DTE Caerwent: Former Wormtech Area LQA2 Addendum

Defence Infrastructure Organisation

Environmental Monitoring at DTE Caerwent

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Contents

Executive Summary

Jacobs was commissioned by Defence Infrastructure Organisation (DIO) to undertake further environmental monitoring at DTE Caerwent following the Phase 2 Land Quality Assessment (LQA) carried out by SKM Enviros (now Jacobs) in 2013-2014. This monitoring task is of a similar scope to that undertaken in 2016 and 2017.

Aims and Scope of Work

Environmental monitoring has been undertaken at DTE Caerwent with the aim of determining:

1. Whether the recovery of topsoils from the former Wormtech green wastes is being undertaken by CTL, and whether this is undertaken in an environmentally sensitive manner;

2. Whether there are any obvious flaws in the material processing, e.g. plastics remaining in finished product, which would mean that they have not been reprocessed from a waste to a saleable product;

3. The amount of waste originating from the Former Wormtech operations which has been processed and the volume for which treatment is outstanding; and

4. Whether the risks to surface waters and groundwaters identified in the previous LQA's undertaken in 2016 and 2017 are still apparent.

On 14th and 15th February 2019, a site walkover visit of the Former Wormtech Area (FWA) at DTE Caerwent was undertaken by Jacobs. At this time, the serviceable, established groundwater monitoring boreholes and surface waters sampling locaitons were inspected and, where possible, sampled. During the visit, key staff of Crownhill Topsoil Ltd (CTL) who operate a waste processing facility at the FWA, were interviewed to obtain information on the ongoing site activities and improvements made since 2017. The aim of the interview was to understand and record significant changes which have occurred at the site since the completion of the LQA in 2014, and obtain an update on the recovery of the green waste remaining at the site from Wormtech activities and how this may progress in future.

Findings of Walkover Visit

Little progress has been made on the treatment of green wastes left by Wormtech since 2017. This is primarily attributed to the revocation of CTL's Environmental Permit (EP) by Natural Resources Wales (NRW) in mid-2018, preventing any further operations, and an existing problem with the treatability of the green waste due to the high plastic content. The presence of these materials presents a risk to surface and groundwater quality.

Despite purchasing a 10mm soil screen (as discussed during the 2017 interview) CTL considers that the processed topsoil would unlikely be saleable as manufactured growing medium (MGM) due to the volume of small plastic fragments remaining within the finished product. CTL has verbally stated that it does not intend to further treat the waste. The implications of this for DIO are discussed in Section 5.3.

The volume of waste and finished products stored by CTL appears to have decreased significantly since 2017, with a Local Area Agreement, granted by NRW to CTL, allowing only the import of material for resale. The woodchip bales previously identified in the 2017 site walkover have since been removed. Housekeeping across the site has improved significantly, with improvements to site drainage and roads free of soils and wastes.

CTL's Environmental Permit

CTL confirmed that it has applied for a new Environmental Permit (EP) following revocation of its existing EP in 2018 due to ongoing concerns with groundwater at the site. A copy of the Permit application has not been provided to Jacobs.

Since the green waste stockpiles are still present on site and have potential to generate leachate, it is anticipated that NRW will require improvements to the site infrastructure beyond the current site improvements prior to granting a new EP.

As described above, NRW has granted CTL a Local Area Agreement for the import of quarried material for resale.

Findings from Monitoring of Surface Water and Groundwater

During the current sampling round, there was no flow from the on-site drainage ditches within or leading from the FWA. One surface water sample was collected from the attenuation pond within the FWA, however a modest flow was noted in the Cas Troggy.

Exceedances of EQS were not reported for the surface water sample. Further, no EQS exceedances were identified in the Cas Troggy brook.

Five of the twelve monitoring wells were unavailable for sampling during the recent site visit. Wells were either damaged (BH111, BH102 and BH7) or dry (BH103 and BH106A). Neither of the upgradient groundwater sampling locations (BH111 and BH103) were able to be sampled, and as such there is no indication of the groundwater quality prior to its passing through the site. None of the groundwater samples exceeded EQS for leachate indicator compounds or metallic contaminants. However, DWS was slightly exceeded for ammoniacal nitrogen in all boreholes, including those down-gradient of the FWA. In general, concentrations of leachate indicator compounds had remained similar to 2017 results, but had slightly increased in BH104 within the FWA.

Recommendations

Recommendations include:

1) Infrastructure improvements to limit leachate generation;

2) Continued monitoring of surface waters and groundwaters with a focus on leachate indicator compounds. Recommended frequency of monitoring is every 6 months for groundwater and 3 months for surface water; and

3) Replacement of damaged boreholes and the installation of protection for remaining above-ground headworks.

1. Introduction

Jacobs has been commissioned by Defence Infrastructure Organisation (DIO) to undertake further environmental monitoring at Ministry of Defence (MOD) DTE Caerwent following the Phase 2 Land Quality Assessment (LQA) undertaken by Jacobs in 2017. Earlier environmental monitoring was also undertaken at the site in 2015 and 2016 following reccomendations outlined in the original LQA in 2014.

1.1 Background Information

Following the failure of Wormtech Ltd. in 2012, a large quantity of green waste was stockpiled at the site within DTE Caerwent. Previous LQAs have demonstrated that leachate derived from the waste posed a risk to local groundwaters and to a lesser degree surface waters, most notably the Cas Troggy Brook. These previous LQAs have included recommendations for the remediation of the wastes and ongoing environmental monitoring.

Subsequent to the completion of the 2014 LQA[1], a topsoil manufacturing company (Crownhill Topsoil Ltd (CTL)) based at DTE Caerwent within the Former Wormtech Area (FWA) commenced a waste processing system, using the stockpiled green waste to create a saleable topsoil-type product. To date, no supervision or verification of the processing activities has been undertaken other than visits from the regulatory body, Natural Resources Wales (NRW).

It was understood from discussions with the DIO Project Manager in 2017 that CTL has not been contracted to undertake treatment of the green wastes. CTL's treatment and recovery of the wastes to date have been undertaken on a voluntary basis as it might be able to process the materials to produce a saleable product. Jacobs understands that the Environmental Permits (EP) under which CTL was operating in 2017 (Permit No's: EB3793HW for mobile plant and NB3597TA for waste) were revoked during the summer of 2018 and as such the green wastes cannot currently be treated, and ownership of, and responsibility for the material, remains under dispute.

Further information regarding the site setting, site history, current site layout and uses, site sensitivity and previous LQA findings are detailed in the 2016[2] and 2017[3] LQA Addendum reports.

1.2 Aims

Environmental monitoring has been carried out at the site with the aim of determining:

1. Whether the recovery of material from the former Wormtech green wastes is being undertaken by CTL, and whether this is undertaken in an environmentally sensitive manner;

2. Whether there are any obvious flaws in the material processing, e.g. plastics remaining in finished product which would mean that they have not been reprocessed from a waste to a saleable product;

3. The amount of residual Wormtech waste which has been processed and the volume for which treatment is outstanding; and

4. Whether the risks to surface waters and groundwaters identified in the previous LQA's and monitoring undertaken in 2016 and 2017 are still apparent. Previous monitoring rounds have been timed to coincide with wet weather where environmental risks are more apparent, however the 2019 monitoring round was undertaken regardless of weather conditions in order to establish the effect that improvements made on the site by CTL, may have had.

1.3 Scope of Works

The scope of works for the environmental monitoring comprised the following tasks:

1. Meet with CTL's representative on site to discuss works to date and proposed activities;
2. If available for examination, provide comment on the CTL remediation plan and environmental management plan;
3. Conduct a site walkover inspection to comment on the general condition of the site, any visible signs of leachate migration and the general suitability of the site's environmental management;
4. Identify significant changes in stockpiles including sealed surfaces, materials visible in stockpiles and visible evidence of leaching from the wastes;
5. Visually examine the topsoil end-product for deleterious materials;
6. Undertake a round of monitoring at up to 10 groundwater monitoring boreholes and up to 6 surface water monitoring locations in and around the former Wormtech Area (FWA). The number of surface water monitoring locations available will be weather dependent. Samples obtained to be scheduled for the same suite of contaminants as analysed during previous monitoring rounds in 2016 and 2017.
7. Produce a brief Monitoring Report collating the information recorded.

1.4 Nomenclature

Throughout the report reference is made to the former Wormtech Area (FWA) and Crownhill Topsoil Ltd (CTL) area which are to all intents and purposes the same area. The FWA is shown on the site layout plan (Figure 1). Since this report principally concerns risks to the water environment due to Wormtech's operations, the study area is generally referred to as FWA except where describing activities solely relating to Crownhill's current activities and responsibilities where the area is referred to as the CTL site. The study area forms a small part of the wider DTE Caerwent Training Estate which is referred to as DTE Caerwent throughout.

The Cas Troggy Brook is referred to by its English name within this report. Elsewhere, it may be referred to by its Welsh name, Castrogi.

The term "topsoil" has been used throughout this report to describe the "manufactured growing medium (MGM)" product from imported green wastes, which was being processed by Wormtech.

2. Information from Current Site Operators (CTL)

During the site visit on 15th February 2019, the Compliance Manager/ Financial Director (Peter Fowler) of Crownhill Topsoil Ltd. confirmed the points listed below. It should be noted that CTL's comments are presented at face value and Jacobs has not sought to verify these:

1. The Permit for inert waste treatment activities at the FWA issued by NRW was revoked during the Summer of 2018 due to the ongoing concern about groundwater issues at the site. Operations which would require a permit are not being undertaken;

2. CTL currently has two EP exemptions by NRW: to import crushed demolition material derived from elsewhere on the DTE Caerwent site, and to import quarried stone as aggregate for resale. No other material is currently brought onto the site as this would breach the existing EP exemptions which are in place;

3. CTL is in the process of applying to NRW for a revised EP to process inert construction waste for reuse as topsoil. No decision is understood to be have been made at the time of writing;

4. CTL has a second yard within the DTE Caerwent site, allowing the processing of inert waste, and is used for screening of materials. These materials are then transported to the site within the FWA for storage and resale;

5. The historic Wormtech green waste material is still present at the south east corner of the FWA site and there are ongoing discussions between DTE Caerwent, NRW and CTL over its ownership;

6. During the site visit in April 2016, Jacobs was informed that CTL was considering the purchase of plant with a 10mm aperture soil screen which would allow more efficient production of the topsoil and removal of higher quantities of plastics. During the February 2019 visit, Jacobs was informed that the 10mm aperture fine soil screen has been purchased but it was considered unlikely it would remove the required volume of plastics for the waste to be resold as topsoil. This had not been trialed, as there is neither an EP nor a Local Area Agreement with NRW in place to allow the processing of the waste materials;

7. Due to the revocation of the EP by NRW, there has been no further attempt at treatment of the green waste in the last 9 months;

8. CTL confirmed that the woodchip bales photographed during Jacobs' 2017 visit have been removed from the site, although no further details on resale or removal were available at this time;

9. The topsoil being stored in Building 1008 is material processed by CTL prior to the revocation of the EP, and is currently being sold;

10. CTL appears not to have a remediation plan or environmental management plan; and

11. CTL confirmed that improvements have been made to the drainage system across the site, consistent with the Drainage Plan (EV/13/0901/103) dated August 2016. This includes the lining of attenuation ponds adjacent to the site office, and creation of a land drain discharging into a lined pond immediately east of the site entrance.

3. Walkover Inspection Findings

A walkover inspection of the site was undertaken on 15th February 2019 alongside sampling activities. Weather conditions during the period before and during sampling was dry and cold, with minimal rainfall in the week preceding the visit. The FWA was particularly dry during the walkover inspection.

Observations from the walkover inspection are detailed in Table 3.1 with additional observations following the table. Surface water monitoring locations which have been referred to in the table are shown on Figure 1.

Table 3.1: Observations During Site Walkover Visit

Plate Ref.	Description of Features	Photograph of Features
1	Stockpiles identified in 2013 as A10 and A11 (see 2014 LQA[1] for locations) south of Building 1008 were removed prior to the 2017 walkover. The location is now a grassed verge with lined attenuation ponds. Plastics and other debris were noted in the topsoil of this grassed area, primarily to the east in the vicinity of the Wormtech stockpiles.	

Plate Ref.	Description of Features	Photograph of Features
2	The former small leachate collection pit immediately east of the emergency water supply is now a 50m x 15m attenuation pond with 2 No. raised separators, lined with 1mm high density polyethylene (HDPE). Depth of the ponds is unknown although it appears to be shallow at a maximum of approximately 40cm. During the 2017 visit, it was noted these ponds were unlined and have since been lined at NRW's request. It is unclear how leachate or runoff generated within the site would reach the attenuation ponds. Collected run-off would then overspill the attenuation ponds once they reach capacity and drain east via a gully into a ditch. The attenuation pond was sampled as SW202.	

Plate Ref.	Description of Features	Photograph of Features
3	Small attenuation pond 20m x 4m lined with 1mm HDPE. Land drain (75mm) enters the northern end of the pond. A slow inflow was observed during the site walkover.	
4	Demolition rubble from Building 1007 (demolished by CTL following a fire) is believed to remain on site, although this is unclear.	

Plate Ref.	Description of Features	Photograph of Features
5	CTL resells imported aggregate which is stored in temporary bays outside Building 1008.	
6	The CTL site has stockpiles of waste soils and demolition materials, most of which precedes the EP revocation. Demolition materials present on site have been sourced from demolition of buildings and material crushing within DTE Caerwent, and subsequently stored within the CTL boundary.	

Plate Ref.	Description of Features	Photograph of Features
7	Building 1008 contains topsoil which predates the revocation of CTL's EP. It is understood that this is still being sold from the site. It is noted that this topsoil has not been produced from the former Wormtech materials on site. The building is approximately 50% full of this material.	
8	Close-up view of finished topsoil material shown in Plate 7. There is no evidence of bagging of this material for sale.	

Plate Ref.	Description of Features	Photograph of Features
9	Green waste stockpile from Wormtech. This remains uncovered with evidence of leachate at the base. The waste contains significant amounts of plastics and woody materials, with minor stone, concrete and metal. The waste mound is located partially on hardstanding, with the south-west face of the pile located on unsurfaced ground. The waste remains unaltered since its deposition by Wormtech, although reprofiled by CTL.	
10	Small quantities of brown leachate being generated from the uncovered green waste stockpile in Plate 9, draining onto hardstanding. It is unclear from the CTL Drainage Plan whether leachate is allowed to freely drain across the site, as a gully adjacent to the stockpiles is marked on the Drainage Plan but listed as blocked (this gully could not be located during the site walkover).	

Plate Ref.	Description of Features	Photograph of Features
11	Green waste pile immediately north of that shown in Plate 9. There is a small amount of leachate draining onto the hardstanding with no clear pathway for drainage into the attenuation ponds.	
12	Leachate pooling at the base of the stockpile shown on Plate 10. Plastic material within the green waste is also visible.	

Plate Ref.	Description of Features	Photograph of Features
13	BH7, adjacent to SW202 within the FWA, has been significantly damaged since the last monitoring round in 2017. This is likely attributed to CTL's site activities.	
14	SW101 ditch within FWA looking south-east towards CTL site. Observed as being dry, with no leachate.	

Plate Ref.	Description of Features	Photograph of Features
15	View of SW105, down-gradient of FWA, looking southwards. Ditch was observed as being dry and vegetated.	
16	SW201, down-gradient of FWA, looking south. The furthest downstream point within this drainage ditch. The ditch was observed as being dry and vegetated.	

Plate Ref.	Description of Features	Photograph of Features
17	View of SW203, down-gradient of FWA, looking south west. Channel was dry and vegetated.	
18	SW102, down-gradient of FWA, looking north-east. The ditch was observed as being dry and vegetated.	

Plate Ref.	Description of Features	Photograph of Features
19	View of the Field Culvert. The field was dry at the time of the site visit and the culvert heavily overgrown.	
20	View of SW103 at the upstream side of the culvert on the Cas Troggy, looking south. The water was clear and had a moderate flow.	

Plate Ref.	Description of Features	Photograph of Features
21	View of SW104 at the downstream side of the culvert on the Cas Troggy, looking north. The water was clear and had a moderate flow.	

Observations in the Former Wormtech Area

The recent walkover survey confirmed that the volumes of green waste were little changed since the previous walkover survey undertaken in 2017. The green waste is located in the same part of the site and forms two mounds, as observed in 2017. CTL confirmed that no measures to limit rainfall percolation through the stockpiles have been employed, such as sheeting or sealing of the surfaces. As such, minor amounts of leachate were observed at the base of the waste (Plates 10 and 12). There was no evidence of algal build-up which was observed during the 2016 visit. There was no evidence of leachate on the roads within the FWA, or pooling at the base of stockpiles. It should be noted that the survey took place during and following a sustained period of dry weather.

There were no obvious signs of changes to the size or height of the green waste stockpiles noted since the previous walkover visit in 2017. Jacobs was informed that there is no ongoing processing of the green waste, and CTL has no plans for its disposal or movement.

There appears to be a significantly lower volume of waste and aggregate stored at the CTL site in general, attributed to the revocation of the EP resulting in cessation of CTL's onsite material processing. One stockpile of processed topsoil was observed in Building 1008, which is noted to pre-date the EP revocation and is currently being sold (Plates 7 & 8).

Improvements were observed to drainage at the site since 2017, with the creation of attenuation ponds (Plates 1 & 2) and existing drainage channels cleared of waste and vegetation. Runoff is now directed into these channels rather than allowed to freely drain across the site. The efficiency of this could not be assessed due to the dry

weather preceding the visit. A small lined attenuation pond (20m x 4m) to the west of the site entrance (Plate 3) is serviced by a land drain and manages runoff in this portion of the site. There was insufficient water at this location to retrieve a sample, although in future visits this location should be considered for additional surface water sampling.

Improvements to housekeeping within the FWA since 2017, were observed during the recent walkover. However, whilst roads were clear and wastes and aggregates separated, it should be noted that due to the revocation of the EP, site activity is more limited than that observed in 2017 i.e. no ongoing crushing or screening activities are currently undertaken at the site. The volume of material observed on site was low, and only one skip containing waste was present. The baled woodchip photographed on site in 2017 has been removed from the site.

Observations along the Drainage Pathways South of the Former Wormtech Area

The drainage ditch within and extending south west of the FWA was dry at the time of the site walkover, and samples could not be collected from monitoring points SW101 and SW203 (Plates 14 & 17). SW202 located within the FWA is now a lined attenuation pond and was sampled at its eastern corner (Plate 2).

Downstream of the FWA, drainage ditches within the central area of DTE Caerwent were all dry and monitoring points could not be sampled (SW105, SW201 and SW102). These ditches meet the drains connected to the FWA, approximately 340 m north-north-east of SW102. Inspection of these drainage ditches found them all to be dry and as a result there was no flow observed into the Cas Troggy brook from DTE Caerwent.

The Cas Troggy brook (SW103 and SW104) had a moderate flow, with low suspended sediments and an absence of odour, sheen or foam noted at both sampling locations.

4. Surface Water and Groundwater Sampling

4.1 Sampling Methodology

The sampling methodology was unchanged from the 2014 LQA[1].

4.2 Sampling Locations

The 2014 LQA[1] and subsequent 2016 and 2017 Addenda[2&3] established groundwater and surface water sampling locations within the FWA and hydraulically up and down-gradient of the FWA. This comprised monitoring locations both within and outside of the DTE Caerwent boundary. During the 2019 monitoring round, it was planned to sample 10 groundwater locations and dip three additional groundwater locations, and sample 6 surface water locations, dependent on which locations held water.

Sampling was undertaken on 14th and 15th February 2019. The surface water and groundwater locations monitored, though not necessarily sampled during this monitoring round are detailed in Table 4.1. A number of surface water and groundwater locations were dry during the visit and could not be sampled (denoted in Table 4.1 with an asterisk). These are included as the absence of flowing water is a useful observation.

Surface water and groundwater monitoring locations are shown on Figure 1. Groundwater monitoring locations with indicative groundwater contours are shown on Figure 2.

Table 4.1: Summary of Surface Water and Groundwater Sampling Locations

Location (*dry)	Description
Surface Water Sampling Locations	
SW201*	Onsite drainage ditch near Building 715, down-gradient of the FWA.
SW202	Lined shallow attenuation pond within the CTL site.
SW203*	Onsite drainage ditch immediately down-gradient of the FWA.
SW101*	Onsite drainage ditch immediately southwest of FWA.
SW102*	Onsite drainage ditch, SW extent of DTE Caerwent at perimeter fence.
SW103	On Cas Troggy brook, upstream of culvert entry.
SW104	On Cas Troggy brook, downstream of culvert, prior to it becoming Nedern Brook.
SW105*	Onsite drainage ditch down-gradient of the FWA.
Field Drain*	Downstream of SW102, outside DTE Caerwent's SE boundary fence.
Field Culvert*	Entrant to Cas Troggy culvert from field outside DTE Caerwent's SE boundary fence.
Groundwater Sampling locations	
BH111#	Up-gradient borehole to the NE of the FWA, near perimeter fence.
BH103*###	Up-gradient borehole on northern edge of FWA close to Building 845.
BH101	NW extent of FWA.
BH102##	Southern extent of FWA.
BH7#	Southern extent of FWA.

Location (*dry)	Description
BH104	SE extent of FWA.
BH105	SW extent of FWA.
BH105A	SW extent of FWA (shallow borehole adjacent to BH130).
BH106	Down-gradient borehole on DTE Caerwent S boundary.
BH106A*	Down-gradient borehole on DTE Caerwent S boundary (shallow borehole adjacent to BH130).
BH107	Down-gradient borehole between FWA and DTE Caerwent S boundary.
BH130	Down-gradient borehole on DTE Caerwent S boundary.

well damaged; could not be sampled
well missing
BH103 was not servicable during the 2017 monitoring round

4.3 Water Quality Field Results

4.3.1 Surface Waters

Surface water quality parameter readings have been taken at the point of sampling. The parameters measured were pH, Electrical Conductivity (EC), temperature, reduction/oxidation potential (Redox), Dissolved Oxygen (DO) and Total Dissolved Solids (TDS). The recorded values have provided a general indication of surface water quality across the site. Immediate field pH and EC readings are beneficial as sample composition can alter during the holding time prior to laboratory analysis.

Surface water quality parameters at the point of sampling are provided in Table 4.2. It should be noted that there was no flow within, nor to the south of the FWA, and SW202 was only able to be collected as it is an attenuation pond.

Table 4.2: Surface Water Quality Parameters at the Point of Sampling

Location	Temp.	pH	Electrical Conductivity	Redox Potential	Total Dissolved Solids	Dissolved Oxygen	Comments
	ºC	pH.Units	µS	mV	ppt[1]	mg/L	
Surface Waters within or near to FWA							
SW202[2]	9.6	7.7	628.1	64.6	0.6	13.2	Medium brown with suspended sediment. Standing water.
SW101	-	-	-	-	-	-	Dry
Down-gradient of FWA							
SW203	-	-	-	-	-	-	Dry
SW105	-	-	-	-	-	-	Dry
SW201	-	-	-	-	-	-	Dry
SW102	-	-	-	-	-	-	Dry
Field Drain	-	-	-	-	-	-	Dry
Field Culvert	-	-	-	-	-	-	Dry
Cas Troggy Brook (down-gradient of DTE Caerwent boundary)							
SW103[2]	13.5	8.2	179.6	88.1	0.2	10.6	Moderate flow, clear with low suspended sediment.
SW104[2]	9.7	8.0	177.7	71.6	0.2	11.5	Moderate flow, clear with low suspended sediment.

Note: [1] parts per thousand

[2] Detectable odour, sheen and foam were absent at all monitoring locations.

. There was a clear decrease in temperature between SW103 (upstream of A48) and SW104 (downstream of A48) likely attributed to its passage through the concrete culvert beneath the A48.

The pH of surface waters was generally neutral to slightly alkaline and is likely caused by the underlying limestone aquifer which is expected to have a slightly alkaline pH.

EC was slightly elevated in SW202, the attenuation pond within the FWA, and suggests an increase in dissolved salts at this location. EC was within normal range at Cas Troggy Brook. In SW202, redox measurement

produced a low positive indicating surface water had a slightly higher reduction potential than the Cas Troggy Brook.

DO concentrations were within normal levels at all monitoring locations. SW202 had a higher DO concentration and conductivity but also a higher reduction potential than in the Cas Troggy brook. TDS concentration was also higher in the FWA than Cas Troggy brook.

There is some minor evidence of leachate contamination within the FWA at SW202, but this is not observed down-gradient in the Cas Troggy brook. The extent, if any, of leachate impacts in drains within the DTE Caerwent boundary, and downstream in the Cas Troggy brook could not be determined due to the dry weather conditions preceding the visit. This impacted on both the generation of leachate within the FWA and runoff into and through the drainage channels.

4.3.2 Groundwater

Groundwater quality parameter readings have been taken at the point of sampling. Parameters were used during purging to determine when abstracted waters had ceased to vary by any significant amount and were therefore considered representative of the aquifer. Two boreholes did not achieve this steady state (BH101 and BH105A) and were purged dry, likely attributed to the dry weather conditions encountered. In this case, samples were obtained following well recharge, Recorded values have provided a general indication of groundwater quality beneath the site.

Groundwater quality parameters at the point of sampling are provided in Table 4.3.

Table 4.3: Groundwater Quality Parameters at the Point of Sampling

Location	Depth to GW	Depth to Base	Temp.	pH	Electrical Conductivity	Redox Potential	Total Dissolved Solids	Dissolved Oxygen	Comments
	m bgl	m bgl	ºC	pH.Units	µS	mV	ppt	mg/L	
Up-gradient of FWA									
BH111	32.84	36.92	-	-	-	-	-	-	Borehole blocked at around 12.0 - 13.0 m, assumed kinked[1].
BH103	-	25.98	-	-	-	-	-	-	Dry
Boreholes within or near to FWA									
BH7	11.20	23.05	-	-	-	-	-	-	Damaged – headworks missing, and standpipe kinked at 0 - 0.20 m bgl. Unable to insert bailer or pump in order to sample.
BH101	11.20	17.06	10.88	7.15	937.18	85.05	0.83	7.56	Dark brown, clearing with purge. Purged dry so sampled after recharge.

Location	Depth to GW	Depth to Base	Temp.	pH	Electrical Conductivity	Redox Potential	Total Dissolved Solids	Dissolved Oxygen	Comments
	m bgl	m bgl	ºC	pH.Units	µS	mV	ppt	mg/L	
BH102	-	-	-	-	-	-	-	-	Could not be located – believed to have been destroyed or covered.
BH104	8.47	15.25	11.61	7.03	856.04	78.58	0.73	3.84	Dark brown but clearing with purge. No odour or sheen.
BH105	4.95	14.05	10.86	7.43	482.54	90.63	0.42	9.62	Dark brown, significant suspended sediment. Clearing to light brown after 10- minute purge. No odour or sheen.
BH105A	5.40	5.91	9.46	7.50	459.79	80.98	0.43	9.76	Light brown, clearing with purge. No odour or sheen. Small amount of water in well but quick recharge.
Down-gradient of FWA									
BH106	16.00	18.52	8.56	7.35	360.59	82.4	0.34	11.88	Very slow recharge. Murky brown, clearing slightly with purge. No odour or sheen.
BH106A	-	5.43	-	-	-	-	-	-	Dry
BH107	12.74	17.77	10.50	7.35	396.24	75.96	0.36	11.04	Light brown, clearing with purge. No odour or sheen.
BH130	5.43	15.77	9.82	7.40	353.09	74.44	0.32	10.18	Strong flow. Medium brown, clear after 6 minutes of purging. No odour or sheen.
Additional groundwater data (boreholes dipped for levels only)									
BH108	5.74	14.96	-	-	-	-	-	-	
BH109	10.03	20.07	-	-	-	-	-	-	Ants nesting in borehole.
BH110	11.73	18.90	-	-	-	-	-	-	

Note: [1] Dipmeter could be inserted to full depth of the well, but bailer became obstructed at 12 – 13m depth

The blockage in BH111 is considered likely to be a severe kink or break of the well caused by ground movements, as the borehole lies on a steeply sloping part of the site. The 2017 LQA identified the kink or blockage at 30 - 30.6 m, however during this monitoring round the blockage appeared to be at 12 - 13 m.

Groundwater pH was broadly neutral in all samples across the site. Temperature was highest within the FWA, in BH101, BH104 and BH105. This is potentially indicative of breakdown of organic materials within leachate.

EC values varied widely across the site with the highest recorded values within the FWA (BH101 and BH104 in particular). There is a clear trend of EC values decreasing with distance down-gradient of the FWA. This may be indicative of leachate percolation within the immediate vicinity of the FWA. However, the potential effect and presence of any leachate within the groundwater appears to be declining the greater the distance from the FWA.

Redox potential was generally consistent across the site, between 74 – 91 mV and indicates a low positive oxidizing environment.

DO concentration is reasonable for groundwater samples, with the exception of BH104 and BH101. This is consistent with high EC in these samples and is suggestive of possible leachate contamination.

TDS concentrations in groundwater samples were all below 0.83 ppt, with highest concentrations observed in boreholes within the FWA.

An indicative groundwater contour plan (Figure 2) has been produced based on groundwater levels recorded during the 2019 monitoring round. The indicative plan shows groundwater flowing in a southerly direction across the FWA and DTE Caerwent. It should be noted that due to the limited number of monitoring locations, this direction of flow remains indicative based upon dipped groundwater levels.

Figure 4.1 shows changes in groundwater heights between the 2013 and 2014 LQA monitoring period and 2016 – 2019 monitoring rounds. The maxima and minima groundwater heights are provided in Table 4.4. BH108 to BH110 are located on the central landfill area, outside of the FWA monitoring zone and have been included to provide information on groundwater depth. This information indicates that groundwater levels during 2019 monitoring are at or just above their lowest recorded height. The levels recorded in BH104 and BH107 were significantly above minimum vales for the period 2013 – 2017, but still below historical maxima. Existing groundwater levels are attributed to the dry winter 2018 – 2019 season preceding the recent monitoring.

Figure 4.1: Comparison of recorded groundwater levels in boreholes from 2013.

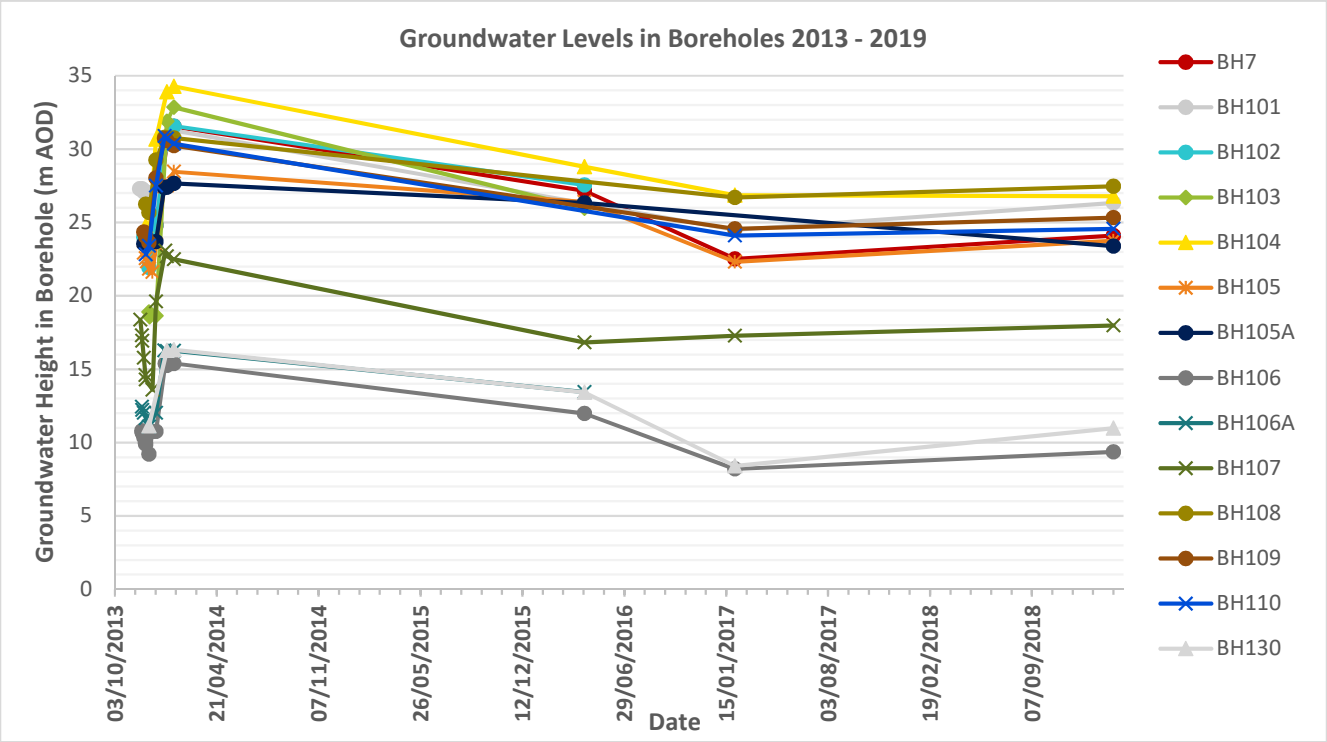


Table 4.4: Comparison of Recorded Borehole Dip Data from 2013 - 2017 with Feb 2019

Borehole Ref.	2013 – 2017		2019	
	Min. Recorded GW Height	Max. Recorded GW Height	Dipped GW Height	Height Change from 2013 Min. Recorded GW Height
BH7	22.52	31.54	24.11	1.59
BH101	24.49	31.27	26.33	1.84
BH102	21.92	31.57	-	-
BH103	18.57	32.85	Dry	-
BH104	23.75	34.28	26.78	3.03
BH105	21.63	28.46	23.77	2.14
BH105A	23.54	27.65	23.38	-0.16
BH106	8.20	15.39	9.37	1.17
BH106A	11.09	16.27	Dry	-
BH107	13.60	23.07	17.98	4.38
BH108	25.67	30.81	27.46	1.79
BH109	23.62	30.72	25.34	1.72

Borehole Ref.	2013 – 2017		2019	
	Min. Recorded GW Height	Max. Recorded GW Height	Dipped GW Height	Height Change from 2013 Min. Recorded GW Height
BH110	22.82	30.90	24.57	1.75
BH111	26.51	39.56	25.98	-0.53
BH130	8.40	16.32	10.98	2.58

4.4 Chemical Analysis Undertaken at Surface Water and Groundwater Locations

During this 2019 monitoring round, three surface water samples and seven groundwater samples have been collected. These samples have been analysed for the following determinands:

- Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), chloride, ammoniacal nitrogen; and
- Arsenic, boron, cadmium, chromium (total), copper, iron (total), mercury, manganese, nickel, lead and zinc.

In addition, one sample from the downstream Cas Troggy (SW104) was scheduled for an EQS Characterisation suite comprising:

- Calcium, Dissolved Organic Carbon (DOC), alkalinity and hardness.

4.5 Methodology of Assessment

The methodology of assessment remains largely unchanged from the 2014 LQA. The only significant change is the use of revised Environmental Quality Standards (EQS) to assess risks to surface waters. In December 2015, previous EQS regulations were replaced in England and Wales by the *"Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015*". For most parameters, the EQS's contained within the 2015 Directions remain the same as those used in the 2014 LQA. However, key changes have been introduced. The changes relevant to this report include:

- Five metals (copper, lead, nickel, manganese and zinc) now have an EQS set for the bioavailable fraction of the metals. These are calculated using the dissolved metal concentration, pH, calcium concentration and DOC; and
- Metals, with the exception of cadmium, no longer rely on the 'hardness class'.

As such, laboratory results provided in the tables below list these five metals as 'dissolved' for screening against Drinking Water Standards (DWS) and 'bioavailable' for screening against EQS.

It should be noted that if an EQS or DWS is exceeded, the impacts may not necessarily be significant, and additional work would be required in order to assess the extent of any impact.

4.6 Surface Waters Assessment

Three surface water samples were collected on 14th February 2019 from the Cas Troggy Brook and an attenuationpond within the FWA (Table 4.1) and analysed for the contaminants listed in Section 4.4. It was not possible to recover samples from drainage ditches within the DTE Caerwent boundary. Analysis results are presented in Table 4.5 and compared against those obtained during 2014 monitoring.

Table 4.5: Surface Water Chemical Analysis Results (Exceedances Highlighted)

Determinand	Units	No. of Samples	EQS (exceeded)	2019		2014		Location of Exceedances
				Min.	Max.	Min.	Max.	
pH	pH Units	3	6.0 to 9.0 (0)	8.2	8.3	6.9	8.7	-
EC	µS/cm	3	-	260	830	190	3600	-
BOD (settled)*	mg O_2/L	3	4.0 (0)	< 4.0	< 4.0	< 4.0	140	-
COD	mg O_2/L	3	-	< 10	23	< 10	720	-
Chloride	mg/L	3	250 (0)	15	110	9.1	420	-
Ammonia (Free)	mg/L	3	-	0.092	0.12	-	-	-
Ammoniacal Nitrogen	mg/L	3	2.5 (0) [A]	0.7	0.9	< 0.01	63	-
Arsenic (dissolved)	µg/L	3	50 (0)	< 1.0	2.0	< 1.0	28	-
Boron (dissolved)	µg/L	3	2000 (0)	< 20	47	17	390	-
Cadmium (dissolved)	µg/L	3	0.15 (0)	<0.08	<0.08	< 0.08	0.37	-
Chromium (dissolved)	µg/L	3	4.7 (0)	< 1.0	2.5	< 1.0	11	-
Copper (dissolved)	µg/L	3	-	< 1.0	7.9	< 1.0	27	-
Copper (bioavailable)	µg/L	3	1.0 (0)	< 0.06	0.42	0.42	23	-
Iron (total)	µg/L	3	1000 (0)	51	450	< 20	4900	-
Mercury (dissolved)	µg/L	3	0.07 (0)	< 0.01	< 0.01	< 0.50	0.88	-
Manganese (dissolved)	µg/L	3	-	< 1.0	13	< 1.0	1300	-
Manganese (bioavailable)	µg/L	3	123 (0)	< 1.0	13	-	-	-
Nickel (dissolved)	µg/L	3	-	< 1.0	2.5	< 1.0	32	-
Nickel (bioavailable)	µg/L	3	4 (0)	< 0.54	1.18	-	-	-
Lead (dissolved)	µg/L	3	-	< 1.0	1.2	< 1.0	110	-

Determinand	Units	No. of Samples	EQS (exceeded)	2019		2014		Location of Exceedances
				Min.	Max.	Min.	Max.	
Lead (bioavailable)	µg/L	3	1.2 (0)	< 0.14	0.17	0.01	0.22	-
Zinc (dissolved)	µg/L	3	-	<1.0	6.1	0.48	72	-
Zinc (bioavailable)	µg/L	3	12.3 (0)	< 0.29	1.8	-	-	-
DOC**	mg/L	1	-	-	7.1	1.10	93.6	-
Calcium**	µg/L	1	-	-	26	20	110	-
Hardness**	mg $CaCO_3$/L	1	-	-	40	123	123	-

* BOD was marked as deviating from the laboratory due to exceeding the holding time prior to analysis. These values are therefore indicative only.

** Analysed in SW104 only

A The Nedern Brook has a “poor” hydrological classification and is classed as a Type 3 watercourse

There were no exceedances of EQS within samples taken from within the FWA attenuation pond and Cas Troggy brook. Concentrations of metals were slightly higher within the FWA attenuation pond in comparison to the Cas Troggy brook. In the Cas Troggy, all metals excluding iron were below the limit of detection. SW202 results continue to indicate the presence of leachate within the FWA and current operational area of CTL, although the key leachate indicator compounds have generally shown a declining trend since 2016.

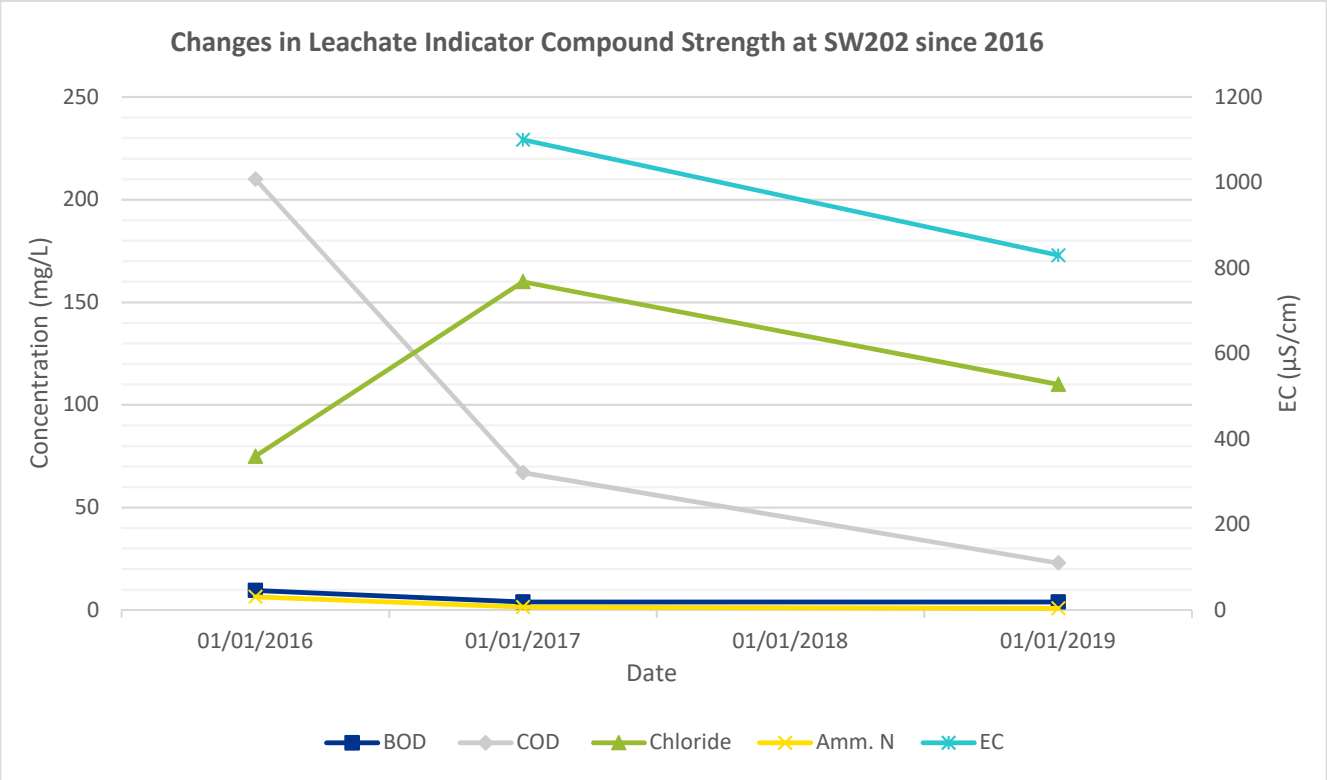
There is an overall declining trend in the concentration of determinands when comparing 2019 results with 2014 and 2017 analysis results. In particular, iron concentrations decreased from 4000 µg/L in 2017 to 450 µg/L in 2019, and manganese (dissolved) from 640 µg/L in 2017 to 13 µg/L in 2019. As such, there is no indication of the natural background elevation of iron and manganese which has been considered a factor in previous reports (Section 6.8 of the 2016 LQA2 addendum)[2].

4.6.1 Evaluation of Contaminant Concentration Trends in Surface Water

Figure 4.2 below shows the variation in concentrations of key leachate indicator compounds at SW202, an attenuation pond within the FWA, since 2016. No earlier monitoring data are available as the attenuation pond from which this sample is taken, was constructed by CTL in 2016. Due to the preceding dry weather conditions resulting in low rainfall prior to the site visit, there was no flow within the drainage network within or outside of the FWA. As such, no downstream drainage trend can be evaluated.

Figure 4.2 shows a decline in leachate indicator compounds within SW202 between 2016 - 2019, excluding chloride concentration which increased between 2016 – 2017. Since 2017, BOD has been below the LOD.

Figure 4.2: Leachate indicator compound concentrations at SW202 since 2016



4.7 Groundwater Assessment

Seven groundwater samples were collected from boreholes at DTE Caerwent between 14th and 15th February 2019 and analysed for contaminants listed in Section 4.4. The assessment of chemical analyses results have been split into locations up-gradient of the FWA; locations within of close to the FWA; and locations downgradient of the FWA.

4.7.1 Assessment of Groundwater Contamination Up-Gradient of the FWA

During the 2019 monitoring round, no up-gradient groundwater samples could be recovered, as BH111 was blocked and BH103 was found to be dry.

4.7.2 Assessment of Groundwater Contamination Within or Close to the FWA

Four monitoring wells within or close to the FWA were sampled during the current environmental monitoring round (BH101, BH104, BH105 and BH105A). No sample was taken from BH7 as the well has been damaged. Chemical analysis results are summarised in Table 4.6 and discussed below.

Table 4.6: Assessment of Contaminants in Groundwater within or close to the FWA (BH101, BH104, BH105 and BH105A) (Exceedances Highlighted)

Determinand	Units	No. of Samples	DWS (exceeded)	EQS (exceeded)	2019		2014		Location of Exceedances (highest in bold)
					Min.	Max.	Min.	Max.	
pH	pH Units	4	6.5 to 10.0 (0)	6.0 to 9.0 (0)	7.7	8.2	7.0	8.0	-
EC	µS/cm	4	2500 (0)	-	520	1100	486	1700	-
BOD (settled)*	mg O_2/L	4	-	-	< 4.0	< 4.0	< 1.0	68	-
COD	mg O_2/L	4	30 (0)	30 (0)	< 10	26	7.2	270	-
Chloride	mg/L	4	250 (0)	250 (0)	16	80	14	260	-
Ammonia (free)	mg/L	4	0.5 (0)	-	< 0.05	0.09	-	-	-
Ammoniacal Nitrogen	mg/L	4	0.39 (4)	2.5 (0)[A]	0.67	1.0	0.046	23	**BH104**, BH105A, BH105, BH101
Arsenic (dissolved)	µg/L	4	10 (0)	50 (0)	< 1.0	< 1.0	0.73	17.2	-
Boron (dissolved)	µg/L	4	1000 (0)	2000 (0)	20	60	< 20	190	-
Cadmium (dissolved)	µg/L	4	5 (0)	0.15 (0)	< 0.08	< 0.08	< 0.02	0.47	-
Chromium (dissolved)	µg/L	4	50 (0)	4.7 (0)	< 1.0	2.2	< 0.2	0.7	-
Copper (dissolved)	µg/L	4	2000 (0)	-	< 1.0	1.7	< 1.0	23	-
Copper (bioavailable)	µg/L	4	-	1 (0)	< 0.03	0.06	0.05	0.74	-
Iron (total)	µg/L	4	200 (3)	1000 (0)	150	320	36	4600	**BH104**, BH101, BH105A
Mercury (dissolved)	µg/L	4	1 (0)	0.07 (0)	< 0.01	< 0.01	< 0.50	< 0.50	-
Manganese (dissolved)	µg/L	4	50 (0)	-	2.7	27	0.73	1800	-
Manganese (bioavailable)	µg/L	4	-	123 (0)	2.7	17.36	0.28	621	-
Nickel (dissolved)	µg/L	4	20 (0)	-	< 1.0	3.8	< 1.0	16	-

Determinand	Units	No. of Samples	DWS (exceeded)	EQS (exceeded)	2019		2014		Location of Exceedances (highest in bold)
					Min.	Max.	Min.	Max.	
Nickel (bioavailable)	µg/L	4	-	4 (0)	< 0.31	1.25	0.6	2	-
Lead (dissolved)	µg/L	4	10 (0)	-	< 1.0	< 1.0	< 0.1	1	-
Lead (bioavailable)	µg/L	4	-	1.2 (0)	< 0.14	< 0.14	0.01	0.20	-
Zinc (dissolved)	µg/L	4	5000 (0)	-	< 1.0	< 1.0	1.9	17	-
Zinc (bioavailable)	µg/L	4	-	12.3 (0)	< 0.29	< 0.31	0.45	2.80	-

* BOD was marked as deviating from the laboratory due to exceeding the holding time prior to analysis. These values are therefore indicative only.

There were no exceedances of EQS in groundwater samples obtained from within the FWA during the 2019 monitoring round. Only ammoniacal nitrogen exceeded the DWS, and was elevated at a minimum of twice the DWS in all samples. This exceedance alongside slightly elevated concentrations of chloride (which fall well below DWS/EWS) is indicative of very minor leachate contamination.

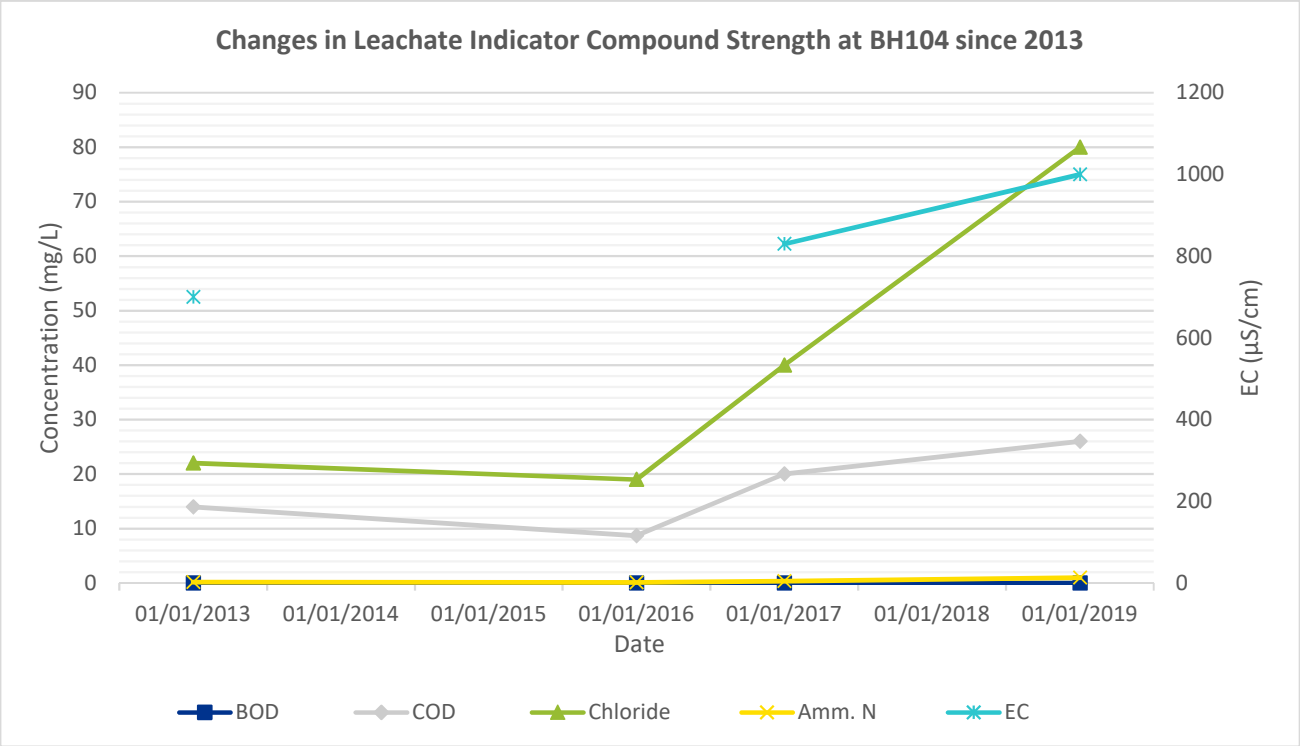
Concentrations of metals within FWA groundwater samples are markedly reduced in comparison to previous monitoring rounds, and are below the EQS. Only iron exceeded the DWS in three boreholes, with the highest concentration recorded in BH104. No determinand values exceed those observed during the 2017 monitoring round, with the majority having decreased by a factor of 10 since.

Evaluation of Contaminant Concentration Trends in the FWA

Figure 4.3 shows the changes in key leachate indicator compounds since 2013 in BH104 within the FWA. Ammoniacal nitrogen has remained relatively stable since 2013, and BOD has remained at < 4 mg/l (below the LOD) since 2013. There has been a slight increase in chloride, COD and EC at this monitoring point since 2013, but all are below the respective EQS.

Concentrations of leachate indicator compounds in other boreholes within the FWA (BH105, BH105A and BH101) are lower than those identified within BH104 during 2019 monitoring, and are generally lower than previous monitoring rounds.

Figure 4.3: Changes in leachate indicator compound concentrations in BH104 since 2013



4.7.3 Assessment of Groundwater Contamination Down-Gradient of the FWA

Three monitoring wells down-gradient of the FWA were sampled in the current round of environmental monitoring (BH106, BH107 and BH130). No sample could be obtained from BH106A as the well was observed to be dry. Chemical analysis results are provided in Table 4.7 and discussed below.

Table 4.7 Assessment of Contaminants in Groundwater Down-Gradient of the FWA (Exceedances Highlighted)

Determinand	Units	No. of Samples	DWS (exceeded)	EQS (exceeded)	2019		2014		Location of Exceedance (highest in bold)
					Min.	Max.	Min.	Max.	
pH	pH Units	3	6.5 to 10.0 (0)	6.0 to 9.0 (0)	8.1	8.3	7.4	7.9	-
EC	µS/cm	3	2500 (0)	-	450	480	326	570	-
BOD (settled)	mg O_2/L	3	-	-	< 4.0	< 4.0	< 4.0	< 4.0	-
COD	mg O_2/L	3	30 (0)	30 (0)	< 10	< 10	5.1	29	-
Chloride	mg/L	3	250 (0)	250 (0)	7.6	16	6.9	18	-
Ammonia (free)	mg/L	3	0.5 (0)	-	0.079	0.20	-	-	-

Determinand	Units	No. of Samples	DWS (exceeded)	EQS (exceeded)	2019		2014		Location of Exceedance (highest in bold)
					Min.	Max.	Min.	Max.	
Ammoniacal Nitrogen	mg/L	3	0.39 (3)	1.730)	0.71	1.5	< 0.01	0.35	**BH106**, BH107, BH130
Arsenic (dissolved)	µg/L	3	10 (0)	50 (0)	< 1.0	< 1.0	< 0.15	1.2	-
Boron (dissolved)	µg/L	3	1000 (0)	2000 (0)	< 20	25	210	1300	-
Cadmium (dissolved)	µg/L	3	5 (0)	0.15 (0)	< 0.08	< 0.08	< 0.08	< 0.08	-
Chromium (dissolved)	µg/L	3	50 (0)	4.7 (0)	< 1.0	< 1.0	0.4	1.0	-
Copper (dissolved)	µg/L	3	2000 (0)	-	< 1.0	< 1.0	< 0.5	2.9	-
Copper (bioavailable)	µg/L	3	-	1 (0)	< 0.05	0.06	0.01	1.33	-
Iron (total)	µg/L	3	200 (3)	1000 (0)	210	280	7	2900	**BH107**, BH130, BH106
Mercury (dissolved)	µg/L	3	1 (0)	0.07 (0)	< 0.01	< 0.01	< 0.05	0.1	-
Manganese (dissolved)	µg/L	3	50 (0)	-	< 1.0	3.1	< 1.0	440	-
Manganese (bioavailable)	µg/L	3	-	123 (0)	< 1.0	3.1	0.67	203	-
Nickel (dissolved)	µg/L	3	20 (0)	-	< 1.0	< 1.0	< 1.0	2.3	-
Nickel (bioavailable)	µg/L	3	-	4 (0)	< 0.42	0.54	0.90	3.36	-
Lead (dissolved)	µg/L	3	10 (0)	-	< 1.0	< 1.0	< 1.0	< 1.0	-
Lead (bioavailable)	µg/L	3	-	1.2 (0)	< 0.14	< 0.14	0.10	0.20	-
Zinc (dissolved)	µg/L	3	5000 (0)	-	< 1.0	< 1.0	< 1.0	5.3	-
Zinc (bioavailable)	µg/L	3	-	12.3 (0)	< 0.29	< 0.29	1.0	2.18	-

In boreholes located down-gradient of the FWA, the common leachate indicator compounds BOD, COD and chloride were all below the DWS and EQS. Ammoniacal nitrogen exceeded the DWS in all three samples, but

did not exceed the EQS. Iron also exceeded the DWS in all three samples, however concentrations appear to have significantly reduced since 2014. There were no exceedances of the EQS for any determinands.

In previous years, the DWS and EQS was exceeded in down-gradient samples for chromium, although this was not reflected in the 2019 monitoring round.

4.7.4 Summary of EQS/ DWS Exceedances in Groundwater

Only ammoniacal nitrogen exceeded the DWS in groundwaters both within the FWA and down-gradient of the FWA. No EQS was exceeded in any groundwater samples obtained during the 2019 monitoring round.

Groundwater quality across the site appears to have improved since 2017. In previous monitoring rounds, EQS/DWS were exceeded for a number of metallic elements including chromium and manganese although this has not been reflected during 2019 sampling. This is potentially attributed to the dry weather confitions experienced in early 2019, as risks to the Cas Troggy are only present in periods of extended wet weather when there is a pathway from the FWA to the field culvert.

However, concentrations of leachate indicator compounds in BH104 within the FWA have steadily increased since 2013. In other boreholes within the FWA, leachate indicator compounds are typically slightly lower or similar to those identified in 2016 and 2017. This could be attributed to lower leachate generation during extended dry weather periods.

There have been clear improvements to runoff collection and drainage within the FWA to limit potential leachate percolation into groundwater. This includes the creation of lined attenuation ponds and development of surface drainage from the northern section of the site.

5. Conclusions

5.1 Surface Water and Groundwater Monitoring

During the current sampling round in February 2019, there was no flow in the drainage ditches in the FWA or within the DTE Caerwent site boundary as the monitoring took place during a period of extended dry and unseasonably warm weather.

The attenuation ponds within the FWA (location of SW202) contained a moderate volume of water and suggests that improvements in drainage carried out by CTL across their site in line with the drainage management plan are effective. Further, a new lined pond to the north-west of the FWA site entrance was observed to have a low but steady flow and drains from the north of the FWA. During the site visit, it was noted that the attenuation ponds appear to be very shallow (approximately 40cm deep). Considering the volume of water being stored in these ponds during the relatively dry weather experienced in early 2019, it is likely that during periods of extended wet weather the attenuation ponds would overtop. Furthermore, there is no clear pathway for leachate to drain into the drainage channels and it would likely flood across hardstanding and grassed areas.

It was anticipated that surface water samples would be collected from six monitoring locations within and down-gradient of the FWA, and off-site. Due to the dry weather, only three samples could be collected. Therefore, the dataset presented in this report is limited. Surface waters within the FWA and down-gradient of the FWA did not exceed any EQS. No surface water samples exceeded the EQS for dissolved metals, and in the Cas Troggy brook all metals (excluding iron) fell below the LOD.

Five of the twelve monitoring wells were unavailable in the current round of sampling, either damaged (BH111, BH102 and BH7) or dry (BH103 and BH106A). BH102 has been noted in previous reports as being destroyed. BH7 has recently been damaged, likely by CTL site operations and is now unservicable and will require repair or replacement. BH103 was dipped as dry, but has not been sampled for some time and is likely unservicable.

No groundwater samples exceeded EQS for leachate indicator compounds. However, DWS was slightly exceeded for ammoniacal nitrogen in all boreholes, including those down-gradient of the FWA and highest in BH106. In general, concentrations of leachate indicator compounds had remained similar to 2017 results but increased in BH104. In other boreholes within the FWA, results are broadly comparable with 2017 readings.

No groundwater samples exceeded the EQS for dissolved metals, with many of the results recorded below the LOD. This is a significant decrease since 2017. The DWS was exceeded for iron in three boreholes within and down-gradient of the FWA. In previous reports, the high concentrations of dissolved metals in groundwater were potentially attributed to high natural background concentrations, although based upon 2019 results this is considered to be an unreliable conclusion.

The presence of the green waste materials left by Wormtech Ltd. continues to present risks to off-site surface water and regional groundwater (beyond DTE Caerwent). These risks may increase during periods of extended wet weather where there is connectivity between the drainage channels and the field culvert. The risks to off-site surface waters may appear to have decreased, although this is attributed to monitoring being undertaken following a period of dry weather where no leachate was generated. Further, the hiatus in the green waste processing alongside this reduction in leachate generation due to dry weather may have had a positive impact on groundwater quality.

5.2 Environmental Permit

CTL confirmed that they are not currently undertaking any permitted activities on the site, since their EP was revoked in summer 2018. CTL has obtained two permit exemptions from NRW to import crushed material derived from elsewhere on the DTE Caerwent site, and to import quarried stone as aggregate for resale.

CTL informed Jacobs that it has submitted a new EP application to NRW and is awaiting a response. This is to cover the waste treatment activities previously undertaken at the site. Copies of the Permit application were not made available to Jacobs.

In support of obtaining a new EP, there has been considerable improvement to site drainage and infrastructure. In 2017 it was recommended by Jacobs that a waste processing area with impermeable surfacing was developed. Whilst waste treatment and crushing is not currently being undertaken at the CTL site, it is envisioned this will take place on existing hardstanding. Jacobs also recommended that infrastructure to prevent leachate formation, or the collection and treatment of leachate, should be developed. As observed during the site walkover, CTL has improved drainage in line with its site drainage strategy, and attenuation ponds have been lined. Leachate was observed draining onto hardstanding and as such the effectiveness of the drainage pathway to the attenuation pond, and capacity of the attenuation ponds during periods of extended wet weather is unclear.

5.3 Processing and Recovery of Waste Materials

Little, if any, progress has been made since the 2017 visit in treating the green wastes left by Wormtech Ltd. This is primarily attributed to the revocation of CTL's Permit by NRW in mid-2018 preventing any further operations. However, CTL's site representative informed Jacobs that there are challenges with the treatability of the green waste due to a high plastic content. After purchasing a 10mm soil screen it became apparent to CTL that the processed material would unlikely be saleable as a topsoil-type material due to the volume of small plastic fragments remaining within the finished product. It therefore appears that there is no further planned treatment of the green waste stockpiles by CTL.

The volume of wastes and finished products stored by CTL appears to have decreased significantly since 2017, with the existing Permit exemptions allowing only the import of quaried materials for subsequent resale. The woodchip bales previously identified in the 2017 site walkover have since been removed. Housekeeping across the site has improved significantly and roads are free of soils and wastes.

5.4 Commercial Risk to MOD

As discussed in the 2017 LQA2[3], in the potential event that CTL goes into receivership or that CTL is not issued with a new EP, a substantial volume of Wormtech material would be left on site.

The ownership of the Wormtech material currently appears to be disputed, with CTL, MOD and NRW appearing to be unwilling to accept responsibility for the material and therefore its liability. The intial agreement for CTL to treat the materials was based upon it being saleable as a topsoil and as such the recent decision by CTL that this is no longer the case leaves no financial incentive for its treatment.

If CTL were to encounter financial difficulty there is a risk that financial provisions held by them would be insufficient for the treatment/ disposal of the remaining green waste stockpiles. Liability for the material may then be left with MoD as landowner and, in effect, being the "last man standing".

6. Recommendations

On-going Monitoring

In the current monitoring round, leachate generation appears to have decreased. It is unclear whether this is attributed to hiatus in treatment of the green wastes, or the dry weather encountered and consequently whether leachate generation might increase if a Permit is granted and treatment resumes and during extended periods of wet weather.

Continued environmental monitoring is required to determine whether risks to the principal aquifer and off-site surface watercourses are directly related to the presence and treatment of the green wastes at the CTL site, and whether remedial measures are required.

It is recommended that once CTL activity resumes (should their application for a new EP be successful), monitoring should be undertaken quarterly for surface water and biannually for groundwater. This should focus on leachate indicator compounds including BOD, COD, EC, DO, ammoniacal nitrogen and chloride.

The recommended scope of monitoring is as follows:

- Biannual sampling of 11 groundwater wells comprising 1 up-gradient location, 6 locations in the FWA, and 4 down-gradient locations;
- Quarterly sampling of surface water at seven locations comprising:
  - SW101 and SW202 in the FWA;
  - SW203, SW105 or SW201 outside of the FWA but within the DTE Caerwent site perimeter; and
  - SW102, field culvert, SW103 and SW104 at the site perimeter/ Cas Troggy brook.

Where possible, monitoring should be coincided with extended periods of wet weather where there is most likely to be flow in the on-site drainage ditches. This would enable a better assessment of risks to surface waters from the FWA.

- Analysis to include General Suite, as detailed in Section 1.3 and undertaken in this monitoring round; and
- Interpretative reporting after each monitoring round in a letter format issued by email.

Replacement of Damaged Monitoring Wells

In support of the recommended ongoing monitoring across the FWA and wider DTE Caerwent site, it will be necessary to repair or replace the damaged monitoring wells: BH111, BH102, BH103 and BH7.

There is potential for further monitoring wells to become damaged in a similar manner to BH102 and BH103, and therefore it is recommended that concrete manhole ring protection measures are added to the remaining raised borehole covers.

Infrastructure Improvements to Limit Leachate Generation

It has been recognised that the majority of leachate generated on site is derived from the green waste stockpiles left by Wormtech Ltd. Whilst drainage measures have been improved across the CTL site, leachate would still be directed from attenuation ponds into the ditches around the site and onwards into surface waters and groundwater. It is recommended that controls to limit leachate generation and transport should be put in place. This would likely involve:

1) Placing the green waste stockpiles under cover by:
    a) Sheeting over;
    b) Moving into existing buildings; or
    c) Construction of new purpose-built sheds or canopies.
2) Collection and off-site treatment of leachates.

To reduce costs associated with this work and improve the likelihood of its implementation it is recommended that Option 1a or 1b should be pursued. In the shorter term, Option 1a would be considered reasonable. It has previously been recognised in the 2017 LQA2[3] that NRW would likely require containment structures in accordance with Eurocode 2[6].

Management of the Risks Posed by CTL's Operation

As CTL is currently operating under an EP exemption, there is a risk that NRW will not renew the EP for waste treatment. It is unlikley that CTL will become insolvent as a result, as it has been operating under EP exemption for approximately 8 months and has continued trading, although the possibility of insolvency for other reasons remains.

If the EP is not renewed by NRW, CTL will remain unable to treat the green waste stockpiles left by Wormtech. However, even if the EP is renewed, CTL has verbally stated that it does not intend to further treat the waste.

To reduce the risk of CTL leaving additional volumes of waste at the FWA, it is recommended that the MOD implement more detailed monitoring of CTL operations if the EP is renewed and waste treatement resumes. This could include:

1) Setting maximum volumes of materials allowed to be stored on site by CTL as part of their lease;
2) Undertake a monthy reconciliation of CTL's weighbridge receipts and dispatches in order to verify that the material stockpiles remain within conditions of CTL's amended lease and to track trends in material volumes;
3) Undertake informal monthly site inspections to verify CTL's compliance with lease conditions and provide a visual check on waste volumes and general housekeeping, including drainage;
4) Commission a formal site inspection on a biannual basis to include:
    a) Environmental sampling of groundwater wells and surface water monitoring locations;
    b) Undertake a site inspection of CTL/ FWA to include interviews with CTL personnel and the DTE Caerwent Range Safety Officer to understand the materials treatment process and environmental management;
    c) Acquire copies of CTL's EP application. This would ideally be provided to MOD by CTL as part of a lease agreement. If necessary, this should be obtained from NRW under the Freedom of Information Act 2000; and
    d) Evaluation of compliance against the EP for observed waste types and calculated waste volumes and comment on visual evidence of compliance.

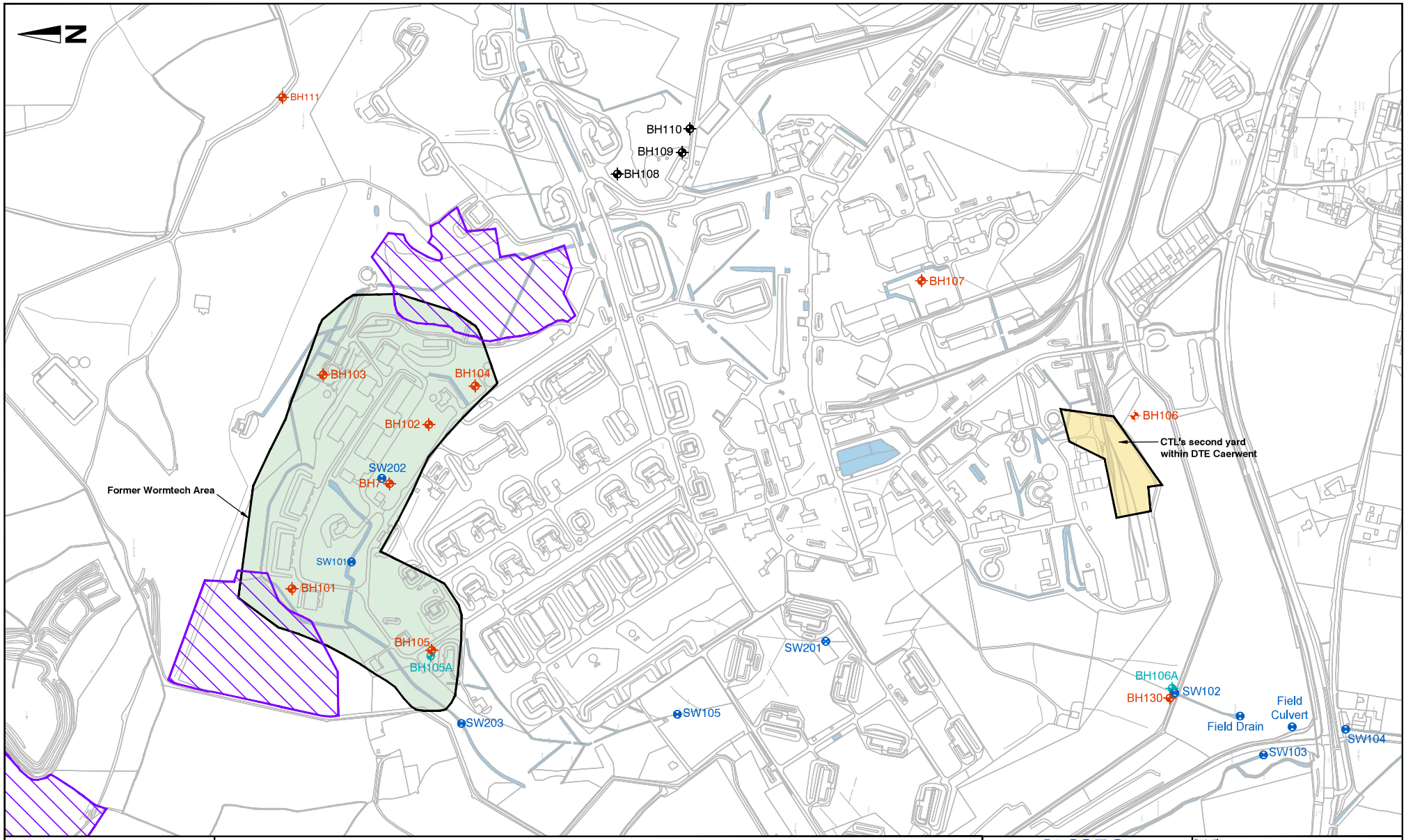
Other issues

Although this falls outside the scope of this report, the apparent change in the depth of the blockage noted in borehole BH111 during the last two rounds of monitoring (see Section 4.3.2) may be indicative of ground movement in that area of the site. Given the history of solution features in the limestone geology which underlies the site, this may be worthy of further consideration by DIO in the context of long term plans for the site.

7. References

1. Jacobs. June 2015. DTE Caerwent: Former Wormtech Area. Land Quality Assessment Report.
2. Jacobs. July 2016. DTE Caerwent: Former Wormtech Area. LQA2 Addendum: Environmental Monitoring at DTE Caerwent.
3. Jacobs. April 2017. DTE Caerwent: Former Wormtech Area. LQA2 Addendum: Environmental Monitoring at DTE Caerwent.
4. European Commission. Drinking Water Legislation. The Directive Overview. Last updated 22/02/16.
5. The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.
6. EN 1992-3 (2006) (English): Eurocode 2: Design of concrete structures- Part 3: Liquid retaining and containment structures.

FIGURES



KEY:

- Former Wormtech Area Assessed in Current Report
- CTL's Second Yard within DTE Caerwent
- Deep Borehole Installed in Rock Aquifer
- Shallow Borehole Installed in Superficial Deposits
- Borehole Dipped but not Sampled
- Surface Water Sampling Point
- Sites of Special Scientific Interest

0 100 200 METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checked	Rev'd	Appr'd
0	08/03/2019	PRELIMINARY	AR	SH	NC	DH

JACOBS
8th Floor, Churchill House, Churchill Way, Cardiff, CF10 2HH
Tel:+44(0)29 2035 3200 Fax:+44(0)29 2035 3222
www.jacobs.com

Client: Defence Infrastructure Organisation

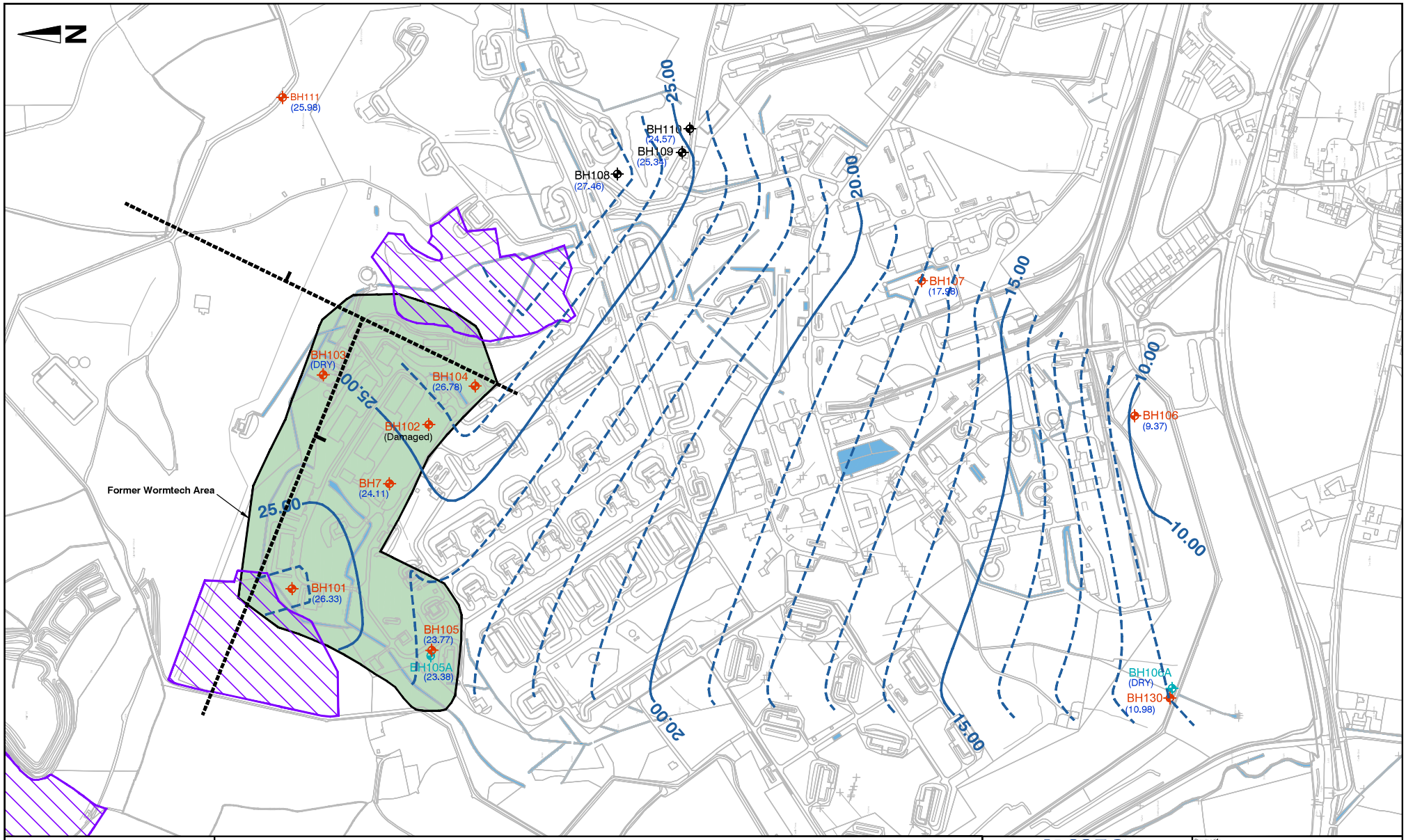
Project: DTE CAERWENT FORMER WORMTECH AREA

Drawing title: SITE LAYOUT AND ENVIRONMENTAL MONITORING LOCATIONS

Drawing status: FINAL

Scale	1:5,000 @ A3	DO NOT SCALE
Jacobs No.	B2355900	Rev 0
Client no.		

Drawing number: B2355900-JAC-GW-DR-0002



KEY:

- Former Wormtech Area Assessed in Current Report
- Deep Borehole Installed in Rock Aquifer
- Shallow Borehole Installed in Superficial Deposits
- Borehole Dipped but not Sampled
- Groundwater Contours (mAOD) February 2019
- Sites of Special Scientific Interest
- Indicative Fault

Rev	Rev. Date	Purpose of revision	Drawn	Checked	Rev'd	Appr'd
0	04/03/2019	PRELIMINARY	AR	SH	NC	DH

JACOBS
8th Floor, Churchill House, Churchill Way, Cardiff, CF10 2HH
Tel:+44(0)29 2035 3200 Fax:+44(0)29 2035 3222
www.jacobs.com

Client: Defence Infrastructure Organisation

Project: DTE CAERWENT
FORMER WORMTECH AREA

Drawing title: INDICATIVE GROUNDWATER CONTOUR PLAN - FEBRUARY 2019

Drawing status: FINAL

Scale	1:5,000 @ A3	DO NOT SCALE
Jacobs No.	B2355900	Rev 1
Client no.		

Drawing number: B2355900-JAC-GW-DR-0001

Appendix A. Laboratory Analysis Certificates

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	19-05670-1
Initial Date of Issue:	22-Feb-2019
Client	Jacobs
Client Address:	Churchill House Churchill Way Cardiff CF10 2HH
Contact(s):	Sarah Hughes
Project	B2355900 MOD Caerwent
Quotation No.:	Q18-15113
Date Received:	15-Feb-2019
Order No.:	
Date Instructed:	15-Feb-2019
No. of Samples:	3
Turnaround (Wkdays):	5
Results Due:	21-Feb-2019
Date Approved:	22-Feb-2019
Approved By:	

Details: Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Water

Project: B2355900 MOD Caerwent

Client: Jacobs			**Chemtest Job No.:**		19-05670	19-05670	19-05670
Quotation No.: Q18-15113			**Chemtest Sample ID.:**		775723	775724	775725
			Sample Location:		BH10b	BH130	BH107
			Sample Type:		WATER	WATER	WATER
			Date Sampled:		14-Feb-2019	14-Feb-2019	14-Feb-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
pH	U	1010		N/A	8.3	8.3	8.1
Electrical Conductivity	U	1020	µS/cm	1.0	460	450	480
Biochemical Oxygen Demand	N	1090	mg O2/l	4.0	< 4.0	< 4.0	< 4.0
Chemical Oxygen Demand	U	1100	mg O2/l	10	< 10	< 10	< 10
Chloride	U	1220	mg/l	1.0	8.1	16	7.6
Ammonia (Free)	U	1220	mg/l	0.050	0.20	0.090	0.079
Ammoniacal Nitrogen	U	1220	mg/l	0.050	1.5	0.71	0.86
Nitrogen (Total)	N	1340	mg/l	1.0	7.5	6.7	4.6
Arsenic (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Boron (Dissolved)	U	1450	µg/l	20	< 20	< 20	25
Cadmium (Dissolved)	U	1450	µg/l	0.080	< 0.080	< 0.080	< 0.080
Chromium (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Copper (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Manganese (Dissolved)	U	1450	µg/l	1.0	1.9	3.1	< 1.0
Nickel (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Lead (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Zinc (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Iron (Total)	N	1450	µg/l	20	210	220	280
Mercury Low Level	U	1460	µg/l	0.010	< 0.010	< 0.010	< 0.010

Chemtest
The right chemistry to deliver results

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1090	Biochemical Oxygen Demand	Biochemical Oxygen demand (BOD)	Electrometric determination of dissolved oxygen in seeded sample initially and after 5 days incubation at 20°C.
1100	Chemical Oxygen Demand	Chemical Oxygen demand (COD)	Dichromate oxidation of organic matter in sample followed by colorimetric determination of residual Cr[VI].
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1340	Total Nitrogen in Waters	Total Nitrogen and organic Nitrogen	Persulphate digestion followed by colorimetry.
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1460	Mercury low-level in Waters by AFS	Mercury	Atomic Fluorescence Spectrometry, with collimated UV source, wavelength 253.7 nm.

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	19-05883-1
Initial Date of Issue:	26-Feb-2019
Client	Jacobs
Client Address:	Churchill House Churchill Way Cardiff CF10 2HH
Contact(s):	Sarah Hughes
Project	B2355900 Mod Caerwent
Quotation No.:	Q18-15113
Date Received:	18-Feb-2019
Order No.:	
Date Instructed:	18-Feb-2019
No. of Samples:	3
Turnaround (Wkdays):	5
Results Due:	22-Feb-2019
Date Approved:	25-Feb-2019
Approved By:	

Details: Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Water

Project: B2355900 Mod Caerwent

Client: Jacobs			**Chemtest Job No.:**		19-05883	19-05883	19-05883
Quotation No.: Q18-15113			**Chemtest Sample ID.:**		776707	776708	776709
			Sample Location:		BH105A	BH105	BH101
			Sample Type:		WATER	WATER	WATER
			Date Sampled:		15-Feb-2019	15-Feb-2019	15-Feb-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
pH	U	1010		N/A	8.2	8.1	7.7
Electrical Conductivity	U	1020	µS/cm	1.0	600	520	1100
Biochemical Oxygen Demand	N	1090	mg O2/l	4.0	[B] < 4.0	[B] < 4.0	[B] < 4.0
Chemical Oxygen Demand	U	1100	mg O2/l	10	< 10	< 10	< 10
Chloride	U	1220	mg/l	1.0	21	16	71
Ammonia (Free)	U	1220	mg/l	0.050	0.088	0.067	< 0.050
Ammoniacal Nitrogen	U	1220	mg/l	0.050	0.86	0.86	0.67
Nitrogen (Total)	N	1340	mg/l	1.0	12	7.5	29
Arsenic (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Boron (Dissolved)	U	1450	µg/l	20	20	60	44
Cadmium (Dissolved)	U	1450	µg/l	0.080	< 0.080	< 0.080	< 0.080
Chromium (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	2.2
Copper (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Manganese (Dissolved)	U	1450	µg/l	1.0	13	2.7	27
Nickel (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Lead (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Zinc (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Iron (Total)	N	1450	µg/l	20	230	150	270
Mercury Low Level	U	1460	µg/l	0.010	< 0.010	< 0.010	< 0.010

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
776707			BH105A	15-Feb-2019	B	Plastic Bottle 1000ml
776708			BH105	15-Feb-2019	B	Plastic Bottle 1000ml
776709			BH101	15-Feb-2019	B	Plastic Bottle 1000ml

Chemtest
The right chemistry to deliver results

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1090	Biochemical Oxygen Demand	Biochemical Oxygen demand (BOD)	Electrometric determination of dissolved oxygen in seeded sample initially and after 5 days incubation at 20°C.
1100	Chemical Oxygen Demand	Chemical Oxygen demand (COD)	Dichromate oxidation of organic matter in sample followed by colorimetric determination of residual Cr[VI].
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1340	Total Nitrogen in Waters	Total Nitrogen and organic Nitrogen	Persulphate digestion followed by colorimetry.
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1460	Mercury low-level in Waters by AFS	Mercury	Atomic Fluorescence Spectrometry, with collimated UV source, wavelength 253.7 nm.

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

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The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	19-05885-1
Initial Date of Issue:	26-Feb-2019
Client	Jacobs
Client Address:	Churchill House Churchill Way Cardiff CF10 2HH
Contact(s):	Sarah Hughes
Project	B2355900 Mod Caerwent
Quotation No.:	Q18-15113
Date Received:	18-Feb-2019
Order No.:	
Date Instructed:	18-Feb-2019
No. of Samples:	4
Turnaround (Wkdays):	5
Results Due:	22-Feb-2019
Date Approved:	25-Feb-2019
Approved By:	

Details: Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Water

Project: B2355900 Mod Caerwent

Client: Jacobs			**Chemtest Job No.:**	19-05885	19-05885	19-05885	19-05885
Quotation No.: Q18-15113			**Chemtest Sample ID.:**	776720	776721	776722	776723
			Sample Location:	SW202	SW103	BH104	SW104
			Sample Type:	WATER	WATER	WATER	WATER
			Date Sampled:	14-Feb-2019	14-Feb-2019	14-Feb-2019	14-Feb-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
pH	U	1010		N/A	8.2	8.3	7.8	8.3
Electrical Conductivity	U	1020	µS/cm	1.0	830	260	1000	250
Biochemical Oxygen Demand	N	1090	mg O2/l	4.0	[B] < 4.0	[B] < 4.0	[B] < 4.0	[B] < 4.0
Chemical Oxygen Demand	U	1100	mg O2/l	10	23	23	26	< 10
Alkalinity (Total)	U	1220	mg/l	10				89
Chloride	U	1220	mg/l	1.0	110	15	80	15
Ammonia (Free)	U	1220	mg/l	0.050	0.094	0.12	< 0.050	0.092
Ammoniacal Nitrogen	U	1220	mg/l	0.050	0.86	0.93	1.0	0.71
Nitrogen (Total)	N	1340	mg/l	1.0	10	7.0	10	8.1
Calcium	U	1415	mg/l	5.0				26
Hardness as Ca	U	1415	mg/l	6				40
Arsenic (Dissolved)	U	1450	µg/l	1.0	2.0	< 1.0	< 1.0	< 1.0
Boron (Dissolved)	U	1450	µg/l	20	47	< 20	30	< 20
Cadmium (Dissolved)	U	1450	µg/l	0.080	< 0.080	< 0.080	< 0.080	< 0.080
Chromium (Dissolved)	U	1450	µg/l	1.0	2.5	< 1.0	1.2	< 1.0
Copper (Dissolved)	U	1450	µg/l	1.0	7.9	< 1.0	1.7	< 1.0
Manganese (Dissolved)	U	1450	µg/l	1.0	13	< 1.0	25	< 1.0
Nickel (Dissolved)	U	1450	µg/l	1.0	2.5	< 1.0	3.8	< 1.0
Lead (Dissolved)	U	1450	µg/l	1.0	1.2	< 1.0	< 1.0	< 1.0
Zinc (Dissolved)	U	1450	µg/l	1.0	6.1	< 1.0	< 1.0	< 1.0
Iron (Total)	N	1450	µg/l	20	450	62	320	51
Mercury Low Level	U	1460	µg/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010
Dissolved Organic Carbon	U	1610	mg/l	2.0				7.1

Chemtest
The right chemistry to deliver results

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
776720			SW202	14-Feb-2019	B	Plastic Bottle 1000ml
776721			SW103	14-Feb-2019	B	Plastic Bottle 1000ml
776722			BH104	14-Feb-2019	B	Plastic Bottle 1000ml
776723			SW104	14-Feb-2019	B	Plastic Bottle 1000ml

Chemtest
The right chemistry to deliver results

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1090	Biochemical Oxygen Demand	Biochemical Oxygen demand (BOD)	Electrometric determination of dissolved oxygen in seeded sample initially and after 5 days incubation at 20°C.
1100	Chemical Oxygen Demand	Chemical Oxygen demand (COD)	Dichromate oxidation of organic matter in sample followed by colorimetric determination of residual Cr[VI].
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1340	Total Nitrogen in Waters	Total Nitrogen and organic Nitrogen	Persulphate digestion followed by colorimetry.
1415	Cations in Waters by ICP-MS	Sodium; Potassium; Calcium; Magnesium	Direct determination by inductively coupled plasma - mass spectrometry (ICP-MS).
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1460	Mercury low-level in Waters by AFS	Mercury	Atomic Fluorescence Spectrometry, with collimated UV source, wavelength 253.7 nm.
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com