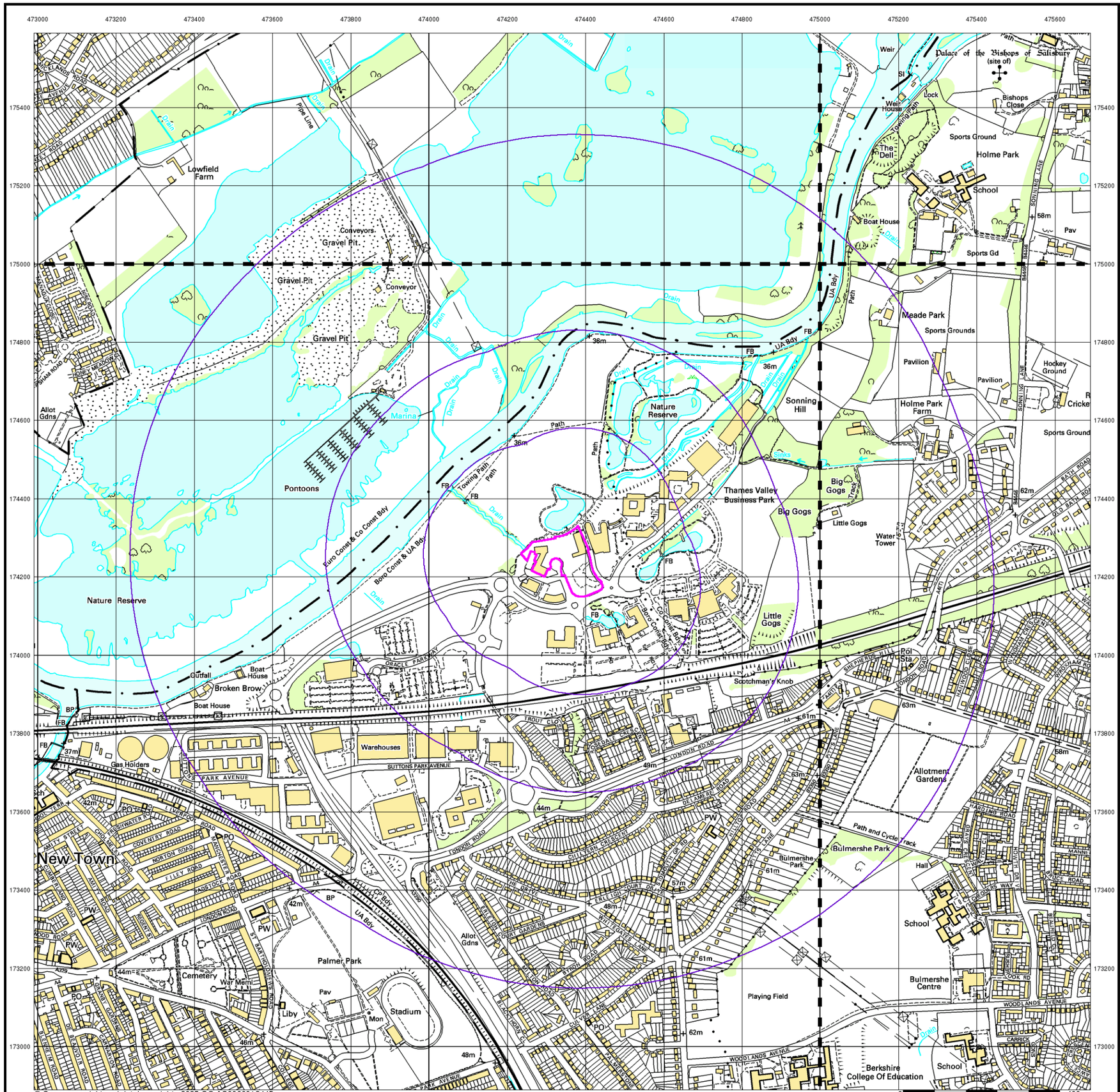

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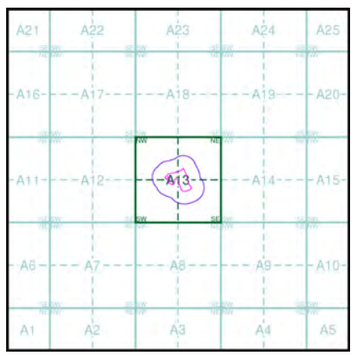

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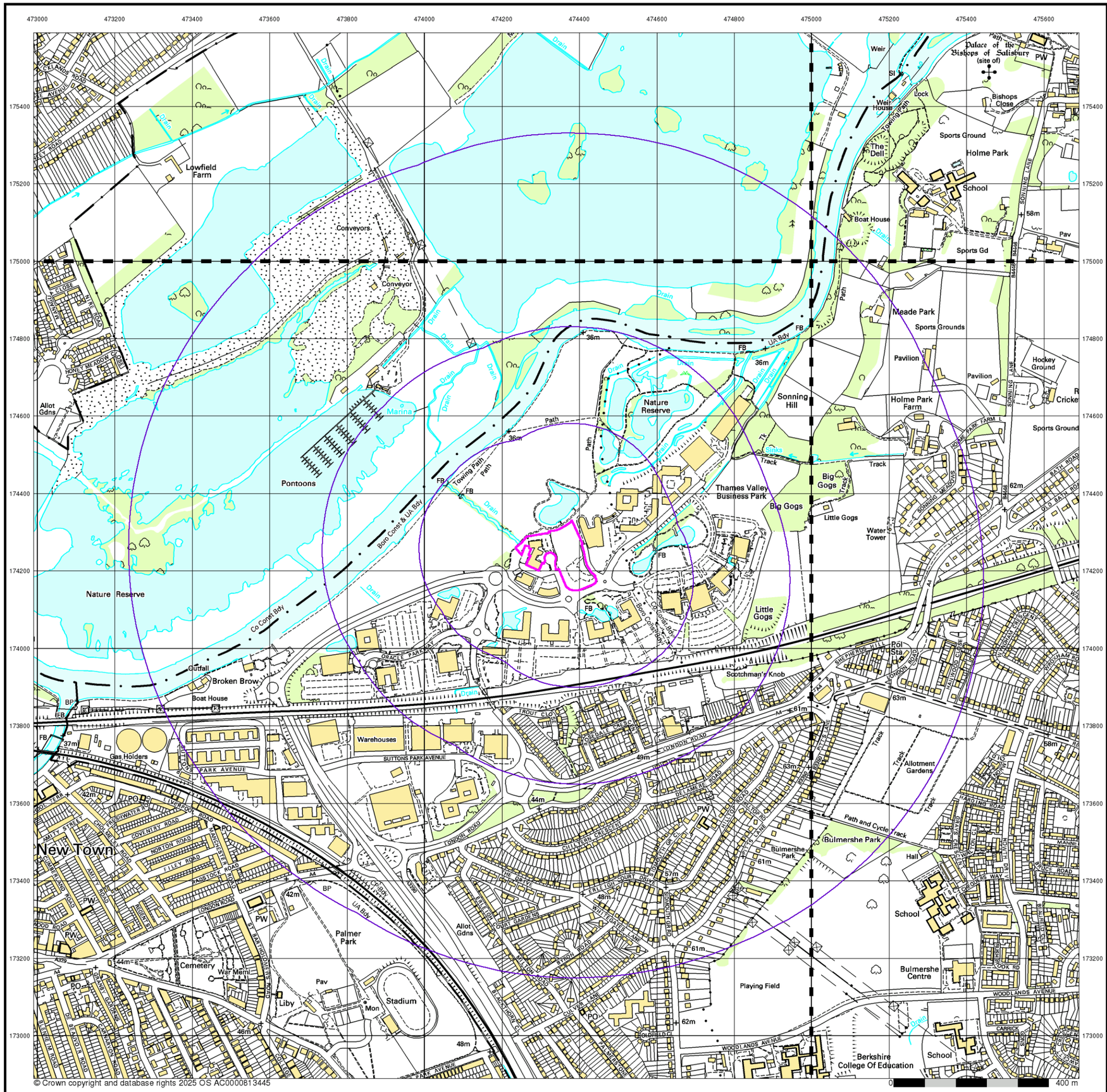
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Conveyors
Conveyor
Allot Gdns
Marina
Pontoons
Nature Reserve
Sonning Hill
Holme Park Farm
Thames Valley Business Park
Big Gogs
Little Gogs
Water Tower
Palace of the Bishops of Salisbury (site of)
Bishops Close
Sports Ground
Holme Park
School
Boat House
Meade Park
Sports Grounds
Pavilion
Hockey Ground
Sports Ground
Nature Reserve
Outfall
Broken Brow
Boat House
Gas Holders
Warehouses
Scotchman's Knob
Allotment Gardens
Path and Cycle Track
Bulmershe Park
Hall
School
Bulmershe Centre
Playing Field
Berkshire College Of Education
New Town
Palmer Park
Cemetery
War Mem
Stadium
Liby
Mon
Pav
Co Const Bdy
Bord Const & UA Bdy
UA Bdy
Drain
Towing Path
Path
Track
Sinks
Weir
Lock
Weir House
Towing Path
The Dell
Sports Gd
Pav
Hockey Ground
Pavilion
Sonning Hill
Big Gogs
Little Gogs
Water Tower
Scotchman's Knob
Allotment Gardens
Path and Cycle Track
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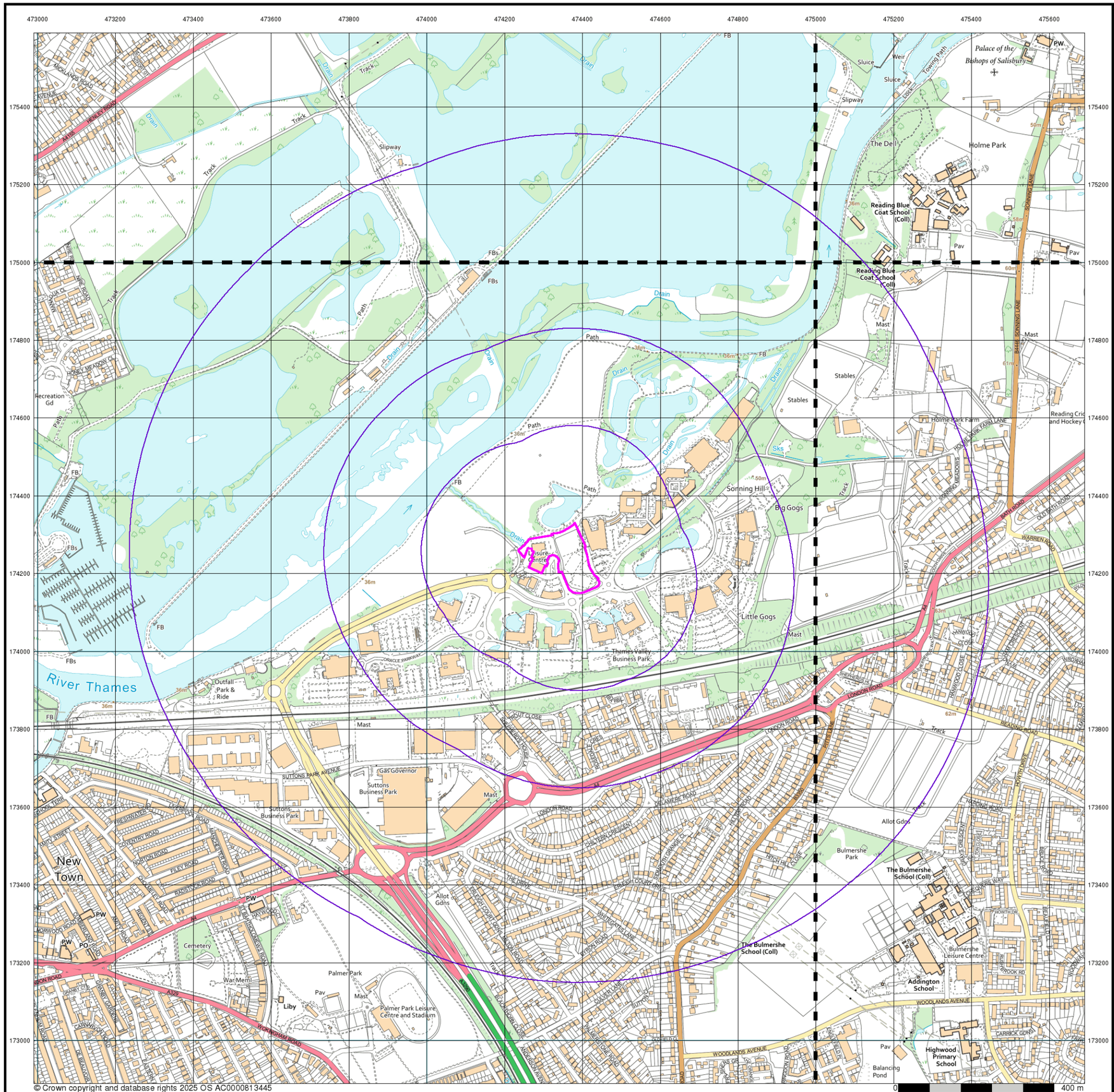

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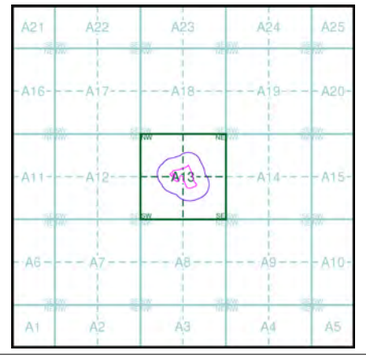

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Appendix C
Previous Investigations

PHASE 2 ENVIRONMENTAL

AND

GEOTECHNICAL INVESTIGATION

NO 3291B/18

AT

BG GROUP SITE,

THAMES VALLEY PARK DRIVE,

READING

AT THE

SITE E CAR PARK

(Factual Report)

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B. CONTAMINATION ANALYSIS
C. CONTAMINATION ASSESSMENT CRITERIA

PHASE 2 ENVIRONMENTAL AND GEOTECHNICAL INVESTIGATION NO 3291B/18/ AT BG GROUP SITE, THAMES VALLEY PARK DRIVE, READING AT THE SITE E CAR PARK (Factual Report)

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1 INTRODUCTION

1.1 This investigation was commissioned by the BG Group in December 2011 in order to provide a ground contamination assessment for the proposed development areas in the site E car park, together with soil parameters for foundation design.

1.2 Previously we have carried out a phase 1 environmental investigation (desk study) for the whole BG Group site (ref 3291/11) which should be read in conjunction with this report. This report however, is solely concerned with the site E car park which occupies the western most end of the BG Group site.

1.3 This factual report (ref 3291B/18) was compiled in September 2018 and is an edited copy of the original phase 2 environmental and geotechnical report (ref 3291A/11) issued in January 2012 which considered other areas of the BG site. It should be noted that the physical investigations documented in this report were carried out in December 2011. As requested, the recommendations sections which gave specific advice for the particular BG Group development proposals have been removed.

2 DESK STUDY FINDINGS

2.1 The preceding desk study showed that the BG Group site was part of a larger area where the disposal of power station ash took place. This area is now largely covered by Thames Valley Park. Pulverised Fuel Ash (PFA) was pumped as a slurry into lagoons on the area during the working life of Earley power station which lay just to the south west of the BG Group site.

2.2 Following demolition of the power station, the disposal of the materials occurred over the site which could contain a variety of contaminants including asbestos (lagging and potentially roof/soffit panels as well as internal panelling), metals in the power station ash from the coal, and hydrocarbon based combustion residues.

2.3 The development of Thames Valley Park and the demolition of the power station were considered to have been part and parcel of the same project. We can see from our observations of the site that the ground below much of the BG Group site has been raised significantly. We suspect that this raising was to give some flood protection to this riverside park.

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2.4 In the time that has passed since the original investigations were carried out, the land use as offices has not changed. No new industrial activities have been noted in this area.

Previous Investigations

2.5 Following the issue of the desk study report in December 2011 we were supplied with copies of various stages of investigations over the wider BG Group area carried out by Waterman Environmental, Peter Brett Associates and Exploration Associates.

2.6 Whilst indicative of the ground conditions below the Site E car park, we would note that none of these investigations included any trial holes in the actual Site E car park area.

2.7 The investigations showed that the wider BG Group site was generally underlain by capped power station ash materials. Not all the report copies included their borehole and trial pits logs however, significant thicknesses of PFA were noted resting upon Alluvium, over Chalk.

2.8 Chemical analysis carried out during those investigations, which are indicative of the conditions below the Site E Car Park, showed that some metals were present at concentrations elevated above background levels but generally below the guideline values for commercial development. Subsequent leachate analysis indicated these metals to be largely insoluble.

2.9 The investigations also showed that the capping to the PFA over the main BG Group site was sandwiched between geotextiles and was a mixed variety of soil types.

Issues to be addressed by the Terramech Phase 2 works (2011)

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2.10 The Terramech desk study identified the presence of old ash lagoons below the Thames Valley Park area, including the Site E Car Park. Shallow foundations placed in this ash will not be suitable to support any new buildings on the site.

2.11 Therefore our investigation included cable percussive boreholes from which preliminary piling or ground improvement schemes could be designed.

2.12 The contamination issues identified by the preceding investigations of the wider BG Group site included sporadic elevated metal concentrations and some sporadic presence of asbestos. We could also see that the Site E car park was indeed used to park cars.

2.13 Our selected suites of analysis therefore considered metals, tarry combustion residues (PAH), petroleum hydrocarbons and asbestos.

3 PHASE 2 INVESTIGATION

3.1 The site work in the Site E Car Park area was carried out on the 15th, 16th and 17th of November 2011, and laboratory tests were completed on the 2nd December 2011.

Scope of Works

Window Sampling

3.2 Seventeen small diameter boreholes were drilled over the Site E Car Park, using a small rubber tracked 'Window Sampling'.

3.3 The drilling rig percussively drives sampling tubes into the ground which are then withdrawn by the rig. Further depth is achieved by driving another tube down from the base of the hole left by the first. This process is repeated until the desired depth, or an obstruction, is met.

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3.4 The soil samples are retained inside the sampler tubes by a removable thin plastic liner. The rig therefore produces a continuous core from ground level to depth. The name window sample is a historic term referring to long sections, or windows, cut out of the sampler tube to allow recovery of the samples.

Cable Percussive Boreholes

3.5 Light cable percussive boreholes (also known as shell and auger boreholes) were also drilled in the Site E Car Park. This drilling method uses a large (6m high) tripod rig which lifts and drops heavy cutting tools, samplers and bailers to advance the borehole. Drilling can be carried out within steel casing tubes which prevent the sides of the borehole collapsing.

3.6 In order to prevent the formation of a contaminant migration pathway down into the chalk aquifer below the site these boreholes were 'double cased'. This means that the borehole length within the fill materials (power station ash) are drilled at 200mm diameter. When natural soils are encountered the drilling is halted and the casing filled with a high plasticity sealing clay (Bentonite).

3.7 The borehole is then redrilled though the sealing clay and down into the natural soils beneath. Any water perched in the fill material cannot then pass down into the lower soils.

Ground Conditions

3.8 The Site E Car Park was open with no buildings present. The ground was seen to be covered by a variety of surface materials including areas of concrete and tarmac and some larger areas covered by compacted scalpings or chippings.

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Window Sample Boreholes

3.9 The window sample boreholes over the Site E Car Park showed that below the surface layers a mixed variety of soil types were present. The most prevalent material was a brown and also a grey coloured gravelly clay with brick and concrete fragments.

3.10 Some boreholes (WS6 WS9, WS11, WS12, WS14) showed that a black sand / silt consistent with power station ash was present directly below the surface materials.

3.11 The boreholes also encountered some pockets of concrete and brick rubble and some fibrous brown material which was initially thought to be decayed timber, subsequent analysis showed this to be Amosite or Brown Asbestos.

3.12 During the drilling work we have carried out tests using a hydrocarbon vapour meter (PID – Photo Ionisation Detector). These included headspace tests on samples placed in bags (after agitation the headspace air in the bag is tested).

3.13 Samples representing the materials encountered were collected in suitable containers as set out later in this report.

3.14 These window sample boreholes over the Site E Car Park were drilled to a depth of 2m only. This was to avoid penetrating any basal sealing layers placed below the power station ash. The three cable percussive boreholes were used to determine the thickness of the capping layer, the thickness of the power station ash and the depth to natural materials.

Cable Percussive Boreholes

3.15 The three cable percussive boreholes were drilled in a line running north to south over the Site E car parks.

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3.16 Borehole BH1 was the southernmost borehole and showed that the capping layer was just 0.8m thick and comprised concrete rubble and other waste in a matrix of dark brown clay. Between 0.8 and 1.8m the borehole revealed black sand which was consistent with power station ash.

3.17 Below this ash to a depth of 2.6m the borehole showed a firm grey and brown clay to be present above a layer of concrete (we cannot tell if this was a cast layer or simply rubble). The concrete extended to a depth of 4m below which more power station ash was noted. This material was more consistent with a clay rather than the ash seen between 0.8m and 1.8m.

3.18 The base of the ash was seen to be at a depth of 5.2m. Below the ash lay a thin layer of chalky silt, in the absence of chalk fragments in the natural sand, gravel and clay deposits below this layer, we suspect this to be a lining layer. Below this lining to a depth of 9.0m lay sand and gravel deposits. The weathered upper layers of the chalk were seen below the sand and gravel.

3.19 Borehole BH2 showed that a thin layer of scalpings (0.30m) were present overlying a black sand (power station ash) which extended to a depth of 2.7m. Between 2.7m and 3.8m the borehole encountered a mixture of crushed concrete with some remnants of steel components which were possibly consistent with sections of reinforcement. Below this rubble the borehole showed that more black sand was present to a depth of 8.5m. Below this lay a thin layer of calcareous silt to a depth of 9.0m which we suspect to be a lining layer. Natural sand, gravel and clay deposits were then seen to a depth of 10.1m below which lay structured chalk.

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3.20 BH3 was drilled closest to the river and showed that again black sand lay very close to the surface below a thin layer (0.3m) of compacted scalpings. This power station ash extended to a depth of 1.7m, where a layer of crushed brick, concrete and other waste was noted. This layer extended to a depth of 3.4m whereupon more black sand was noted to a depth of 9.3m.

3.21 Between 9.3m and 10m the borehole found the same lining layer seen in BH1 and BH2, below this lay natural alluvial materials comprising sand gravels and clays to a depth of 11.3m, whereupon the borehole entered structured chalk.

Ground Strength

3.22 The cable percussive boreholes included SPT tests through the fill (rubble and PFA) materials which showed that PFA strata were in a loose state of compaction with potential voids present at depth whilst the demolition rubble was in some places dense.

Soil Sampling

3.23 The window sample borehole cores were split immediately after drilling and the samples were recovered for contamination analysis in accordance with BS10175 (2011).

3.24 The samples were placed in laboratory supplied containers including amber glass jars with hydrocarbon resistant seals and plastic waterproof pots.

3.25 The samples were then placed in plastic cool boxes with frozen ice packs to be transported to a fridge at our laboratory for storage before being couriered to an accredited laboratory for analysis.

3.26 The assessment parameters and criteria are discussed in separate sections.

Conclusions Drawn From The Borehole Data

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3.27 The boreholes on the Site E Car Park have shown that a thin layer of natural pale brown chalky silt was present at the base of the fill materials.

3.28 The ash above that was seen to be present into two layers separated by a thick layer of mixed rubble, flint gravels and clays. Sporadic pockets containing fragments of white cementitious board and bubbly black clinker were also noted in the rubble.



Above, a view of one end of the sample liner from WS1B beside the Hutton Building showing a layer of Brown Asbestos (Amosite) at about 0.8m, just above the grey PFA

3.29 Borehole WS18 on the Site E Car Park beside the Hutton Building however, appears to show that whole layers of brown fibrous Asbestos (Amosite) were placed very close to the surface.

3.30 Finally the surface layers above the power station ash in the block E car park appear to be a haphazard mixture of soils containing rubble, clays and some power station ash.

4 CONTAMINATION TEST RESULTS

Summary Table

4.1 The identified potential contaminants in each linkage from the conceptual model formulated in our desk study are reproduced below. The most appropriate method for assessment is then defined.

Contaminants of Concern and Appropriate Testing Suites		
Source	**Associated Contaminants**	**Testing Suite**
Made ground Working waste from the power station (PFA & FBA)	Arsenic, Cadmium, Chromium, Lead, Magnesium, Mercury, Molybdenum, Nickel, Selenium, Vanadium & Zinc	Terramech 2
Made ground Demolition waste from the power station (special Waste)	**Furnace Bottom ash found during demolition** Arsenic, Cadmium, Chromium, Iron, Lead, Magnesium, Mercury, Molybdenum, Nickel, Selenium, Vanadium & Zinc **Coal Stockpiles** Hydrocarbons associated with coal tars such as Anthracene and other Poly-cyclic Aromatics. Sulphates from pyrites in the coal which form acids with water **Lagging and heat shields** Asbestos as remnants of the lagging around pipework as well as heavy heat shields for the furnaces. **Electrical Installations and cables** Cable/transformer oils comprising Poly-chlorinated by-phenyls (PCBs)	Terramech 1
Power Station	**Furnace Bottom ash found during demolition** Arsenic, Cadmium, Chromium, Iron, Lead, Magnesium, Mercury, Molybdenum, Nickel, Selenium, Vanadium & Zinc **Coal Stockpiles** Hydrocarbons associated with coal tars such as Anthracene and other Poly-cyclic Aromatics. Sulphates from pyrites in the coal which form acids with water **Lagging and heat shields** Asbestos as remnants of the lagging around pipework as well as heavy heat shields for the furnaces. **Electrical Installations and cables** Cable/transformer Oils comprising Poly-chlorinated by-phenyls (PCBs) **(PFA & FBA)** Arsenic, Cadmium, Chromium, Lead, Magnesium, Mercury, Molybdenum, Nickel, Selenium, Vanadium & Zinc	Terramech 1
Brick Works	Arsenic, Cadmium, Chromium, Iron, Lead, Magnesium, Mercury, Molybdenum, Nickel, Selenium, Vanadium & Zinc among other metals bio-accumulated with the fuels used together with pyrogenic poly-cyclic aromatics in kiln ash such as Pyrene. etc	Terramech 2
Casements Factory	**Steel Additives** Chromium, Vanadium, Molybdenum, Boron **Surface treatments** Chromium, Nickel Copper Zinc Cyanide. **Other sheet metals** Aluminium Copper, Zinc	Terramech 1
Gas Works	Ferric Ferro Cyanide, sulphates, iron oxides. Phenols and cresols as creosote, with heavier Coal tars comprising poly cyclic aromatic hydrocarbons and ammonia	Terramech 2

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Suites of Laboratory Analysis				
Terramech Suite 1	**Terramech Suite 2**	**Banded Hydrocarbon analysis (CWG)**	**Polycyclic Aromatic Hydrocarbons (16 individual PAH compounds)**	**CLEA (2006)**
Asbestos (Screen)		Aliphatic C5-C6	Naphthalene	Arsenic
Antimony		Aliphatic >C6-C8	Acenaphthalene	Cadmium
Arsenic	Arsenic	Aliphatic >C8-C10	Acenaphthene	Mercury
Barium		Aliphatic >C10-C12	Fluorene	Nickel
Boron (W/S)		Aliphatic >C12-C16	Phenanthrene	Selenium
Cadmium	Cadmium	Aliphatic >C16-C35	Anthracene	Benzene
Chromium	Chromium	Aliphatic >C35-C44	Fluoranthene	Toluene
Chromium (Hexavalent)		Total Aliphatics (C5-C44)	Pyrene	Ethylbenzene
Copper	Copper	Aromatic C6-C7	Benzo(a)anthracene	m-Xylenes
Iron		Aromatic >C7-C8	Chrysene	o-Xylene
Lead	Lead	Aromatic >C8-C10	Benzo(b)Fluoranthene	p-Xylenes
Magnesium (Total)		Aromatic >C10-C12	Benzo(k)Fluoranthene	Dioxins Furans and Dioxins like PCBs
Mercury	Mercury	Aromatic >C12-C16	Benzo(a)Pyrene	
Molybdenum		Aromatic >C16-C21	Indeno(1,2,3-cd)Pyrene	
Nickel	Nickel	Aromatic >C21-C35	Dibenzo(a,h)anthracene	
Selenium	Selenium	Aromatic >C35-C44	Benzo(g,h,i)Perylene	
Total Acid Soluble Sulphate		Total Aromatics (C5-C44)		
Sulphur (Total)		Volatile Hydrocarbons (C5-C12)		
Vanadium	EPH (As item 4) C10 to C40	Extractable Hydrocarbons (C12-C44)		
Zinc		Total Hydrocarbons (C5-C44)		
Free Cyanide		MTBE		
Total Cyanide	Total Cyanide	Benzene		
Organic Matter		Toluene		
Organic Carbon		Ethylbenzene		
Fraction Organic Carbon		m-Xylenes		
pH		o-Xylene		
W/S Sulphate as SO4	Water Soluble Sulphates	p-Xylenes		
Acid Soluble Sulphide				
Thiocyanate as SCN				
Phenol	Phenol by HPLC			
Total Monohydric Phenols				
CWG banded Hydrocarbons C5 to C44				
BTEX aromatics				
PAH 16	PAH 16			

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Soils Assessment Criteria

4.2 At the time of the investigation the results were assessed against guideline values current at that time. New guidances have been issued by the Environment Agency (CLEA Model v1.071 – 2015), The Department for the Environment, Farming and Rural Affairs (SP1010 C4SL 2014) and the Chartered Institute of Environmental Health / Land Quality Management Ltd S4UL – 2015) as discussed below.

4.3 For the assessment below, the measured soil concentrations for particular contaminants are compared to acceptable limits set out in two main guidance reports. Both give values derived using the Environment Agency CLEA model.

4.4 Our assessments are based on a hierarchy of CLEA model derived values where the Environment Agency Soils Guideline Values (SGVs - 2008) and Suitable For Use Values (S4UL - 2015) from the Chartered Institute of Environmental Health are most preferred, followed by values derived by Terramech using the CLEA model.

4.5 We have included an assessment value for Lead derived in the DEFRA SP1010 report using the CLEA model and the original minimal or tolerable levels of risk methodology used for SGVs and S4ULs. These guideline values are appended.

Asbestos

4.6 We have used CIRIA C733 (Asbestos In Soil And Made Ground) methodology to derive guideline values for three main types of asbestos in a number of exposure scenarios based on the minimal or tolerable levels risk level of 1 in 100,000 used to derive HCVs for other contaminants.

Soil Contamination

4.7 The generic exposure scenario for commercial land use has been selected for the assessment of soil contamination concentrations. The screening values are appended.

Metals and Inorganic Compounds

4.8 The Terramech analysis of soils from the actual the Site E Car Park area showed elevated Arsenic, Chromium, Lead, Nickel and Zinc concentrations.

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4.9 The samples with elevated concentrations of Chromium, where also tested for Hexavalent Chromium, none was detected.

4.10 The metal concentrations measured were all below the guideline values for commercial developments (EA SGV v1.06 2009 & CIEH/LQM 2nd Ed – 2009 as well as CIEH/LQM S4UL 2015, EA CLEA 1.071 & SP1010 C4SL).

Inorganic Compounds

4.11 The analysis included Inorganic Compounds comprising various Cyanide and Sulphate based compounds.

4.12 The analysis showed that some elevated sulphate values were noted, which is consistent with combustion residues from coal. The values were at trace concentration and not expected to pose any risks to human health.

4.13 Cyanides were not detected in the samples from our 2011 investigation in the Site E Car Park area.

Hydrocarbon Totals

4.14 Some of the Terramech samples were analysed using a crude total hydrocarbons test with a similar extract method which gives a total for both Aliphatic Hydrocarbons (open chain molecules) and Aromatic Hydrocarbons (ringed molecules) in the diesel range.

4.15 The remaining Terramech samples were tested using a banded method where concentrations are given for each of different weight bands of hydrocarbons spanning the gasoline and diesel ranges, as well as giving the division between Aliphatic and Aromatic Hydrocarbons.

4.16 Hydrocarbons were detected in some of the samples however, none of the concentrations in any one band exceeded the commercial exposure scenario

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screening value for that band. The total hydrocarbon values were seen to be below the lowest screening value for Aliphatic or Aromatic Hydrocarbons.

Mono-cyclic Aromatic Hydrocarbons

4.17 The analysis did not detect any of the specific Mono-cyclic Aromatics (single ring molecule) such as Benzene and its derivatives (Toluene, Ethylbenzene and Xylenes) nor did it detect the petrol additive (MTBE).

Poly-cyclic Aromatic Hydrocarbons

4.18 The concentrations of sixteen specific Poly-cyclic Aromatic Hydrocarbons (multi ring molecules) were assessed. Members of this group of sixteen are present in coal tars, combustion by-products and fuels and they are recognised as the most prolific of the thousands of aromatic compounds that have been documented.

4.19 This showed that although present, none of the sixteen were present at concentrations exceeding their respective individual commercial exposure scenario screening values set out in CIEH/LQM S4UL 2015.

Hydrocarbons (Phenols)

4.20 Phenols (total Monohydric Phenols includes Cresols or Methylphenol and Chlorinated Phenols) were below detection limits in all samples from the Site E Car Park area. Therefore the concentrations did not exceed the screening value for Phenol published in the new Soil Guideline Value (SGV) report or CIEH/LQM S4UL 2015, EA CLEA 1.071 & SP1010 C4SL

Asbestos

4.21 Samples were recovered from the cable percussive boreholes on the Site E Car Park area which revealed the presence of Chrysotile fibres to depths of 4.0m in

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BH1 and 2.5m in BH2. Fibres were not detected in samples from BH3 below depths of 1.0m.

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4.22 Samples from the window sample boreholes on the Site E Car Park area also showed that asbestos was present (as discussed in the ground conditions section). Amosite was detected in the sample from WS9 at 0.8m and WS16 at 0.9m. Chrysotile asbestos was detected in WS9, WS11, WS13, WS14 and WS15, notably at depths of up to 1.95m in WS13.

Groundwater Contamination

4.23 On the basis of the findings of the preceding investigations by Watermans, which concluded that the ash lagoon material did not pose a risk to groundwater, we did not carry out any groundwater analysis as part of our 2011 investigation.

Ground Gases

4.24 Ground gas monitoring was not carried out by Terramech due to the work carried out by Waterman Environmental which dismissed the potential for any ground gas hazards over the whole BG Group site.

Waste Classification

4.25 Waste Acceptance Criteria (WAC) testing was carried out on the arisings from the cable percussive boreholes, as well as the window sample boreholes on the Site E Car Park. These materials were kept in a skip for off site disposal and represent a mixture of the soils which would be generated by any earthworks at this site.

4.26 The analysis showed that the soils could be considered to be suitable for inert landfill however, asbestos was detected in these materials which included Amosite and Chrysotile Asbestos.

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4.27 The presence of cement bound asbestos would not preclude the materials being disposed at an inert landfill subject to some specific provisions as of 16th July 2005.

4.28 Schedule 1, paragraph 16 of the Landfill Regulations sets out these specific provisions for asbestos wastes from as follows:

- The waste must contain no hazardous substances other than bound asbestos, including fibres bound by a binding agent or packed in plastic;
- Construction material containing asbestos or other suitable asbestos waste can only be accepted in a landfill dedicated to these wastes or in a separate cell of a non-dedicated landfill, provided it is sufficiently self-contained;

4.29 The results should be forwarded to the landfill proposed to receive the arisings/excavated material.

5 NOTES

5.1 This is a draft report issued for comment or review and should not therefore be relied upon, circulated or submitted as a final document.

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DRD/JRP 19 September, 2018