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Groundwater Monitoring At Harwell

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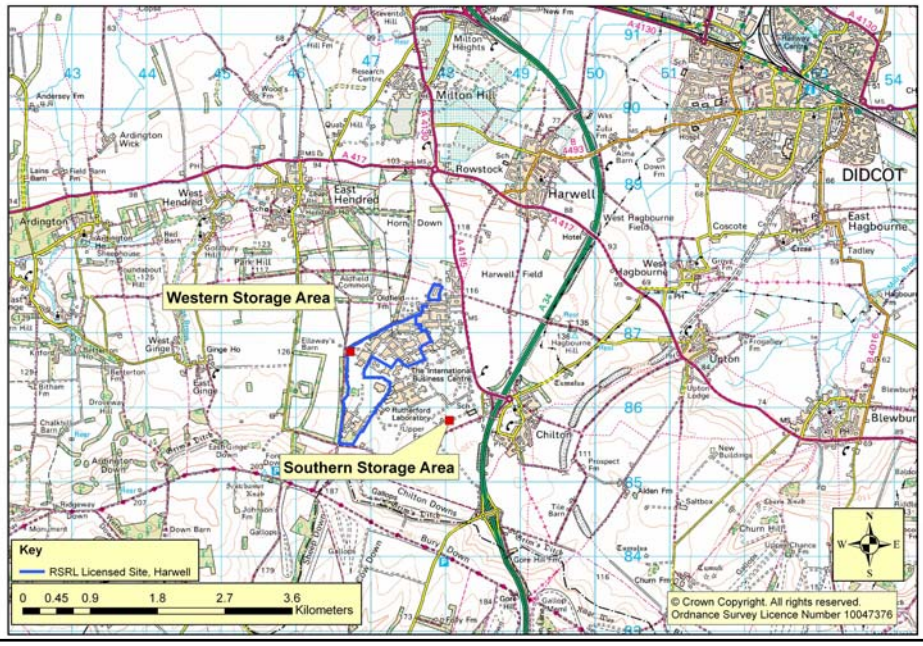
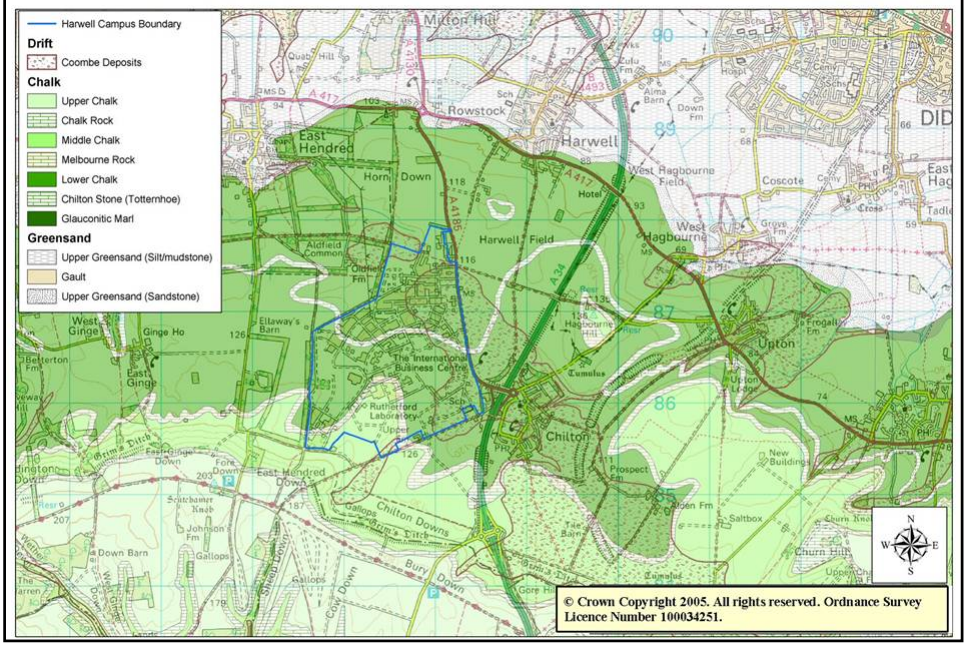
Overview

- Background
- Monitoring objectives
- Data overview
- Data management
- Conclusions

Site Location and Principal Sources



Geology (note - since updated by BGS)



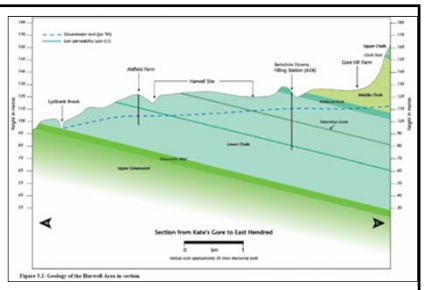
Sources of Organic Chemical Contamination In Groundwater

- Southern Storage Area (SSA) – former RAF munitions store
  - 6 unlined chemical pits
  - 4 te solvents?
  - Late 1940s to 1970s
- Western Storage Area (WSA)
  - Licensed landfill
  - 25 unlined pits
  - 20+ te solvents?
  - 1970s to late 1980s
- Other minor sources
  - Stores soakway
  - Reactor site

Contamination Problem Detected

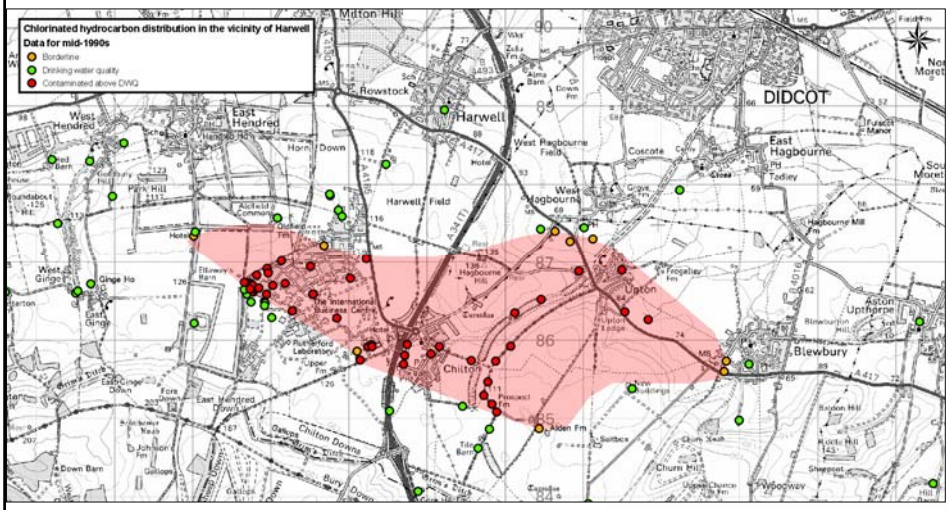
- 1989 - Carbon tetrachloride detected at drinking water standard at borehole 6 km from WSA
- Traced to the sources mentioned above
- Major programme immediately put in place by UKAEA, now managed by RSRL on behalf of NDA
- Early 1990s – BPEO study carried out, remediation strategy developed in consultation with stakeholders
- Borehole drilling started, monitoring started…

Main Findings from Initial Investigations

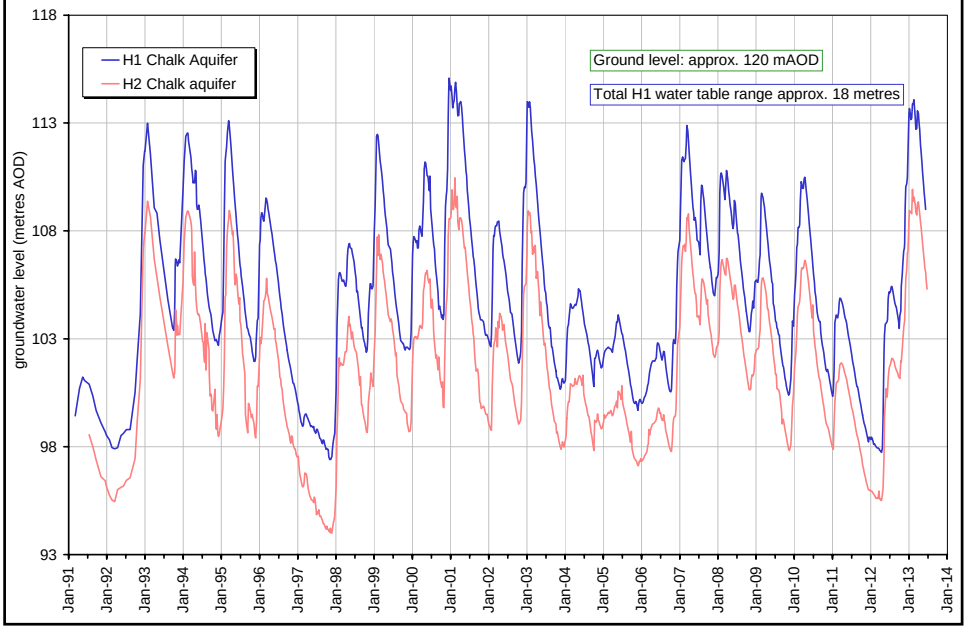


- Deep unsaturated zone
  - 5 to 23 m below ground level (bgl)
- Two distinct flow horizons in the Chalk
  - "H1" unconfined aquifer 0-30 m bgl
  - "L1" layer aquitard 3-5 m thick
  - "H2" confined aquifer to ~65 m bgl
- Seasonal changes in groundwater flow direction
- Contaminants of concern:
  - Overall plume – five core chlorinated solvents
    - Chloroform, carbon tetrachloride, tetrachloroethene, trichloroethene, 1,1,1-trichloroethane
  - At WSA:
    - PCBs
    - PAHs
    - No evidence of DNAPL
    - LNAPL (light oils) layer with high solvent concentrations - possibly prevented DNAPL penetration to deep aquifer
  - No evidence of radiological contamination

Contaminant Plume, mid 1990s



Groundwater Hydrographs HWS9 (unconfined) and HWS9A (confined)



Remediation Strategy

- **Receptors**: ensure contaminated water not consumed
- **Source (i)**: Southern Storage Area
  - Groundwater containment (until 2002)
  - Pit removal (completed 2002)
- **Source (ii)**: Western Storage Area
  - Groundwater containment: complete by 2025
  - Pit removal (completed 2005)
  - Unsaturated zone remediation (success means capping no longer required)
- **Pathway**: monitor water quality (jointly with EA)
- Stakeholder communications
- Objective:
  - no more active remediation after 2025

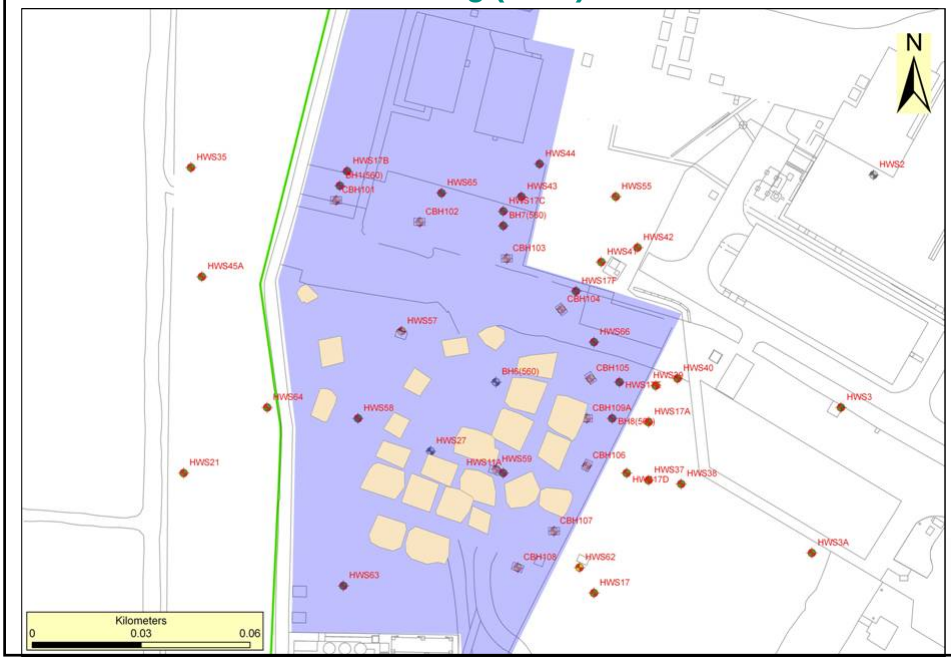
Monitoring Network: Pre-1990 Boreholes

- Some existing boreholes on site:
  - WSA “OCC” series - monitoring standard landfill parameters, not VOCs etc (in spite of overpowering solvent smells!)
  - B175 series (investigation of radiological land quality issue)
  - 10 or so others for unknown purposes
  - Site water supply borehole
  - Eight drilled by IGS in early 1980s - deepest 551 m bgl!
- Most of these have limitations – eg wrong depth, diameter, or place

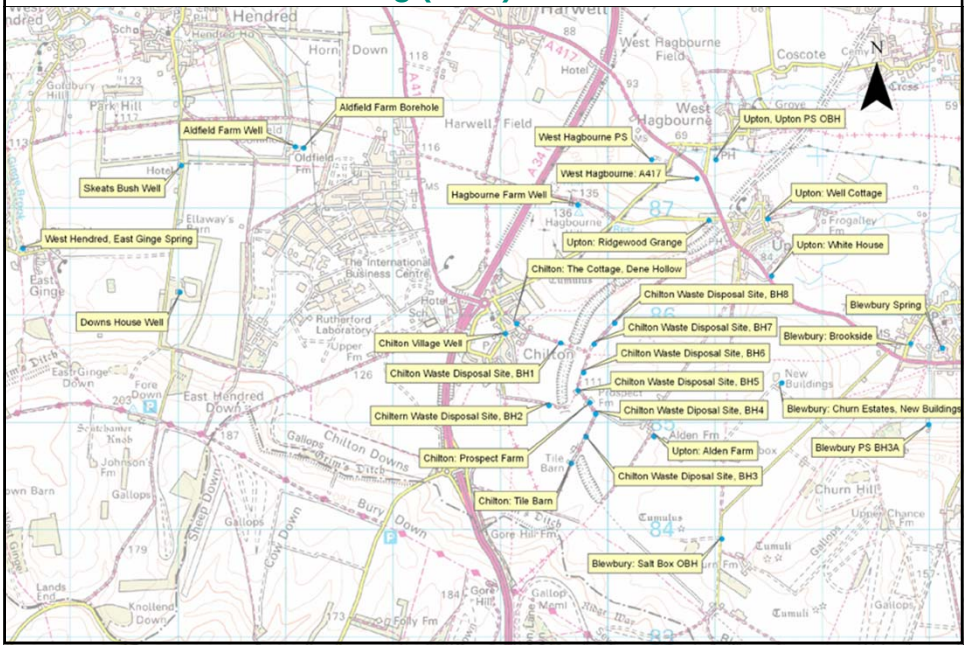
Monitoring Network 1990 onwards

- HWS series boreholes drilled specifically in relation to the chlorinated solvent issues
  - "A" suffix denotes boreholes with a response zone in the confined Chalk flow horizon
  - "G" suffix denotes Upper Greensand (4 boreholes)
- EA (as National Rivers Authority originally) set up off-site monitoring programme
  - includes water supply boreholes, wells, monitoring boreholes at nearby landfill, springs (many in wrong place, depth etc)
- Over 180 monitoring points have been used

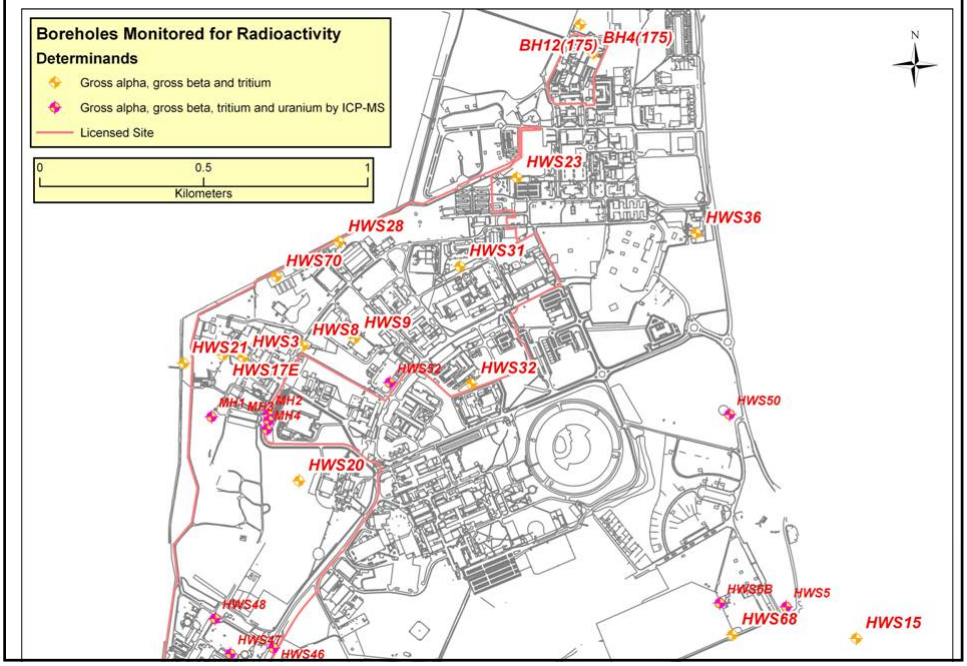
RSRL "On-Site" Monitoring (2013)



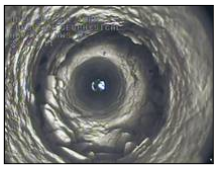
EA Off-Site Monitoring (2013)



Radiological Reassurance Monitoring (2013)



Monitoring Protocols



- Majority of boreholes large diameter (100-150 mm id), open hole in response zone
- Some more recent boreholes fully cased (sets of three at one location – unconfined Chalk, confined Chalk and Upper Greensand)
- All sampled with variable speed electric submersibles (Grundfos MP1 or SQ), throttled back for sampling
- Purge for 3 well volumes
- Purge water passed through mobile GAC filter system
- Samples for chemical analysis stored at 4ºC
- Samples for RA filtered using in line 0.45µm filter

Monitoring Objectives

- Initial focus on:
  - Defining the problem: sources; geology; hydrogeology; geophysics; contaminant types and distribution (in 3 dimensions)
  - Designing remediation schemes
  - Receptor management
- As programme develops:
  - Performance monitoring of remediation projects
  - Is the plume shrinking – WFD, MNA
  - Reassurance monitoring for radioactivity in groundwater
  - Inform decommissioning projects
  - Inform de-licensing case, de-designation and new build projects (eg Diamond, Chestnut Field Housing)
  - Focus shifting to off site plume

The End Points

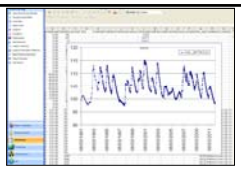
Both of these required backfilling and/or replacement of boreholes

Monitoring Regime

	Water Levels	Chemicals	Radioactivity
Weekly	10 boreholes across site	14 Hydraulic containment plant boreholes	None
Quarterly	32 RSRL boreholes mainly close to WSA and SSA, plus EA		None
Six Monthly	96 RSRL boreholes	91 RSRL boreholes, plus EA	27 boreholes

- All aspects have been subject to periodic review
- Chemical sampling was 2-monthly
- RA sampling was quarterly
- Gradual removal of boreholes from programme if no longer relevant to monitoring objectives
- 8 new boreholes added in off-site

Data Management



- Initial data checking and collation using spreadsheets
- Data sent to hydrogeological consultant (AMEC) for use in preparing reports
- AMEC also obtain data from EA
- AMEC compile data in Access database – this is sent to RSRL and the EA, with 6-montly updates
- Data are also uploaded in the IMAGES database used by RSRL for decommissioning and de-licensing information management
- Frequency of meetings, reports etc reviewed to match objectives, stakeholder requirements

Conclusions

- Mature programme, subject to periodic review – objectives change over time
- Have aimed to keep it cost effective – eg limited modelling, use of loggers.
- Focus on what we are trying to achieve – not an R&D project
- Future work will include:
  - Design of monitoring to support land remediation projects
  - Ongoing challenge of scope
  - Ensuring ongoing access to boreholes outside RSRL site
  - Monitoring scheduled to continue to end of Harwell decommissioning and beyond - planning for post NDA?