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Issue 1

Site Restoration Programme

Trawsfynydd Deposit for Recovery Permit Application

The Waste Sampling Plan

June 2026

Trawsfynydd Deposit for Recovery Permit Application – the Waste Sampling Plan

Author: Heather Barker

Signature: Date: 09 June 2026

Lead Verifier: Sam Fuller

Signature: Date: 10 June 2026

Authorise for issue: Sion Richards

Signature: Date: 11 June 2026

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1	09 June 2026	H. Barker	

Distribution

Nuclear Restoration Services

The Waste Sampling Plan

Contents

The guidance on the classification and assessment of waste (1st Edition v1.2.GB) (WM3) requires a sampling plan to underpin any waste classifications and hazardous waste assessments.

This Sampling Plan has been developed using guidance in Appendix D of WM3 and following the structure provided in EN 14899 ‘Framework for preparation and application of a Sampling Plan’. It provides a written record of why we are sampling in support of the Trawsfynydd Deposit for Recovery (DfR) permit application.

1 Identify involved parties

Waste producer: Representatives with NRS site based team at Trawsfynydd who are responsible for ensuring compliance with the DfR permit.

DfR operator: The waste producer is also the DfR operator. However, this Sampling Plan is focused primarily on the requirements of the waste producer.

Consultants: NRS consultants who have produced the Sampling Plan and those who are certified assessors in using the HazWaste online tool.

Regulator: The Sampling Plan is being reviewed by members of Natural Resources Wales as part of the permit determination process.

2 Identify objectives and define technical goals

The key objective of the proposed testing programme is to satisfy NRS and the regulator that all wastes accepted within the permitted area from the Reactor Building Height Reduction (RBHR) project are non-hazardous and are in accordance with the acceptable List of Waste (LoW) Codes for a DfR permit.

The technical goals are to better understand whether the waste streams contain any hazardous properties or Persistent Organic Pollutants (POPs) and if so, NRS and the regulator are confident that the concentrations are within acceptable levels. So that there is no potential adverse risk to the environment or potential harm to human health.

The waste streams generated during the RBHR project which are addressed by this Sampling Plan comprise a mixture of monolithic concrete blocks, Pre-Cast Concrete Panels (PCCPs) and bricks.

3 Determine the composition and quality of the concrete and brick

This is necessary to ensure that the requirements of the Duty of Care are met and that the wastes are adequately characterised so that they can be handled and managed in an appropriate manner. It is also necessary to establish whether the waste streams from the RBHR project can be safely recovered.

To comply with the requirements of the DfR permit, all wastes accepted within the permitted area must be non-hazardous and assigned an appropriate LoW Code.

4 Determine generic level of testing required

<u>Level 1 – comprehensive basic characterisation</u>
This sampling plan supports a level 1, comprehensive waste characterisation scheme for waste which will be generated on-site in the next 2-3 years, during the demolition of two identical reactor buildings.

Level 1 comprehensive basic characterisation can be achieved using screening initiatives to build on the small existing dataset which was gathered during the Data Quality Objectives (DQO) assessment[1]. This preliminary assessment focused on determining the

1 TRAWS/L28302/DOC/0041 Characterisation in support of height reduction of Trawsfynydd Reactor Buildings and TRAWS/L28302/DOC/0154 Trawsfynydd Height Reduction Project: Pre-Demolition Assessment of Materials Against Clearance Thresholds

concentrations of visible contaminants including TPH, lead paint and PAHs within the reactor buildings. Asbestos is discussed in section 8.

Level 1 will include more extensive testing to ensure a better understanding of all potential contaminants which may have been introduced either during the original manufacturing processes or during the construction and maintenance of the reactor buildings.

This sampling plan outlines the following phased approach to the level 1 characterisation:

- Initial screening exercise to improve existing knowledge of the variability of the individual component streams which will be generated during the RBHR project.

- Phase 1: A phase of testing to determine 'total' concentrations of parameters of interest will provide data on the composition of each individual waste stream.

- Phase 2: Undertake a comprehensive hazardous waste assessment on the sampling data collected. This will be conducted by a member of the NRS Waste Team who is a certified assessor for the Hazwaste online tool. This will determine if the waste streams are non-hazardous and whether they are suitable for acceptance within the DfR permitted area for use in the extension and improvement of the Recycled Concrete Aggregate (RCA) laydown area.

- Phase 3: Undertake statistical analysis on the results of the hazardous waste assessment to determine whether an appropriate level of confidence has been achieved and to evaluate the variability within the population and/or sub-populations. This is a decision point for determining whether further testing of samples may be needed based on the variability found within the initial round of testing.

Level 2 - compliance testing

The Sampling Plan underpins level 2 compliance testing. This will be carried out by NRS (the waste producer) to ensure that the quality of the waste streams generated during the demolition works remain within agreed boundaries throughout the 2-3 years of the RBHR project.

5 Identify constituents and characteristics to be tested

Level 1 – comprehensive basic characterisation

The LoW Codes which are included in the DfR permit application are as follows.

List of Waste Codes	Description
17 01	**Concrete, Bricks, Tiles and Ceramics**
17 01 01	Concrete
17 01 02	Bricks
17 01 03	Tiles and Ceramics
17 01 07	Mixtures of Concrete, Bricks, Tiles and Ceramics

WM3 guidance on the classification of waste lists the codes above are mirror codes, therefore NRS (as a waste producer of mirror-entry hazardous/non-hazardous wastes) are required to assess the waste to determine the presence or absence of dangerous substances or hazardous properties. WM3 lists hazardous properties H1-H15, which include oxidising, flammable, irritant, harmful, toxic, carcinogenic, corrosive, infectious, mutagenic, and ecotoxic hazardous properties.

WM3 guidance also requires the waste to be assessed for the presence of Persistent Organic Pollutants (POPs). Of the fifteen POPs listed in Box 2.2 of WM3, polychlorinated biphenyls (PCBs) are the only ones to have the potential to be present within the reactor buildings. The presence of PCBs, whilst considered unlikely, were used in masonry sealant manufactured in the 1950s and 1960s. If used, they could have migrated into the monolithic concrete blocks. However, maintenance works on the reactor buildings undertaken by CAN Ltd from 2011 onwards have largely replaced any sealant and joint bridging[2].

The waste concrete and brick samples will be taken by courier to a laboratory with certified accreditation to ISO 17025 for preparation and testing. Analysis for the following suite of determinands will provide results for 'total concentrations' and assist in determining the nature and form of any hazardous compounds found to be present.

Barium
Magnesium
Manganese
Vanadium
Phenols
Cyanide
Chloride
Sulphate
Phosphate
Antimony
Arsenic
Cadmium
Chromium (speciated)
Copper
Lead
Mercury
Nickel
Selenium
Zinc
Total Poly Aromatic Hydrocarbons (PAHs)
Total Petroleum Hydrocarbons (TPHs) C6-C40
pH and acid/alkali reserve
Moisture content
Total Polychlorinated Biphenyls (PCBs)

Total concentration (using *aqua regia* digestion) testing will be undertaken and the results assessed prior to any waste being accepted within the permitted area.

2 Trawsfynydd Power Station – Reactor Hall Repairs | CAN Limited

Level 2 compliance testing
The frequency and number of samples taken from the crushed concrete/brick stockpile will be determined once the level 1 testing has been completed and the results assessed.

Environmental reassurance testing
Inert WAC testing, plus leachable Cr(VI) will also be carried out, not to satisfy WM3 but to provide assurance with regards risks to groundwater.

6 Background information on the waste

Site details
All wastes will be generated from the RBHR project taking place at the Trawsfynydd Nuclear Power Station, over the next 2-3 years. The original construction materials: monolithic concrete blocks, PCCPs and bricks were generated using standard manufacturing processes and raw materials in use in the late1950s and early 1960s.

Trawsfynydd Nuclear Power Station was constructed between 1959 to 1964. Both reactor buildings are entirely separate and virtually identical with façades predominantly featuring exposed cast in-situ reinforced concrete (monolithic concrete) and PCCP, the later accounting for circa 50-60% of total elevation area. A relatively small quantity of brickwork was also used in the construction of the upper portion of each reactor building.

The constituents and the relative ratios used in the construction of the monolithic concrete blocks was specified for use in their construction and can be found in the ESSD report Appendix A.2. The concrete specification includes the potential use of flyash to replace part of the cement fraction in concrete destined for one of the following uses:

- Blinding, filling, casing and backing in class X concrete
- Temporary foundations and structures
- Permanent foundations below ground level where early strength is not important

Whilst none of the above types of concrete relate to materials being generated as part of the RBHR project, the suite of determinands has been chosen to reflect potential naturally occurring trace metal contaminants which may possibly have been introduced into the concrete from naturally occurring materials or as admixtures. Raw materials, such as the aggregates used in the manufacture of concrete, were sometimes sourced from areas with high mineralisation depending on the geographic location of the quarry.

Portland cement contains naturally occurring trace metals, primarily sourced from the raw materials (limestone, clay, shale, and iron ore) and the fuels used during clinker production. Similarly clay and shale are also used in brick making. Common trace elements include **chromium, nickel, lead, arsenic, zinc, manganese, vanadium, antimony and selenium**. Trace metals in cement occur at varying concentrations (typically ranging from single-digit to low-hundred parts per million) depending on the geological origin of the quarry:

- **Chromium (Cr):** Often the most monitored metal, as it can be present as hexavalent chromium (Cr^{6+}) which is known to cause contact dermatitis and allergic reactions.
- **Nickel (Ni):** Present in trace quantities, often associated with magnesium oxides.
- **Lead (Pb):** Trace amounts originating from clay and shale minerals.
- **Arsenic (As):** Found in small concentrations, with variations depending on the specific type of Portland cement (e.g., Type V).
- **Zinc (Zn) and Manganese (Mn):** Commonly occurring in the natural minerals and raw ores used for cement fluxing.

- **Vanadium(V) and Antimony (Sb):** Trace elements that remain bound in varying fractions during the hydration process.
- **Manganese (Mn) and Selenium (Se):** Calcareous and Argillaceous Materials e.g. limestone and chalk are the primary sources of calcium), alongside clay, marl, and shale which are the primary sources of silica, alumina, and iron. All may naturally contain minute background levels of both manganese and selenium.

The PCCPs (to all elevations and on both reactor buildings) are of a similar construction method, the only variations are in terms of size and support mechanisms. They were constructed out of class B reinforced concrete with stiffening ribs on the perimeter. The PCCPs were originally cast face up in a mould onto a permanent 38mm thick soffit board/insulation finish to the inside face. The reinforced concrete was cast using aggregates and a proportion of local granite.

The PCCPs all span horizontally with mild steel dowels which were threaded through dowel holes in the panel nibs/corbels. These were then grouted to permanently hold the panels either together or to the reactor building superstructure. Dowel holes were formed using asbestos cement sleeves, which will be mechanically removed from each panel once the panel has been lowered to the ground from the reactor building. The soffit board which contains asbestos will also be removed from the panels before they are taken to the DfR area (see also Section 8 below).

There is little information available on the manufacturing process for the small quantity of brickwork used on the reactor buildings. Historical reports suggest that it was similar to that used across the Magnox estate and are commonly referred to as Staffordshire engineering bricks.

7 Evaluate existing data

The DQO explored non-radioactive potential contaminants and concluded that the following were the most likely:

- Traces of oils in and around the building fabric of the shield cooling filter gallery areas, and in areas where overhead cranes have been used (Main Charge Halls, Fuelling Machine Maintenance Bays, Circulator Halls and 131-foot areas). Other areas may also be affected
- Lead-based paints may have been used throughout the buildings
- Bitumen may have been used in the original roofing felt
- Mercury may be present in discrete batteries inboard of sidewalls
- Waste electronic and electrical equipment (WEEE) in the ion chamber rooms inboard of sidewalls

Samples were taken and analysed for the following determinands:

TPH C6 to C40
EPA PAH 16 suite
Benzo[a]anthracene (BaP)
A broad range of metallic elements including mercury and lead
Acid-soluble sulphates (concrete aggregate only)

A total of 65 samples were recovered from reactor building 1 and 71 from reactor building 2. The buildings were zoned according to the potential for radioactive and chemical contamination. Zoning for non-radioactive properties was mirrored as separate zones in reactor building 1 and 2

Zone	Geographical Area	Anticipated contaminants
7	Internal walls and floors	Nothing specifically identifiable
8	Cranes and rails1	Paint which may be of interest for the purpose of metal recycling
9	Charge Hall and Fuelling Machine Maintenance Bay Walls	Potential for spills of oils during routine operations
10	Batteries	Mercury
11	131’ Area, Boiler Boxes, Hot Gas Duct Cells, Stairwells, Shield Fan Rooms, Boiler Interspaces	Oils used during maintenance activities
12	Damp proofing and roofing materials	Bitumen, lead flashing around roof lights

Both random sampling and biased sampling (in areas where contamination or attributes of interest are known to be present) were undertaken.

Samples from each area within zones 9 and 11 were used to establish the extent of oil contamination. Ahead of sampling, a visual inspection of the areas was undertaken to establish the potential for oil contamination. For areas with low potential, a minimum of three samples were analysed and provided they do not indicate a Hazardous classification (see below) no further sampling was required. For areas with higher potential a minimum of 10 samples per area were assessed. For example, within each reactor building the Fuelling Machine Maintenance Bay (FMMB) was treated as one area with enhanced potential for oil contamination and so 10 samples were assessed for hazardous properties.

A series of numerical limits were set out to determine whether materials require to be categorised as Hazardous due to contamination with unknown oils based on the concentration of Total Petroleum Hydrocarbons (TPH), and the concentration of benzo[a]anthracene (BaP) relative to TPH. For areas with low potential, the results for each sample were used individually for this assessment. If any of these exceed the limits, then the DQO report was revised and additional samples were assessed.

For areas with higher potential, the 95th percentile value of TPH was used, calculated as:

95th percentile = μ+(SE x 1.833)
Where μ = the mean value of TPH for the population
SE = the standard error on the measurement, defined as SE = s/ ($\sqrt{n}$)
Where s = the standard deviation of the TPH results for the population and n = the number of samples analysed

And 1.833 = the critical value of the 1-sided t-distribution corresponding to 95% confidence with 9 (i.e., n-1) degrees of freedom

In all cases, the BaP concentrations relative to TPH were assessed for each individual sample.

The approach to determining the concentration of acid-soluble sulphates in concrete samples relative to the maximum limits set out in table 13 of BS EN 13242 was similar to that employed for TPH, that is the 95th percentile was only used where either any of the analytical results exceeded the limits or the mean result was deemed sufficiently close to the limit by the Intelligent Customer.

14 concrete samples were taken from areas with dark staining, suspected to be oil. These were also tested for the standard 16 PAHs and for total petroleum hydrocarbons (TPH, C6 – C40). In all cases, individual PAH analytes were determined below limits of detection. Results for TPH analysis varied between 32 and 4,900 mg/kg (i.e. a maximum of 0.49%). 9 of them had BaP/TPH ratios of <0.01% and the other 5 had TPH results far below the threshold of 1,000 mg/kg.

10 of the concrete samples were chosen to test acid-soluble sulphate content. The results varied between 2690 and 7210 mg/kg.

12 paint samples were analysed for their lead content. Results varied between 60 and 410 mg/kg (i.e. a maximum of 0.04%).

All samples were deemed to be non-hazardous, however the existing dataset is not sufficiently comprehensive to enable full level 1 characterisation of the three waste streams e.g brick, monolithic concrete blocks and PCCPs. We have expanded the suite of determinands to include trace metals and PCBs, which will provide data to understand both the manufacturing process of the building materials and also the method of construction employed at the time. See section 5 above which includes a comprehensive suite of determinands which will be used for the Level 1 testing going forwards.

The existing data cannot be used to identify variability within the overall population and/or sub-populations because it specifically targets areas of known visible contamination. A further screening step is therefore required to improve the level of knowledge of both the constituent raw materials used with the manufacturing processes of the time and also the construction methods used, particularly in relation to the possible use of masonry sealants.

8 Asbestos sampling and testing

<u>Pre-Cast Concrete Panels and brick</u>

Based on a review of records (see section 4.1 of **EMS Summary Appendix 6**), asbestos sleeves and soffit boards (visible ACM) are present in the concrete panels, and these will be removed (as a CAR 2012 controlled activity) from the panels as part of decommissioning prior to the panels becoming waste, and records will be kept of the removal and signed off as asbestos free by an Asbestos Competent Person.

The records indicate that this single source, along with the bricks, had no other asbestos used in construction. See narrative in **EMS Summary Appendix 6 Section 4.1**. Document **TRAWS/L28302/DOC/0328 (Assessment of ACMS associated with PC Panels)** includes details of ACM (sleeves and soffit boards) within the panels which is to be removed and consigned off-site as hazardous waste prior to acceptance in the DfR area.

The remainder of this section is concerned with characterisation of asbestos contamination within monolithic concrete.

Monolithic concrete blocks

A review of site records found that asbestos was also used to finish monolithic concrete surfaces through a ‘bagwashing’ technique. A series of characterisation exercises have taken place between 2020 – 2022, where a total of 160 samples were collected across five sampling sub-populations.

This found asbestos is present >0.1% hazardous threshold in the monolithic concrete pour joints (highest recorded result 3.11%), which comprises a total of 16m3 of the 8214m3, asbestos was not detected in the remainder. The rest of this section discusses this material and approach to waste classification and management.

Characterisation process

The characterisation of asbestos has been overseen by the site Asbestos Competent Person. The summary below outlines the process followed and should be read in conjunction with:

- **Stakeholder briefing note on minimally asbestos contaminated reinforced concrete from planned bulk demolition, December 2020.** (included **in ERA Appendix A3**)
- **TRAWS/L28302/DOC/0384 Trawsfynydd Reactor Building Asbestos Quantity Calculation Pack.** References referred to in this document are:
    - Underpinning Chrysolite Analysis of Wash Bagged Surface Finish within the RCA - M/EF/TRA/REP/0008/21 Issue 1 (May 2021)
    - Element Certificate of Analysis – Document Reference 3.10.7 Issue 12
    - XRD Analysis of Concrete Fibres – HSE-SD ref. PE11650
    - HSE Laboratory Report – Worksheet No. FIB/21-4562 (PLM)
    - HSE Laboratory Report – Worksheet No. 21-4562 (XRD)
    - HSE Laboratory Report - Worksheet No. FIB/21-4563 (PLM)
    - HSE Laboratory Report - Worksheet No. 21-4563 (XRD)
    - HSE Laboratory Report - Worksheet No. FIB/21-4619 (PLM)
    - HSE Laboratory Report - Worksheet No. 21-4619 (XRD)
    - HSE Laboratory Report - Worksheet No. 22-4760 / FLM (XRD)
    - HSE Laboratory Report - Worksheet No.22-4759 / MF (XRD)

Dec 2020

Characterisation commenced. It was reasonable to assume bagwash (which was historically a finishing technique to address imperfections in the concrete) was not applied evenly, however our initial approach was to treat the bagwash as uniformly applied. We initially consulted with NRW in Dec 2020. We prepared a briefing note for Gareth Lewis, Iwan Williams, Richard Clarke, Mike Baggs & David Wilby (See Appendix A3 of the ERA).

At this meeting, NRS’ approach to treat the bagwash as a uniform product was agreed in principle. This then framed what the product was and how we would go about subsequently evaluating compliance against the 0.1% WM3 threshold. We identified that removal of bagwash would be impractical early on and documented this in the briefing note (extract below):

> We do not consider the removal of the RC surface ‘bagwash’ as being reasonably practical as this is not a bona fide product or differentiable from the structural concrete. It is currently envisaged that the RC will be remotely demolished and processed into graded material and in the case of the Ponds, utilised for filling below-ground voids in the complex itself.

Further information on bagwash and the impracticalities of removal can be found below (see '**Further discussion on bagwash**').

May 2021
We then engaged our radio-chem IC to generate a sampling plan in May 2021 (ref M/EF/TRA/REP/0008/21).
Via VSP analysis we identified we needed to recover 32No randomised samples per population. Populations were as follows (colour coded to assist with tracking through to the results):

1. Reactor building 1
2. Reactor building 2
3. Pond complex (this was later discounted as the samples failed clearance, so we substituted a split-population covering both RBs = 16No per RB).

May-August 2021
The sampling was undertaken by Element (accredited to ISO17025) instructed under Service Request (TRA/ASB/0026) in July-August 2021.
Whilst the above was being undertaken our understanding of the product improved and we suspected that the asbestos fraction was in the bagwash pour lines ONLY – not across the RC entirety. This was initially evidenced by bulk certificate 107834 (attached) with analysis by PLM.

August 2021
We procured the services of the HSE to conduct specialised testing on the materials. Contract proposal attached (PE11650) with the HSE undertaking analytical methods PLM (Polarised Light Microscopy) & XRD (X-Ray diffraction).
XRD is widely considered one of the best methods for determining % asbestos content because employs discriminatory methods to measure the crystalline structure of asbestos minerals. Underpinning:

- This technique allows specific identification of crystalline silicate minerals and not just detection of fibres.
- The quantification is accurate.
- The method analysis full sample volume and avoids bias (possibly encountered through non-homogenous materials or local fibre clustering). PLM looks at small fields whereas and XRD provide representational results.
- The method can distinguish asbestiform silicates from other minerals.
- The detection range is excellent so fit for purpose when determining mass % content.
- It was recommended by the HSE.

Samples sent:

- Consignment 1 – RB1 32no samples sent 31/08/2021 for PLM & XRD (population 1)
- Consignment 1 – RB2 32no samples sent 31/08/2021 for PLM & XRD (population 2)
- Consignment 2 – 32no samples sent 04/10/2021 (16No per RB) for PLM & XRD (population 3)

Our understanding of the product characteristics moved on extensively during this time and we were able to identify that asbestos was only present in the bagwash and not homogeneously applied to the reinforced concrete (independently verified by the HSE results).

September 2021
Results received from the HSE:

- Consignment 1 (population 1) – RB1 32No sample results:

  - PLM test cert 21-4562 PLM attached. Result = unanimously confirmed chrysotile in bagwash.
  - XRD test cert 21-4562 XRD attached. Result = no asbestos detected from homogenised samples (RC mixed + bagwash)

- Consignment 1 (population 2) – RB2 32No sample results:
  - PLM test cert 21-4563 PLM attached. Result = unanimously confirmed chrysotile in bagwash.
  - XRD test cert 21-4563 XRD attached. Result = 1.2% (±0.12%) percentage chrysotile from homogenised samples (RC mixed + bagwash).

- Consignment 2 (population 3) – 32No samples across RB1 & RB2 recorded via
  - PLM test cert 21-4619 PLM attached. Result = unanimously confirmed chrysotile in bagwash.
  - XRD test cert 21-4619 XRD attached. Result = 1.1% (±0.05%) percentage chrysotile from homogenised samples (RC mixed + bagwash).

These results for 3No populations proved chrysotile was not present universally on the rc superstructure and testing was concluded.
We, however, were keen to further characterise so we then engaged the same suppliers to sample and test against a further two populations to accurately target % of asbestos in the bagwash.

January 2022
Further to the above developments we tasked Element again with recovering samples from pour joint locations only (see Figure 1). Pour joints are discernible as a darker line within the fully bound host rc however removal is not reasonably practicable and would introduce significant additional foreseeable hazards with no appreciable gain i.e. we will never be able to declare the building fabric ‘fibre free’.

- 32No samples for Reactor Building 1 (population 4)
- 32No samples from Reactor Building 2 (population 5)

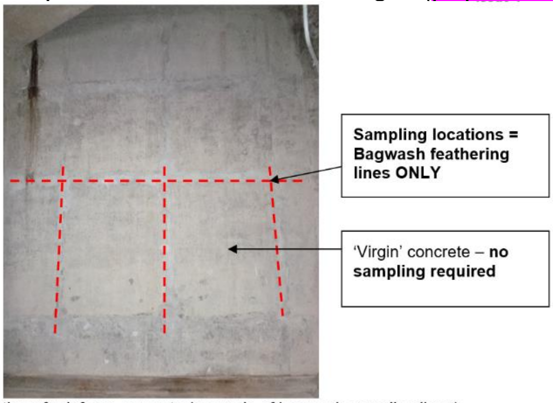

Figure 1: Full elevation of reinforce concrete (example of bagwash sampling lines)

Further to the above refinement, further samples were sent to the HSE of the bagwash material only:

- Consignment 3 (population 4) – 32No samples from RB1 **bagwash for XRD only** sent 31/01/2022

- Consignment 3 (population 5) – 32No samples from RB2 **bagwash for XRD only** sent 31/01/2022

March 2022

Results received from the HSE:

- Consignment 3 (population 4) – RB1 32No samples of bagwash only for XRD:
  - XRD test cert 4760 attached. Result = 0.18% (±0.26%). Individual results for 5No sub samples were as follows: 0% (Not detected), 0.26%, 0.44%, 0% (Not detected), 0% (Not detected).

- Consignment 3 (population 5) – RB2 32No samples of bagwash only for XRD:
  - XRD test cert 4759 attached. Result = 2.86% (±0.22%). Individual results for 3No sub-samples were as follows: 2.67%, 2.79% and 3.11%. **[NOTE = WORST RESULT USED TO CALCULATE % CHRYSOTILE FACTION]**

May 2025

The calculations pack (Ref: TRAWS/L28302/DOC/0384) features the following outputs:
Also note that discernibly less chrysotile identified when comparing results across populations with RB2 consistently worst case.
Based upon the above calculations have been undertaken to confirm the following:

- Taking the worst-case result and assessing the superstructure we can conclude:
  - Total volume of rc vertical elements = ~8214m³
  - Bagwash contributing volume = ~16m³
  - % of asbestos in bagwash ~3.11 or ~0.5m³
  - **WM3 check = 0.006% < 0.1% [therefore non-hazardous by HP7]**

- Further discrete worst-case scenario:
  - A 1m³ RC block consigned and processed in isolation could result in a theoretical discrete worst case. Using the highest output volume of Pour Joints Compared to Wall Volume from the studied cases, Wall Number 6 (HGDC areas) is identified as the theoretical worst case due to the slenderness and reduction in rc volume for dilution.
  - Contaminant in total pour joint volume = 0.14 x 0.0311 = 0.00435m³
  - Convert to 1m³ of wall = 0.00435 / 34 = 0.00012806m³
  - % = (0.000128 / 1) x 100 = **0.0128% < 0.1% [therefore non-hazardous by HP7]**

Conclusions

The comprehensive testing programme indicates that the waste can be confidently classified as non-hazardous. The basic characterisation completed indicates that a theoretical worst case individual consignment of 1m3 to the laydown area is 0.01% which is well below the threshold. As the waste will be deposited at the same site as generation, the basic characterisation testing is considered adequate for compliance purposes. Section 1.1.3b of the Council Decision states that no additional compliance testing is required because full basic characterisation is already being carried out on each of the batches (campaigns).

Further discussion on bagwash

The bagwash product is unique to Trawsfynydd. Referring to it as a coating or textured coating product can be misleading as it infers a substrate and finishing build-up **which is clearly not the case at Trawsfynydd**.

<table>
<tr><th>Product</th><th>Image</th><th>Extract from HSG264 – Asbestos Survey Guide</th></tr>
<tr>
<td>Sprayed coating

Note: products are clearly discernible with substrate / finish relationship e.g. Limpet.</td>
<td>
</td>
<td>
<table>
<tr><th colspan="4">Sprayed coatings</th></tr>
<tr>
<td>Dry applied, wet applied and trowelled finish.</td>
<td>Thermal and anti-condensation insulation on underside of roofs and sometimes sides of industrial buildings and warehouses. Acoustic insulation in theatres, halls etc. Fire protection on steel and reinforced concrete beams/columns and on underside of floors. Overspray of target areas is common.</td>
<td>Sprayed coatings usually contain 55%–85% asbestos with a Portland cement binder. Crocidolite was the major type until 1962. Mixture of types including crocidolite until mid–1971. Asbestos spray applications were used up to 1974.</td>
<td>The surface hardness, texture and ease of fibre release will vary significantly depending on a number of factors. Sprays have a high potential for fibre release if unsealed, particularly if knocked or the surface is abraded or delaminates from the underlying surface. Dust released may then accumulate on false ceilings, wiring and ventilation systems.

'Limpet' (also used for non-asbestos sprays).</td>
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<tr>
<td>Textured coating

Note: products are clearly discernible with substrate / finish relationship e.g. Artex.</td>
<td>
</td>
<td>
<table>
<tr><th colspan="4">Other encapsulated materials</th></tr>
<tr>
<td>Textured coatings.</td>
<td>Decorative/flexible coatings on walls and ceilings.</td>
<td>3–5% chrysotile asbestos. Chrysotile added up to 1984 but old stock may have been used for several more years.</td>
<td>Generally fibres are well contained in the matrix but may be released when old coating is sanded down or scraped off. 'Artex', Wondertex',</td>
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Trawsfynydd Bagwash **Note:** Even though patterns are recognisable, the **products are not clearly discernible and substrate / finish relationship not applicable.**	 Figure 3: Site surface texture (>2m)  Figure 4: Site imperfections (<0.5m)	**The below is not taken from HSG264 but provided for appropriate context:** Specific to the reinforced concrete elements of the build fabric, and as part of the construction sequence, a finishing technique was applied on industrial scale. The technique is partly detailed on construction issue finishes drawings by way of descriptor 'flush pointing (bagged)'. In terms of the sequence, once the formwork was struck, surface imperfections and irregularities in the pour were polished out using a mixture of fine sand, cement and dilute polyvinyl acetate (PVA). Whilst the finishing method is orthodox and still used to today, the Site version was fairly unique with the mortar mix applied using hessian bags. Anecdotally, the cementitious mix was bagged and dipped ad-hoc into a chrysotile additive prior to application. Hence the tradesman term 'bag washing'. The primary driver at the time was a well-bonded aesthetic finish with direct implications for decontamination, whilst thermal and acoustic enhanced properties were incidentally beneficial. As a result of the application process and lack of robust quality control, there is widespread variance in applied material composition and heterogeneous chrysotile faction – as per results obtained- see above.

Reasonably practicable position

The bagwash has been demonstrated to be a low-hazard, non-friable material, with fibres firmly bound within a cementitious matrix and integral to the concrete substrate. It is stable in situ, not easily discernible from the host material, and not prone to fibre release with administered control measures.

A structured assessment of “reasonable practicability” was undertaken, considering both (i) the balance of risk versus sacrifice (time, cost, effort), and (ii) whether removal would introduce greater risk. This concluded the following:

- Residual risk from retention is low and controlled:
    - The material will remain encapsulated until demolition, at which point controlled deconstruction techniques, dust suppression and controlled processing will be employed, mitigating exposure potential.
- Removal is not reasonably practicable:
    - The methods available to remove the material would be intrusive, time-intensive and operationally complex, requiring extensive works at height, access into constrained environments and large-scale intervention across structurally integral surfaces.
    - The removal method would be destructive and potentially de-stabilising introducing a significant hazard associated with potential component pre-weakening and local/global instability.
- Removal introduces greater overall risk:
    - Early removal would increase worker exposure duration and introduce additional hazards including respirable dust, manual handling, HAVS, work at height and complex plant operations.
- Disproportion between risk and sacrifice is evident:
    - In line with established legal interpretation, the quantum of risk presented by the retained material is insignificant when compared to the significant time, cost, and safety burden required for its removal.
- End-state compliance is achieved:
    - The works to remove the bagwash would not render the reinforced concrete ‘fibre free’.
    - Post-demolition crushing and processing (6F2) results in an overall asbestos concentration well below the 0.1% w/w threshold defined in WM3, ensuring the material does not classify as hazardous waste.

On this basis, it is the NRS position that removal of the bagwash prior to demolition is not reasonably practicable and retention in situ with subsequent precision demolition and controlled processing & deposition represents a compliant, proportionate and risk-optimised approach.

9 Define the scale

The ‘scale’ defines the minimum quantity (mass or volume) of material below which variations are judged to be unimportant.

We intend to define the scale equivalent to tonnage of waste processed within a week assuming daily eight-hour shifts of crushing and screening activities. This is approximately 400 tonne/day e.g. 1000 tonne per week. The characteristics of the concrete and brick may show small daily variations, which account for minor changes in the original manufacturing process. However, these variations are likely to smooth out over a week and therefore between weeks.

This means that during characterisation of the waste, concentration data must be representative of average concentrations within 1,000 tonnes. Samples collected at a smaller scale could potentially exhibit greater variability, and so will be composited and thoroughly mixed before analysis.

The scale of the level 2 compliance testing will reflect a similar scale to the characterisation data.

10 Select the sampling approach

The majority of samples will be randomised and will generally be taken from the walls and floors over a surface area of concrete blocks, PCCPs or brickwork which equates to a total mass of 1,000 tonnes (considering its relative density and thickness). Samples will be taken before the demolition works commence and therefore, they will be from the most readily accessible locations within the building. When sampling the monolithic concrete blocks, this will be undertaken from the external surfaces.

A technique known as Visual Sampling Plan (VSP)[3] will be used to plot the locations of the random samples.

Approximately 20-30 samples will be collected for each of the three waste streams. The following number of samples from each waste stream will then be analysed. The remaining samples will only be analysed if the variability in the analytical results is greater than anticipated:

Waste type	Tonnage	Number of composite samples
Monolithic concrete	26,000	10
PCCPs	4,000	10
Brick	650	6

Each sample will be a composite comprised of 4 individual samples (each one being representative of the equivalent of a 250 tonne mass), which are then combined into a single sample container. A total of 26 composite samples will be collected and taken to a laboratory with ISO 17025 accredited certification. The suite of determinands is identified in section 5.

3 Visual Sample Plan | PNNL

In addition 5 of the 10 composite samples of monolithic concrete will be tested for total PCBs.

Samples will be acquired using techniques which, wherever possible minimise the production of dusts. All samples will be labelled and fully traceable to a central register. Samples will be individually wrapped in plastic bags and maintained at low temperature in a refrigerator whilst on site, to avoid loss of volatile components. Samples will be transported by courier in a cool box, to maintain low temperature conditions. Further details relating to the sampling methodology will be include in the sampling form (and example of which is provided at the end of this sampling plan).

11 Applying statistical parameters and reliability

The choice of statistical parameter is related to the level of testing. For Level 1 – comprehensive basic characterisation we initially propose to use the 95th percentile, which measures variability (e.g. relative standard deviation) and fairly extreme behaviour. However depending on the analytical results, we will keep this under review.

The reliability of the results considers ‘bias’, ‘precision’, and ‘confidence’. Reliability for Level 1 – comprehensive basic characterisation should be as high as possible.

As any sampling introduces a degree of random uncertainty, or ‘sampling error’. This uncertainty can be quantified by putting a ‘confidence interval’ around the result - with the semi-width of the confidence interval being known as the ‘precision’ of the estimate.

Associated with any confidence interval is a specified level of confidence, such as 90%. With 90% confidence intervals, about 9 in 10 such intervals will truly contain the true population parameter. Whereas with a 99% confidence interval, the precision will be more than half again as wide as a 90% confidence interval.

For a given level of confidence, the number of samples and the variability of the underlying population will both affect the precision. We consider that the variability of the population is likely to be fairly small and we have considered this when determining the number of samples to be taken. We initially propose to use the 90% confidence interval and 20% precision. However we will keep this under review.

The statistical parameter and reliability of the sampling results will determine whether there is an appropriate level of confidence and accuracy that the wastes are non-hazardous and can be successfully recovered within the DfR permitted area.

If there is insufficient confidence in the accuracy of the sampling results, then we will review the sampling approach and determine if further analysis of samples may be necessary.

An Example of a Sampling Form

SAMPLING FORM	
GENERAL INFORMATION	
Sampling Plan completed by:	On behalf of:
Client (Company): Contact:	Material producer: Contact:
Other involved parties:	
Sampling to be carried out by (Company):	Name of sampler:
SPECIFY THE OBJECTIVE OF THE TESTING PROGRAMME	
Overall Sampling Objective: **Technical Goal:**	
DEVELOPING THE PRACTICAL INSTRUCTION	
MATERIAL	
Type of material:	Location: (address) Trawsfynydd Nuclear Power Station
Form and nature of arising:	
Background information:	
Identify access problems that may affect sampling programme:	
SAMPLING METHODOLOGY	
Scale:	
Sampling population:	
Specify detailed sampling location	
Specify date and time(s) of sampling:	
Specify persons to be present:	
Identify equipment:	
Specify no. of samples to be collected:	

Specify no.of increments per sample:
Specify increment size/sample size:
Description of sampling event:
Detail requirements for on-site determinations:
Identify sample coding methodology:
Identify safety precautions:
SUB-SAMPLING
Detail procedure:
PACKAGING, PRESERVATION, STORAGE AND TRANSPORT REQUIREMENTS
Preservation:
Storage: Store in a cold-store until all the samples are collected.
Transport: Deliver the samples to the laboratory using a proprietary courier. Specify a 24 hour confirmed delivery date.
ANALYTICAL LABORATORY
Company details: Contact: Delivery Date: