Water Bodies	Points
Within 50 of the site boundary	3
Greater than 50m but less than 250m of the site boundary	2
Greater than 250m but less than 1km	1
Greater than 1km	0

3e =	3
-------------	----------

Table 3f LANDFILL GAS: Receptors	
Human Presence	Points
On site or within 50m of site boundary	5
Greater than 50 but less than 150m of site	3
Greater than 150m but less than 250m of the site	1
Greater than 250m of the site	0.5

3f =	1
-------------	----------

Risk Equation	SPR Values	Max Score	Linkages	Normalised Scores (%)
SPR 1 = $1a \times (2a + 2b + 2c) \times 3e$	75	300	Leachate → Surface Water	25.00
SPR 2 = $1a \times (2a + 2b + 2c) \times 3b$	25	300	Leachate → SWDTE	8.33
SPR 3 = $1a \times (2a + 2b) \times 3a$	30	240	Leachate → human Presence	12.5
SPR 4 = $1a \times (2a + 2b) \times 3b$	15	240	Leachate → GWDTE	6.25
SPR 5 = $1a \times (2a + 2b) \times 3c$	15	400	Leachate → Aquifer	3.75
SPR 6 = $1a \times (2a + 2b) \times 3d$	0	560	Leachate → Surface Water	0.00
SPR 7 = $1a \times (2a + 2b) \times 3e$	45	240	Leachate → SWDTE	18.75
SPR 8 = $1a \times 2c \times 3e$	30	60	Leachate → Surface Water	50.00
SPR 9 = $1a \times 2c \times 3b$	10	60	Leachate → SWDTE	16.67
SPR 10 = $1b \times 2d \times 3f$	7.5	150	Landfill Gas → Human Presence	5.00
SPR 11 = $1b \times 2e \times 3f$	0	250	Landfill Gas → Human Presence	0.00

Risk Classification	Score Range
High Risk (Class A)	Greater than or equal to 70% for any individual SPR linkage
Moderate Risk (Class B)	Between 40% and 70% for any individual SPR linkage
Low Risk (Class C)	Less than or equal to 40% for any individual SPR linkage

Overall Risk	Moderate Risk (Class B)
--------------	-------------------------

5.0 CONCLUSIONS

5.1 RISK CATEGORY

The Tier 2 Risk Assessment process has resulted in the risk rating for the historic landfill remaining as Moderate Risk. SPR Linkage number 8 has been proven and thus risk rating assigned accordingly as Moderate. As part of the Tier 2 risk assessment an ecological survey which was carried out stated that the landfill site lies approximately 0.80km North of Killyconny Bog SAC 000006. The Tier 1 risk assessment reported that Killyconny bog was >1km from the waste body. As Killyconny Bog is 0.80km from the historical landfill a number of SPR linkages have been changed from the Tier 1 Assessment.

- SPR2 has changed from a linkage score of 0.00 to 8.33;
- SPR4 has changed from a linkage score of 0.00 to 6.25; and
- SPR9 has changed from a linkage score of 0.00 to 16.67.

The change in the linkage scores did not change the overall risk rating of the site which remains as Moderate Risk.

5.2 GROUNDWATER

Based on the groundwater quality data gathered during the Tier 2 investigation the historic landfill is not having a significant impact on the groundwater quality down-gradient of the historic landfill site. This assessment is based on results of groundwater monitoring carried out on the trial hole (TH21 – Baseline Data Source) located down-gradient of the historic landfill site. The waste is underlain by a layer of peat which appears to be retarding the downward movement of any leachate resulting in preferential flow to the surface water system.

5.3 SURFACE WATER

Based on the surface water quality data gathered during the Tier 2 investigation the historic landfill is not having a significant impact on the water quality downstream of the landfill site. The Q Values up-gradient and down-gradient are what would be assigned to poor quality water. The watercourse/drain running along the Northeastern boundary of the site is deemed to be seriously polluted. As mentioned above in Section 5.2 the peat layer is preventing the leachate entering the groundwater, but appears to be seeping into the watercourse/drain adjacent to the site. Given the age of the waste it is likely that the majority of mobile contaminants have long since leached into the watercourse/drain adjacent to the site. As mentioned in Section 5.1 SPR Linkage Number 8 has been proven thus risk ranking assigned accordingly i.e. Moderate Risk.