WASTE STREAM 9A73 Contaminated Gravel

SITE	Berkeley
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	ILW
Is the waste subject to Scottish Policy:	No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	47.0 m³
Total future arisings:		0 m³
Total waste volume:		47.0 m³

Comment on volumes: Gravel will be removed from the vault when the wastes accumulated in the vault are retrieved. There will be no further arisings of this waste.

Uncertainty factors on volumes:				
	Stock (upper):	x 1.2	Arisings (upper)	x
	Stock (lower):	x 0.8	Arisings (lower)	x

WASTE SOURCE Contaminated gravel (stone chippings) on the floor of the vault. The gravel was applied before any waste was discharged to the facility.

PHYSICAL CHARACTERISTICS

General description: The waste comprises the gravel that was placed at the bottom of the vault, along with the associated sludge type material. This material, known as the amalgam, consists of the waste materials which have dropped in from the waste above during the history of filling the vaults, and which will also fall in during the waste retrieval phase. The gravel will therefore contain graphite chunks, springs, dusts, ion exchange material, Magnox sludge, made up of magnesium carbonate and magnesium hydroxide, and mild steel corrosion products, from the waste containers and Miscellaneous Contaminated Items streams. The gravel is coarse in nature, typically 50mm in diameter, but of unknown chemical composition. It may be either silica or limestone based material. There is a range in the volume of the vaults amalgam due to the uncertainties in how much each waste item will contribute to the amalgam. There are no large items that may require special handling.

Physical components (%vol): The vaults amalgam will predominantly consist of coarse gravel, Magnox sludge and fines, ion exchange materials and mild steel corrosion products.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~1.5

Comment on density: The gravel is coarse in nature (typically 50mm across) and is assumed to be either limestone or silica based.

CHEMICAL COMPOSITION

General description and components (%wt): The chemical composition of the gravel chippings is not known, although it is likely to be either silica or limestone based material. Magnesium carbonate and magnesium hydroxide will be present, along with phenol formaldehyde and alumino-silicate ion exchange materials. Fission products, actinides and other activation products will be present as contaminants.

Chemical state: Alkali

Chemical form of radionuclides: H-3: Any tritium is expected to be present as water but some may be in the form of other inorganic compounds or as organic compounds.
C-14: Chemical form of carbon 14 has not been determined but may be graphite.
Cl-36: The chemical form of chlorine 36 in these wastes is not known.
Se-79: The selenium content is insignificant.
Tc-99: The technetium content is insignificant.
Ra: Radium isotope content is expected to be insignificant.
Th: The thorium isotope content is insignificant.
U: Chemical form of U isotopes has not been determined but may be oxides.
Np: The neptunium content is insignificant.
Pu: Chemical form of plutonium isotopes has not been determined but may be plutonium oxides.

Metals and alloys (%wt): Metals will be present as corrosion products or as small item contamination so metal

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thicknesses are expected to be typically 1 or 2 mm.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	NE		
Other ferrous metals	NE	Only trace metallic content would be expected to be associated with the original gravel, but there may be contamination from the wastes resting on the gravel.	
Iron			
Aluminium	0		
Beryllium	TR		
Cobalt			
Copper	0		
Lead	0		
Magnox/Magnesium	NE		
Nickel	NE	Nimonic.	
Titanium			
Uranium			
Zinc	0		
Zircaloy/Zirconium	NE		
Other metals	0	No "other" metals present.	

Organics (%wt): There are drums of ion exchange material in the vaults, although not directly resting on the gravel. The drums will have corroded to an extent, therefore, the gravel is likely to be contaminated with spilt Lewatit DN, the organic ion exchanger. This material is phenol formaldehyde based.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	0		
Paper, cotton	0		
Wood	0		
Halogenated plastics	0		
Total non-halogenated plastics	0		
Condensation polymers	0		
Others	0		
Organic ion exchange materials	NE		
Total rubber	0		
Halogenated rubber	0		
Non-halogenated rubber	0		
Hydrocarbons			
Oil or grease			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics	NE		

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Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	NE		
Inorganic sludges and flocs.....	0		
Soil.....	0		
Brick/Stone/Rubble.....	~100.0		
Cementitious material.....	0		
Sand.....			
Glass/Ceramics.....	0		
Graphite.....	NE		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	NE		
Free non-aqueous liquids.....	NE		
Powder/Ash.....	NE		

Inorganic anions (%wt): The inorganic anion content of the gravel has not been fully assessed. Carbonates and silicates may be present.

	(%wt)	Type(s) and comment
Fluoride.....	NE	
Chloride.....	NE	
Iodide.....	NE	
Cyanide.....	0	
Carbonate.....	NE	
Nitrate.....	NE	
Nitrite.....	NE	
Phosphate.....	NE	
Sulphate.....	NE	
Sulphide.....	NE	

Materials of interest for waste acceptance criteria: Magnox may be present in the gravel. Magnox can form hydrides in a damp environment. These metal hydrides can become pyrophoric causing explosions and fires. However, precise conditions are required to form a hydride, including a damp and oxygen free environment, essentially a sealed void, and this is highly unlikely as the waste has been stored loose in the vault.

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

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Biodegradable materials.....	0
Putrescible wastes.....	0
Non-putrescible wastes.....	
Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	NE
Higher activity particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances / non hazardous pollutants: None expected.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	0	
Boron (in Boral).....		
Boron (non-Boral).....		
Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....		
Molybdenum.....		
Thallium.....		
Tin.....		
Vanadium.....		
Mercury compounds.....		
Others.....		
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		

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EEE Type 5.....

Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids…….		
Other organic complexants.....		
Total complexing agents.....	TR	

Potential for the waste to contain discrete items: Not yet determined. In & of itself not a DI; context will define if likely to contain any "rogue" items that could be (i.e. if FED Vault lining then yes, but would be removed if > DI Limits in conditioned waste ; if SPFs then no)

PACKAGING AND CONDITIONING

Conditioning method: This stream will be packaged in Type VI DCIC containers, the remainder of vault 1 waste will be co-packaged together in Concrete boxes (9A61, 9A62, 9A67, 9A32, 9A40, 9A48, 9A53) and Type VI DCIC containers (9A25, 9A31, 9A39, 9A47, 9A52, 9A60 and 9A66). Packages for vault 1 are assigned to 9A25, 9A32 & 9A73.

Plant Name: -

Location: Berkeley Site

Plant startup date: -

Total capacity (m^3/y incoming waste): -

Target start date for packaging this stream: -

Throughput for this stream (m^3/y incoming waste): -

Other information: -

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
3m^3 RS box	100.0	~2.044	2.5	23

Likely container type comment: -

Range in container waste volume: -

Other information on containers: -

Likely conditioning matrix:

Other information: -

Conditioned density (t/m^3): -

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing: -

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Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Disposal at a Geological Disposal Facility	Disposal at LLWR	100.0	2030	Medium	There is a possibility that the gravel at the bottom of the vaults could be LLW but by the time all the other waste in the vault is retrieved/detritus fallen down into it this has a fairly low probability

RADIOACTIVITY

Source:	Contamination may have been transferred to the chippings via direct contact with waste materials. The ability of the chippings to absorb soluble active materials depends on the chemical composition of the chippings themselves.
Uncertainty:	The waste is assumed to be ILW. This can be confirmed only when the waste is retrieved. The gravel is not expected to be washed to reduce activity.
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:	The activity has been derived from the activities of the wastes contained in the vault.
Other information:	-

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	1.73E-03	D D 2			Gd 153		8		
Be 10	4E-09	D D 2			Ho 163		8		
C 14	2.00E-04	D D 2			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	8E-06	D D 2			Lu 174		8		
Ar 39		8			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40		8			Hf 182		8		
Ca 41	2E-06	D D 2			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	1.97E-06	D D 2			Pb 210		8		
Co 60	1.39E-04	D D 2			Bi 208		8		
Ni 59	3E-04	D D 2			Bi 210m		8		
Ni 63	2.70E-02	D D 2			Po 210		8		
Zn 65		8			Ra 223		8		
Se 79	1.21E-09	D D 2			Ra 225		8		
Kr 81		8			Ra 226		8		
Kr 85		8			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	4.89E-04	D D 2			Th 227		8		
Zr 93	5E-06	D D 2			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m	1.10E-04	D D 2			Th 232		8		
Nb 94	1.00E-06	D D 2			Th 234	7E-07	D D 2		
Mo 93	6.99E-06	D D 2			Pa 231		8		
Tc 97		8			Pa 233	4.16E-08	D D 2		
Tc 99	2E-06	D D 2			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	6.04E-07	D D 2		
Ag 108m	1.95E-06	D D 2			U 235	2E-08	D D 2		
Ag 110m		8			U 236	5.00E-08	D D 2		
Cd 109		8			U 238	7E-07	D D 2		
Cd 113m		8			Np 237	4.16E-08	D D 2		
Sn 119m		8			Pu 236		8		
Sn 121m	2.47E-05	D D 2			Pu 238	7.11E-05	D D 2		
Sn 123		8			Pu 239	2E-04	D D 2		
Sn 126	4.35E-09	D D 2			Pu 240	2.00E-04	D D 2		
Sb 125		8			Pu 241	1.46E-03	D D 2		
Sb 126		8			Pu 242	6E-08	D D 2		
Te 125m		8			Am 241	3.44E-04	D D 2		
Te 127m		8			Am 242m	3.71E-07	D D 2		
I 129		8			Am 243	8.00E-08	D D 2		
Cs 134		8			Cm 242	3.06E-07	D D 2		
Cs 135	7E-08	D D 2			Cm 243	4.25E-08	D D 2		
Cs 137	4.95E-03	D D 2			Cm 244	2.25E-07	D D 2		
Ba 133		8			Cm 245		8		
La 137		8			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145		8			Cf 250		8		
Pm 147	9.46E-09	D D 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	2.66E-05	D D 2			Other a				
Eu 152	1.39E-03	D D 2			Other b/g				
Eu 154	5.95E-04	D D 2			**Total a**	**8.17E-04**	**D D 2**	**0**	
Eu 155	2.38E-06	D D 2			**Total b/g**	**3.85E-02**	**D D 2**	**0**	

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