# Monitoring of mercury vapour in Rutherford Building, Manchester Museum and Psychology Annex

## *Background.*

1. As part of the investigation into the Churcher Report, Safety Services has been monitoring airborne mercury vapour concentrations in these buildings since August 2008, and working closely with Health & Safety Laboratories (HSL) in fulfilling the Coggon report recommendations. Quarterly monitoring results are available at http://www.manchester.ac.uk/rutherfordreview/ and an overview report of results up to October 2011 is appended.

2. In December 2011, a routine survey visit to a Museum basement storeroom (G54), found concentrations higher than usual and approaching the Workplace Exposure Limit (WEL). The reasons for this are not fully understood but remedial works are being implemented and time spent in the store is recorded by staff so that occupational exposures can be calculated. Recorded times are of the order of a few minutes a day for regular users.

## *Proposals for next phase of mercury monitoring*

3. Mercury vapour monitoring has been carried out using a number of different techniques:
    - Active (pumped) samples, deployed over a period of 8 or 24 hours
    - Passive samples left in situ for 1 or 2 weeks
    - On the spot survey data from a mercury vapour analyser.

4. Each method has advantages and drawbacks, and provides a different insight into the overall picture. Generally speaking, survey data is quick and very useful in identifying areas where more detailed investigation is justified.

5. The Coggon recommendations have been fully complied with, but the experience of over 3 years' monitoring suggests that whilst concentrations remain well under WELs, they are subject to unpredictable variation. For example, it is thought that the G54 circumstances changed when an Estates & Facilities project opened up a basement tunnel between Rutherford Building and Beyer Building.

6. The recommendation is to continue mercury monitoring as follows:

    - Carry out an annual survey in-house using our own mercury analyser
    - Respond reactively to proposals from the occupants or from Estates & Facilities to change anything that could affect occupational exposures (eg room occupancy, room use, refurbishments, any structural changes penetrating walls, floors or ceilings)
    - Commission more detailed monitoring on a case-by-case basis In the event of finding concentrations in excess of 50% WEL (10µg/m3).

Dr Melanie Taylor
Head of Safety Services, Sept 2012.

# Appendix

# Review of airborne mercury vapour monitoring results in Rutherford, Psy Annex and Museum, June 2009 to October 2011

## Background.

1 The University of Manchester accepted the recommendations of the Coggon report[1] in full, and engaged the Health & Safety Laboratory (HSL) to continue a programme of monitoring mercury vapour concentrations in key areas of 3 buildings used by Rutherford.

2 It also developed its own policy criteria for responding to monitoring results, the mercury "thermometer" reproduced in Appendix 1.

3 Monitoring also sought to establish the effect of comprehensive remediation work carried out during 2010, in rooms 2.057 and 2.058 Rutherford Building (numbered 2.62 and 2.63 in historic documents), and room 1.39 in the Psychology Annex.

4 In essence, the monitoring programme between June 2009 and October 2011 included:

Rutherford Building –12 months' post remediation monitoring in rooms 2.57, 2.58, 2.59 and 2.53

Psychology Annex –12 months' data post remediation monitoring in rooms 1.31, 1.38, 1.39, 1.41, 1.41A, 1.41B

Museum – monitoring in B58, B56, B62, B55, G54 and G53, as these have a history of mercury concentrations >4 µg/m$^3$.

5 Sampling protocols and analysis techniques were agreed with HSL, and analyses were carried out by them. All the results have been made available on the University's web pages[2].

6 This paper summarises the monitoring results and attempts to explain changes over time. See charts in Appendix 3 and floor plans in Appendix 4.

7 Charts are given for 3 different types of measurement. The passive samplers were exposed to the room atmosphere for 14 days, and give one measurement of Hg concentration averaged over the whole sample period. By their nature, these measurements cannot identify any diurnal variations or short duration peaks in concentrations. The pumped samplers were deployed for 8 hours (to represent the average working day) and 24 hours (to assess if there were differences between concentrations during the day and night periods).

[1] http://www.manchester.ac.uk/rutherfordreview/finalreports/DC%20final%20report%20080410.pdf
[2] http://www.manchester.ac.uk/rutherfordreview/

## Discussion

8 When interpreting the results, the following factors should always be borne in mind:

- An expected future WEL[3] of 20 µg/m$^3$
- Coggon's recommendation that further monitoring is carried out in rooms with concentrations above 4 µg/m$^3$, and
- The University's adopted policy criteria.

A note on errors and uncertainty

9 Advice from HSL was sought about errors in both sampling and analysis techniques and their detailed response is in Appendix 2. Placement of samplers in rooms inevitably introduces error unless the vapour concentrations are very evenly distributed (an unlikely scenario in many typical rooms). Passive samplers were located as close as practicable to the breathing zone of a room occupant, typically clipped to the nearest shelving or desk upstand. Pumped samplers were a bit more intrusive because of the pump noise, but were also located reasonably close to a room occupant's breathing zone. All were placed in the same locations from quarter to quarter, so the measurements could be compared with some confidence, all other variables being equal.

10 Nevertheless, results cannot be quoted with more than ± 20% certainty.

## Rutherford Building

11 Extensive remediation was carried out in rooms 2.057 and 2.058 between April - Oct 2010.

12 In room 2.057, concentrations tracked here were already reduced due to temporary vapour control measures taken before June 2009. There was limited access to the room whilst the major remediation works were in progress in 2010, but analysis since the room was reinstated shows levels dropping until May 2011 but rising slightly again in Oct 2011 to 2.5 µg/m$^3$. Independent monitoring carried out by ALControl for the remediation project gives lower results for 2.057 and 2.058.

13 All data sets for Rooms 2.058 show a significant reduction over time from the concentrations that triggered the remediation. For five successive quarterly measurements, readings have been less than 1.0 µg/m$^3$.

14 Although the absolute numerical values differ in 2.058, the broad patterns are the same for 14 day passive samples and the 8 hour/24 hour pumped samples. HSL is currently considering further analysis of the pumped sample data as this potentially gives insight into diurnal variations which have not before been reported in the scientific literature.

15 Measurements were taken in room 2.059, as it was adjacent to the rooms identified as needing remediation. The rise in concentration in July almost certainly is the result of general disturbance of air flows during remediation next door, and concentrations

[3] http://www.hse.gov.uk/aboutus/meetings/hseboard/2008/261108/b82.pdf and subsequently issued in HSE consultation document CD234 at http://www.hse.gov.uk/consult/condocs/cd234.htm

subsequently have returned to a steady 0.3 µg/m$^3$ for four quarterly measurements up to Oct 2011.

16 Room 2.053 is on the other side of the corridor, and shows a similar pattern to room 2.059 - very low concentrations generally, with an increase to 1.1 µg/m$^3$ during the remediation in summer 2010, and subsequent return to <1.0 µg/m$^3$, for a full year.

## Psychology Annex

17 Following the routine analysis result for room 1.39 in March 2010 (of 14.4 µg/m$^3$), this room was subject to the same rigorous remediation process as adopted for the Rutherford Building rooms, by the same contractor, between Sept-end Nov 2010.

18 In the suite of rooms at the end of this corridor (1.41B, 1.41A and 1.41), earlier results and investigations had suggested a source of mercury vapour, probably under the floor. Results varied over time, and were consistently higher in Room 1.41B, but were below the 10.0 µg/m$^3$ policy trigger until July 2010. Concentrations measured in 1.41A and 1.41 also rose in July 2010, and one possible cause is warmer environmental conditions.

19 However, concentrations have dropped significantly following the work in 1.39, and in Nov 2010, were between 0.8 – 1.8 µg/m$^3$. This initially suggested an under-floor airflow between the sources discovered under 1.39 and the end of the corridor, and that removal of the sources and/or air flow blocked by making good the structure as part of the remediation reduced vapour concentrations along the whole corridor. However, results in rooms 1.41/1.41A and 1/41B since Nov 2010 show increases, albeit to under or around 4 µg/m$^3$.

20 Mercury concentrations in room 1.40 have been consistently very low. This may be because it was originally constructed as a staircase and may still have different structural containment and inter-connectivity with other rooms along the corridor.

21 In room 1.39 itself, results since the high concentration in March 2010 have been very low (< 1.0 µg/m$^3$ for four quarters) and independent monitoring carried out by ALControl for the remediation project confirms very low concentrations.

22 Concentrations in room 1.38 have not exceeded 1.4 µg/m$^3$ during this assessment period, and appear not to have been significantly affected by the changes in 1.39, although the March 2011 result is a reduction to 0.4 µg/m$^3$. However, there is a suggestion that levels are higher in the winter months.

23 Results for Room 1.31, at the other end of the corridor, are below 4 µg/m$^3$ except for the Nov 2010 one which was 4.2 µg/m$^3$. Concentrations fell over the next 3 measurements to Oct 2011. Whilst the levels are well under the proposed workplace exposure limit, some are close to the University's policy trigger of 4 µg/m$^3$.

24 Additional monitoring and survey work has been carried out in room 1.31, using the Safety Office mercury analyser Jerome Model: J405-0008. On three occasions, safety office staff visited early on Monday mornings, after this area had been shut up over the weekend, in an attempt to establish maximum concentrations and possible source(s) of mercury vapour. To date, no possible source has been identified, and concentrations have been found to drop

down to below 4 µg/m$^3$ quite rapidly after the occupant opens the office door and window. Occupational exposures are therefore very low.

## Manchester Museum

25 Prior to July 2010, routine quarterly monitoring had yielded mercury concentrations broadly between 4-8 µg/m$^3$ for rooms B56, B58, B62 and G53. These rooms are artefact storerooms, and since October 2010, a record has been kept of staff spending any time in the rooms to retrieve or work with items. Exposures were controlled and well under WEL because of the limited time people spent in these environments. A plausible source of mercury has not been discovered to date. The rooms are generally stripped back to their basic structural elements (original walls, floors and ceilings, although some have a partial wooden raised floor laid on the original to support the racking systems).

26 Rooms B56, B58, B62 and G53 all show the same pattern, however, of a marked increase in measured concentrations in July 2010. These measurements coincided with the extensive remediation work in rooms 2.057/8, Rutherford Building. The lift shaft adjacent to the wall of 2.058 is the same shaft as in the Museum room B64 and opposite rooms B61 and B62, and could plausibly act as a conduit between the two sites, in which case, a rise in concentrations in July 2010 may not be surprising.

27 Since July 2010, there has been a significant reduction to ≤ 2.8 µg/m$^3$ over winter samples, but an increase, in some cases above 4 µg/m$^3$, in the May 2011 results. This suggests that an environmental factor such as external temperature is also having an influence on the air flows in these rooms.

28 Room G54 defies this finding. The pattern of mercury concentrations is generally higher than other rooms in the Museum, and the concentrations in July 2010 were relatively low and increased in Nov 2010. The March 2011 is half the Nov 2010 result, and similar to the March 2010 one. Over 6 quarters, there may be a seasonal influence in this room, as the results for the "winter" quarters are higher than for the summer ones, but for some reason, the effect differs from the other rooms. All these rooms have controlled humidity and temperature environments.

29 Work has been carried out to check room temperature records and presets, and data on equipment breakdown, in an effort to rule out the effects of internal temperature and humidity. Checks are also being made against meteorological records for any associations with external wind speed, wind direction and other environmental effects.

30 Although occupational exposures are well under the WEL, these results suggested there must be an as yet undiscovered source of mercury vapour feeding into G54.

31 Earlier attempts at surveying G54 had failed to yield any plausible sources of mercury vapour but on 2 Dec 2011, a survey found much higher concentrations in this room that had ever been previously recorded (around 24 µg/m$^3$ in most areas of the room and on its mezzanine floor). This was very unusual so a much more detailed survey commenced using the Jerome analyser. This showed that air in the floor void was contaminated with mercury vapour, and was being drawn up into the room around the stanchions supporting the mezzanine floor. Further discussions are now underway to resolve this issue. Historic variations may have

been due to atmospheric air pressure and other conditions affecting sub-floor air movements, and it is thought these may have changed as a result of an intrusive project to improve heating in Beyer Building which involved opening up the tunnel between Beyer and Rutherford Buildings.

## Future monitoring programme & recommendations.

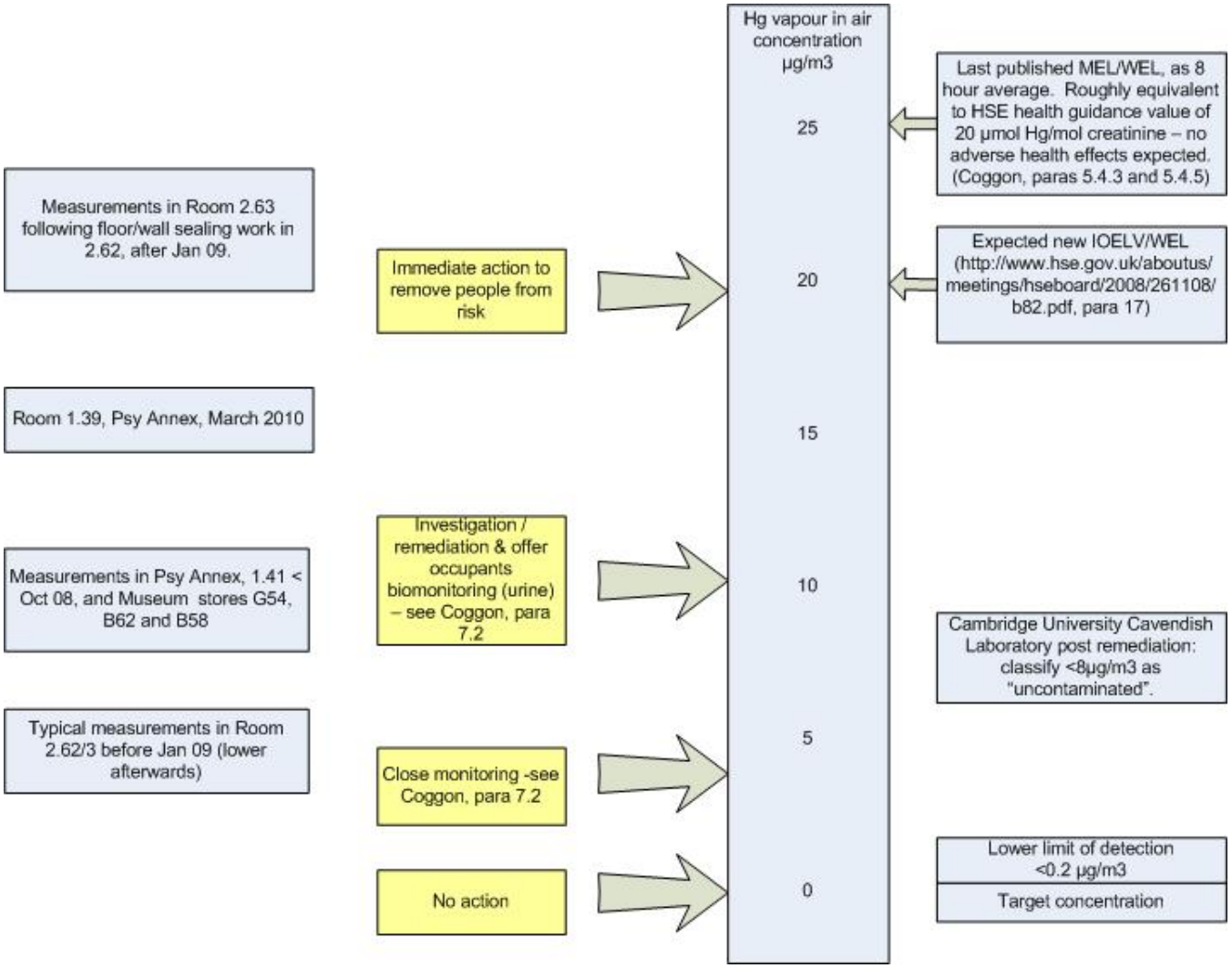
32 The Coggon recommendation to monitor for 12 months post-remediation of rooms 2.057 and 2.058 in the Rutherford Building (and subsequently, room 1.39 in the Psychology Annex) has been carried out. There have been some notable reductions in those rooms but some anomalous results have been found elsewhere.

33 Room G54 in the Museum warrants further investigation. Rooms 1.41/A/B in the Psy Annex should remain under observation.

Dr Melanie Taylor
Head of Safety Services

Nov 2011.

# Appendix 1


Hg vapour in air concentration µg/m3
25
20
15
10
5
0
Last published MEL/WEL, as 8 hour average. Roughly equivalent to HSE health guidance value of 20 µmol Hg/mol creatinine – no adverse health effects expected. (Coggon, paras 5.4.3 and 5.4.5)
Expected new IOELV/WEL (http://www.hse.gov.uk/aboutus/meetings/hseboard/2008/261108/b82.pdf, para 17)
Cambridge University Cavendish Laboratory post remediation: classify <8µg/m3 as "uncontaminated".
Lower limit of detection <0.2 µg/m3
Target concentration
Measurements in Room 2.63 following floor/wall sealing work in 2.62, after Jan 09.
Immediate action to remove people from risk
Room 1.39, Psy Annex, March 2010
Measurements in Psy Annex, 1.41 < Oct 08, and Museum stores G54, B62 and B58
Investigation / remediation & offer occupants biomonitoring (urine) – see Coggon, para 7.2
Typical measurements in Room 2.62/3 before Jan 09 (lower afterwards)
Close monitoring -see Coggon, para 7.2
No action

# Appendix 2 : HSL observations on sampling and analysis errors

Email (1), 1/4/2011

“Analytical methods (from ISO, EN, MDHS, OSHA, NIOSH, IFA, INRS method sources) in general have been reviewed in terms of meeting measurement uncertainty requirements (EN 482) and other performance checks as part of an EU funded projected involved HSL amongst others. An end product was the Gestis database of methods hosted by our Germany friends at IFA which can be found here

http://www.dguv.de/ifa/en/gestis/analytical_methods/index.jsp

This database recommends the use of ISO 17733 method for mercury measurements (still essentially MDHS 16 rewritten in international standards terms) and quotes calculated uncertainties as per procedures set out in EN 482 as

Hg vapour (elemental) - pump sampling - 21 % .

Hg vapour (elemental) - diffusive sampling - 24 %

calculated provided that diffusion sampling was in excess of 6 hours and pumped sampling in the range 15 min - 4 hours, pump flow meter checks within 5 % etc of stated flow rate etc.

For info, the procedures set out in EN 482 to calculate measurement uncertainty is currently being revised (will be ratified shortly) to be more in tune with calculation requirements set out in ISO GUM (the bible for measurement uncertainty calculations!) and using ISO GUM approach the above uncertainties have been revised to

Hg vapour (elemental) - pump sampling - 15 % .

Hg vapour (elemental) - diffusive sampling - 22 %

The above calculations were also undertaken when the limit value was 25 ug m-3 but the shift to 20 ug m-3 should have no effect.

In summary, for diffusion sampling was in excess of 6 hours and pumped sampling in the range 15 min - 4 hours, one can say that the results reported for samples taken is within ~ +/- 20 %.”

Best wishes

Owen

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Email (2), 4/4/2011

“I have looked at the calculation sheets put together for the Gestis method databases project (incl. measurement uncertainty) for mercury methods.

In summary the analytical expanded uncertainty component is ~ 7 %  for Hg analysis to ISO 17733 (essentially MDHS 16 rebadged) and probably a bit lower than this if you factor in increased instrument sensitivity and cleaner/more reproducible blank sorbent media available nowadays since this database was populated a few years ago.

This is a 'mean' value  from laboratory validation studies (actually validation data from MDHS 16 validation work here) for pumped sorbent tubes studies conducted over a sampling period of 1 - 8 hrs (200 mg tube, 0.2
l/min) and 2 - 8 hrs for the SKC diffusive badge charged using standard Hg atmospheres set up over the range 0.1 WEL to 2 WEL  (by WEL I mean here the old 25 ug m-3 limit value but a shift to a slightly lower SCOEL 20 ug m-3 should not affect this mean value).”

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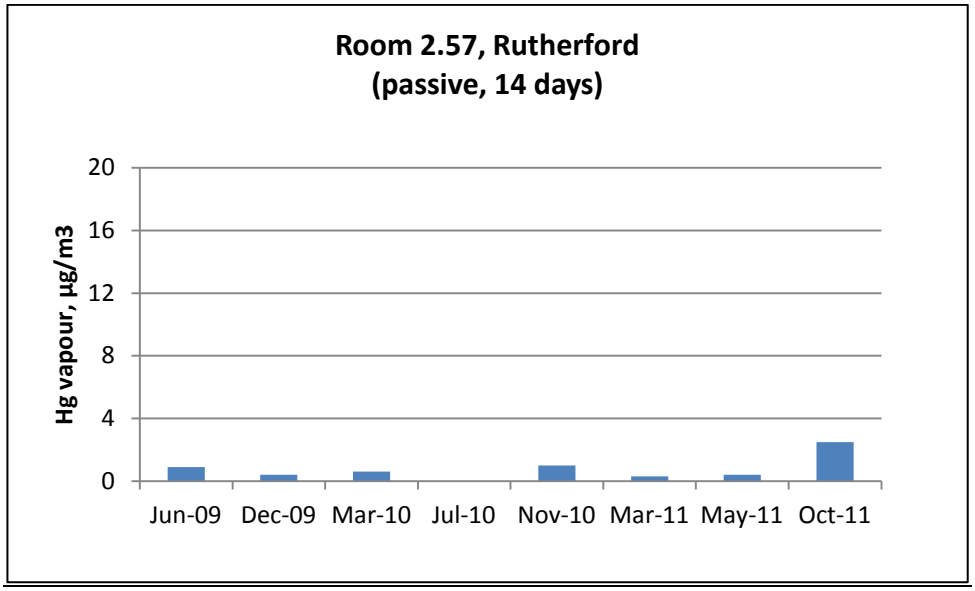
# Appendix 3 : HSL monitoring results

The following charts and tables are for rooms where 3 or more data points are available. Monitoring has been carried out in other rooms on a more ad hoc basis, to check consistency with original results. The whole data set is available on the Rutherford Review web pages.

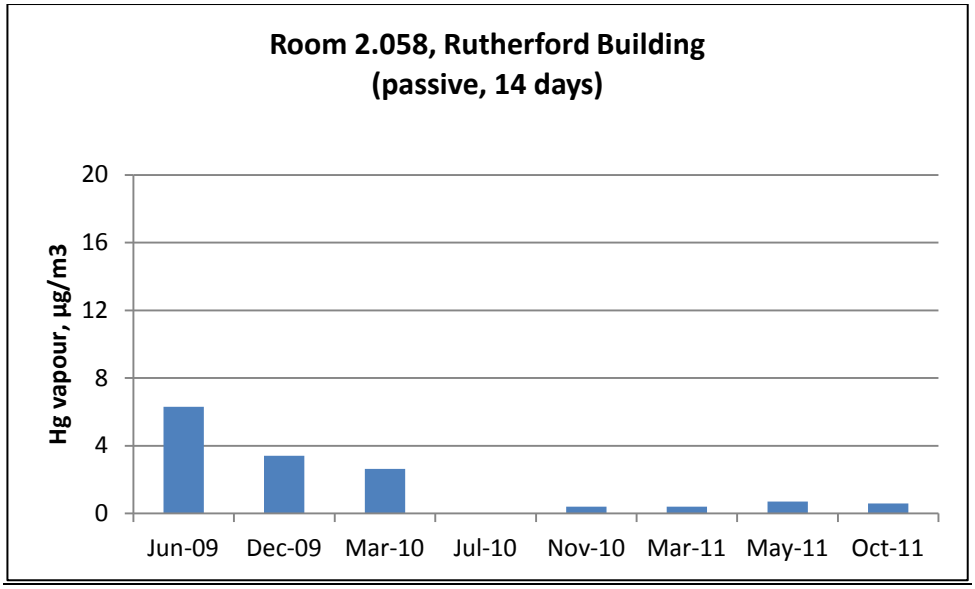
## Rutherford Building

### Room 2.057



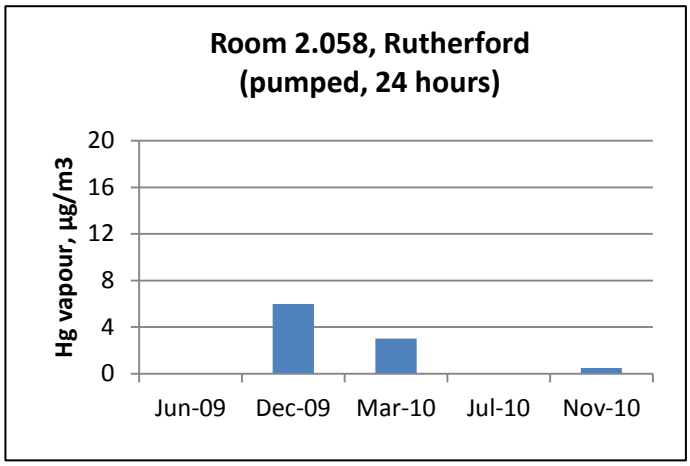

| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03762/09 | Jun-09 | 0.9 |
| 09121/09 | Dec-09 | 0.4 |
| 02646/10 | Mar-10 | 0.61 |
| n/a | Jul-10 | n/a |
| 09335/10 | Nov-10 | 1.0 |
| 01633/11 | Mar-11 | 0.3 |
| 03706/11 | May-11 | 0.4 |
| 07287/11 | Oct-11 | 2.5 |

Room 2.058

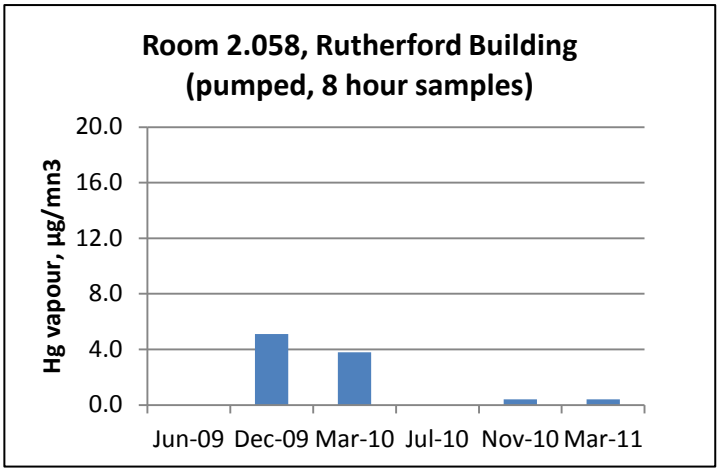



| HSL Sample number | Date | Concentration mercury in air (µg/m3) |
|---|---|---|
| 03761/09 | Jun-09 | 6.3 |
| 9132/09 | Dec-09 | 3.4 |
| 02656/10 | Mar-10 | 2.6 |
| n/a | Jul-10 | n/a |
| 09298/10 | Nov-10 | 0.4 |
| 01634/11 | Mar-11 | 0.4 |
| 03707/11 | May-11 | 0.7 |
| 07288/11 | Oct-11 | 0.6 |

Room 2.058 (cont)

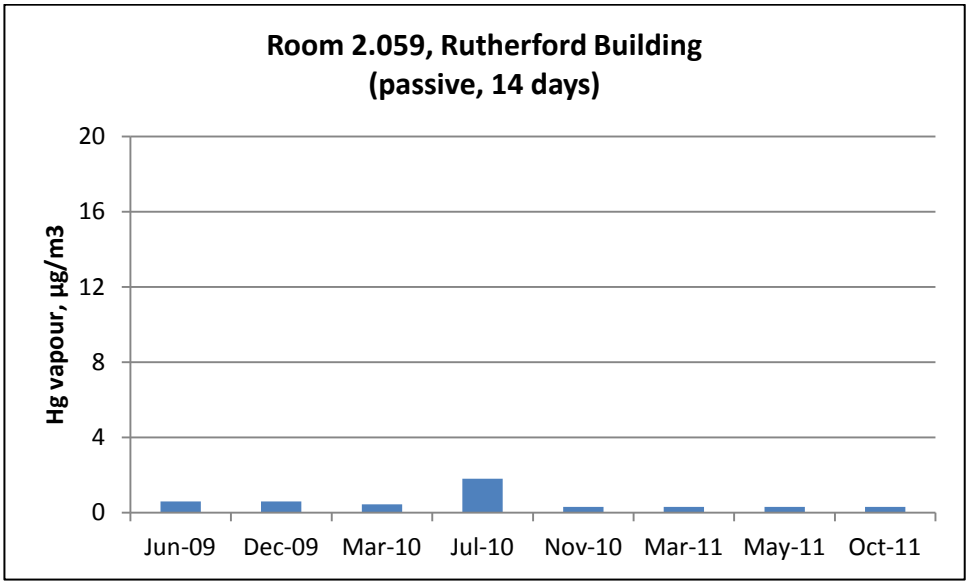



| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| n/a | Jun-09 | n/a |
| 9131/09 | Dec-09 | 6.0 |
| 02655/10 | Mar-10 | 3.03 |
| n/a | Jul-10 | n/a |
| 09297/10 | Nov-10 | 0.5 |



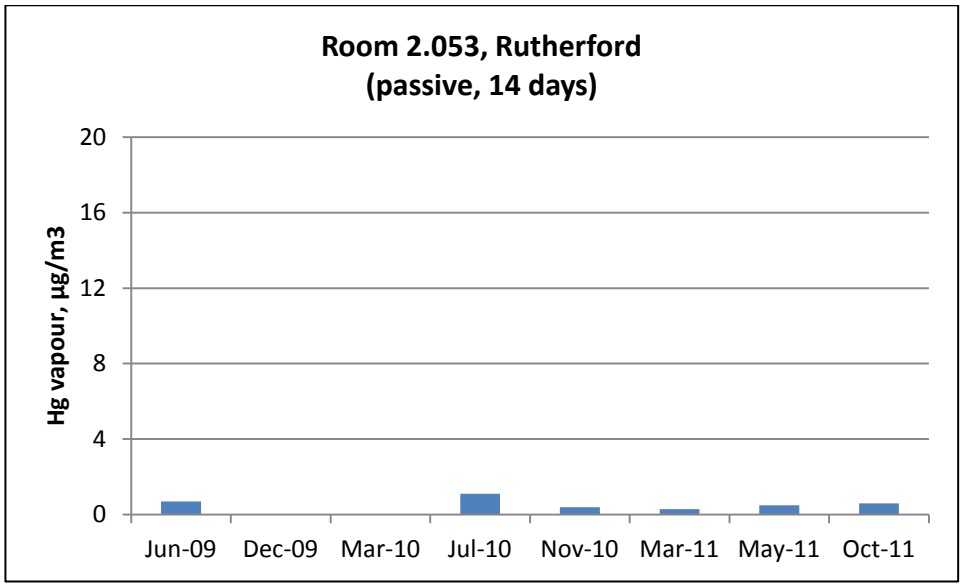

| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| n/a | Jun-09 | n/a |
| 9132/09 | Dec-09 | 5.1 |
| 02656/10 | Mar-10 | 3.79 |
| n/a | Jul-10 | n/a |
| 09298/10 | Nov-10 | 0.4 |
| 01634/11 | Mar-11 | 0.4 |

Room 2.059




| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03765/09 | Jun-09 | 0.6 |
| 09123/09 | Dec-09 | 0.6 |
| 02643/10 | Mar-10 | 0.45 |
| 06379/10 | Jul-10 | 1.8 |
| 09331/10 | Nov-10 | 0.3 |
| 01635/11 | Mar-11 | 0.3 |
| 03708/11 | Nay-11 | 0.3 |
| 07289/11 | Oct-11 | 0.3 |

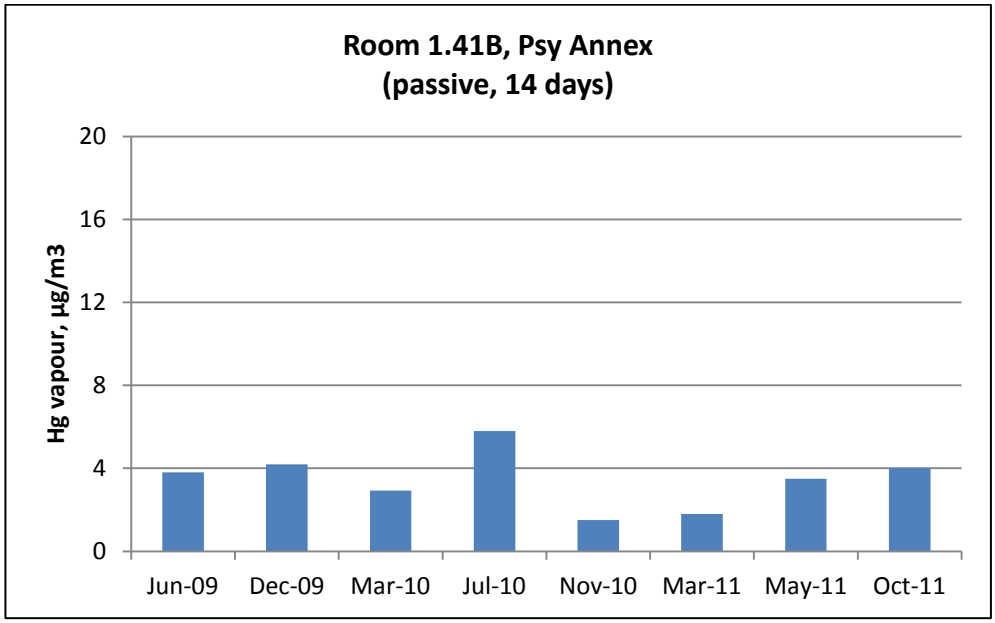
Room 2.053




| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03764/09 | Jun-09 | 0.7 |
| n/a | Dec-09 | n/a |
| n/a | Mar-10 | n/a |
| 06381/10 | Jul-10 | 1.1 |
| 09333/10 | Nov-10 | 0.4 |
| 01636/11 | Mar-11 | 0.3 |
| 03711/11 | May-11 | 0.5 |
| 07290/11 | Oct-11 | 0.6 |

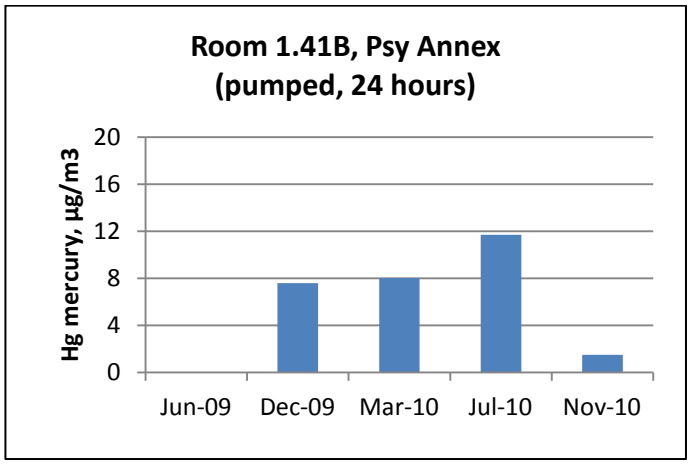
Psychology Annex

Room 1.41B

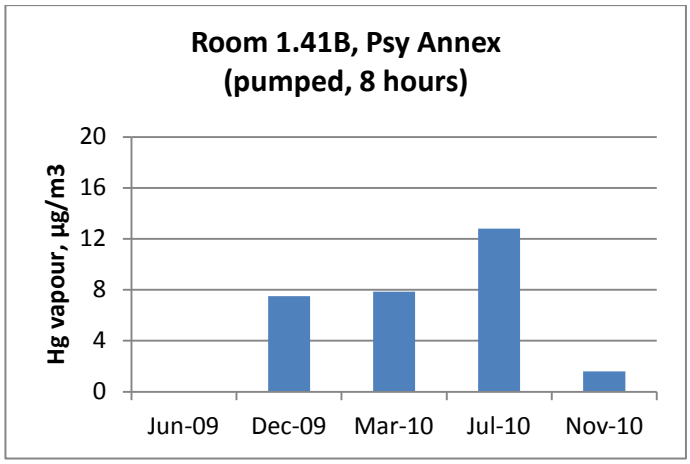



| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03868/09 | Jun-09 | 3.8 |
| 09118/09 | Dec-09 | 4.2 |
| 02641/10 | Mar-10 | 2.92 |
| 06376/10 | Jul-10 | 5.8 |
| 09328/10 | Nov-10 | 1.5 |
| 01632/11 | Mar-11 | 1.8 |
| 03704/11 | May-11 | 3.5 |
| 07285/11 | Oct-11 | 4.0 |

Room 1.41B (cont)

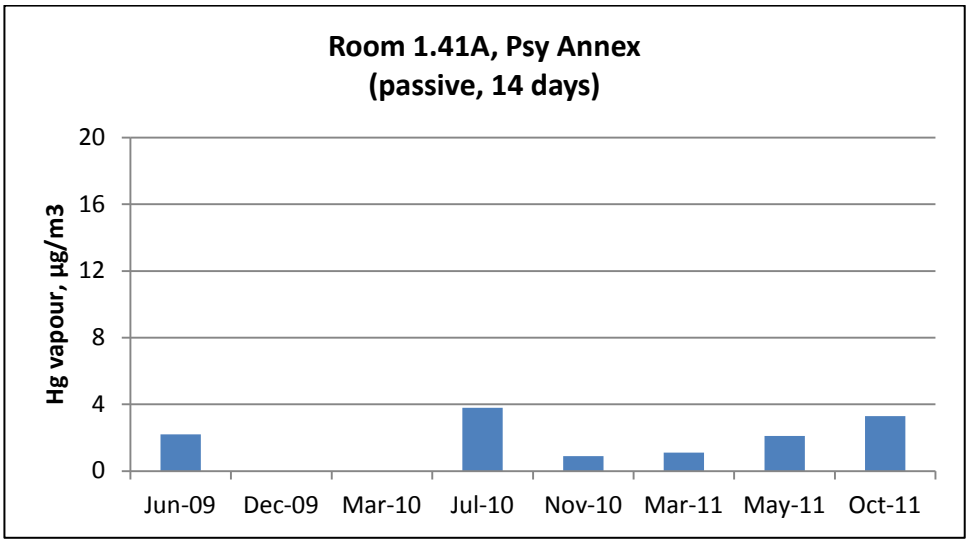



| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| n/a | Jun-09 | n/a |
| 09133/09 | Dec-09 | 7.6 |
| 02653/10 | Mar-10 | 8.03 |
| 06358/10 | Jul-10 | 11.7 |
| 09293/10 | Nov-10 | 1.5 |



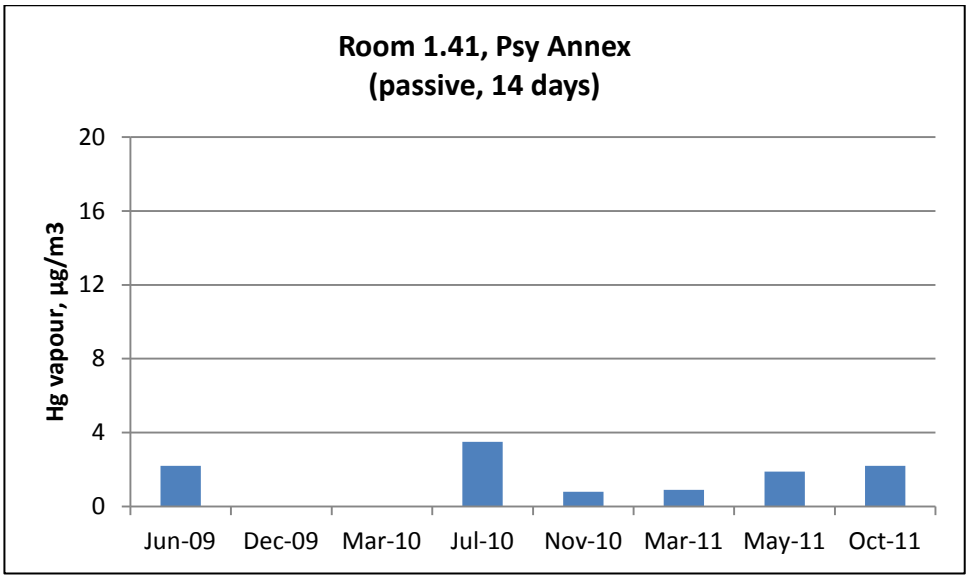

| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| n/a | Jun-09 | n/a |
| 09134/09 | Dec-09 | 7.5 |
| 02654/10 | Mar-10 | 7.86 |
| 06359/10 | Jul-10 | 12.8 |
| 09294/10 | Nov-10 | 1.6 |

Room 1.41A



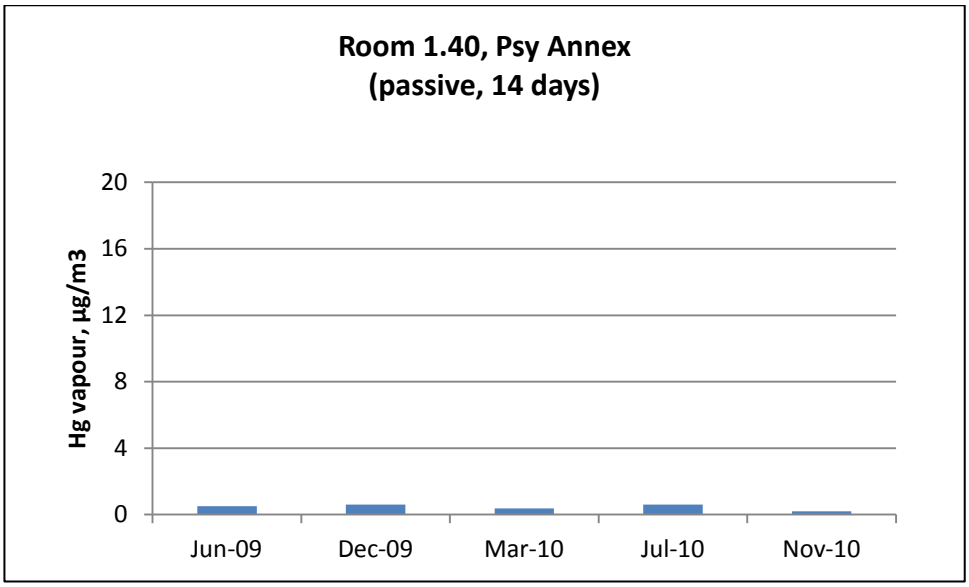

| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03866/09 | Jun-09 | 2.2 |
| n/a | Dec-09 | n/a |
| n/a | Mar-10 | n/a |
| 06389/10 | Jul-10 | 3.5 |
| 09329/10 | Nov-10 | 0.9 |
| 01631/11 | Mar-11 | 1.1 |
| 03703/11 | May-11 | 2.1 |
| 07284/11 | Oct-11 | 3.3 |

Room 1.41



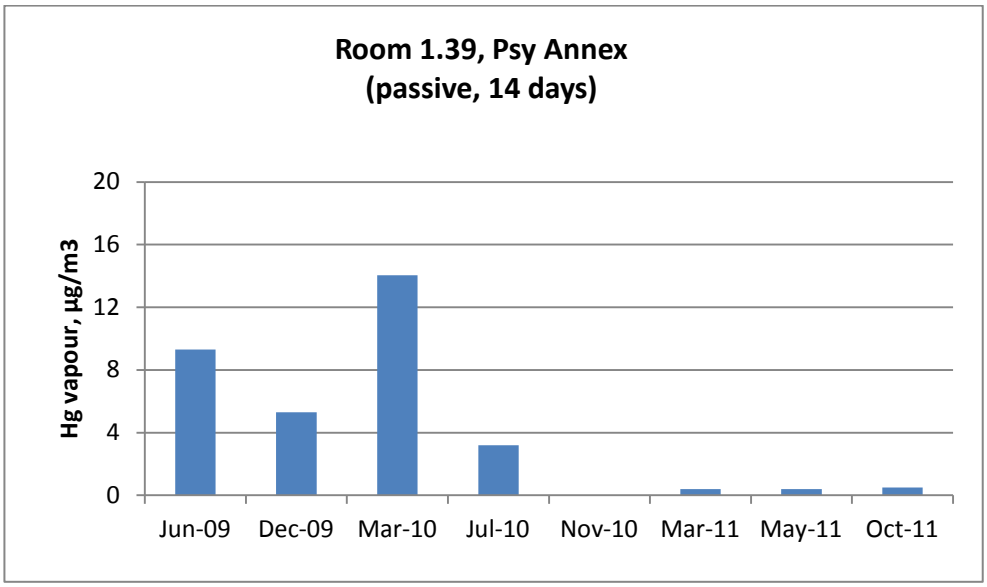

| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03866/09 | Jun-09 | 2.2 |
| n/a | Dec-09 | n/a |
| n/a | Mar-10 | n/a |
| 06389/10 | Jul-10 | 3.5 |
| 09327/10 | Nov-10 | 0.8 |
| 01630/11 | Mar-11 | 0.9 |
| 03702/11 | May-11 | 1.9 |
| 07283/11 | Oct-11 | 2.2 |

Room 1.40



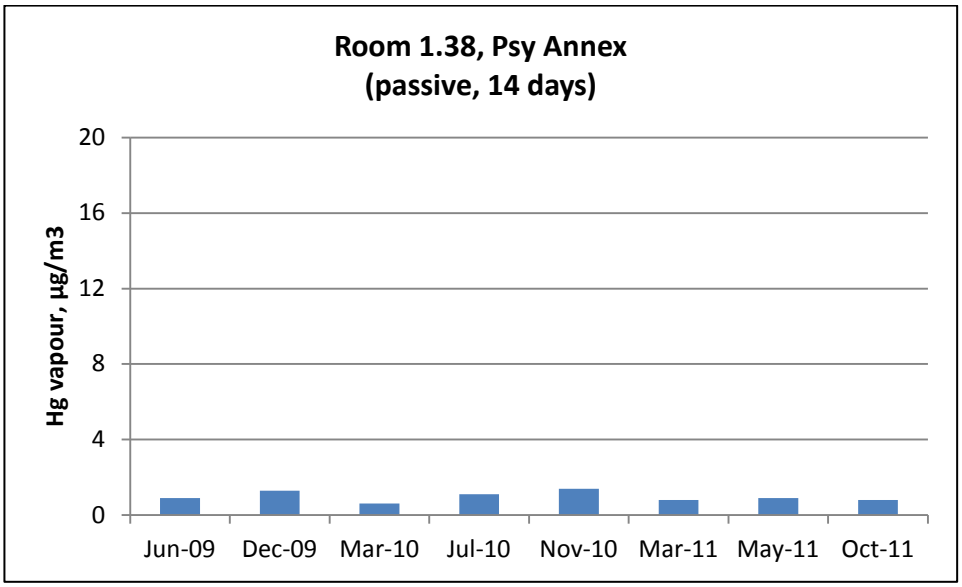

| HSL Sample number | Date | Concentration mercury in air (µg / m$^3$) |
|---|---|---|
| 03864/09 | Jun-09 | 0.5 |
| 09117/09 | Dec-09 | 0.6 |
| 02639/10 | Mar-10 | 0.37 |
| 06375/10 | Jul-10 | 0.6 |
| 09326/10 | Nov-10 | 0.2 |

Room 1.39



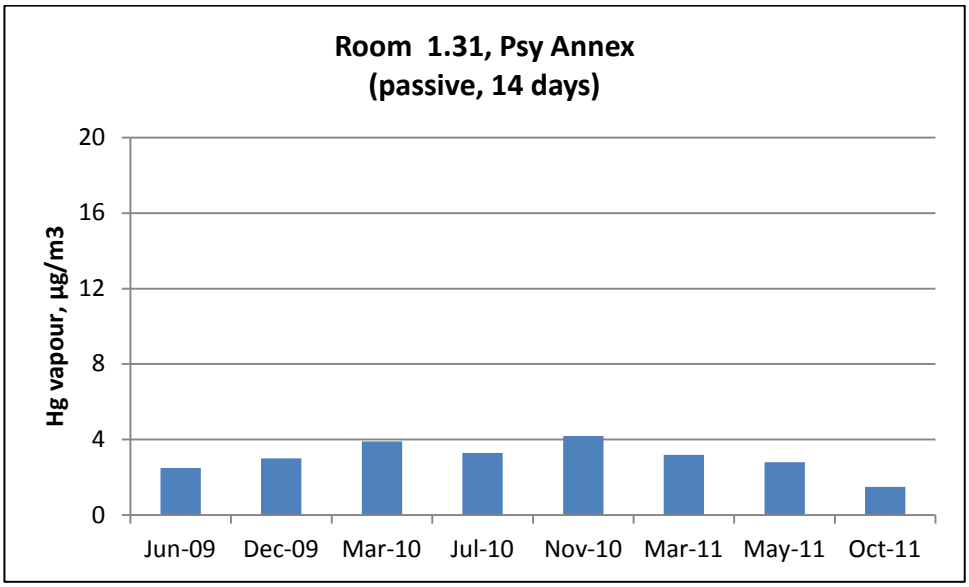

| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03863/09 | Jun-09 | 9.3 |
| 09119/09 | Dec-09 | 5.3 |
| 02648/10 | Mar-10 | 14.04 |
| 06373/10 | Jul-10 | 3.2 |
| n/a | Nov-10 | n/a |
| 01629/11 | Mar-11 | 0.4 |
| 03701/11 | May-11 | 0.4 |
| 07282/11 | Oct-11 | 0.5 |

Room 1.38




| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03862/09 | Jun-09 | 0.9 |
| 09120/09 | Dec-09 | 1.3 |
| 02642/10 | Mar-10 | 0.61 |
| 06374/10 | Jul-10 | 1.1 |
| 09323/10 | Nov-10 | 1.4 |
| 01628/11 | Mar-11 | 0.8 |
| 03700/11 | May-11 | 0.9 |
| 07281/11 | Oct-11 | 0.8 |

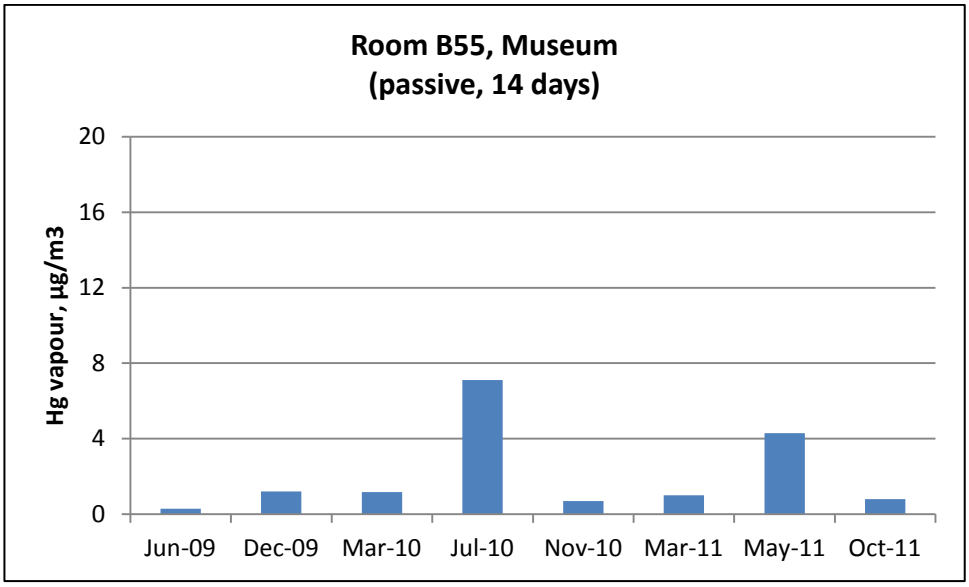
Room 1.31




| HSL Sample number | Date | Concentration mercury in air (µg / m$^3$) |
|---|---|---|
| 03847/09 | Jun-09 | 2.5 |
| 09116/09 | Dec-09 | 3.0 |
| 02633/10 | Mar-10 | 3.9 |
| 06377/10 | Jul-10 | 3.3 |
| 09314/10 | Nov-10 | 4.2 |
| 01627/11 | Mar-11 | 3.2 |
| 03699/11 | Nay-11 | 2.8 |
| 07280/11 | Oct-11 | 1.5 |

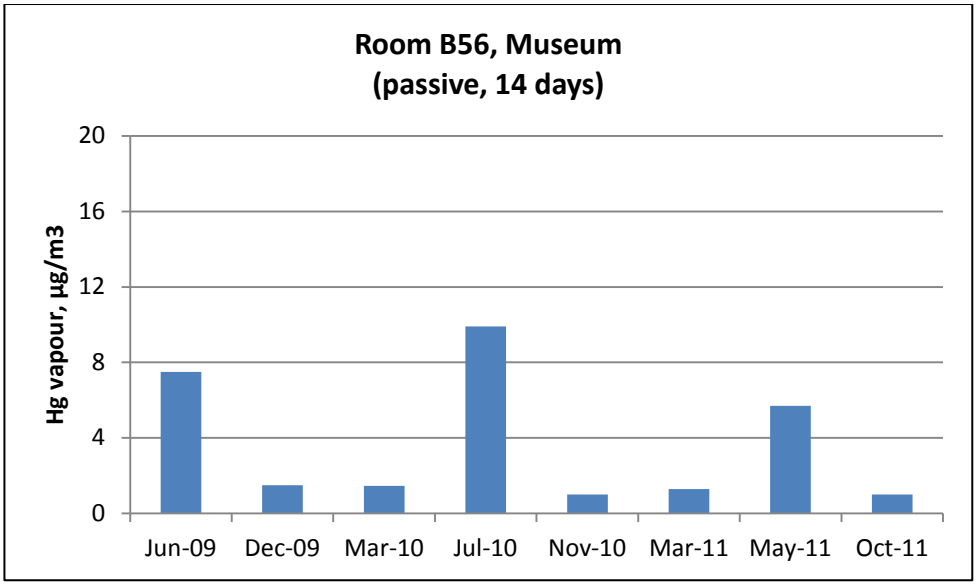
Manchester Museum

Room B55



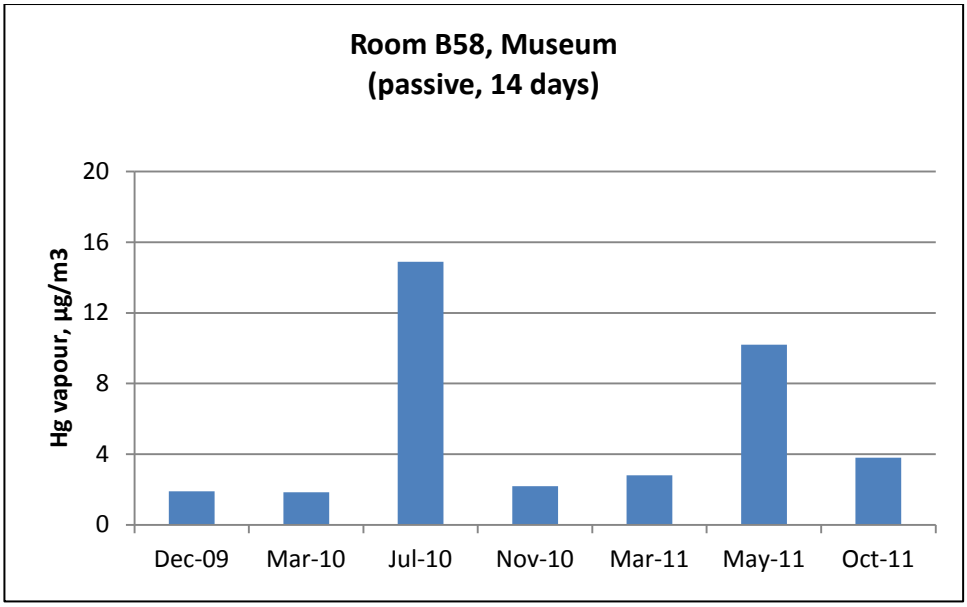

| HSL Sample number | Date | Concentration mercury in air (µg / m$^3$) |
|---|---|---|
| 03791/09 | Jun-09 | 0.3 |
| 09109/09 | Dec-09 | 1.2 |
| 02637/10 | Mar-10 | 1.18 |
| 06366/10 | Jul-10 | 7.1 |
| 09303/10 | Nov-10 | 0.7 |
| 01623/11 | Mar-11 | 1.0 |
| 03694/11 | May-11 | 4.3 |
| 07275/11 | Oct-11 | 0.8 |

Room B56



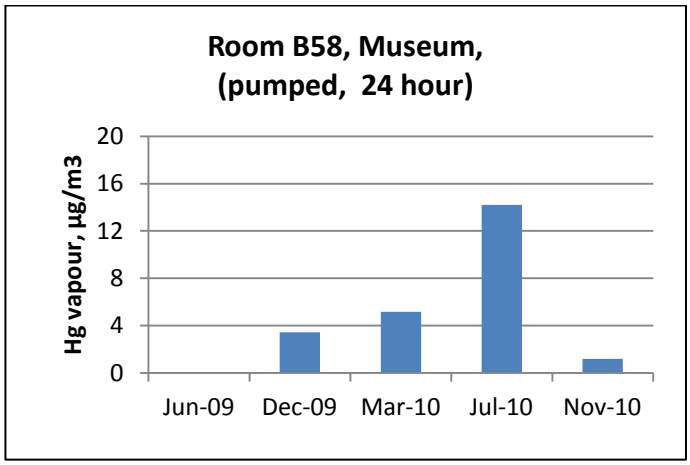

| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03792/09 | Jun-09 | 7.5 |
| 09110/09 | Dec-09 | 1.5 |
| 02636/10 | Mar-10 | 1.46 |
| 06367/10 | Jul-10 | 9.9 |
| 09304/10 | Nov-10 | 1.0 |
| 01622/11 | Mar-10 | 1.3 |
| 03693/11 | May-11 | 5.7 |
| 07274/11 | Oct-11 | 1.0 |

Room B58

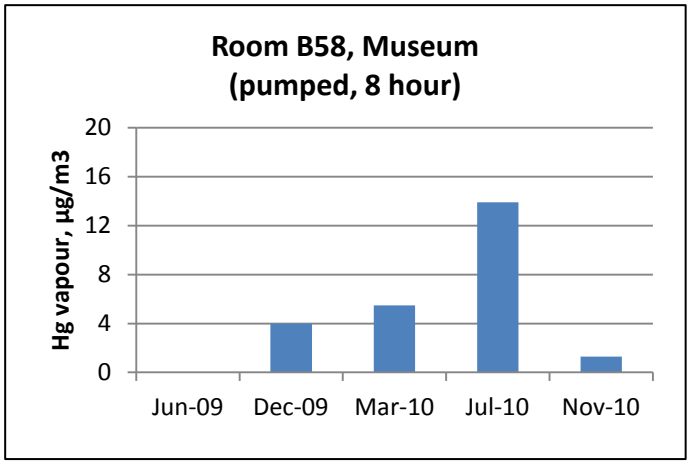



| HSL Sample number | Date | Concentration mercury in air ($\mu g / m^3$) |
|---|---|---|
| n/a | Jun-09 | n/a |
| 09111/09 | Dec-09 | 1.9 |
| 02640/10 | Mar-10 | 1.85 |
| 06364/10 | Jul-10 | 14.9 |
| 09306/10 | Nov-10 | 2.2 |
| 01621/11 | Mar-11 | 2.8 |
| 03692/11 | May-11 | 10.2 |
| 07273/11 | Oct-11 | 3.8 |

Room B58 (cont)

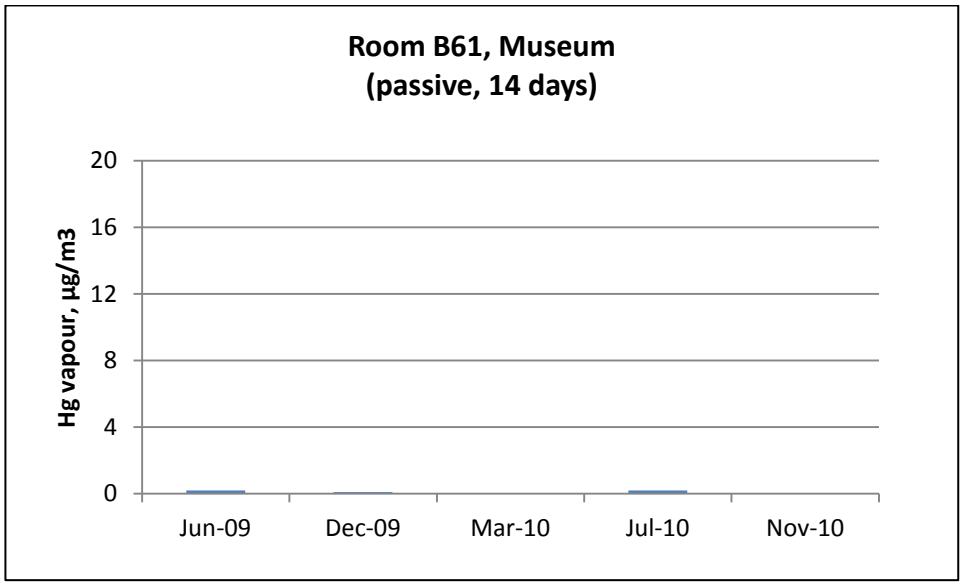



| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| n/a | Jun-09 | n/a |
| 09129/09 | Dec-09 | 3.44 |
| 02651/10 | Mar-10 | 5.18 |
| 06362/10 | Jul-10 | 14.2 |
| 09295/10 | Nov-10 | 1.2 |



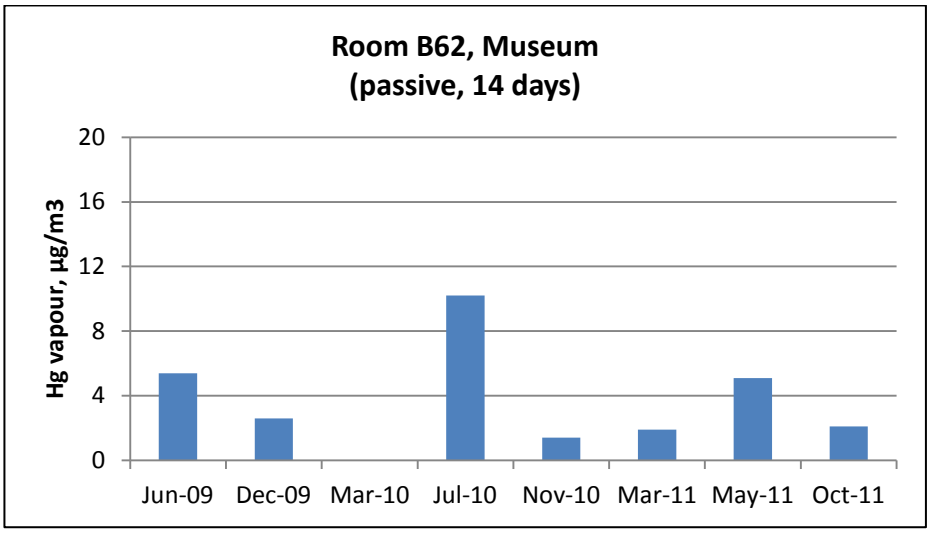

| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| n/a | Jun-09 | n/a |
| 9130/09 | Dec-09 | 4.0 |
| 02652/10 | Mar-10 | 5.49 |
| 06363/10 | Jul-10 | 13.9 |
| 09296/10 | Nov-10 | 1.3 |

Room B61



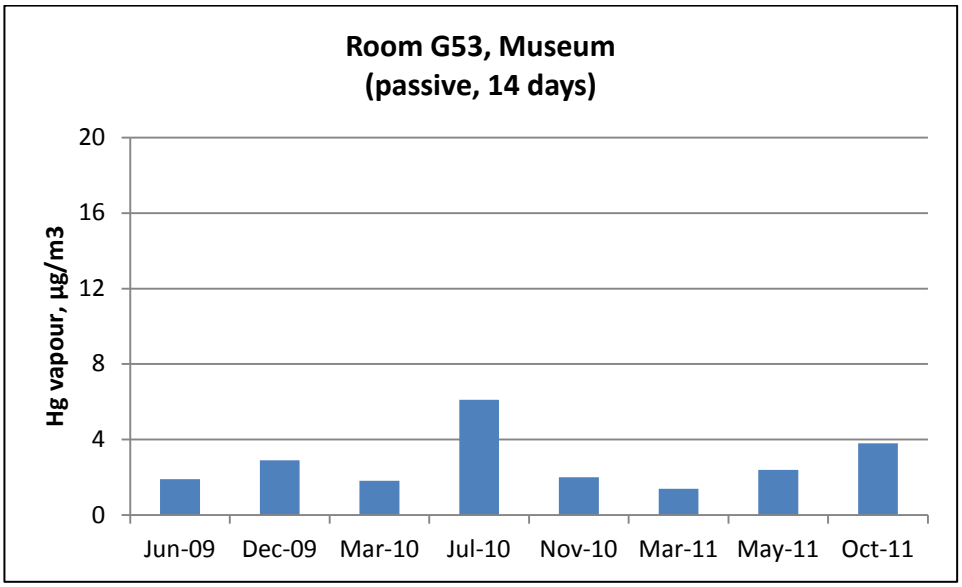

| HSL Sample number | Date | Concentration mercury in air (µg / m$^3$) |
|---|---|---|
| 03795/09 | Jun-09 | 0.2 |
| 09112/09 | Dec-09 | 0.1 |
| 02634/10 | Mar-10 | 0.05 |
| 06369/10 | Jul-10 | 0.2 |
| 09307/10 | Nov-10 | 0.0 |

Room B62



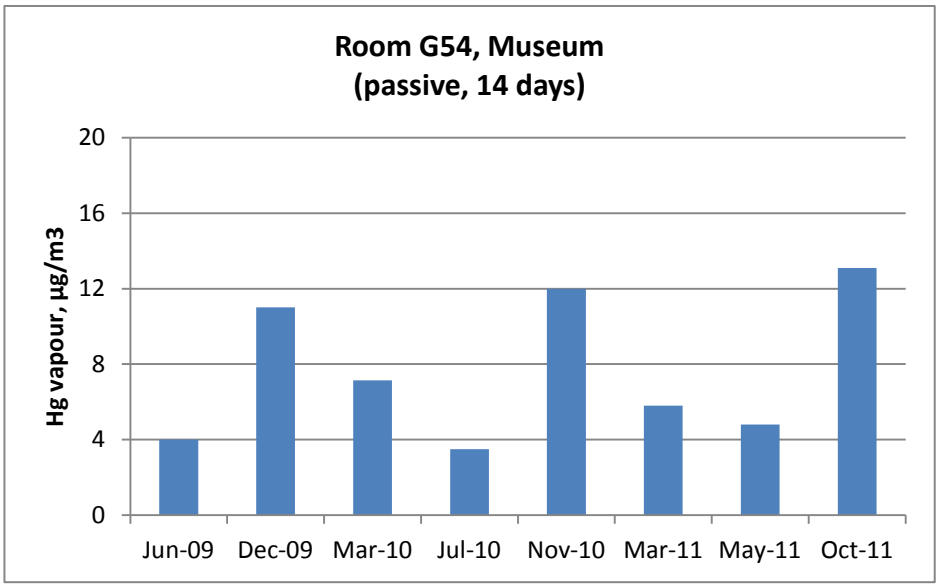

| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03796/09 | Jun-09 | 5.4 |
| 09113/09 | Dec-09 | 2.6 |
| n/a | Mar-10 | n/a |
| 06365/10 | Jul-10 | 10.2 |
| 09308/10 | Nov-10 | 1.4 |
| 01625/11 | Mar-11 | 1.9 |
| 03695/11 | May-11 | 5.1 |
| 07276/11 | Oct-11 | 2.1 |

Room G53




| HSL Sample number | Date | Concentration mercury in air (µg/m$^3$) |
|---|---|---|
| 03815/09 | Jun-09 | 1.9 |
| 09114/09 | Dec-09 | 2.9 |
| 02632/10 | Mar-10 | 1.81 |
| 06371/10 | Jul-10 | 6.1 |
| 09301/10 | Nov-10 | 2.0 |
| 01625/11 | Mar-11 | 1.4 |
| 03697/11 | May-11 | 2.4 |
| 07277/11 | Oct-11 | 3.8 |

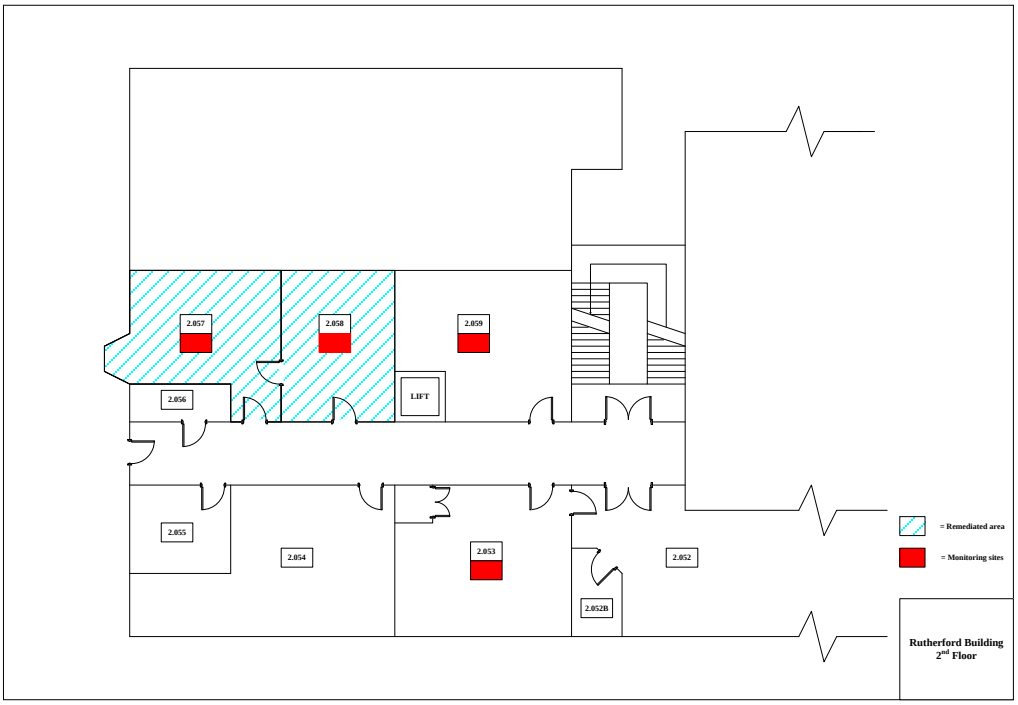
Room G54



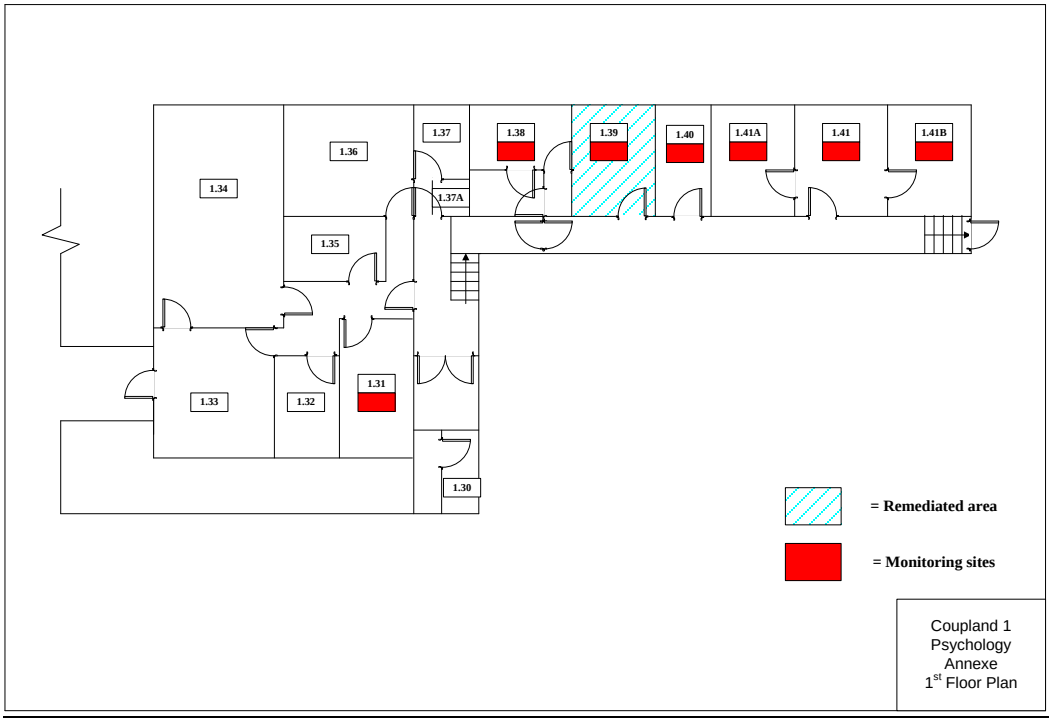

| HSL Sample number | Date | Concentration mercury in air (µg / m$^3$) |
|---|---|---|
| 03816/09 | Jun-09 | 4.0 |
| 09115/09 | Dec-09 | 11.0 |
| 02631/10 | Mar-10 | 7.14 |
| 06370/10 | Jul-10 | 3.5 |
| 09302/10 | Nov-10 | 12.0 |
| 01626/11 | Mar-11 | 5.8 |
| 03697/11 | May-11 | 4.8 |
| 07278/11 | Oct-11 | 13.1 |

# Appendix 4 : Floor Plans

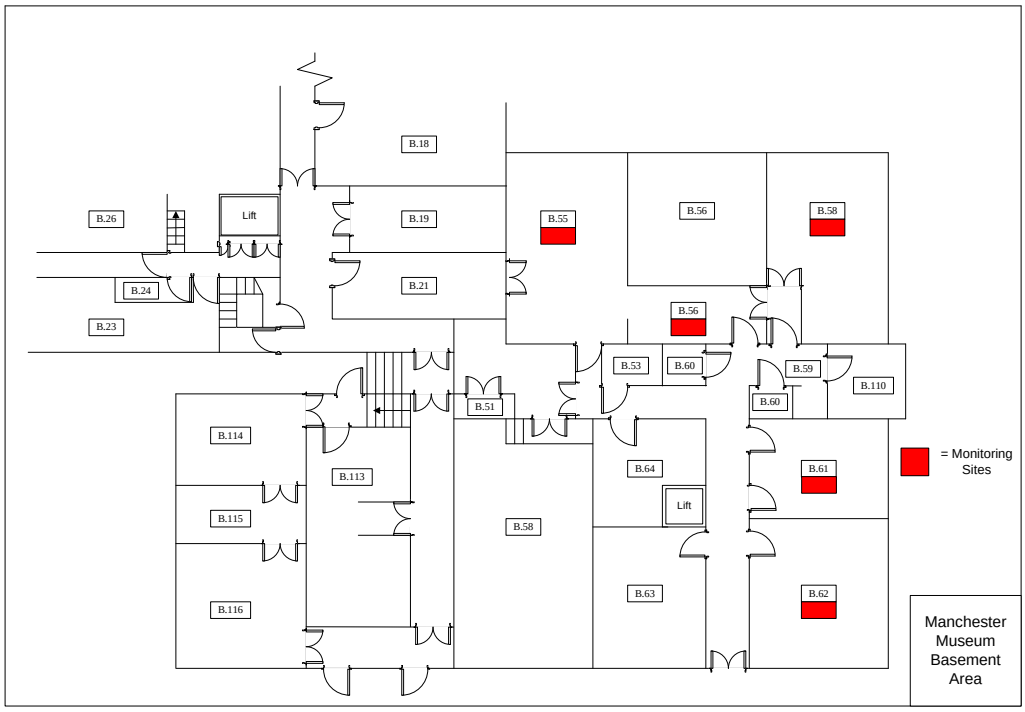
## Rutherford Building, 2nd floor.




## Psychology Annex, 1st floor.



## Manchester Museum, Basement




## Manchester Museum, Ground Floor.