

# **Berkeley & Oldbury Site Stakeholder Group**

## **Environmental Monitoring & Radioactive Discharges for 2020**



**Presented at the Autumn 2021 Meeting**

## CONTENTS

|                                                                                                       |    |
|-------------------------------------------------------------------------------------------------------|----|
| 1. INTRODUCTION .....                                                                                 | 3  |
| 2. RADIATION DOSES TO WORKERS.....                                                                    | 4  |
| Fig 2.1 Oldbury, Total Personnel Radiation Doses .....                                                | 5  |
| Fig 2.2 Berkeley Site, Total Personnel Radiation Doses .....                                          | 6  |
| 3. GASEOUS EFFLUENT DISCHARGES .....                                                                  | 7  |
| Fig 3.1 Oldbury Site, Annual Discharges of Radioactive Aerosols - Tritium .....                       | 8  |
| Fig 3.2 Berkeley Site, Annual Discharges of Radioactive Aerosols - Tritium.....                       | 9  |
| Fig 3.3 Oldbury Site, Annual discharges of Radioactive Aerosols – Carbon 14 .....                     | 10 |
| Fig 3.4 Berkeley Site, Annual Discharges of Radioactive Aerosols - Carbon 14.....                     | 11 |
| Fig 3.5 Oldbury Site, Annual Discharges of Radioactive Aerosols – Beta Particulate.....               | 12 |
| Fig 3.6 Berkeley Site, Annual Discharges of Radioactive Aerosols - Beta Particulate .....             | 13 |
| 4. LIQUID EFFLUENT DISCHARGES .....                                                                   | 14 |
| Fig 4.1 Oldbury Site, Annual Liquid Effluent Discharges of Tritium .....                              | 15 |
| Fig 4.2 Berkeley Site, Annual Liquid Effluent Discharges of Tritium.....                              | 16 |
| Fig 4.3 Oldbury Site, Annual Liquid Effluent Discharges of Caesium 137 .....                          | 17 |
| Fig 4.4 Berkeley Site, Annual Liquid Effluent Discharges of Caesium 137.....                          | 18 |
| Fig 4.5 Oldbury Site, Annual Liquid Effluent Discharges (Others) .....                                | 19 |
| Fig 4.6 Berkeley Site, Annual Liquid Effluent Discharges (Others).....                                | 20 |
| Fig 4.7 Oldbury Site, Annual Disposals of LLW .....                                                   | 21 |
| Fig 4.8 Berkeley Site, Annual Disposals of LLW.....                                                   | 22 |
| 5. ENVIRONMENTAL MONITORING .....                                                                     | 23 |
| Fig 5.1 Oldbury & Berkeley Sites, Radioactivity on Tackishades (Zirconium – 95 and Niobium – 95)..... | 24 |
| Fig 5.2 Oldbury & Berkeley Sites, Strontium 90 in Milk.....                                           | 25 |
| Fig 5.3 Oldbury Power Site, Radiation Dose rates at 0.5 – 1 km sites .....                            | 26 |
| Fig 5.4 Berkeley Site, Radiation Dose rates at 0.5 – 1 km sites .....                                 | 27 |
| Fig 5.5 Oldbury & Berkeley Sites, Radiation Dose rates at Estuary Sites .....                         | 28 |
| Fig 5.6 Oldbury & Berkeley Sites, Radioactivity in Seaweed (Total Beta) .....                         | 29 |
| Fig 5.7 Oldbury & Berkeley Sites, Radioactivity in Silt (Total Beta) .....                            | 30 |
| Fig 5.8 Oldbury & Berkeley Sites, Radioactivity in Fish (Total Beta) .....                            | 31 |
| 6. SUMMARY OF RADIATION DOSES TO THE PUBLIC .....                                                     | 32 |
| 7. CONCLUSIONS .....                                                                                  | 33 |
| 8. TERMS AND DEFINITIONS .....                                                                        | 34 |

## **1. INTRODUCTION**

This report contains information on the discharge and disposal of radioactive waste at Oldbury and Berkeley Licensed Sites for 2020. The report provides details on worker doses, radioactive solid waste disposal, gaseous and liquid effluent discharges and results of the environmental monitoring programme for this period.

Oldbury and Berkeley share a joint environmental monitoring programme due to their close proximity. Oldbury and Berkeley are managed by Magnox Limited. Oldbury is a second generation Magnox station with two concrete pressure vessel reactors. The station commenced operation in 1967. Reactor 1 was shutdown for the last time on 29 February 2012 and Reactor 2 was shutdown for the last time on 30 June 2011. Berkeley Power Station was an earlier Magnox station that operated between 1962 and 1989.

Both sites are regulated under the Environmental Permitting Regulations (EPR). Information on discharges and environmental measurements are sent on a regular basis to the Environment Agency. The Environment Agency is the single regulator for radiological discharges from Oldbury and Berkeley although the Foods Standards Agency remains a consultant to the Agency. The Environment Agency carry out their own environmental programmes and issue annual reports summarising their results. Inspectors from the Environment Agency visit each site regularly to inspect the company's facilities and discuss results and any issues.

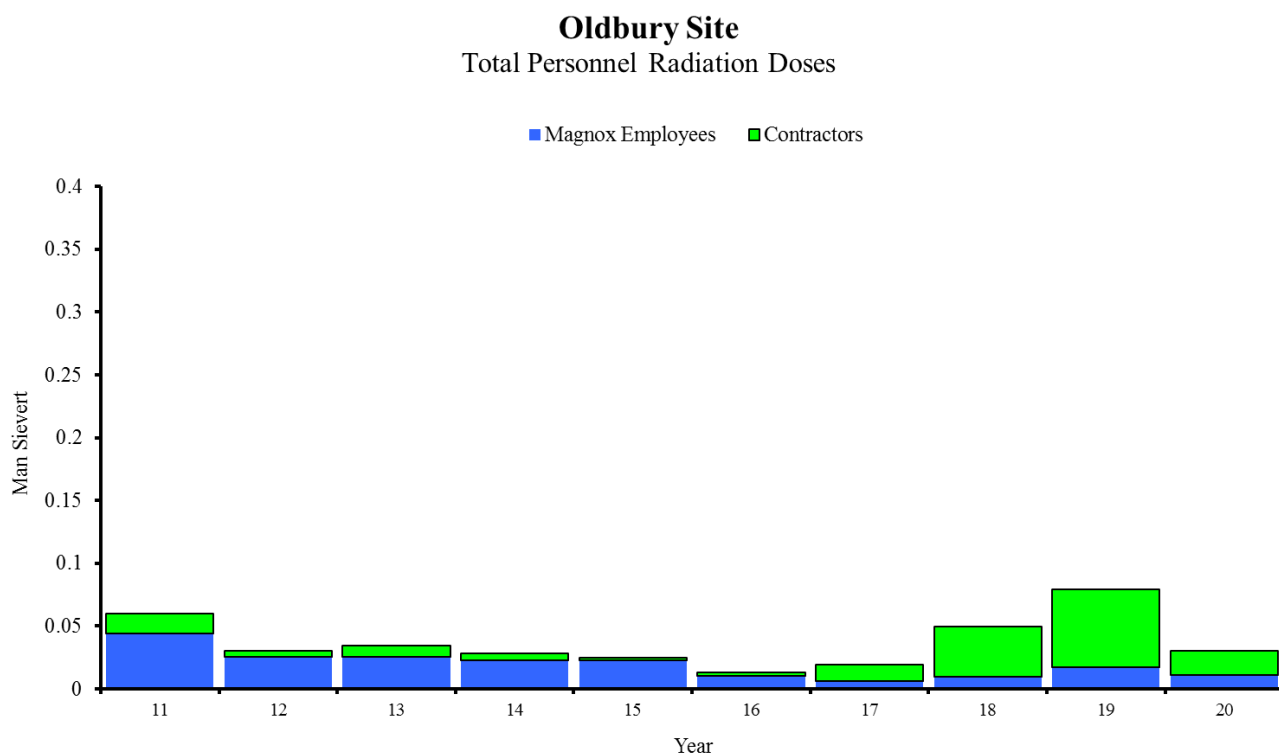
Should anyone have any comments or require any clarification regarding the content of this document please contact the Environment, Health, Safety, Security & Quality Manager (EHSSQ Manager), Oldbury Site, Oldbury Naite, Thornbury, South Gloucestershire, BS35 1RQ. This report has been approved for issue by the EHSSQ Manager.

## **2. RADIATION DOSES TO WORKERS**

Magnox Limited has responsibility under the Ionising Radiation Regulations 2017 to assess and control the radiation dose of each person working within the sites' controlled areas.

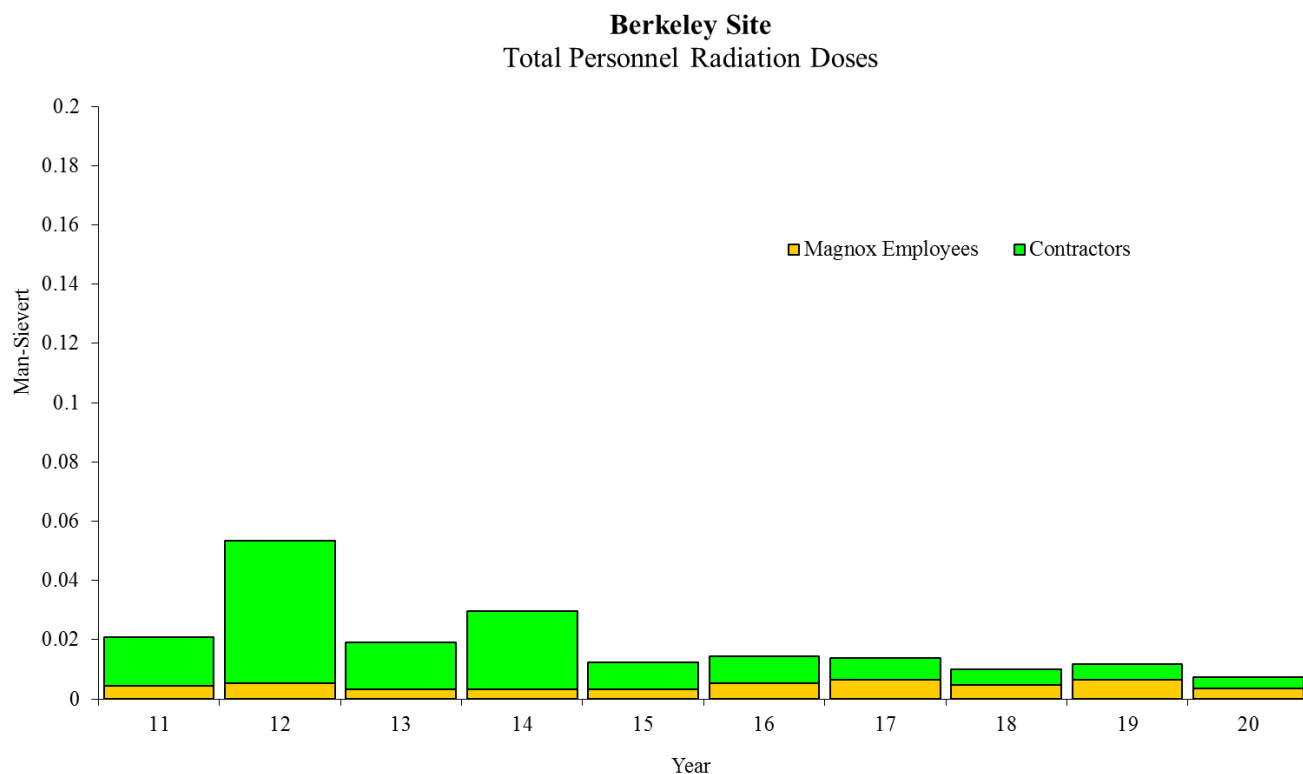
The whole body dose received by an individual is measured by an electronic personal dosimeter (EPD) which records the amount and type of radiation received and provides pre-set audible and visual warnings to enable dose control. The EPD and associated software provides dose information for all individuals working inside the controlled areas.

Control of exposure is achieved by ensuring that all doses are kept As Low As Reasonably Practicable (ALARP) and well below statutory limits. All work activities within the controlled areas are pre-planned and continually assessed to ensure that the ALARP principle is applied.



**Fig 2.1**      ***Oldbury Site, Total Personnel Radiation Doses***

Pond decommissioning work accounts for most of the 2018 to 2020 dose.



**Fig 2.2** *Berkeley Site, Total Personnel Radiation Doses*

Variations in dose received are dependant on the type of decommissioning work carried out. Cell 1 – 10 decommissioning took place in 2012.

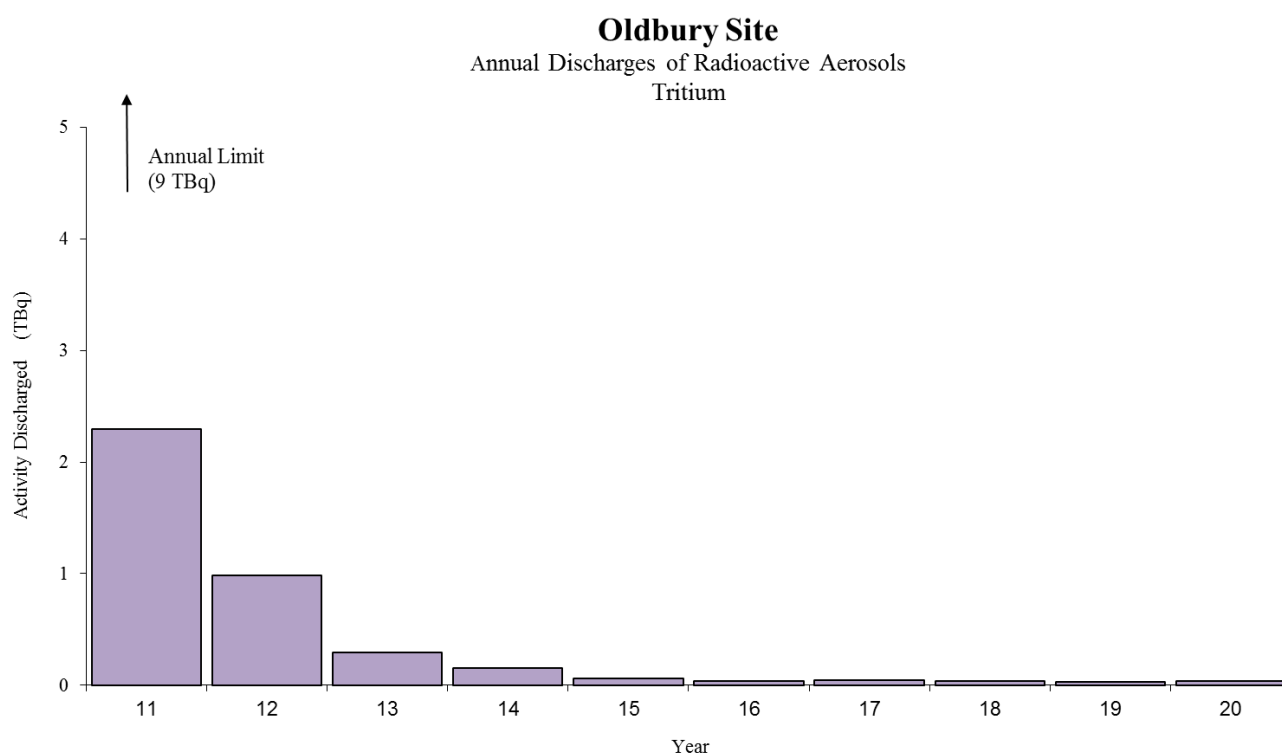
### **3. GASEOUS EFFLUENT DISCHARGES**

Site specific permits for discharging radioactive gaseous effluent to atmosphere are granted by the Environment Agency.

Authorisation limits are set after considering the actual quantities of radioactivity each site needs to discharge and the need to keep environmental risks below an acceptable level. Best Available Techniques (BAT) are used to minimise discharges and ensure doses to the public are as low as reasonably practicable (ALARP). The sites are required to justify that any gaseous emissions greater than the Quarterly Notification Level (QNL) were discharged in accordance with BAT. There is a very considerable safety margin between the permit limit and the limit that could present a significant health risk to members of the public. In addition, most discharges are well below the permit limit and any resultant doses to the public are insignificant. Because radionuclides behave differently in the environment and influence doses to the public in varying amounts, individual limits are granted for certain radionuclides.

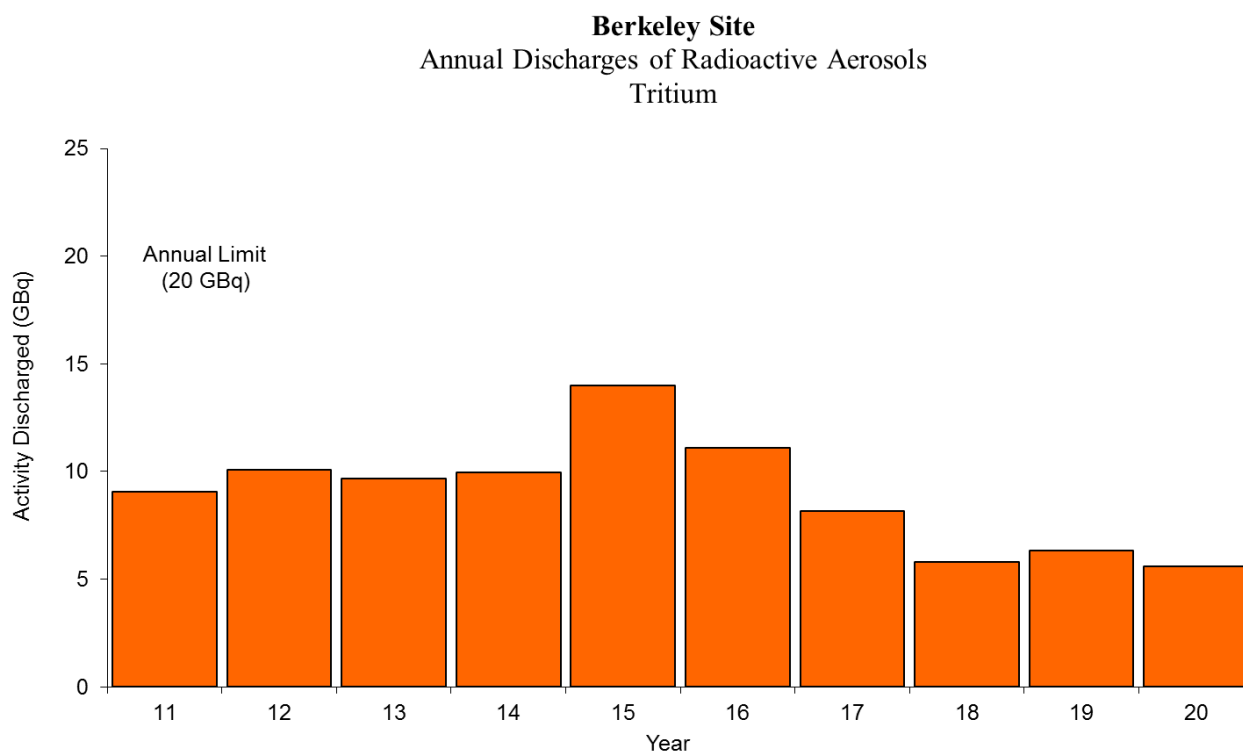
The Berkeley EPR Permit was re-issued on 1<sup>st</sup> May 2021 with a new Tritium annual limit of 1 TBq and two new approved outlets for the modular intermediate level waste encapsulation plant (MILWEP) and R4 sludge canning building.

This section of the report presents the data for Oldbury and Berkeley from gaseous discharges from each radionuclide. The aerial discharges from Oldbury have decreased since the cessation of generation in 2012.



**Fig 3.1**      ***Oldbury Site, Annual Discharges of Radioactive Aerosols - Tritium***

Tritium (H-3) is a low energy beta emitting radionuclide with a low radiotoxicity. It was generated in the reactor by neutron activation of lithium impurities in the graphite core and directly via the fission process. The reactors are depressurised and contain air. The small discharges will vary with temperature, moisture content and atmospheric pressure and will vent through stacks installed in January 2017. There will also be a contribution to the tritium discharge from the cooling pond ventilation system.

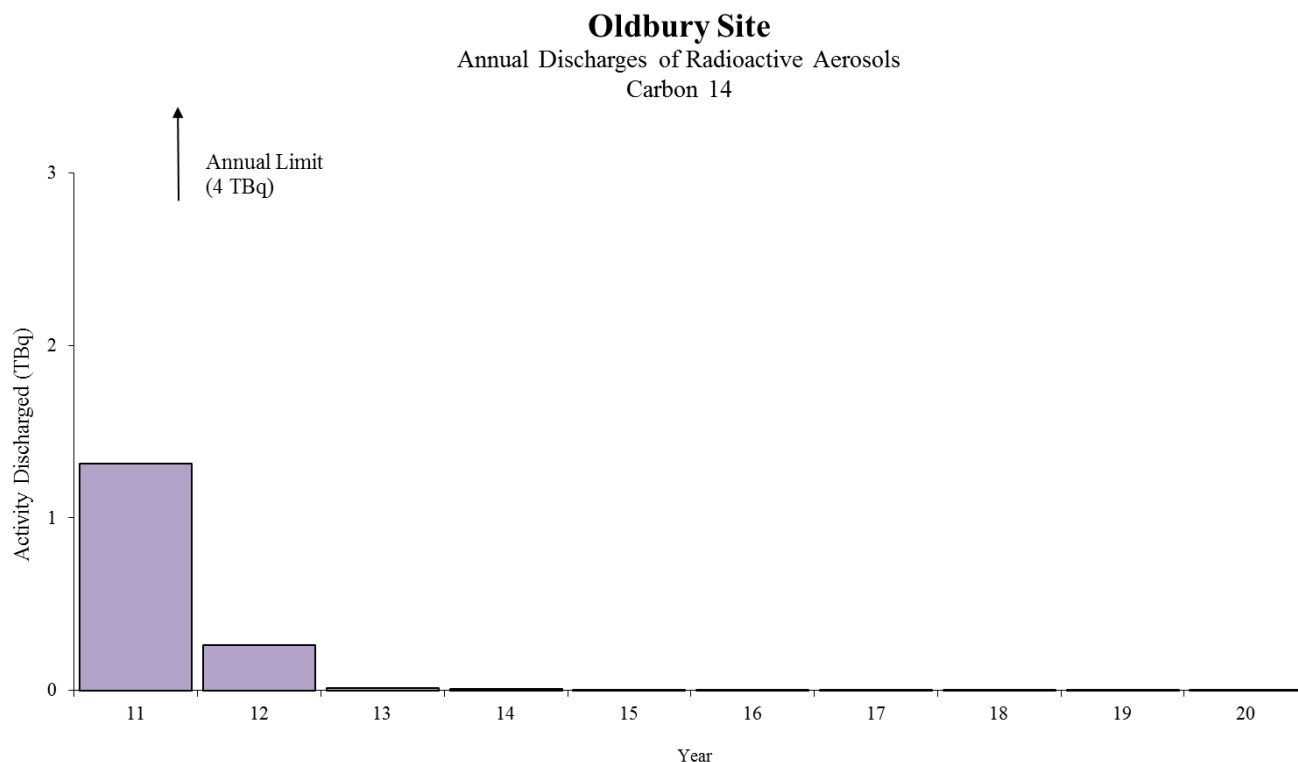


**Fig 3.2** *Berkeley Site, Annual Discharges of Radioactive Aerosols - Tritium*

Tritium discharges from Berkeley originate from the Safestores (Reactors), the Active Waste Vault (AWV) building Intermediate Level Waste (ILW) retrieval module and the ILW Conditioning Facility.

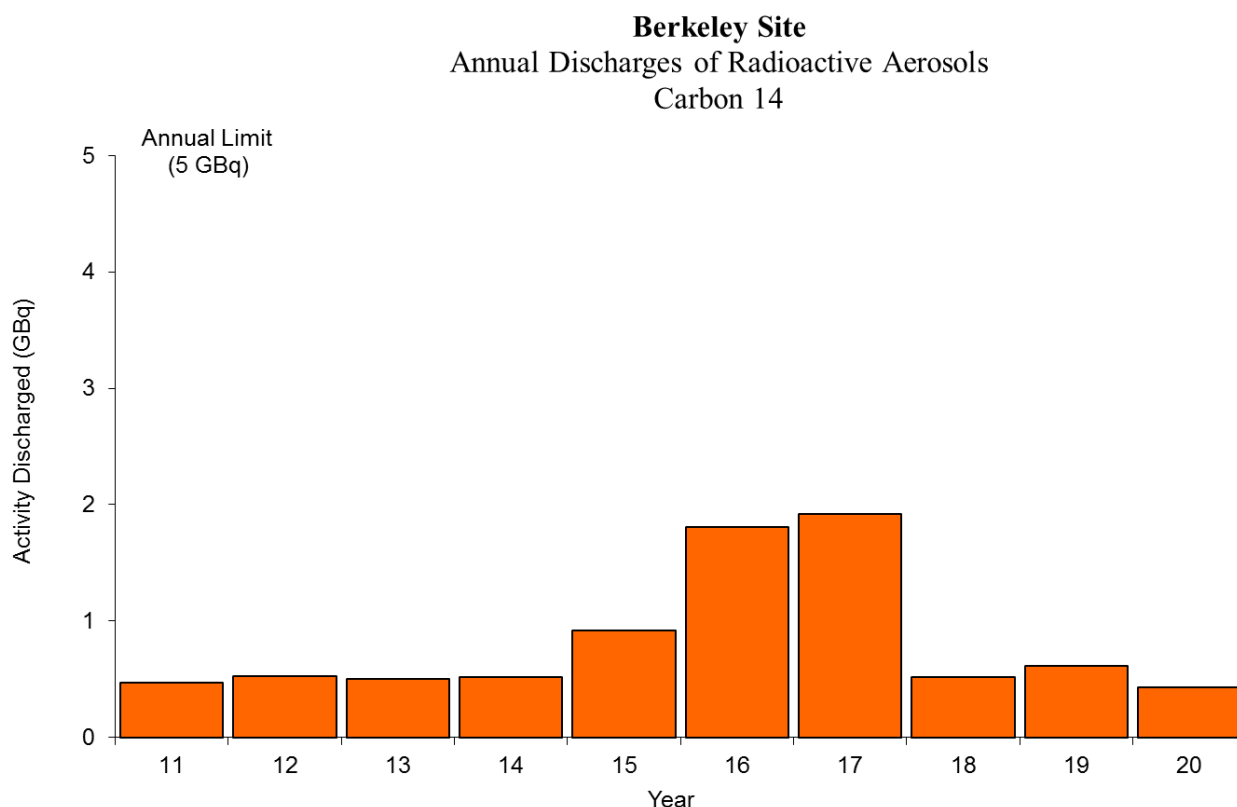
The reactors are depressurised to atmospheric pressure and contain air. The discharges will therefore vary with both atmospheric pressure and in the case of tritium with moisture content. The reactors were put into safe storage in 2010 which prevents entry by personnel unless required for maintenance work. Discharges are now assessed using monitoring results over the last 5 years and current breathing rates of the reactors calculated using temperature and pressure measurements. The discharges vary with atmospheric pressure and with moisture content for tritium, so an apparent change in tritium is a feature of atmospheric conditions.

Tritium discharges from the AWV building ILW retrieval module and the ILW conditioning facility are measured. The increase in site tritium discharges is due to the AWV building ILW retrieval module and the ILW conditioning facility commencing operations during 2015. The Berkeley EPR Permit was re-issued on 1<sup>st</sup> May 2021 with a new Tritium annual limit of 1 TBq.



**Fig 3.3**      **Oldbury Site, Annual discharges of Radioactive Aerosols – Carbon 14**

Carbon 14 is a low energy beta emitting radionuclide which was generated in the reactor by neutron activation of stable carbon, nitrogen and oxygen. The reactors are depressurised and contain air. The small discharges will vary with temperature, moisture content and atmospheric pressure and will vent through stacks installed in January 2017.

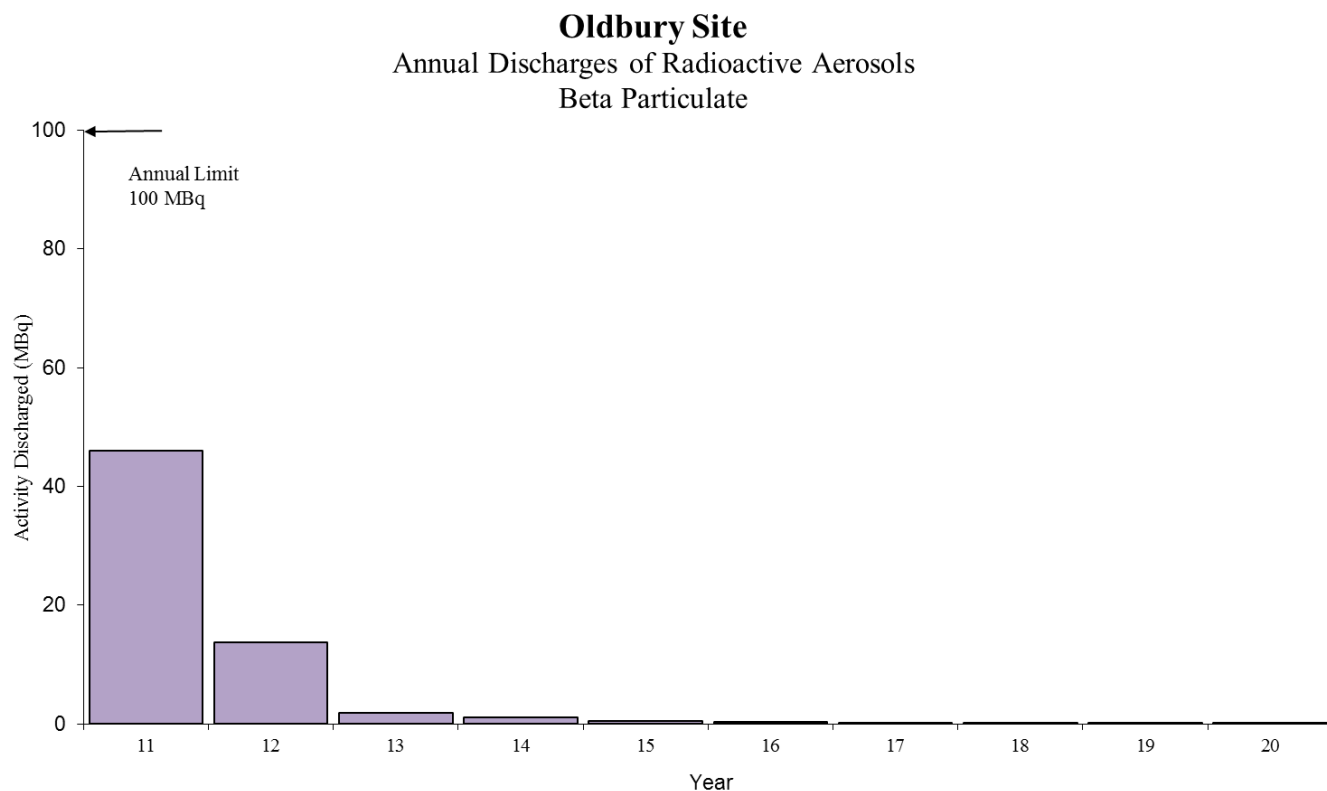


**Fig 3.4** *Berkeley Site, Annual Discharges of Radioactive Aerosols - Carbon 14*

Carbon 14 discharges from Berkeley originate from the Safestores (Reactors), the Active Waste Vault (AWV) building Intermediate Level Waste (ILW) retrieval module and the ILW Conditioning Facility.

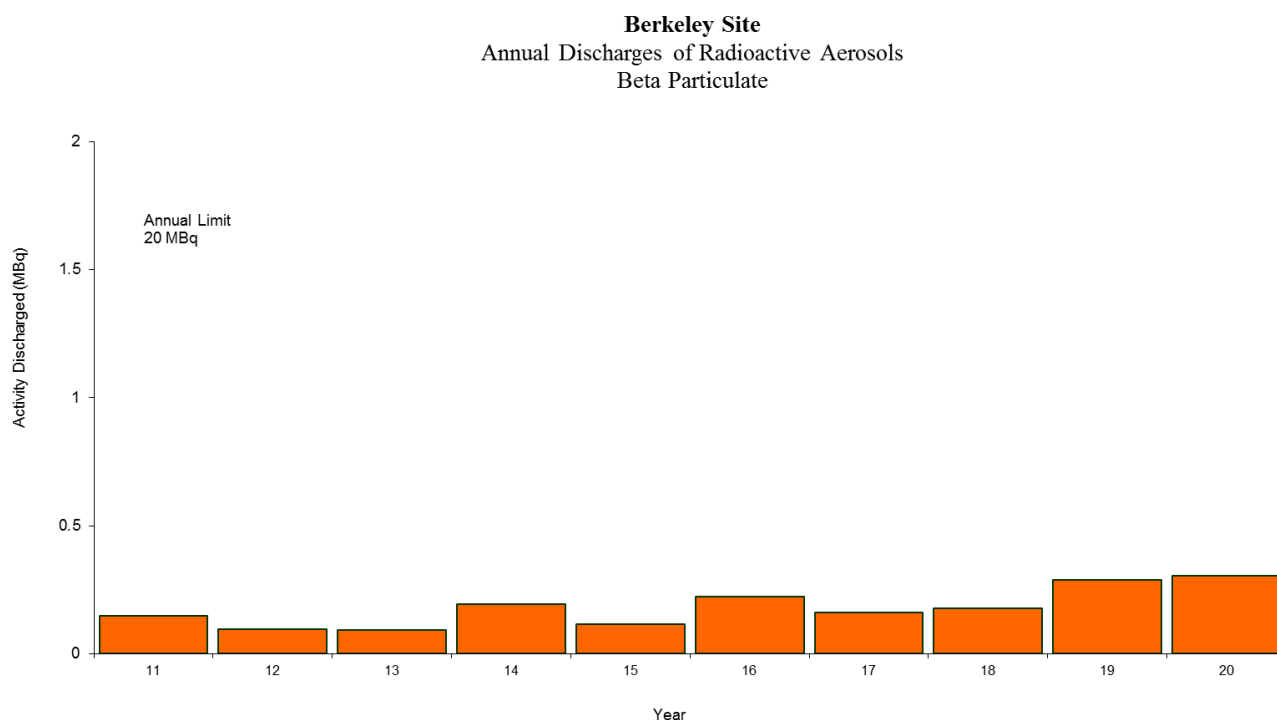
Carbon-14 will be assessed as described in section 3.2. The discharges vary with atmospheric pressure and with moisture content for C-14, so an apparent change in C-14 is a feature of atmospheric conditions.

Carbon-14 discharges from the AWV building ILW retrieval module and the ILW conditioning facility are measured. The increase in Carbon-14 discharges seen in 2015 and 2016 is due to the AWV building ILW retrieval module and the increase in 2017 is due to the ILW Conditioning facility commencing operations during that year.



***Fig 3.5 Oldbury Site, Annual Discharges of Radioactive Aerosols – Beta Particulate***

Particulate material is sampled and analysed for radioactivity. The reactors are depressurised and contain air. The small discharges will vary with temperature and atmospheric pressure and will vent through stacks installed in January 2017.



***Fig 3.6 Berkeley Site, Annual Discharges of Radioactive Aerosols - Beta Particulate***

Particulate material is sampled and analysed for radioactivity, the results are well below the Beta Particulate limit and minimum detectable activities.

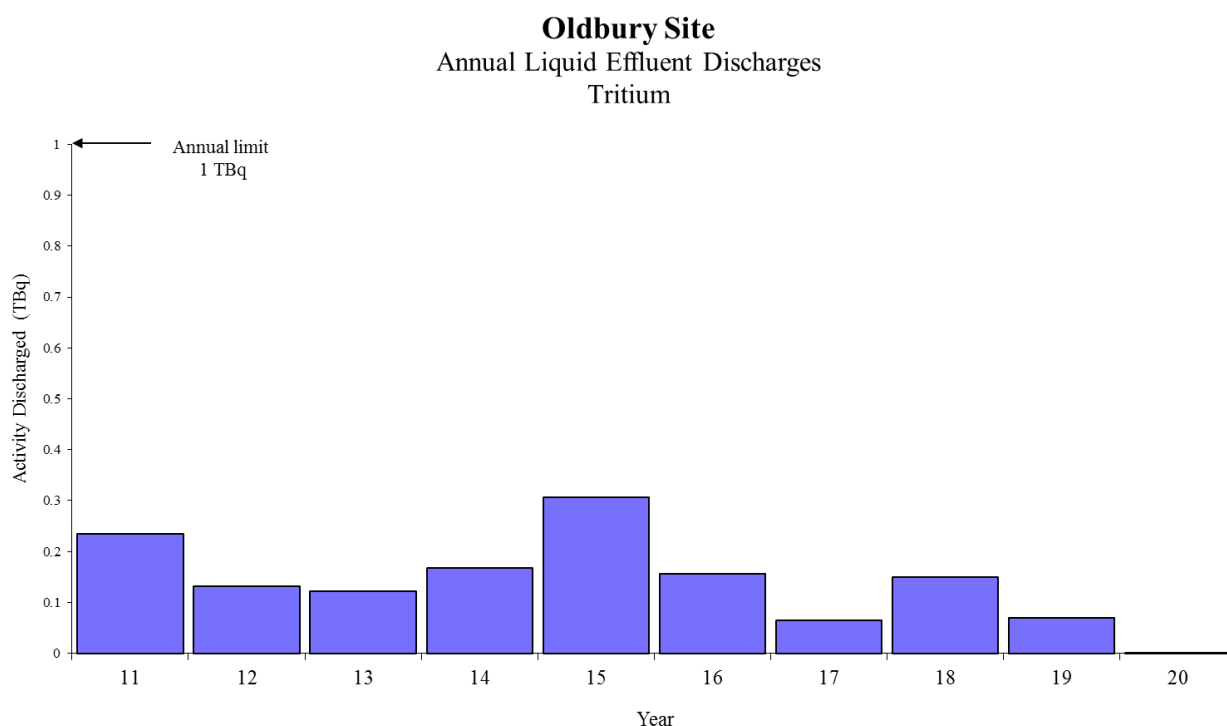
#### **4. LIQUID EFFLUENT DISCHARGES**

Site specific permits for discharging radioactive liquid effluent to the Severn Estuary are granted by the Environment Agency. The permit limits are set after considering the actual quantities of radioactivity each site needs to discharge and the need to keep environmental risks below an acceptable level. Best Available Techniques (BAT) are used to minimise discharges and ensure doses to the public are As Low As Reasonably Practicable (ALARP). The sites would be required to justify that any liquid discharges greater than the Quarterly Notification Level (QNL) were discharged in accordance with BAT.

At Oldbury, the principle source of radioactive liquid effluent arose from the treatment of cooling pond water and pond water draining which was completed in early 2019. Other smaller sources originate from change rooms and decontamination facilities. Liquid is filtered in the effluent treatment plant before passing to final hold up tanks where its radioactive content and chemical make-up are analysed prior to the effluent being authorised for discharge.

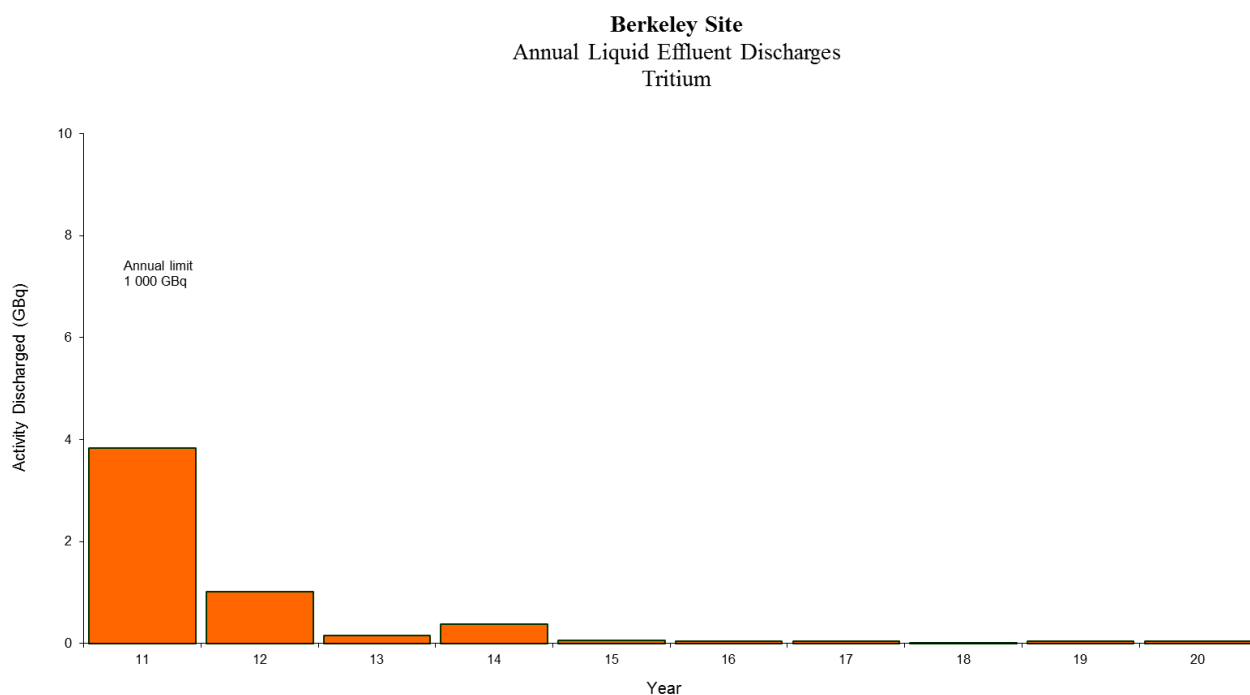
Principle sources of liquid effluent from Berkeley arise from decommissioning activities and operation of the site. However, the radioactive liquid effluent generated at Berkeley is a very small fraction of what the arisings were during generation. This is due mainly to the decommissioning of the areas that in the past would have previously generated liquid effluent. Liquid Effluent is transferred to the liquid effluent compliance plant (LECP) via the Site Bowser, from Intermediate Bulk Containers, other suitable liquid containers and the Active Drains Reception Tank 2 in the Shielded Area.

The first discharge from the new Berkeley LECP which replaced the old active effluent treatment plant was in December 2013.



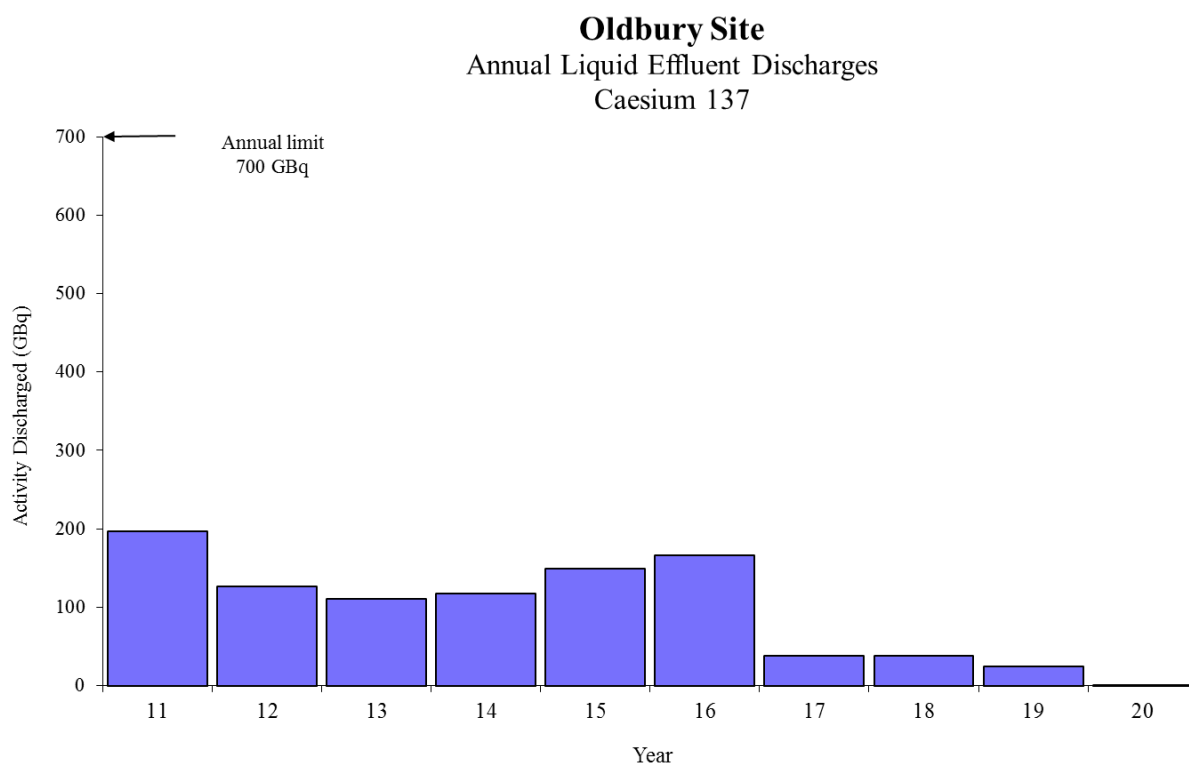
**Fig 4.1**      *Oldbury Site, Annual Liquid Effluent Discharges of Tritium*

Tritium (H-3) is a low energy beta emitting radionuclide with a low radiotoxicity. The increase in 2015 tritium was due to a concentrated period of moving Magnox fuel elements from the dry reactor cores to the cooling ponds before completion of de-fuelling at the end of year. Tritium discharges have reduced following pond water draining which was completed in May 2019.



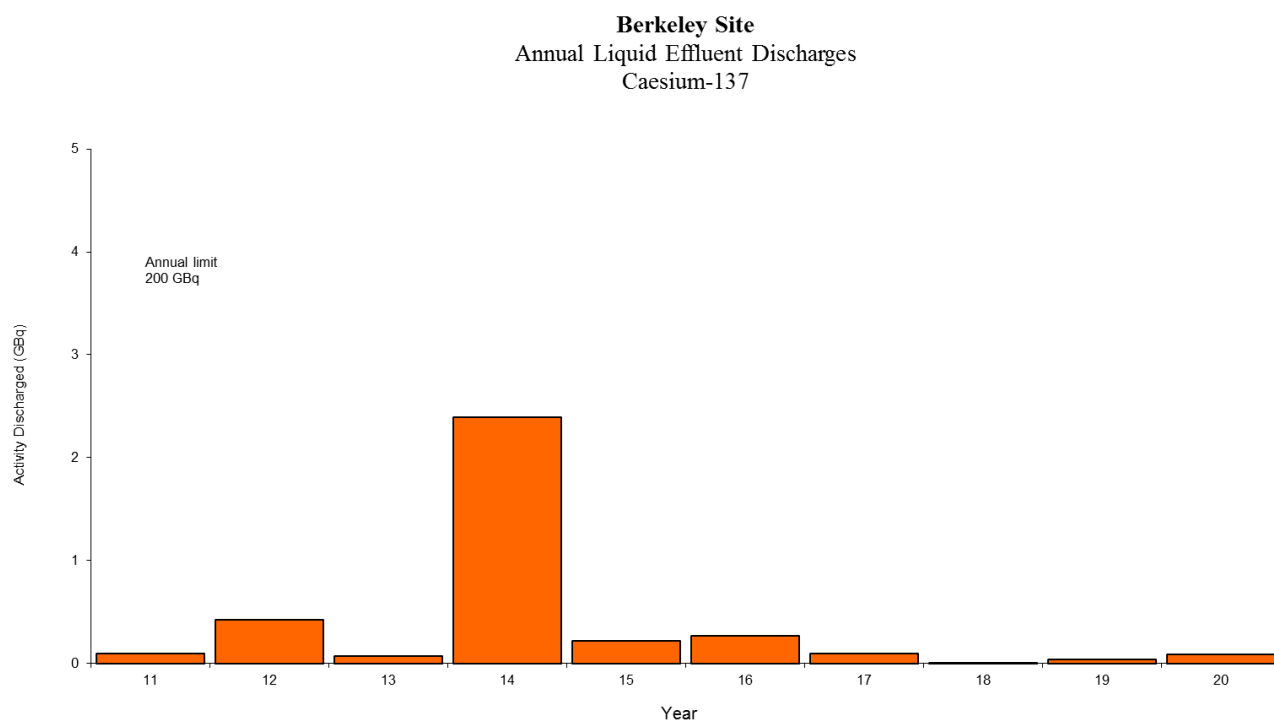
**Fig 4.2** *Berkeley Site, Annual Liquid Effluent Discharges of Tritium*

Tritium is discharged via the effluent treatment plant. Although Berkeley Site is a decommissioning Site, the 12 year half life of tritium will mean that traces still remain. Discharge results are well below the Tritium limit.



**Fig 4.3**      **Oldbury Site, Annual Liquid Effluent Discharges of Caesium 137**

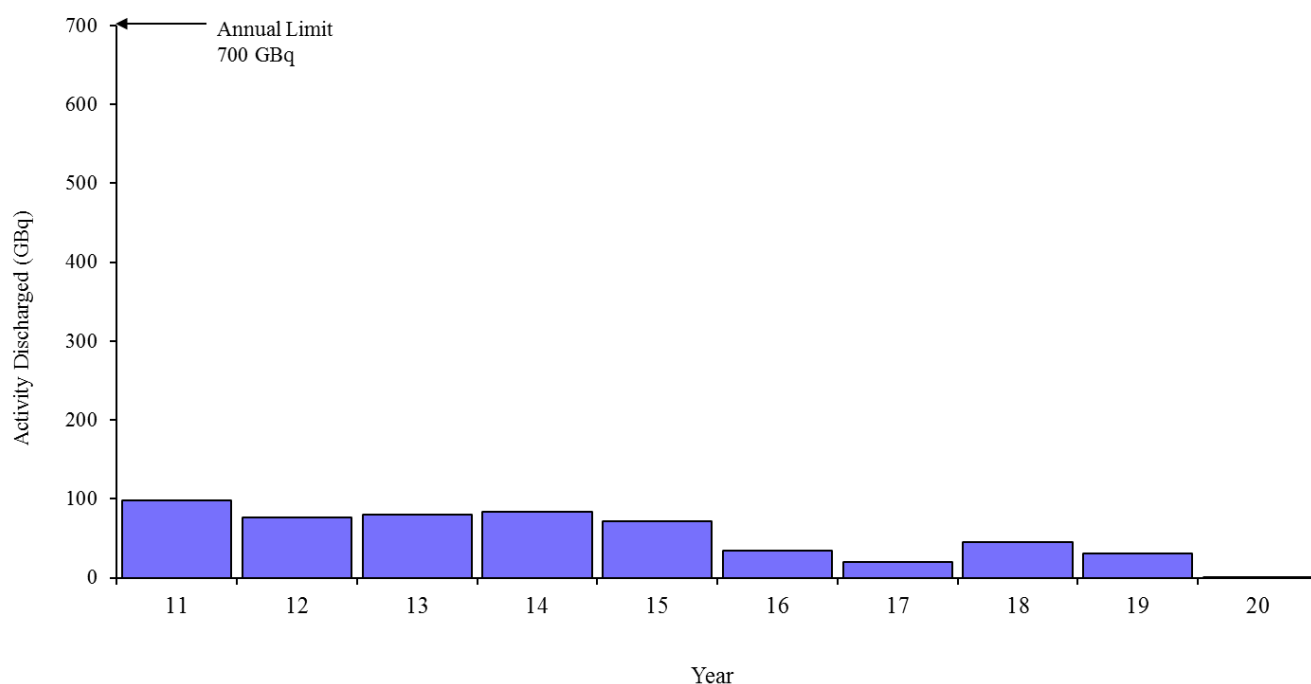
Caesium-137 is a gamma emitting radionuclide. Discharges have reduced following pond water draining which was completed in May 2019. Discharges are well below the Caesium-137 limit.



**Fig 4.4** *Berkeley Site, Annual Liquid Effluent Discharges of Caesium 137*

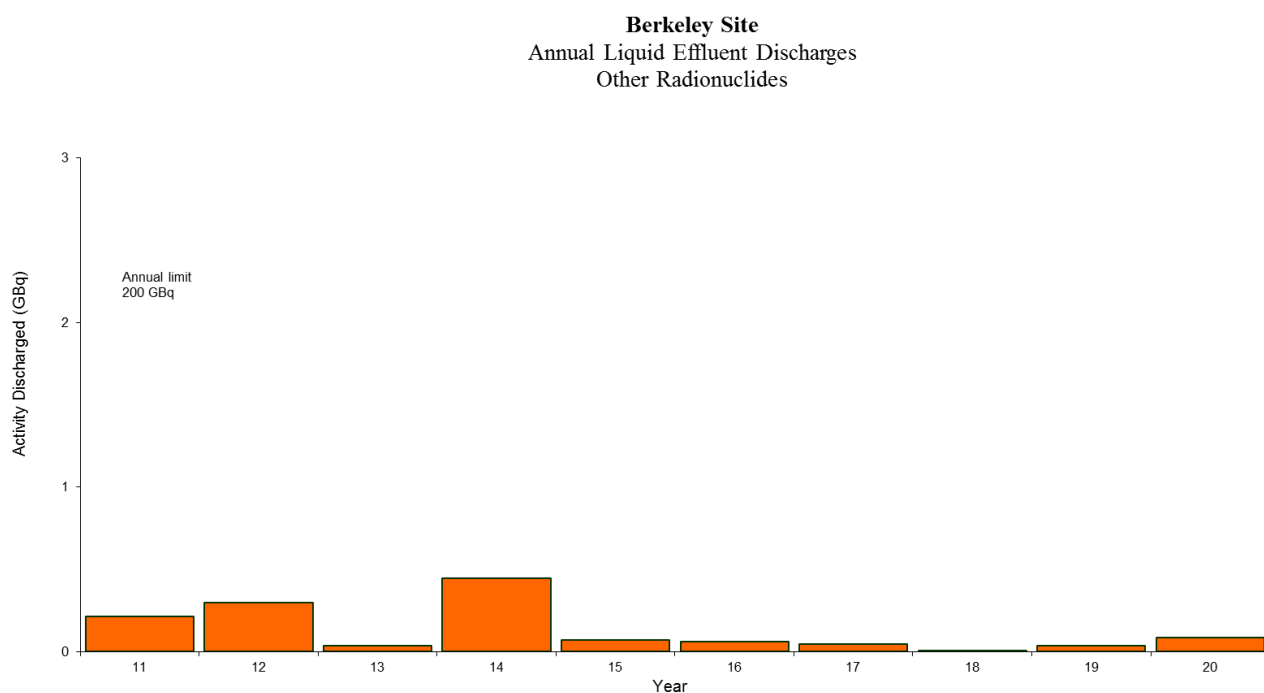
Caesium-137 is a gamma emitting radionuclide. The increase in 2014 caesium-137 discharges was due to decommissioning work on the caesium removal plant (CRP). Discharges are well below the Caesium-137 limit.

**Oldbury Site**  
Annual Liquid Effluent Discharges  
Other Radionuclides



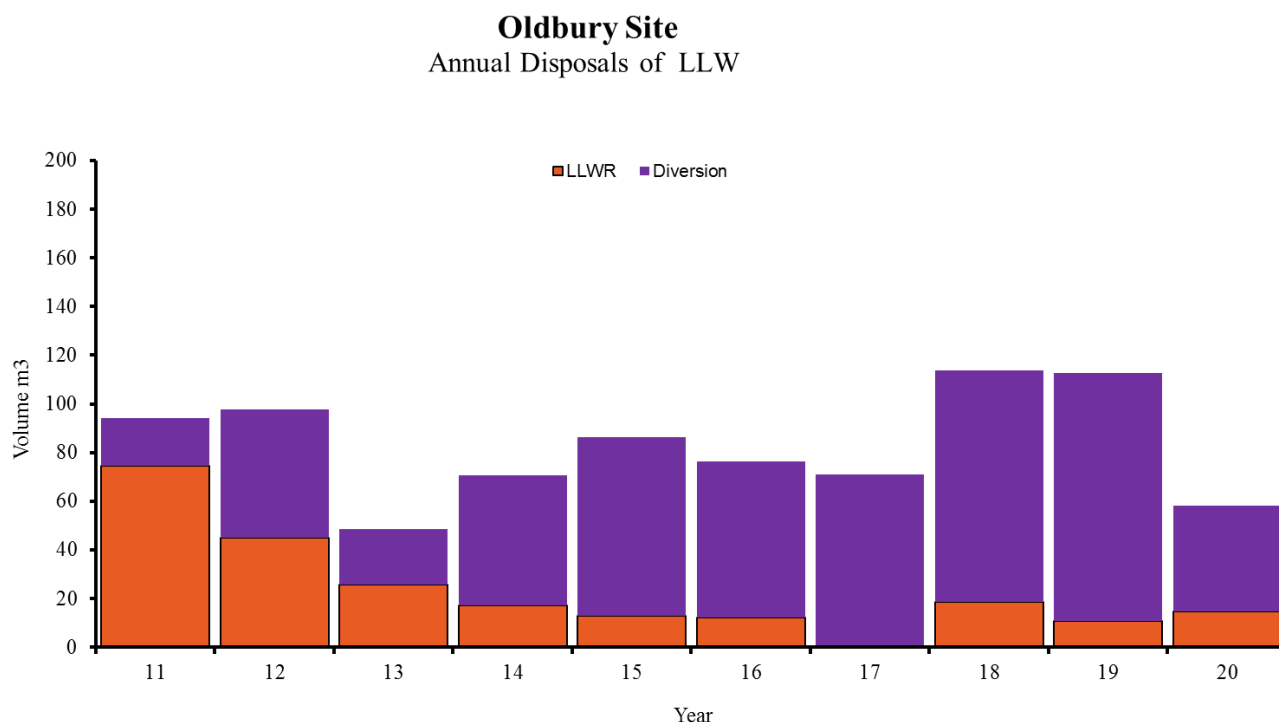
**Fig 4.5**      **Oldbury Site, Annual Liquid Effluent Discharges**

'Other activity' refers to all other measurable activity other than Caesium and Tritium which are regulated separately. Discharges have reduced following pond water draining which was completed in May 2019. Discharges are well below the permit limit.



**Fig 4.6** *Berkeley Site, Annual Liquid Effluent Discharges*

‘Other activity’ refers to all other measurable activity other than Caesium and Tritium which are regulated separately. Discharges are well below the permit limit.

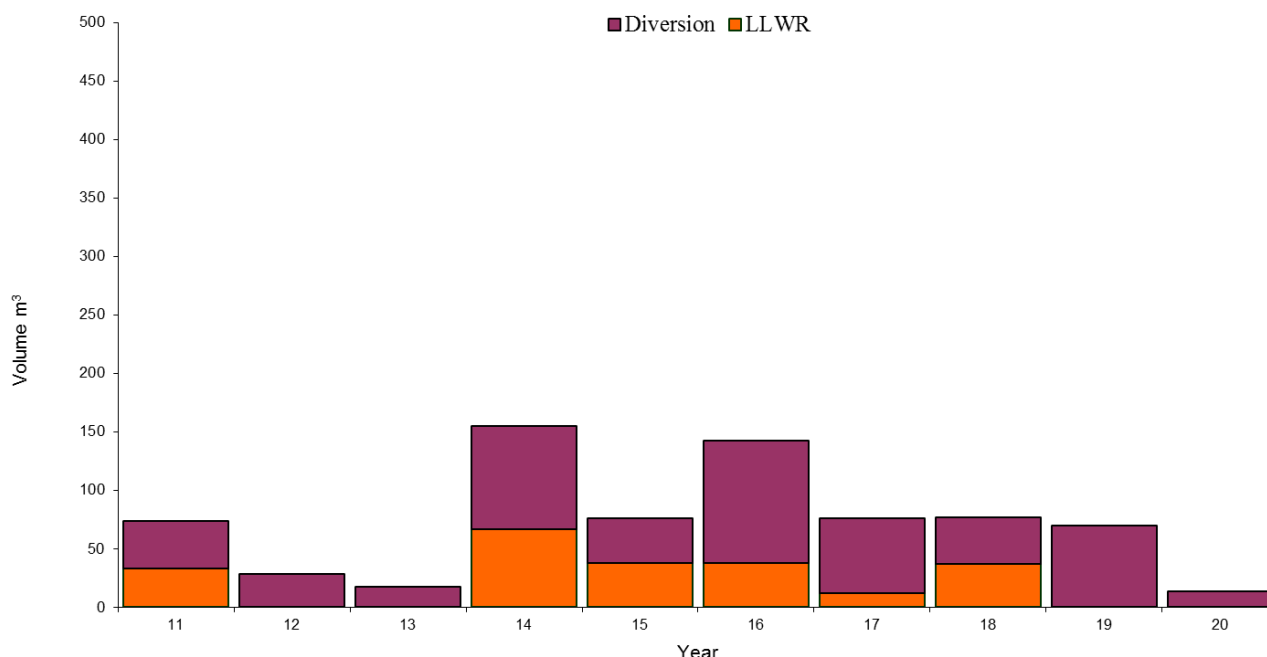


**Fig 4.7** *Oldbury Site, Annual Disposals of LLW*

Low level radioactive waste (LLW) is generated during the maintenance and decommissioning of the site.

Typical types of radioactive waste include redundant plant items, filters, clothing and cleaning wipes. Low level waste is processed in the on-site facilities in preparation for despatch for disposal. Oldbury works with the Low Level Waste Repository (LLWR) to deliver the National Waste Programme for low level waste and LLW is sent from Oldbury under the LLWR Framework agreement. The Waste Hierarchy is used for LLW and where possible waste is diverted from direct disposal by utilising the offsite metallic treatment or incineration routes. Waste that is disposed of to LLWR may be supercompacted at LLWR's waste management and compaction plant (WAMAC) facility thus reducing the landfill volumes further.

### Berkeley Site Annual Disposals of LLW



**Fig 4.8** *Berkeley Site, Annual Disposals of LLW*

Low level radioactive waste (LLW) is generated from decommissioning activities at the Berkeley Site. The Waste Hierarchy is used for LLW and where possible waste is diverted from direct disposal by utilising the metallic treatment or incineration routes.

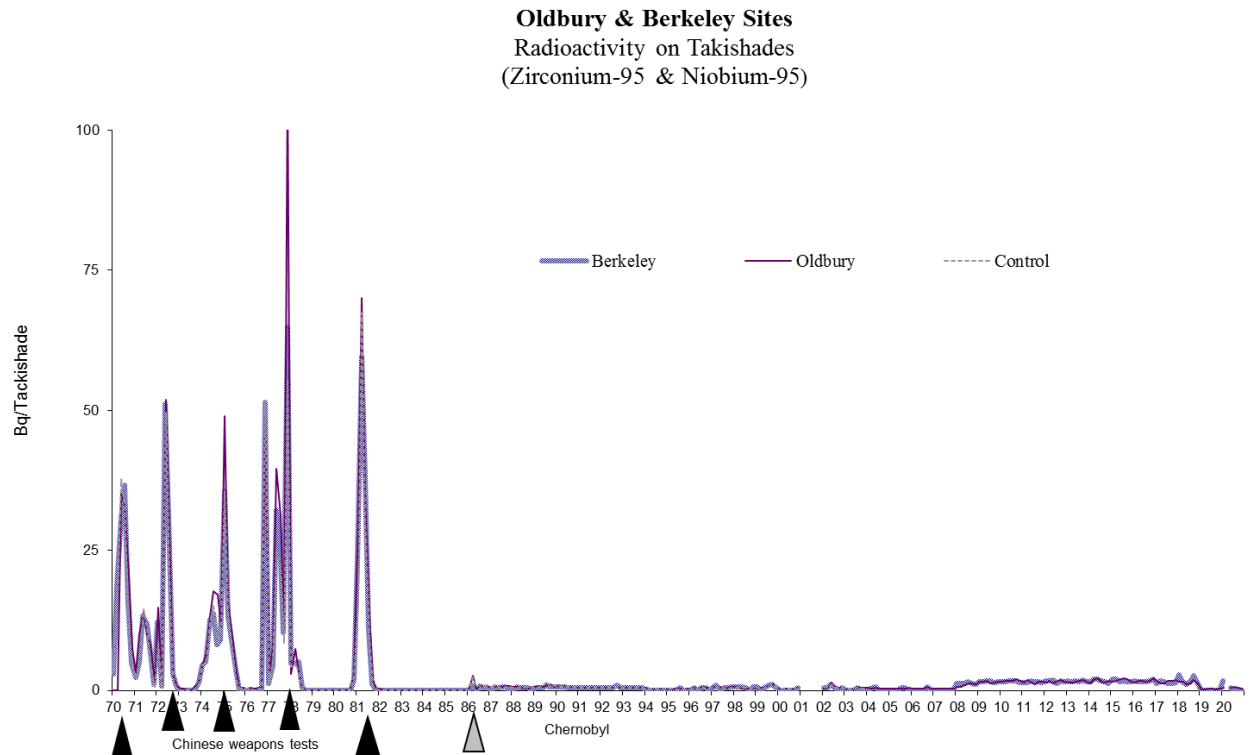
The waste is sent to LLWR in Cumbria for direct disposal following sorting, treating and compaction. Certain types of waste are super compacted prior to disposal at the LLWR. Combustible wastes are burnt offsite at a licenced incinerator and very low level waste (VLLW) is sent to a licenced facility using the LLWR Framework agreement.

## **5. ENVIRONMENTAL MONITORING**

An environmental monitoring programme is carried out by Oldbury. The purpose of the programme is several-fold but is primarily designed to provide data for the doses to members of the public to be assessed.

Samples such as grass, milk, soil, silt, seaweed, fish and tackishade dust collectors are usually collected all year round and analysed in a specially designed low level counting laboratory. Gamma radiation dose-rates are also measured in the estuary and land sites in concentric rings around the stations.

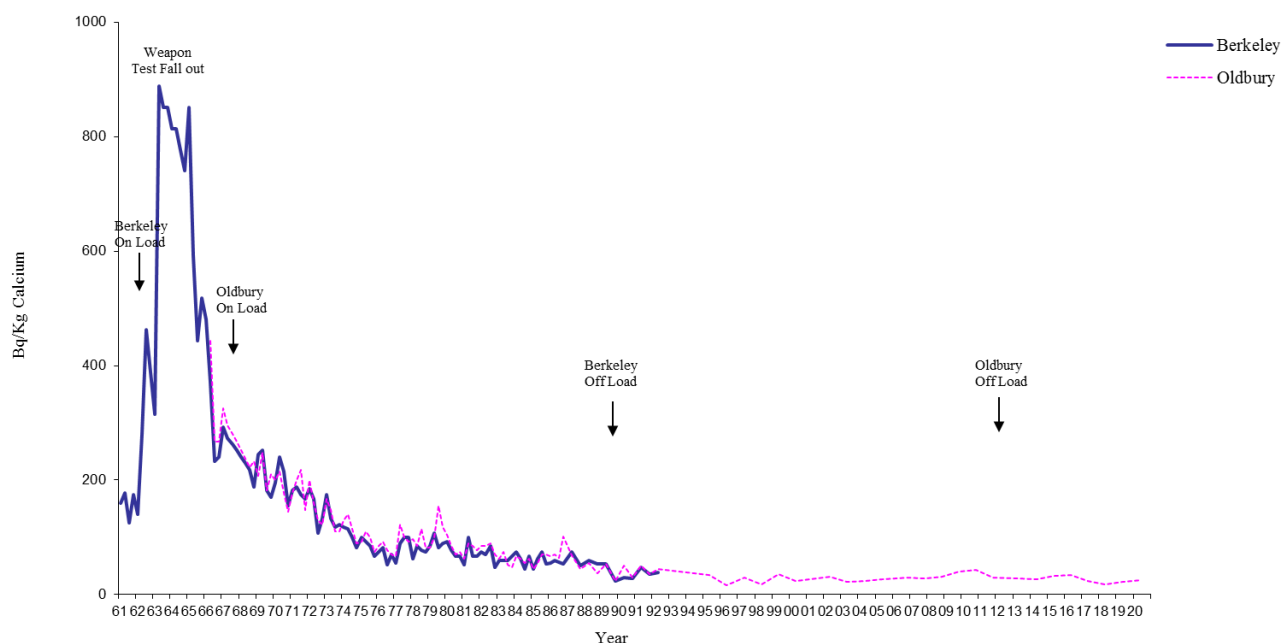
All results are submitted to the Environment Agency for scrutiny and comparison with their own independent monitoring programmes.



**Fig 5.1 Oldbury & Berkeley Sites, Radioactivity on Tackishades (Zirconium – 95 and Niobium – 95)**

Tackishades are passive dust collectors that are very sensitive indicators of airborne radioactive particulate material. The effects of the Chinese weapons testing above ground in the 1970's and the Chernobyl accident in 1986 illustrate the sensitivity of these collectors. All readings are now instrument background levels.

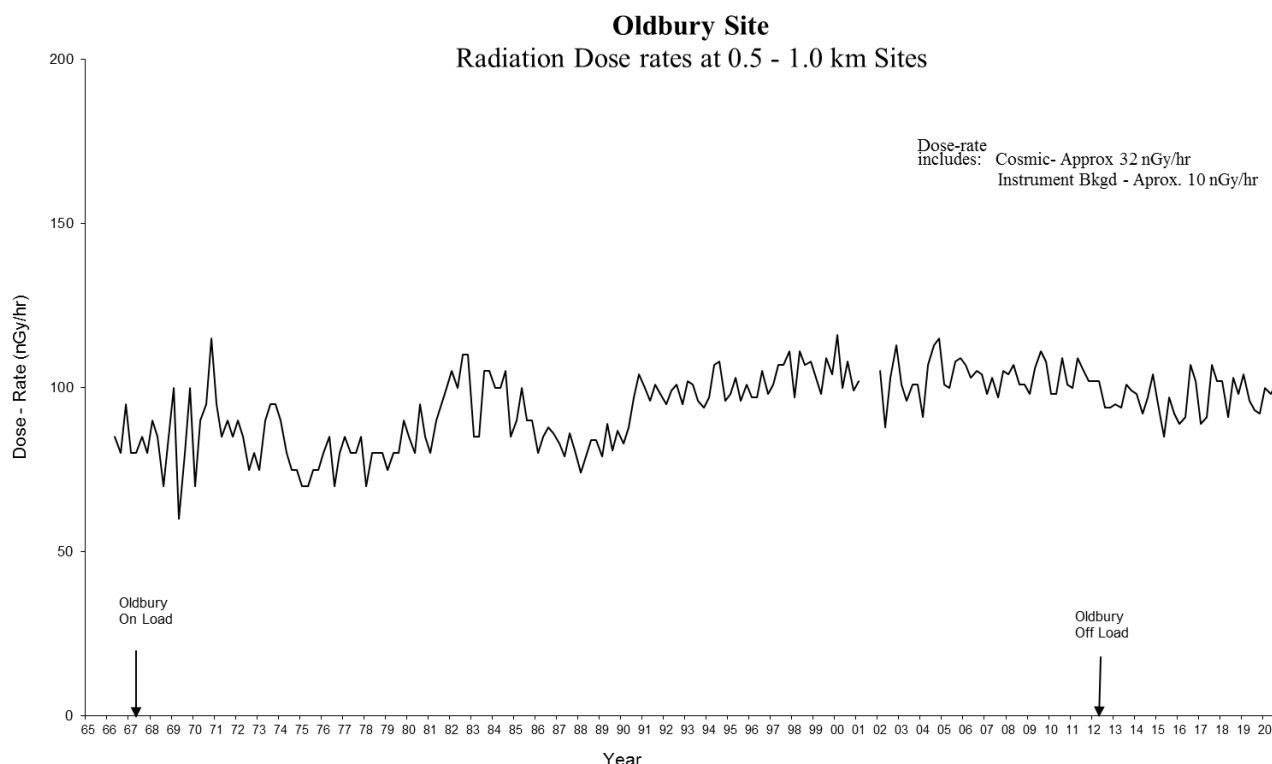
### Oldbury & Berkeley Sites Strontium-90 in Milk (Quarterly Mean)



**Fig 5.2** *Oldbury & Berkeley Sites, Strontium 90 in Milk*

Radioactive strontium is chemically similar to calcium and like calcium is concentrated in milk. Strontium-90 is a beta emitting radionuclide and is generated in the fuel as a fission product.

The presence of strontium-90 in milk would only occur in the event of a fuel element failure and a subsequent discharge of gas to the environment. The Berkeley and Oldbury reactor vessels no longer contain any fuel elements.



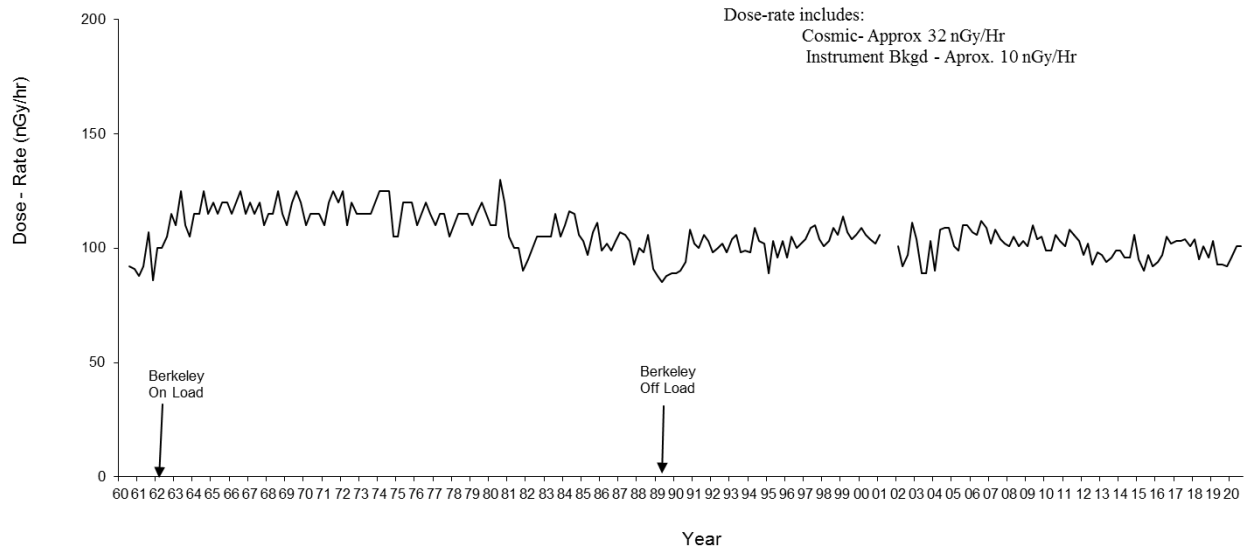
**Fig 5.3**      **Oldbury Site, Radiation Dose rates at 0.5 – 1 km sites**

Gamma dose-rate measurements are regularly taken in an arc around the station at a distance of between 0.5 and 1.0 Km.

Measurements are taken 1 metre above ground level. Environmental dose-rates include cosmic radiation from outer space, terrestrial radiation from naturally occurring radioactive elements in the ground and instrument background readings.

Measurements will depend on environmental conditions such as cloud cover and atmospheric pressure on the day. Gamma dose-rates due to the site's operations are indistinguishable above natural background dose-rates.

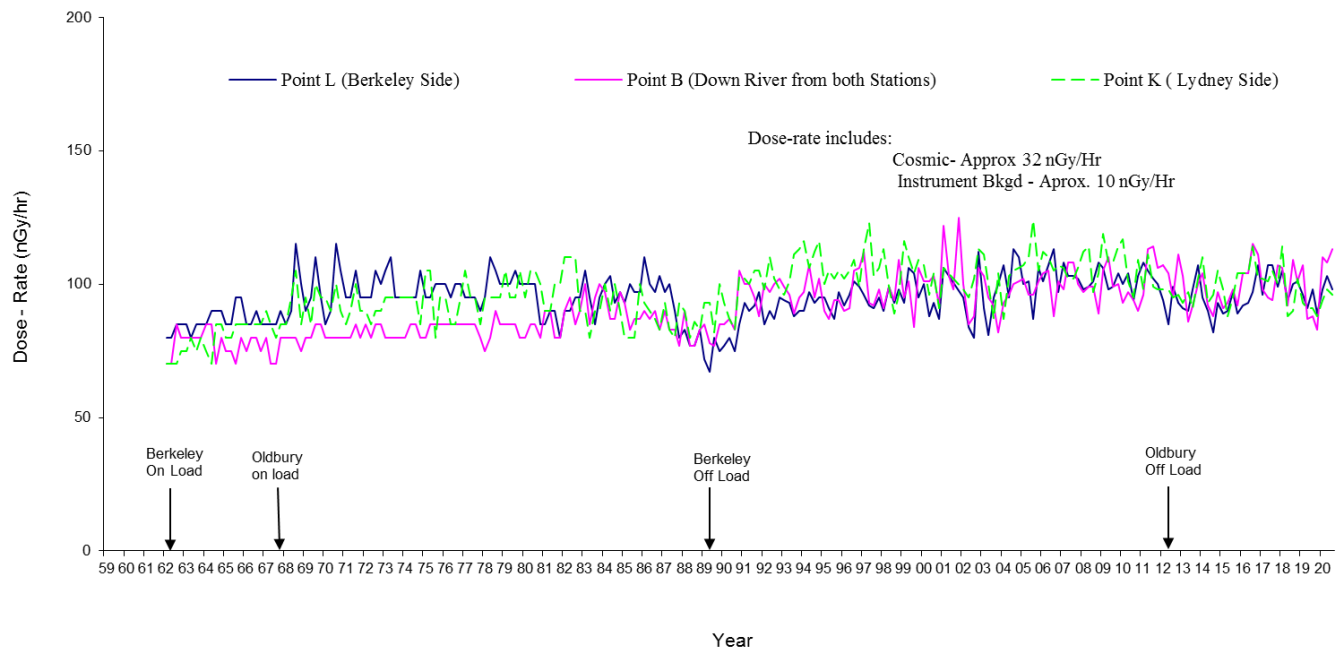
**Berkeley Site**  
Radiation Dose rates at 0.5 - 1.0 km Sites



**Fig 5.4** *Berkeley Site, Radiation Dose rates at 0.5 – 1 km sites*

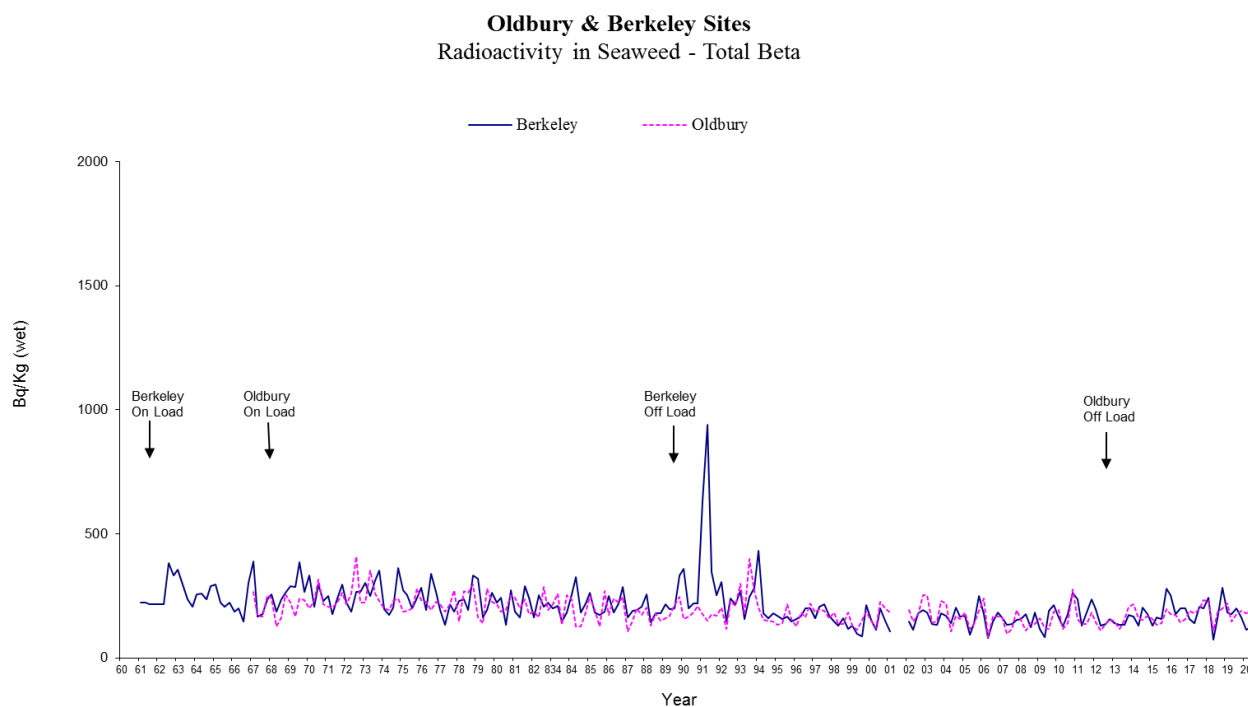
Gamma dose-rates due to the site's operations are indistinguishable above natural background dose-rates.

### Oldbury & Berkeley Sites Radiation Dose rates at Estuary Sites



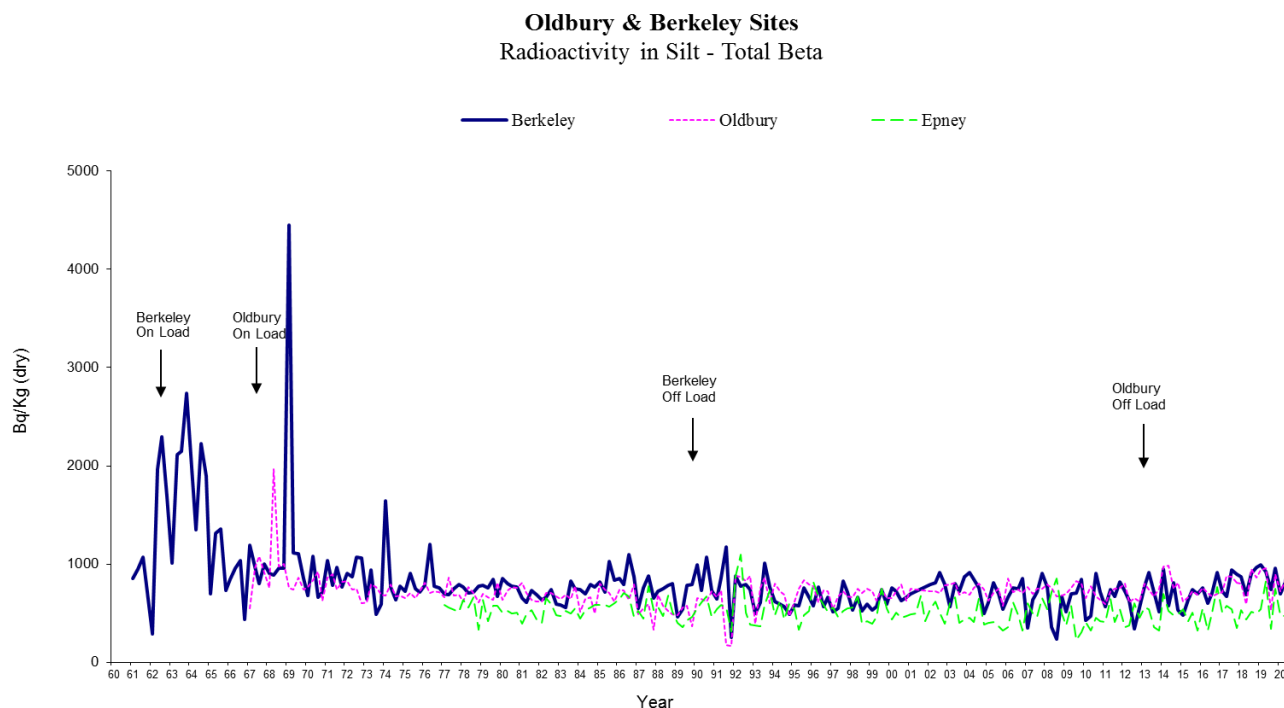
**Fig 5.5** *Oldbury & Berkeley Sites, Radiation Dose rates at Estuary Sites*

Gamma dose-rates are measured regularly in the estuary on both sides of the channel. Measurements are taken 1 metre above silt and do vary slightly due to environmental conditions such as cloud cover and atmospheric pressure and the movement of silt and sand in the channel.



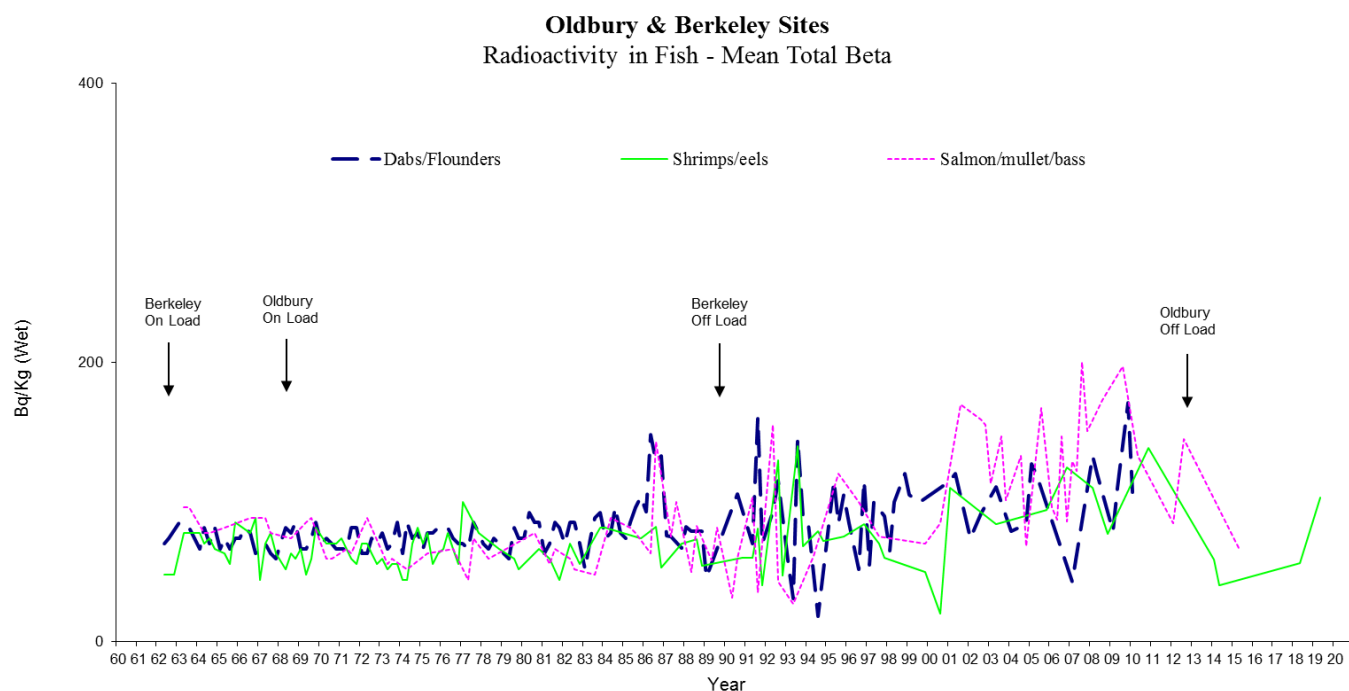
**Fig 5.6** *Oldbury & Berkeley Sites, Radioactivity in Seaweed (Total Beta)*

Seaweed is chosen as an indicator material as it tends to concentrate radionuclides such as Caesium-137 and Iodine-131. A large proportion of the radioactivity in seaweed is naturally occurring Potassium-40. The peak in 1991 is attributable to fuel pond decommissioning activities carried out at Berkeley.



**Fig 5.7** *Oldbury & Berkeley Sites, Radioactivity in Silt (Total Beta)*

Silt is collected from inter-tidal areas of the estuary and its radioactive content measured once it is dried. Levels of naturally occurring Potassium-40 vary depending on tidal patterns. Fission products such as Caesium-137 may be detected at very low levels due to the Chernobyl incident in 1986 and residuals from liquid effluent discharges.



**Fig 5.8**      **Oldbury & Berkeley Sites, Radioactivity in Fish (Total Beta)**

Samples of commercially caught fish are collected from both sides of the channel and the edible portion analysed.

## 6. SUMMARY OF RADIATION DOSES TO THE PUBLIC

The annual dose in 2019 to members of a small local group of the general public (RIFE – 25) are recorded below. Note dose assessments are normally a year in arrears as information is collated and assessed.

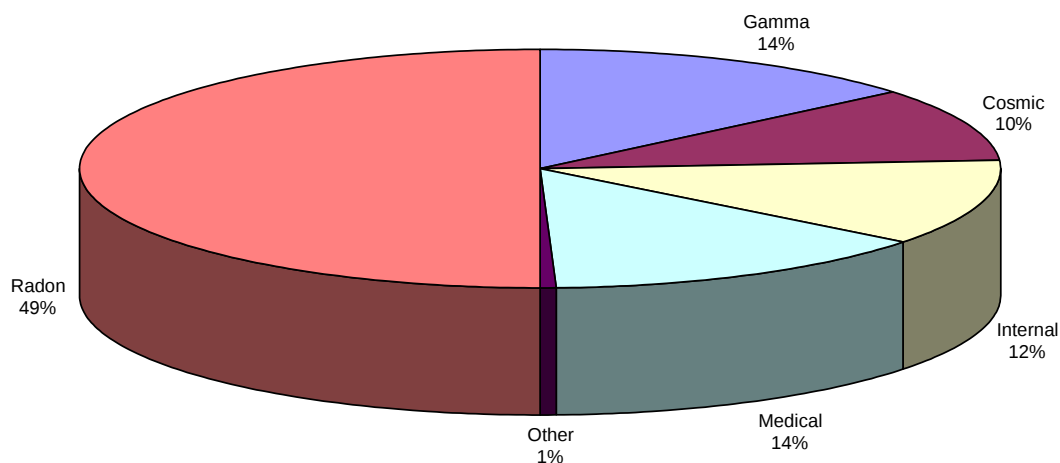
### OLDBURY & BERKELEY

External radiation from intertidal areas: 9  $\mu\text{Sv}$  (Houseboat Dwellers)

Seafood consumers: < 5  $\mu\text{Sv}$

The doses may be compared with the annual background dose to the UK population calculated by the Public Health England to be 2600  $\mu\text{Sv}$  (figure 6.1)

Figure 6.1: Average Annual Background Dose to UK Population - 2600  $\mu\text{Sv}$



## **7. CONCLUSIONS**

- 7.1 The aerial discharges from Oldbury have decreased following the cessation in electricity generation on 29 February 2012.
- 7.2 The liquid discharges from Oldbury have decreased in 2020 following the draining of the fuel storage ponds.
- 7.3 There have been no significant changes to Berkeley aerial and liquid discharges or decommissioning activities.
- 7.4 A reduced environmental monitoring programme was completed between March – June 2020 during the first national Covid lockdown.
- 7.5 The environmental monitoring programme did not identify any significant increases in radiation in the environment.

## 8. TERMS AND DEFINITIONS

### 1) Becquerel (Bq)

The Becquerel (Bq) is a unit of radioactivity.

1 Becquerel means one radioactive disintegration per second. The Becquerel is a very small unit.

|                      |   |                       |
|----------------------|---|-----------------------|
| 1,000,000 Bq         | = | 1 Megabecquerel (MBq) |
| 1,000,000,000 Bq     | = | 1 Gigabecquerel (GBq) |
| 1,000,000,000,000 Bq | = | 1 Terabecquerel (TBq) |

### 2) Gray (Gy)

The Gray (Gy) is a unit of absorbed dose.

1 Gray is the special name given for one joule of energy from ionising radiation absorbed in one kilogram of a substance.

$$\frac{1}{1,000,000,000} \text{ Gy} = 1 \text{ nanoGray (nGy)}$$

### 3) Sievert (Sv)

1 Sievert (Sv) is a unit of effective absorbed dose.

The Sv is a measure of radiation dose equivalent, i.e. it takes into account the biological effect of the particular radiation being considered.

$$\frac{1}{1,000} \text{ Sv} = 1 \text{ milliSievert (mSv)}$$

$$\frac{1}{1,000,000} \text{ Sv} = 1 \text{ microSievert (}\mu\text{Sv)}$$

### 4) ALARP

ALARP is the term used to ensure that the doses to staff and the public are controlled such that they are As Low As Reasonably Practicable.

### 5) BAT

BAT is defined as: 'the latest stage of development of processes, facilities or methods of operation which indicate the practical suitability of a particular measure for limiting waste arisings and disposal'.