

<b>WASTE STREAM</b>	<b>2N06</b>	<b>LLW from Site LLW Operations</b>
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**SITE** LLWR (near Drigg)  
**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** LLWR SLC Limited

**WASTE TYPE** VLLW

Is the waste subject to Scottish Policy: No

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2022.....	~19.5 m <sup>3</sup>
Future arisings -	1.4.2022 - 31.3.2023.....	~7.5 m <sup>3</sup>
	1.4.2023 - 31.3.2024.....	~6.5 m <sup>3</sup>
	1.4.2024 - 31.3.2137.....	~741.0 m <sup>3</sup>
Total future arisings:		755.0 m <sup>3</sup>
Total waste volume:		774.5 m <sup>3</sup>

Comment on volumes: Arisings are based on continuing LLW disposal operations and the Repository Infrastructure Programme. Some programmed activities have no future date set, hence the wide range of dates in the last volume category. Future arisings are estimated based on planned future projects and operations activities; there may be considerable variance in the volumes generated, particularly after the next 3 years. Volumes are more likely overestimates as some material could be suitable for Clearance and Exemption and diversion routes.

Uncertainty factors on volumes: Stock (upper): x 1.2 Arisings (upper) x 1.5  
 Stock (lower): x 0.7 Arisings (lower) x 0.7

**WASTE SOURCE** Waste is generated as a result of operations to handle VLLW consigned to an offsite facility and from maintenance of the repository infrastructure (e.g. leachate management system).

**PHYSICAL CHARACTERISTICS**

General description: Waste primarily comprises of contaminated waste grout and sediment generated during maintenance work on the leachate management system / streams. Redundant equipment from refurbishment projects, PPE and waste from historical experiments are also covered by this waste stream. Waste will be segregated where possible to optimise diversion from the repository. Sediment arising from maintenance of the leachate system, streams and weirs will be dewatered prior to final packaging. The process to dewater the leachate sediment involved adding flocculating agents (these sum to negligible quantities with respect to the whole of this waste stream).

Physical components (%wt): metals (19.15%), organics (15.42 %) and other materials, including cementitious material etc.(65.43%)

Sealed sources: The waste does not contain sealed sources. N/A

Bulk density (t/m<sup>3</sup>): ~0.5

Comment on density: Based on total stream mass divided by total stream volume. Note: grout and sediment densities are typically 0.9 t/m<sup>3</sup>.

**CHEMICAL COMPOSITION**

General description and components (%wt): As described in the physical characteristics. Some of the sediment is likely to contain organic matter. Magnafloc 90L and Coagulant C50 will be present in dewatered leachate system sediments.

Chemical state: Alkali

Chemical form of radionuclides: H-3: Of any form that has been disposed of to the repository.  
 C-14: Of any form that has been disposed of to the repository.  
 Cl-36: Of any form that has been disposed of to the repository.  
 Se-79: Not expected to be present.  
 Tc-99: Of any form that has been disposed of to the repository.  
 I-129: Of any form that has been disposed of to the repository.  
 Ra: Of any form that has been disposed of to the repository.  
 Th: Of any form that has been disposed of to the repository.  
 U: Of any form that has been disposed of to the repository.

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Np: Of any form that has been disposed of to the repository.  
 Pu: Of any form that has been disposed of to the repository.

Metals and alloys (%wt): Up to 7% of the metal content is sheet metal (ductwork and tanks).

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~~1.2	Not known for the majority.	
Other ferrous metals.....	~17.7	Not known for the majority.	
Iron.....	NE		
Aluminium.....	~~0.09	Not known for the majority.	
Beryllium.....	0		
Cobalt.....	0		
Copper.....	~~0.11	In electrical equipment.	
Lead.....	0		
Magnox/Magnesium.....	0		
Nickel.....	0		
Titanium.....	0		
Uranium.....	0		
Zinc.....	0		
Zircaloy/Zirconium.....	0		
Other metals.....	NE		

Organics (%wt): From soft waste / PPW, redundant equipment components and sediment.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	~~0.52		
Paper, cotton.....	~~0.26	In soft waste / PPE.	
Wood.....	~~0.26	Trees from stream clearance.	
Halogenated plastics .....	~~1.9	From soft waste / PPE and redundant equipment.	
Total non-halogenated plastics.....	~~0.22		
Condensation polymers.....	~~0.01	In soft waste / PPE.	
Others.....	~~0.21	Various from redundant equipment.	
Organic ion exchange materials....	0		
Total rubber.....	~~0.44		
Halogenated rubber .....	~~0.44	PPE and redundant equipment.	
Non-halogenated rubber.....	0	(All rubber assumed halogenated).	
Hydrocarbons.....			
Oil or grease .....			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...			
Asphalt/Tarmac (no coal tar)....			
Bitumen.....			
Others.....			
Other organics.....	~12.4	Sediment and vegetation.	

Other materials (%wt): -

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	0		
Inorganic sludges and flocs.....	~1.7		
Soil.....	~-0.47	Legacy drummed waste containing sand / soil.	
Brick/Stone/Rubble.....	~-0		
Cementitious material.....	~61.3	Excess grout (pulverised fuel ash and ordinary portland cement)	
Sand.....	NE	Included under soil.	
Glass/Ceramics.....	~-2.0	Fibreglass filters.	
Graphite.....	0		
Desiccants/Catalysts.....	0		
Asbestos.....	0		
Non/low friable.....	0		
Moderately friable.....	0		
Highly friable.....	0		
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	NE	covered under cementitious material (pulverised fuel ash)	

Inorganic anions (%wt): Magnafloc 90L (anionic polyacrylamide flocculant) and Coagulant C50 will be present in dewatered leachate system sediments.

	(%wt)	Type(s) and comment
Fluoride.....	NE	
Chloride.....	NE	
Iodide.....	NE	
Cyanide.....	NE	
Carbonate.....	NE	
Nitrate.....	NE	
Nitrite.....	NE	
Phosphate.....	NE	
Sulphate.....	NE	
Sulphide.....	NE	

Materials of interest for waste acceptance criteria: N/A

	(%wt)	Type(s) and comment
Combustible metals.....	NE	
Low flash point liquids.....	0	
Explosive materials.....	0	
Phosphorus.....	0	
Hydrides.....	0	
Biological etc. materials.....	0	
Biodegradable materials.....	P	

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Putrescible wastes.....	P	Vegetation.
Non-putrescible wastes.....	P	Paper, cotton, wood.
Corrosive materials.....	0	
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	0	
Higher activity particles.....	NE	Potentially in sediment, but unlikely.
Soluble solids as bulk chemical compounds.....	0	

Hazardous substances / non hazardous pollutants:      The sediment will be sampled to determine if it contains hazardous substances, e.g. toxic metals. They may be hazardous substances present in redundant equipment not yet arisen as waste.

	(%wt)	Type(s) and comment
Acrylamide.....	0	
Benzene.....	0	
Chlorinated solvents.....	0	
Formaldehyde.....	0	
Organometallics.....	0	
Phenol.....	0	
Styrene.....	0	
Tri-butyl phosphate.....	0	
Other organophosphates.....	0	
Vinyl chloride.....	0	
Arsenic.....	0	
Barium.....	0	
Boron.....	0	
Boron (in Boral).....	0	
Boron (non-Boral).....	0	
Cadmium.....	0	
Caesium.....	0	
Selenium.....	0	
Chromium.....	NE	Could be present in stainless steel alloy.
Molybdenum.....	NE	Could be present in stainless steel alloy.
Thallium.....	0	
Tin.....	0	
Vanadium.....	0	
Mercury compounds.....	0	
Others.....	NE	
Electronic Electrical Equipment (EEE)		
EEE Type 1.....	~~0.10	stripped down circuit boards
EEE Type 2.....	NE	
EEE Type 3.....	~~0.10	Electrical and electronic tools (e.g. corded drills cordless drills, hoovers etc.)
EEE Type 4.....	0	

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EEE Type 5.....	<0.10	batteries bfrom battery powered tolls/ equipment.
Complexing agents (%wt):	Yes	
	(%wt)	Type(s) and comment
EDTA.....	0	
DPTA.....	0	
NTA.....	0	
Polycarboxylic acids.....	0	
Other organic complexants.....	TR	Vegetation treated with glyphosate.
Total complexing agents.....	TR	

Potential for the waste to contain discrete items:      Yes. Yes - redundant equipment (i.e pumps and tools), although the discrete item activity limits should not be challenged.

**TREATMENT, PACKAGING AND DISPOSAL**

Planned on-site / off-site treatment(s):	Treatment	On-site / Off site	Stream volume %
	Low force compaction		
	Supercompaction (HFC)	Off-site	~6.0
	Incineration	Off-site	~8.0
	Solidification		
	Decontamination		
	Metal treatment	Off-site	~2.0
	Size reduction	On-site	NE
	Decay storage		
	Recycling / reuse	On-site	NE
	Other / various	On-site	~10.0
	None	Off-site	~74.0

Comment on planned treatments:      Sediment will be dewatered (this is 'other / various'). Waste will be size reduced to optimise packing efficiency and minimise voidage for wastes disposed of in the LLW repository. Project waste management plans have already identified wastes suitable for reuse, but these are not included in the volumes for this waste stream.

Disposal Routes:	Disposal Route	Stream volume %	Disposal density t/m3
	Expected to be consigned to the LLW Repository	NE	
	Expected to be consigned to a Landfill Facility	~90.0	~0.50
	Expected to be consigned to an On-Site Disposal Facility		
	Expected to be consigned to an Incineration Facility	~8.0	~0.20
	Expected to be consigned to a Metal Treatment Facility	~2.0	~0.50
	Expected to be consigned as Out of Scope	NE	
	Expected to be recycled / reused	NE	
	Disposal route not known	NE	

Classification codes for waste expected to be consigned to a landfill facility:      grout, small volumes of soft waste, redundant plant and equipment.

**Upcoming (2022/23-2024/25) Waste Routing (if expected to change from above):**

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Disposal Route	Stream volume %		
	2022/23	2023/24	2024/25
Expected to be consigned to the LLW Repository	~95.0	~85.0	~80.0
Expected to be consigned to a Landfill Facility			
Expected to be consigned to an On-Site Disposal Facility			
Expected to be consigned to an Incineration Facility	~5.0	~10.0	~10.0
Expected to be consigned to a Metal Treatment Facility			
Expected to be consigned as Out of Scope	~5.0	~5.0	~10.0
Expected to be recycled / reused			
Disposal route not known			

**Opportunities for alternative disposal routing:** Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Authorised landfill	Out of scope	~10.0	31/03/2023	High	This stream consists of various plant equipment from the LLW Operations on the LLWR Site. During campaigns of grouting external customer containers, it is necessary to 'chip out' this grout once dried. A sampling campaign took place in early 2020 to determine the appropriate route, the analysis showed that this was suitable for VLLW. There will be a further opportunity to Out of Scope a portion of this waste.

**Waste Packaging for Disposal:** (Not applicable to this waste stream)

Container	Stream volume %	Waste loading m <sup>3</sup>	Number of packages
1/3 Height IP-1 ISO			
2/3 Height IP-2 ISO			
1/2 Height WAMAC IP-2 ISO			
1/2 Height IP-2 Disposal/Re-usable ISO			
2m box (no shielding)			
4m box (no shielding)			
Other (loose or in bulk bag)			

Other information: Waste from this waste stream may be mixed in the disposal container with waste from other LLWR streams to optimise packaging efficiency.

**Waste Planned for Disposal at the LLW Repository:** (Not applicable to this waste stream)

Container voidage: N/A - waste is not destined for disposal to the LLW Repository.

Waste Characterisation Form (WCH): -

Waste consigned for disposal to LLWR in year of generation: -

**Non-Containerised Waste for In-Vault Grouting:** (Not applicable to this waste stream)

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

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Inaccessible voidage: -

Other information: -

**RADIOACTIVITY**

Source: The activity derives from waste disposed of to the repository. Grout, equipment and PPE becomes contaminated as a result of contact with consignors' waste. Sediment from the leachate system is contaminated by activity that has leached from the vaults and trenches. Previously the activity content of this waste stream has been reported as NE to avoid duplication of data. However, activity has been declared for waste intended for diversion from the repository (e.g. the sediment).

Uncertainty: Some of the sediment has been characterised by sampling, but the specific activity and range of nuclides present has been found to vary. The uncertainties reflect the limitations of extrapolating from available sample data.

Definition of total alpha and total beta/gamma: Where totals are shown on the table of radionuclide activities they are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma'.

Measurement of radioactivities: Specific activities have been based on sample results and assumptions regarding the variance in specific activity through the leachate system. Levels of contamination on equipment have been based on operational experience and are generally conservative. The specific activities of soft waste reflect typical consignment activities.

Other information: No activity has been estimated for waste expected to be disposed of directly as LLW. This is because activity is being returned to the vault and has already been accounted for. These zero activity volumes have been included in the average specific activity calculation, hence the average specific activity inventory is significantly lower than expected for diverted wastes. Waste diverted will not be subtracted from the inventory of LLW disposed at LLWR.

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	-1.36E-07	CC 2	-8.20E-06	CC 2	Gd 153				
Be 10					Ho 163				
C 14	-1.59E-08	CC 2	-9.65E-07	CC 2	Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36	-5.22E-10	CC 2	-3.16E-08	CC 2	Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40	-1.02E-11	CC 2	-6.19E-10	CC 2	Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54					Pb 205				
Fe 55	-1.38E-09	CC 2	-8.33E-08	CC 2	Pb 210	-1.22E-09	CC 2	-7.39E-08	CC 2
Co 60	-9.29E-09	CC 2	-5.62E-07	CC 2	Bi 208				
Ni 59					Bi 210m				
Ni 63	-7.35E-10	CC 2	-4.45E-08	CC 2	Po 210	-7.32E-11	CC 2	-4.43E-09	CC 2
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226	-5.23E-09	CC 2	-3.17E-07	CC 2
Kr 85					Ra 228	-8.18E-11	CC 2	-4.95E-09	CC 2
Rb 87					Ac 227				
Sr 90	-3.57E-08	CC 2	-2.16E-06	CC 2	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230	-2.43E-09	CC 2	-1.47E-07	CC 2
Nb 93m					Th 232	-5.38E-09	CC 2	-3.25E-07	CC 2
Nb 94					Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233				
Tc 99	-5.34E-09	CC 2	-3.23E-07	CC 2	U 232				
Ru 106	-3.48E-10	CC 2	-2.11E-08	CC 2	U 233				
Pd 107					U 234	-2.43E-08	CC 2	-1.47E-06	CC 2
Ag 108m					U 235	-1.55E-10	CC 2	-9.36E-09	CC 2
Ag 110m					U 236				
Cd 109					U 238	-2.75E-08	CC 2	-1.67E-06	CC 2
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238	-1.01E-09	CC 2	-6.10E-08	CC 2
Sn 123					Pu 239	-1.13E-08	CC 2	-6.81E-07	CC 2
Sn 126					Pu 240	-3.46E-09	CC 2	-2.09E-07	CC 2
Sb 125	-8.09E-12	CC 2	-4.89E-10	CC 2	Pu 241	-8.76E-08	CC 2	-5.30E-06	CC 2
Sb 126					Pu 242				
Te 125m					Am 241	-5.89E-09	CC 2	-3.56E-07	CC 2
Te 127m					Am 242m				
I 129	-2.67E-10	CC 2	-1.61E-08	CC 2	Am 243				
Cs 134	-8.09E-12	CC 2	-4.89E-10	CC 2	Cm 242				
Cs 135					Cm 243	-3.31E-10	CC 2	-2.00E-08	CC 2
Cs 137	-8.85E-08	CC 2	-5.35E-06	CC 2	Cm 244	-2.10E-11	CC 2	-1.27E-09	CC 2
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152					Other b/g				
Eu 154	-4.85E-11	CC 2	-2.94E-09	CC 2	<b>Total a</b>	<b>-8.70E-08</b>	<b>CC 2</b>	<b>-5.27E-06</b>	<b>CC 2</b>
Eu 155					<b>Total b/g</b>	<b>-3.83E-07</b>	<b>CC 2</b>	<b>-2.31E-05</b>	<b>CC 2</b>

**Bands (Upper and Lower)**

- A a factor of 1.5
- B a factor of 3
- C a factor of 10
- D a factor of 100
- E a factor of 1000

Note: Bands quantify uncertainty in mean radioactivity.

**Code**

- 1 Measured activity
- 2 Derived activity (best estimate)
- 3 Derived activity (upper limit)
- 4 Not present
- 5 Present but not significant
- 6 Likely to be present but not assessed
- 7 Present in significant quantities but not determined
- 8 Not expected to be present in significant quantity