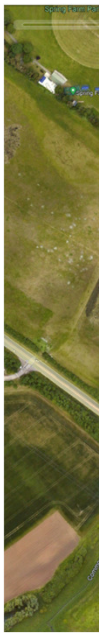
Geo-Environmental

Arnolds Field, Launders Lane

Overview of Investigation works



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Goggle Earth Image March 2022

Instructed works

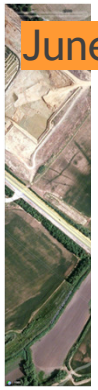
- Desk based review of readily available records in relation to site
- Liaison with the Environment Agency
- A site walkover to assess access and H&S requirements for intrusive works
- Intrusive Investigation works to:
  - Establish the types of materials present on the site
  - To obtain soil (and water where encountered) samples for testing for a range of contaminants/substances based on desk based assessment of site
  - Installation of monitoring wells on site
  - A period of spot ground gas and water monitoring
  - Provision of a Ground Investigation Report to present our findings.

Desk Based Assessment

- Former sand and gravel quarry that was subsequently registered as a landfill with the last waste recorded as being accepted in 1965
- The site was licensed to accept inert, commercial, industrial, household and solid sludge waste.
- The details of the type of restoration works on the site post landfilling are unknown but is assumed that the site was restored with a thin cap of non-landfill materials, e.g. soil or stone
- No measures to deal with possible ground gases are understood to have been installed as part of any restoration works
- More recently unauthorised placement of waste materials has occurred on the site.
- A review of historical photographs indicates that some level of earthworks, materials movements and potential placing of materials occurred between 1999 and 2019
- A Freedom of Information (FOI) Request was made by Geo-Environmental to the Environment Agency detailed that between 30,000m^3 and 50,000m^3 of waste material was deposited on site between 2011 and July 2014. This material consisted of mixed household, commercial and industrial material, suspected from a waste transfer station.
- It is understood that the site has the tendency to combust periodically, causing smoke and odour issues associated with fires on site.
- Site walkover was undertaken on the 8th August 2023 to inform the scope of intrusive works

Overview of Landfill Sites in Area

Historical Photographs (Google Earth)



Summary of Possible Plausible Source of Contamination

- Soils associated with the former quarrying activities on site
- Shallow soils and Infilled/waste material (resulting from past activities on site) – including regulated landfilling with Inert and Household waste
- Shallow soils/Infilled/waste material (resulting from unauthorised deposition of waste)
- Leachate (Run off/migration through the ground)
- Asbestos
- Ground gases/vapours (waste materials and filled ground)
- Naturally occurring aggressive ground conditions
- Fire fighting
- Off site land uses (quarries, landfills, cemetery and agricultural use)

Summary of Possible Plausible Pathways

- Direct Contact
- Inhalation
- Vertical & Lateral Migration
- Shallow Groundwater
- Chemical Attack (to services/concrete/structures)
- Flooding

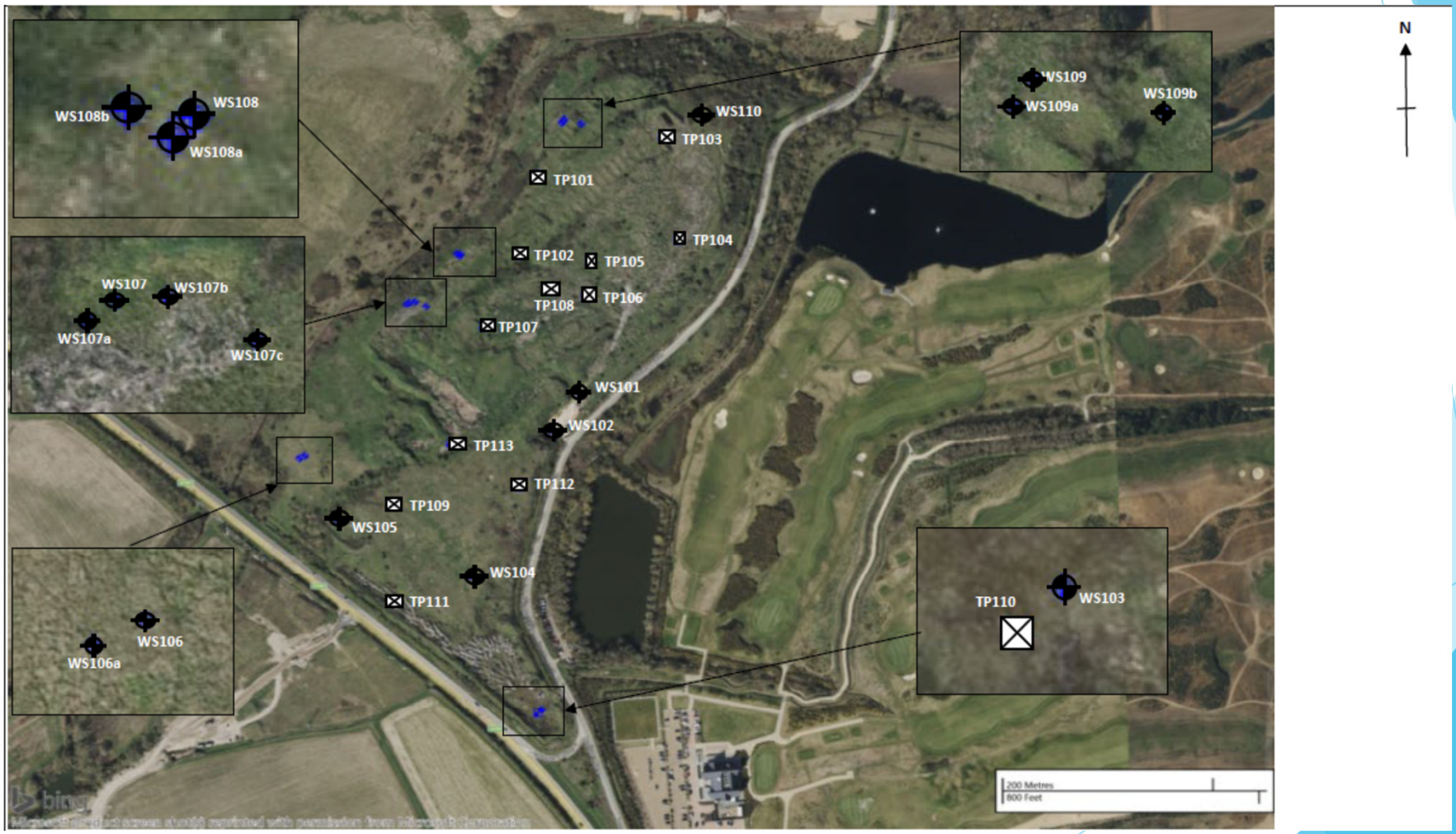
Summary of Possible Plausible Receptors

- End Users
- Soft Landscaping
- Built Environment
- Adjacent Land Users
- Groundwater
- Surface Water
- Ecological Receptors

Intrusive Investigation Works

- Undertaken between 18th and 22nd September 2023
  - 13No. machine excavated trial pits to depths of between 3.00m and 4.50m bgl (Referenced TP101 to TP113).
  - 18No. dynamic sampler boreholes to depths of up to 5.00m bgl (Referenced WS101 to WS106, WS106a, WS107, WS107a—c, WS108, WS108a-b, WS109, WS109a-b and WS110).
  - Installation of 10No. boreholes (Referenced WS101, WS102, WS103, WS104, WS105, WS106a, WS107c, WS108b, WS109b & WS110) with gas and groundwater monitoring standpipes;
  - Positions surveyed in on site
- Return Spot Ground Gas and Water Monitoring visits:
  - 3rd, 13th and 27th October and 6th and 20th November 2023
  - Further visit planned for 4th December

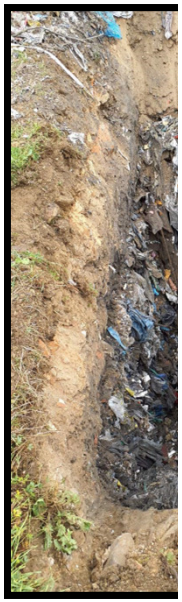
Exploratory Hole Location Plan



Access Around Site

Type of Materials we Found

TP101



TP102

TP104

TP105 Spoil

TP107

TP110 - water at base

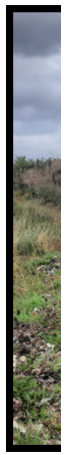
What we found …

- **Sandy soil with -** Cobbles and boulders of concrete and brick. Other items included tyres, plastic fragments, plastic bags, cement bags, CD players, cassette tapes, timber, slate, ceramic tiles, textiles, hessian, plastic gloves, glass bottles, cabling, ceramic pipe, plastic bottles, paper, metal bars, bike parts, packing tape and timber sleeper. Suspected bonded Asbestos Containing Material (ACM).
- **Clay soils with** - brick and concrete. Other items included tiles, metal bucket, metal car parts, polystyrene, timber, glass bottles, fibreglass, plastic, ceramic tiles, clinker, tarmac, hessian, coal, slate, suspected Asbestos Containing Material (ACM).
- **Domestic Waste -** comprising 20% to 85% plastic bag, up to 50% gravelly SAND, gravels are fine to coarse brick and concrete and flint, 5% timber, 5% textiles. Other items included: metal pipes, plastic pipes, rope, metals cans, brick, hessian materials, cladding, cables, ceramics, plastic bottles, shoes, foam, car parts, underlay, and car registration plates, cassettes, paper labels, metal, tree trunk, carpet, metal wire, plastic tray, netting, plastic bucket.
- **Organic odours**
- **Oily/tarry odours & sheen**
- **Iridescent colouring**
- **Charred Plastic**
- **Trommel Fines** (material that comes from the mechanical treatment of waste)

Surface Tipped Materials

Surface tipped materials near TP111

Evidence of surface fires near TP111



Smouldering surface materials near TP110

Surface materials on track to TP107

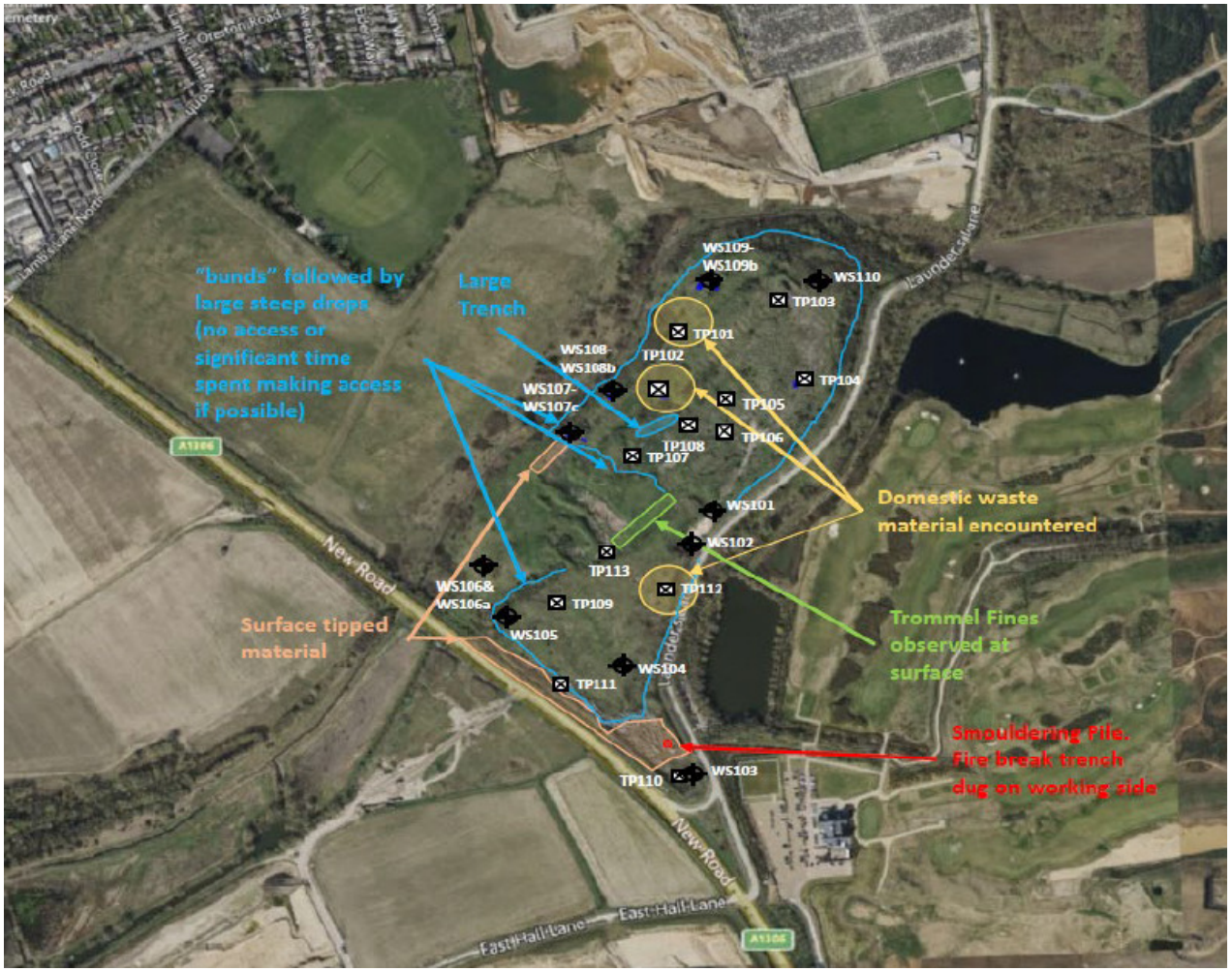
Surface materials on track to WS107s

View east from track

On site Monitoring

- Engineer has personal gas monitors and a radiation monitor on site during the investigation
- No readings above background level were identified

Summary of Encountered Materials



Asbestos

- Cement bound asbestos is notably non-flammable and non-combustible and was often used as a fireproofing material therefore the risk from these fragments is low.
- Where asbestos is bound within cement, or mixed within a soil mass, it is considered that there is negligible to low potential for fibres to be released, unless actively weathered or broken up.
- It is recommended that air monitoring is undertaken on/around the site to inform further assessment of the potential for airborne fibres to be released to the air from asbestos present at ground level

Sample	Material Detected	Total % asbestos in the sample by hand picking/weight. *	Location on site
TP103 0.75m	Asbestos Cement - Chrysotile	-	Northern Area (Higher elevation)
TP104 0.00m	Asbestos Cement - Chrysotile	-	Northern Eastern Area (Higher elevation)
TP105 3.20m	Loose Fibres - Chrysotile	<0.001	Northern Area (Higher elevation)
TP106 0.00-1.80m	Insulation Lagging - Chrysotile, Amosite Asbestos Cement - Chrysotile	-	Northern Area (Higher elevation)
TP106 2.20m	Loose Fibres - Amosite	<0.001	Northern Area (Higher elevation)
TP106 3.00-3.40m	Insulation Lagging - Chrysotile Asbestos Cement - Chrysotile	-	Northern Area (Higher elevation)
TP107 1.80m	Loose Fibrous Debris - Chrysotile	0.034	Central Area (Higher elevation)
TP111 0.60m	Loose Fibres - Amosite	<0.001	Southern Area (Lower elevation)
TP113 3.30m	Loose Fibres - Chrysotile	<0.001	Southern Area (Higher elevation)

Geo-Environmental

Soil Geochemical Results – Summary

Contaminant	Minimum	Maximum	Maximum Sample (mbgl)	Location of the maximum concentration within analysis on site
Arsenic (mg/kg)	12	830	TP110 3.40m	Southern Area (Lower elevation)
Beryllium (mg/kg)	0.69	2	TP104 3.30m	Northern Area (Higher elevation)
Cadmium (mg/kg)	0.2	2.4	TP106 2.20m	Northern Area (Higher elevation)
Chromium (mg/kg)	22	110	TP109 2.5m	Southern Area (Higher elevation)
Copper (mg/kg)	37	4700	TP106 2.20m	Northern Area (Higher elevation)
Lead (mg/kg)	100	4400	TP106 2.20m	Northern Area (Higher elevation)
Mercury (mg/kg)	0.3	210	TP109 2.5m	Southern Area (Higher elevation)
Nickel (mg/kg)	18	49	TP106 2.20m	Northern Area (Higher elevation)
Selenium (mg/kg)	<1	<1	-	
Vanadium (mg/kg)	38	100	TP106 2.20m	Northern Area (Higher elevation)
Zinc (mg/kg)	91	2000	TP106 2.20m	Northern Area (Higher elevation)
Hexavalent Chromium mg/kg)	0	0	-	
Cyanide (mg/kg)	0.1	4.4	TP104 3.30m	Northern Area (Higher elevation)
Boron (mg/kg)	1.1	6.3	WS102 4.70m	Entrance compound (Lower elevation)
Phenol (mg/kg)	1.0	1.1	TP106 2.20m	Northern Area (Higher elevation)
PAH (mg/kg)	0.05	94	TP103 0.75m	Northern Area (Higher elevation)
BTEX (µg/kg)	5	5	-	
TPH (mg/kg)	0.1	15000	TP110 3.40m	Southern Area (Lower elevation)
VOCs (µg/kg)	<5.0	<5.0	-	
SVOCs (µg/kg)	<0.05	3.4	TP110 3.50m	Entrance compound (Lower elevation)
PCBs (mg/kg)	<0.001	0.043	TP106 2.20m	Northern Area (Higher elevation)

Geo-Environmental

Soil Geochemical Results (Exceedances)

Contaminant	Public Open Space (Park) Screening Criteria (mg/kg)	Samples exceeding criteria	Maximum Value (mg/kg)	Exceedance locations on site
Arsenic	170	TP110 3.40m bgl	830	Southern Area (Lower elevation)
Lead	1300	TP106 2.20m bgl	4400	Northern Area (Higher elevation)
Benzo(b)fluoranthene	13	TP103 0.75m bgl WS107c 2.30m bgl	28	Northern Area (Higher elevation) Western Area (Lower elevation)
Benzo(a)pyrene	11	TP103 0.75m bgl WS107c 2.30m bgl	22	Northern Area (Higher elevation) Western Area (Lower elevation)
Dibenzo(ah)anthracene	1.1	TP103 0.75m bgl WS107c 2.30m bgl	2.1	Northern Area (Higher elevation) Western Area (Lower elevation)

- Results assessed again criteria for public open space (parks) - based on possible unauthorised access to the site.

Geo-Environmental

Geochemical Water Results

Contaminant	Minimum	Maximum	Maximum Sample	Location on site
Arsenic (µg/l)	4.14	223	TP110 3.50m bgl	Southern Area (Lower elevation)
Barium (µg/l)	250	430	WS103 3.70m bgl	Eastern Area (Lower elevation)
Beryllium (µg/l)	<0.1	<0.1	-	-
Cadmium (µg/l)	<0.02	0.03	TP110 3.50m bgl	Southern Area (Lower elevation)
Chromium (µg/l)	0.9	1.1	WS102 3.18m bgl	Eastern Area (Lower elevation)
Copper (µg/l)	0.8	3.5	WS103 3.70m bgl	Eastern Area (Lower elevation)
Lead (µg/l)	0.5	7.6	WS102 3.18m bgl	Eastern Area (Lower elevation)
Mercury (µg/l)	<0.05	<0.05	-	-
Nickel (µg/l)	2.5	10	WS102 3.18m bgl	Eastern Area (Lower elevation)
Selenium (µg/l)	<0.6	2.3	TP110 3.50m bgl	Southern Area (Lower elevation)
Vanadium (µg/l)	1.4	6.7	WS102 3.18m bgl	Eastern Area (Lower elevation)
Zinc (µg/l)	3.2	28	WS102 3.18m bgl	Eastern Area (Lower elevation)
Hexavalent Chromium (µg/l)	<0.5	<0.5	-	
Cyanide (µg/l)	<10	430	WS102 3.18m bgl	Eastern Area (Lower elevation)
Ammoniacal Nitrogen as NH3 (µg/l)	11000	47000	TP110 3.50m bgl WS102 3.18m bgl	Southern Area (Lower elevation) Eastern Area (Lower elevation)
Boron (µg/l)	610	4200	WS102 3.18m bgl	Eastern Area (Lower elevation)
Iron (mg/l)	0.14	1.6	TP110 3.50m bgl	Southern Area (Lower elevation)
PAH (µg/l)	<0.01	3.3	TP110 3.50m bgl	Southern Area (Lower elevation)
BTEX (µg/l)	<3.0	<3.0	-	-
TPH (µg/l)	<1.0	1700	TP110 3.50m bgl	Southern Area (Lower elevation)
VOCs (µg/l)	<3.0	<3.0	-	-
SVOCs (µg/l)	<0.01	3.3	TP110 3.50m bgl	Southern Area (Lower elevation)
PCBs (µg/l)	<0.02	<0.02	-	-

Geo-Environmental

Geochemical Water Results

Contaminant	Drinking Water Standards	EQS Freshwater	AtRisk Commercial*	Samples exceeding criteria	Maximum Value
Arsenic	10µg/l	50µg/l	-	TP110 3.5m bgl	223 µg/l
Boron	1000µg/l	2000 µg/l	-	WS102 3.18m bgl	4200 µg/l
Mercury	1µg/l	1 µg/l	-	WS102 3.18m bgl	7.6 µg/l
Chloride	250mg/l	250 mg/l	-	WS102 3.18m bgl	440 mg/l
PAH	0.1µg/l	-	-	TP110 3.50m bgl	1.84 µg/l

Ground Gas Summary

- Methane in the range of 0.0% to 33.4%
- Carbon dioxide in the range of 0.1% to 30.2%
- Carbon monoxide in the range of 0ppm and 12ppm
- Hydrogen sulphide between 0ppm and 61ppm
- Oxygen in the range 0.1% to 21.9%
- Volatile Organic Compounds (VOCs) between 0.8ppm and 302ppm
- Atmospheric pressure in the range of 991mb to 1020mb
- Borehole flows with recorded steady flows between -0.2 to 0.3 l/hr.

Note: % – percentage based on the volume analysed; ppm – parts per million; l/hr flow reported as litres per hour; mb - millibars

Geo-Environmental

Gas Monitoring Results

		WS101	WS102	WS103	WS104	WS105	WS106a	WS107c	WS108b	WS109b	WS110
CH4%	Minimum	0.6	0	0	0	0.1	0.1	0	0	0	**0**
	Maximum	33.4	32.8	19.5	0.3	0.4	7.5	6	0.2	0.1	**0.5**
CO2%	Minimum	0.5	0.1	0.1	0.1	0.1	0	0.5	0.1	0.1	**0.1**
	Maximum	30.2	23.2	5.1	6.7	4.4	0.5	19.1	12.9	5.9	**2.3**
O2%	Minimum	0.1	0.1	0.1	3.2	13.2	0.3	0.4	7.5	11.9	**3.2**
	Maximum	21.2	21.4	21.9	21.0	21.0	21.6	21.2	21.9	21.1	**21.3**
H2S ppm	Minimum	0	0	0	0	0	0	0	0	0	**0**
	Maximum	61	16	0	0	0	0	0	0	0	**0**
CO ppm	Minimum	0	0	0	0	0	0	0	0	0	**0**
	Maximum	2	2	4	0	0	7	12	0	0.1	**0.1**
VOC	Minimum	3.4	2.9	3.4	4.1	0.9	3.9	1.4	1.9	1.7	**1.5**
	Maximum	13.7	3.2	4	4.5	31.1	4.5	44.9	27.9	17.8	**15.3**
Pressure mb	Minimum	991	991	991	991	991	991	991	991	991	**991**
	Maximum	1019	1018	1020	1016	1018	1019	1019	1018	1019	**1019**
Flow (l/hr)	Minimum	-0.1	-0.1	-0.1	-0.1	0	-0.2	-0.1	0	-0.1	**-0.1**
	Maximum	**0.1**	**0.1**	**0**	**0.2**	**0.1**	**0.1**	**0.2**	**0.1**	**0.3**	**0**

Conclusions

- A baseline investigation has been undertaken. Investigation and sampling was only undertaken over a limited area of the overall site.
- It was not possible to determine the boundary between historical waste and more recent waste deposits through the investigation as there are no clear horizons.
- Waste in Trial Pit (TP)113 contained crisp packets with an expiry date of 2011.
- Materials with combustible properties were encountered on the surface and in the ground.
- No specific ignition sources were identified on site (e.g. LPG Canisters).
- Charred materials were identified on site at the surface (in the southern portion of the site) and in the Trench in the centre of site and as limited horizons in trial pits.

Conclusion - Ground Gases

- Initial monitoring of ground gases has detected the presence of Methane, Carbon Dioxide, hydrogen sulphide, carbon monoxide and volatile organic compounds.
- The monitoring has not detected any significant flow of the ground gases beneath the site.
- Localised pockets of gases could be present, with concentrations likely to reduce towards the surface.
- The risk to off site receptors is considered to be low based on the low flow identified.
- Gas monitoring is ongoing and further assessment of the data will be undertaken on completion of the monitoring in December.
- Methane can be flammable within a specific concentration range and the presence of pockets of methane could potentially exacerbate or sustain fires within the deposited waste. However, an ignition source would still be required.

Conclusion – Contaminants in Soil

- Where contamination has been identified at depth and the soil remains undisturbed the risk from these contaminants to human health is considered to be low as there is no source-pathway-receptor linkage.
- Where contaminants in the soil are present near or on the surface then the risk from these can be reduced by minimising contact with the soils e.g. ensuring the site is secured to prevent unauthorised access.
- This could also be reduced by capping the soils with a clean uncontaminated cover layer such that these materials present in the near surface soils.
- If soils were required to be removed from the site for formal disposal off site then it should be noted that they have been classified as having hazardous and non-hazardous properties which would affect where they can be disposed.

Conclusion – Mobility of Contaminants

- Some evidence of mobile contamination leaching into the water within the site was noted.
- Water identified through monitoring was considered to be linked to infiltration occurring through the site from rainfall.
- No evidence of a continuous water body was noted within the shallow waste materials.
- However:
  - Testing of the Common Watercourse was not possible due to the vegetation overgrowth preventing safe access
  - Capping the site with a less permeable material would help prevent infiltration and leaching

Recommendations

- The site should be secured to prevent unauthorised access:
  - This will reduce any external influences on the site
  - Reduce direct contact with contaminants on site
  - Reduce disturbance of contaminants on site
  - Prevent further flytipping
- Reassurance air monitoring should be undertaken with respect to any potential for asbestos fibres to be present within the site and along site boundaries.
- Ground Gas monitoring is ongoing, however further assessment of the ground gases should be undertaken.

Recommendations - Continued

- Capping of the site (which would require further assessment of the gassing regime) would serve to reduce the available oxygen to waste materials within the ground, so as to reduce the potential for fires. Gas mitigation measures may also be required to pockets of ground gases building up. Thereby reducing the risk of fires on the site.
- Would reduce any potential for asbestos fibres if identified from the recommended monitoring.
- Would reduce the potential for release of any other contaminants (waste materials or soil) from the site.

- It should be noted that any proposed development on site would need to be assessed based on risk and may alter the risk profile in relation the site and/or require a different level of remediation/actions to mitigate any source-pathway-receptor linkages

Fires

- The investigation has not identified a definitive cause of the fires. However, the following the following are considered to be possible iginition sources:
  - Human Intervention
  - Decomposition of the waste materials which generate heat which may form an ignition source
  - The presence of methane which is flammable in certain concentration/conditions and could potentially exacerbate or sustain fires within the deposited waste

Fires – Potential Mitigation

- Remediation Recommendations
  - Fencing, CCTV etc. to stop more combustible materials going onsite and prevent potential for arson
  - Capping the site to starve combustible material of oxygen while allowing methane to escape though consideration of gassing regime in designing the capping.

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Any Questions?