NAPL: does it matter?

What can we learn from the last 15 years – A review of UK case studies

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ERM UK

The business of sustainability

ERM

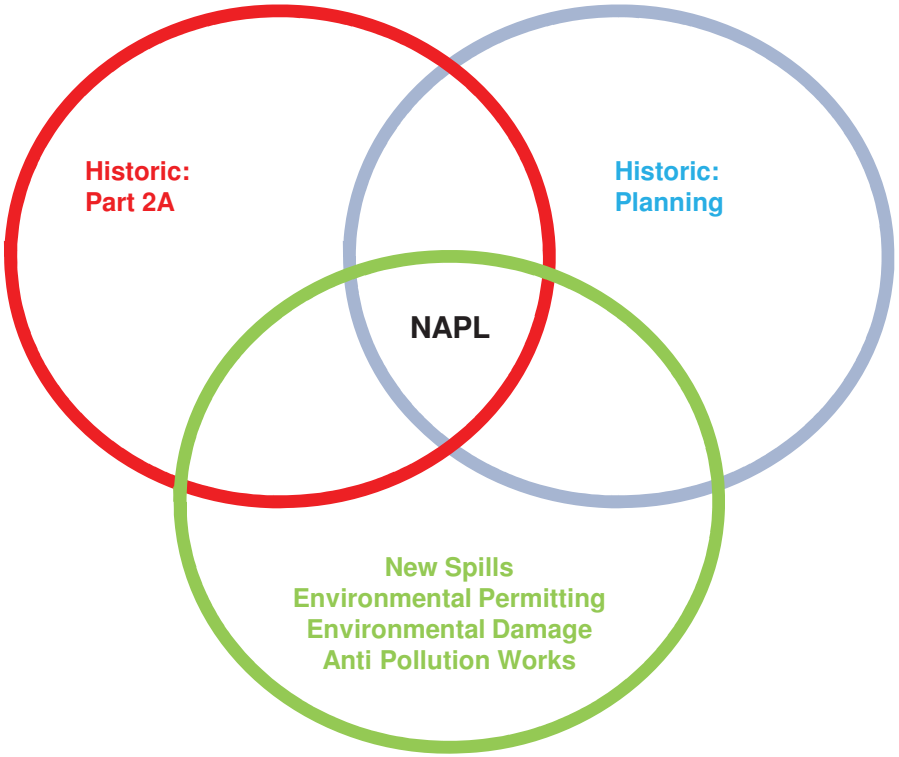
Today's talk

- Legislative context
- The database
  - Site Characteristics
  - Remedial Drivers
  - Remedial Endpoints
  - Remedial Technologies
- Conclusions
- Did NAPL Matter?

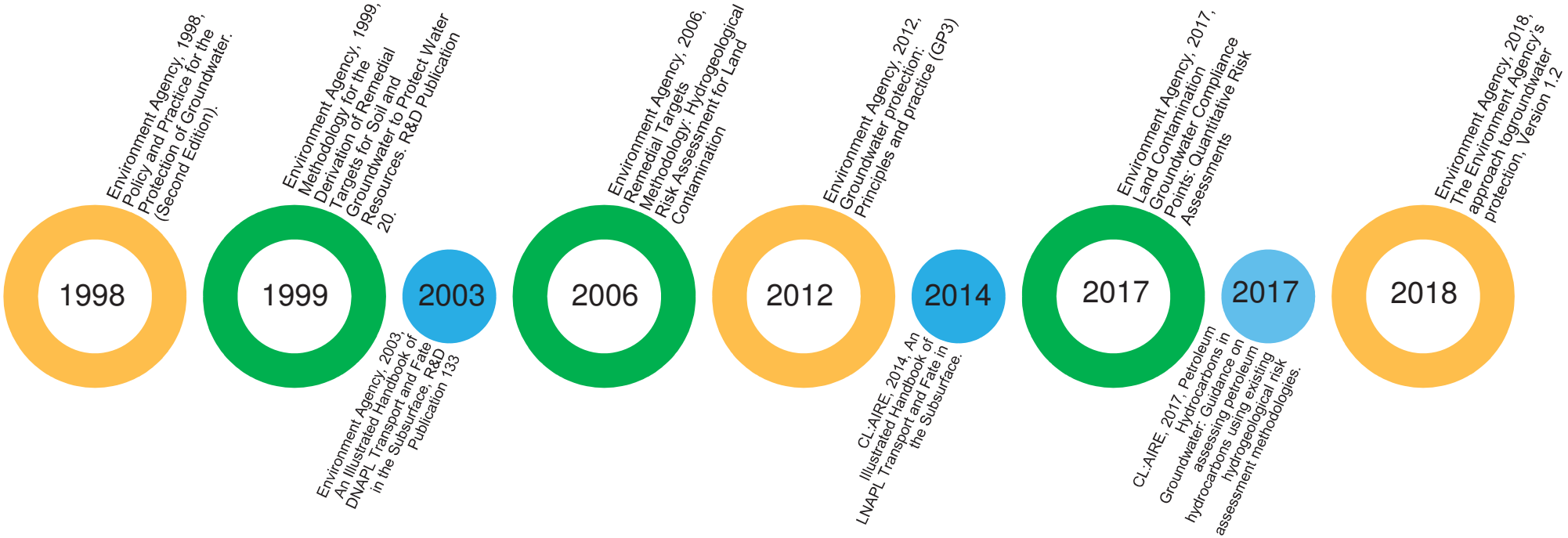
NAPL: Does it Matter ?

Legislative context in England & Wales

Where does NAPL fit within the Contaminated Land Regime ?



NAPL Regulations & Guidance Key documents



P20 1999

Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources

P. A. Marsland and M. A. Carey

Research Contractor:
Aspinwall & Company

Environment Agency
Rio House
Waterside Drive
Aztec West
Almondsbury
Bristol
BS32 4UD

Environment Agency R&D Publication 20

5.4 Free product or non-aqueous phase liquid (NAPL)

A common problem that may need to be assessed is where the source of contamination is either free product floating on the water table (LNAPL) or more dense material present below the water table (DNAPL). The free product may represent a direct risk to the receptor via its movement through the saturated zone, or an indirect risk due to its solution and subsequent transport (dissolved phase) to the receptor. The assessment will need to consider both cases. If free product is considered to represent a direct risk to an identified receptor, then remedial action will generally be required. Where solution and transport by groundwater needs to be assessed, then the remedial target is determined for groundwater in direct contact with the free product.

Current Guidance

Land contamination groundwater compliance points: quantitative risk assessments
How to select compliance points for the assessment of risks to groundwater from land contamination.
Published 14 March 2017 Environment Agency

Manage the effect of non-aqueous phase liquids

If your site has mobile non-aqueous phase liquids (NAPLs) that are present on or below the water table, the Environment Agency considers the source of contamination to have already entered groundwater.

In these cases, you should follow the requirements for setting compliance points and:

- minimise further entry of hazardous substances to groundwater from the overlying unsaturated zone
- minimise expansion of the plume to prevent further pollution

NAPLs pose an indirect risk to receptors due to the dissolution of constituent compounds in groundwater and subsequent transport. Mobile NAPLs may also represent a direct risk to receptors via movement through the unsaturated or saturated zone providing a secondary source of contamination.

You need to manage the contamination to ensure you:

- remove or control mobile NAPL where its migration could present an unacceptable risk
- remove or control residual NAPL where its dissolution or volatilisation could present an unacceptable risk
- remediate dissolved phase or vapour phase hydrocarbons where they could create an unacceptable risk

Published 14 March 2017

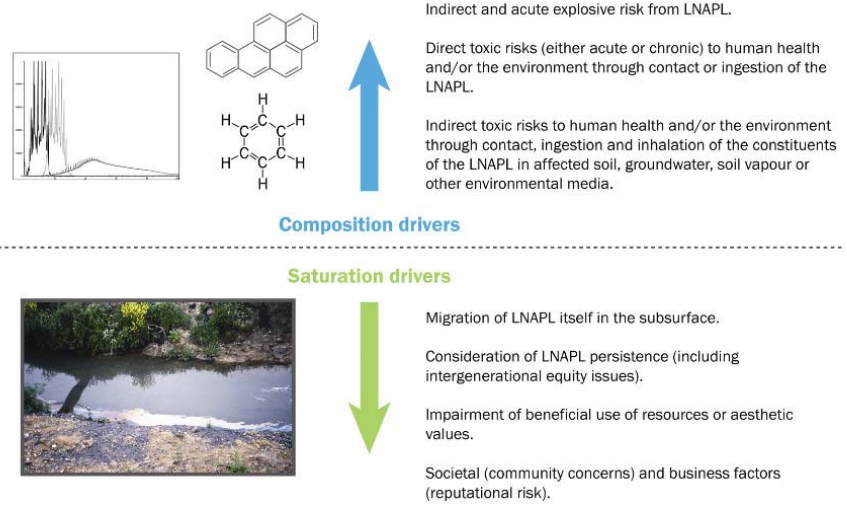


Figure 7.1. Examples of remediation drivers at LNAPL sites (adapted from ITRC (2009a) and Johnston (2010); photograph courtesy of M.O. Rivett).

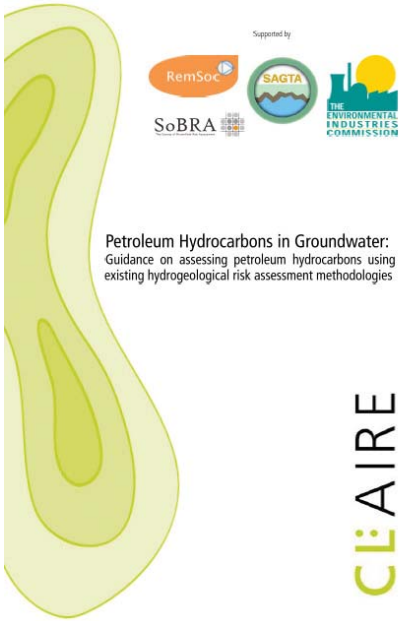
From - CL:AIRE 2014 LNAPL Handbook

https://www.gov.uk/guidance/land-contamination-groundwater-compliance-points-quantitative-risk-assessments

Current Guidance

Where NAPL is present, the risk assessment should consider:

- Whether the NAPL is expanding, steady or declining;
- Likelihood and causes of movement of mobile NAPL;
- Significance and likely longevity of dissolved-phase contamination arising from mobile and / or residual NAPL;
- Potential for VOC emissions from NAPL;
- Potential for depletion of the LNAPL source over time, leading to a declining source concentration (e.g. Thornton et al., 2013);
- Technical feasibility of NAPL remediation, including;
  - residual NAPL saturation in local geology;
  - theoretical NAPL removal efficiency;
  - theoretical mass removal achievable.
- Sustainability criteria – for example, the balance of environmental, social and economic impacts caused by attempts to remediate a NAPL source, versus the environmental, social and economic benefit of undertaking that remediation.



NAPL: Does it Matter ?

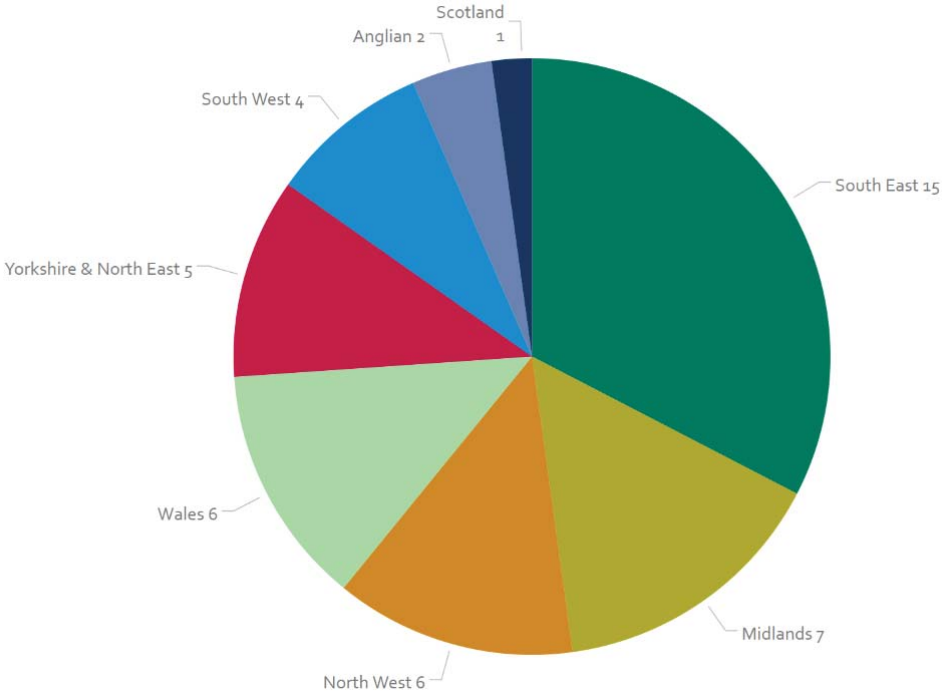
Case Studies

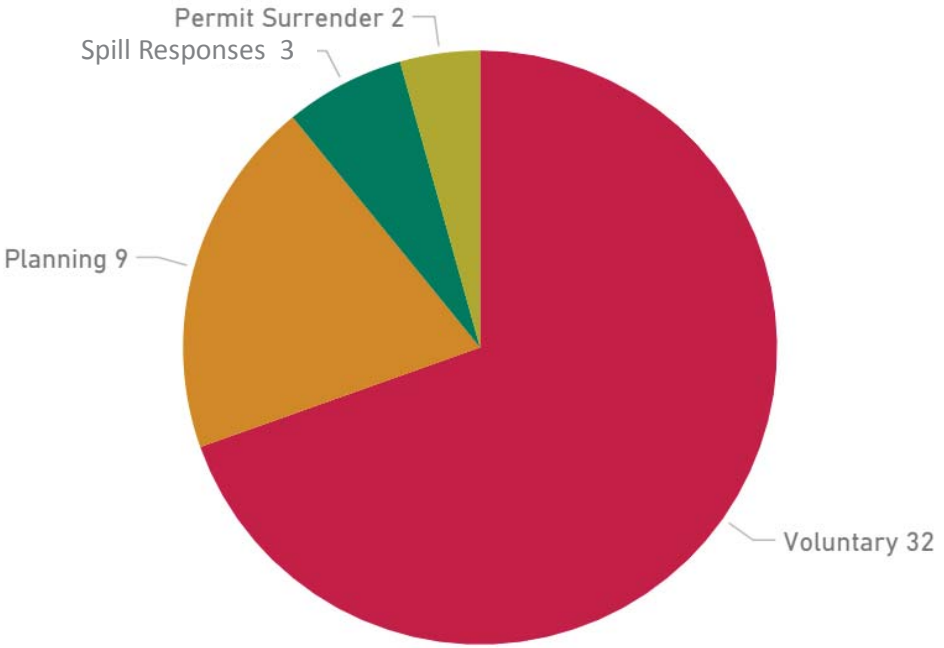
ERM NAPL Projects Review 2003 to 2019

- We surveyed our colleagues for all the ERM projects in the UK that have involved NAPL source areas since 2003, when the DNAPL Guidance was published
- IMPORTANT NOTE: we recognise ERM are not fully representative of the wider contaminated land businesses in the UK. ERM's clients are typically large, multi-national corporations, and only 10 of the 46 NAPL projects in the survey were for residential redevelopment
- Of the 46 separate NAPL projects recorded since 2003, 12 are ongoing to some extent and we have an additional three sites not included as there has been no regulatory agreement (in early stages)
- We present the results of this survey in the following four sections
  - What do NAPL sites look like?
  - What are the factors that drive remediation at NAPL sites?
  - What technologies were deployed?
  - ..to answer the question; **does NAPL matter**?

What do NAPL sites look like?

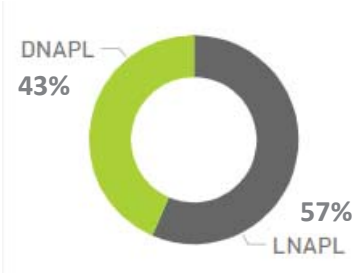
- these are not evenly spread across the UK – or across regulatory context…



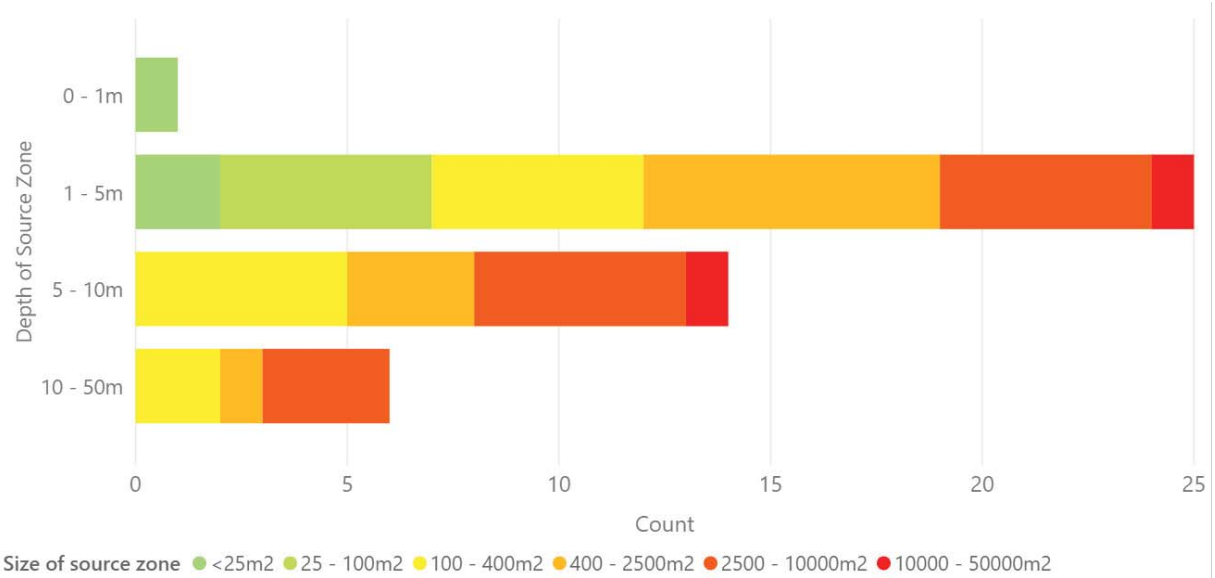


What do NAPL sites look like?

Light or Dense?



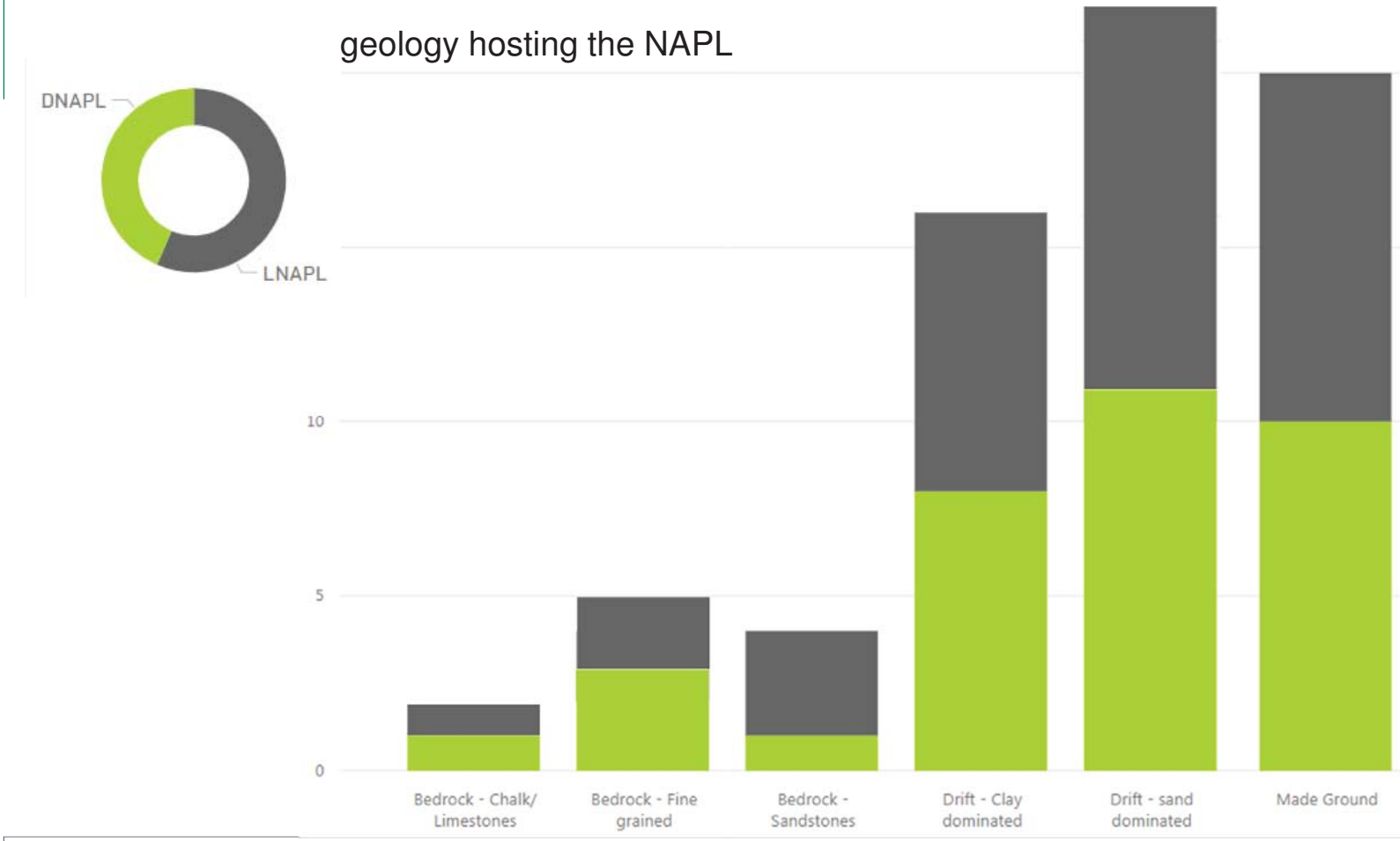
Depth and Area



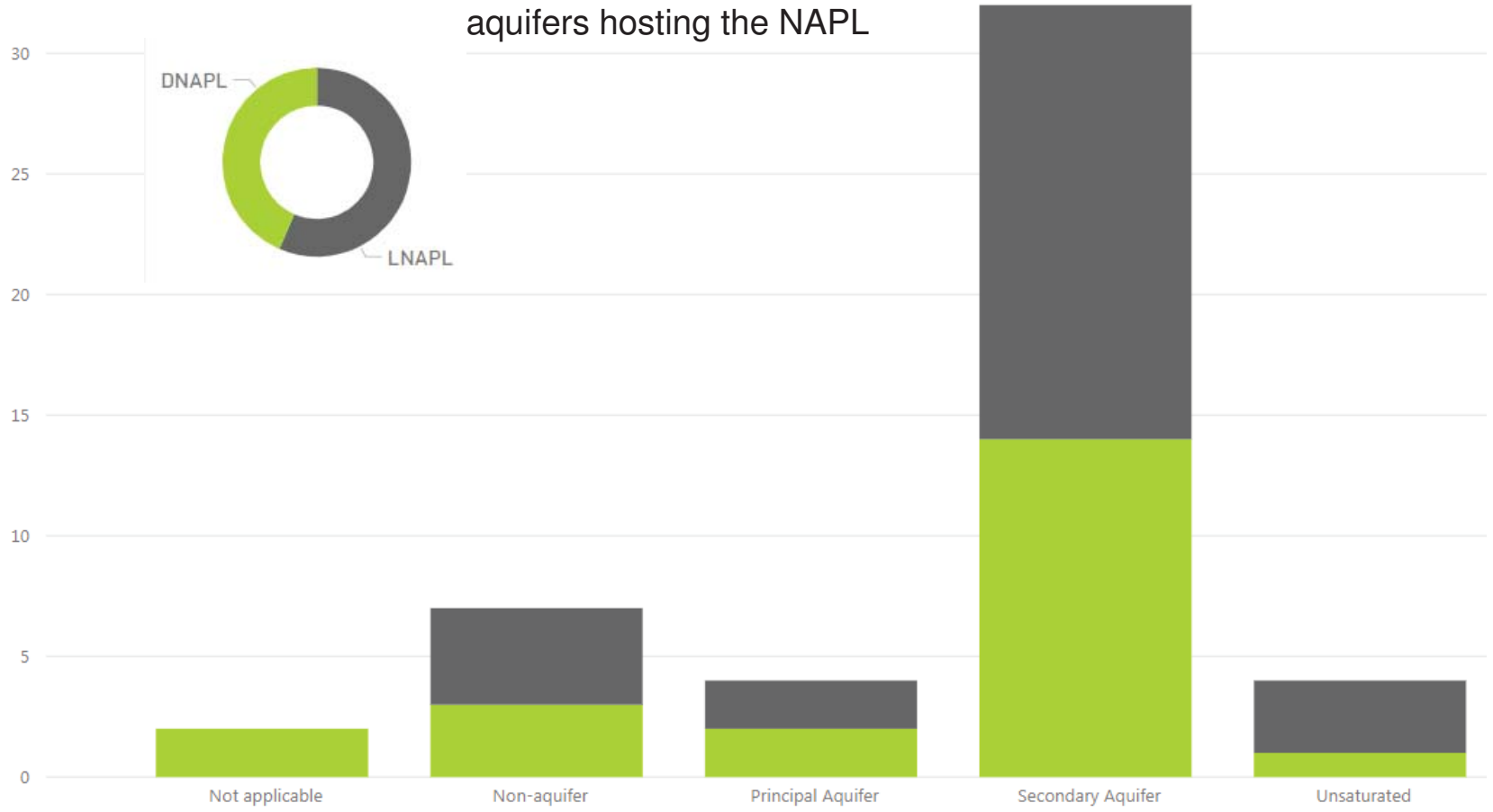
NAPL Composition

NAPL Composition	Count
Chlorinated Solvents	14
Mixed TPH overall a LNAPL	10
TPH - Light range	7
TPH - Middle range	7
Mixed overall a DNAPL	5
TPH - Heavy Range	2
Coal Tar	1

What do NAPL sites look like?

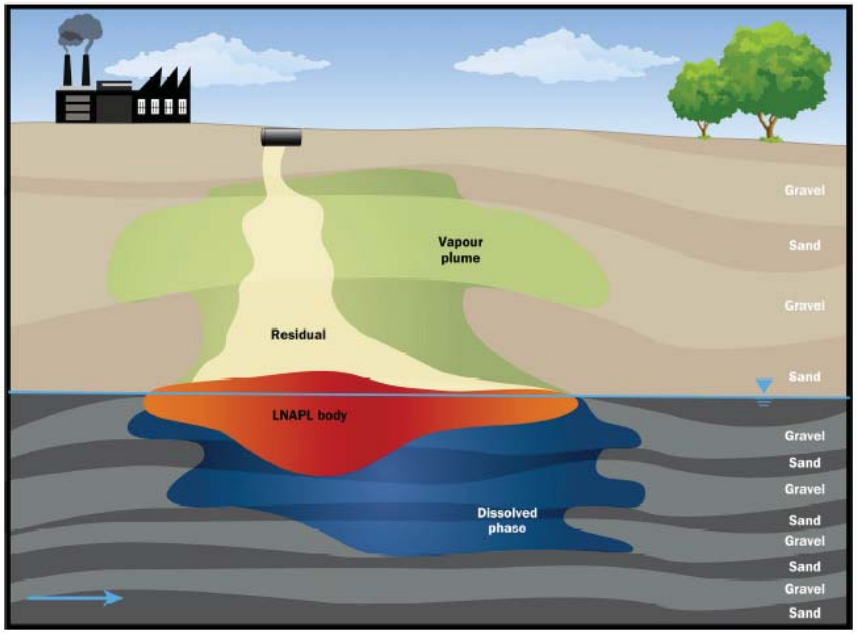


What do NAPL sites look like?



What do NAPL sites look like?

Typical ERM UK **LNAPL** Site is:



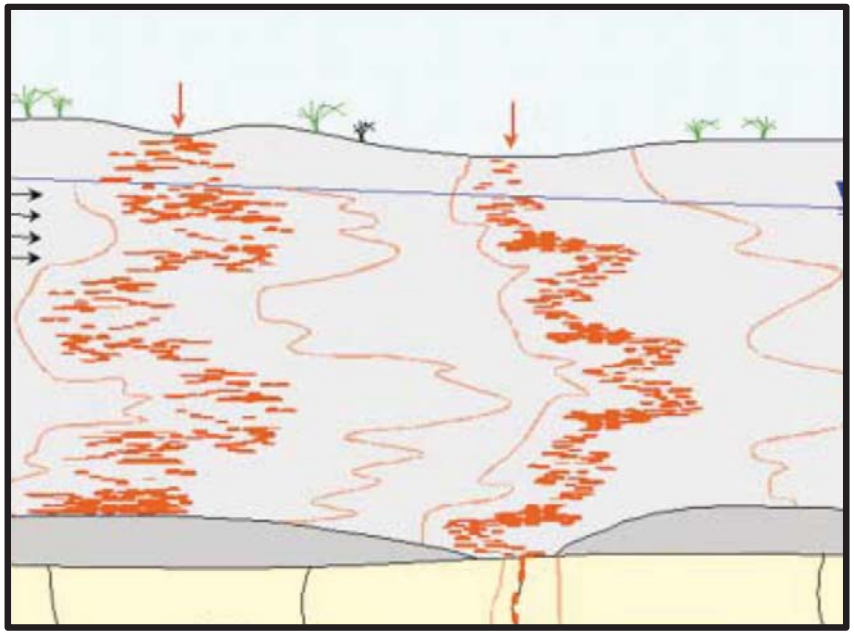
CL:AIRE, 2014. An illustrated handbook of LNAPL transport and fate in the subsurface. CL:AIRE, London. ISBN 978-1-905046-24-9. Download at www.claire.co.uk/LNAPL

- composed of a mix of TPH fractions. Light and medium TPH fractions also common
- at a depth of 1 to 5 m
- between 400 – 2,500 m^2 in plan view
- in Made Ground and Drift, more in sands than clays
- in a Secondary Aquifer

- Notable exceptions:
  - Very small, very shallow source area in fractured sandstones
  - Very large, very deep source area in very thick sands

What do NAPL sites look like?

Typical ERM UK **DNAPL** Site is:



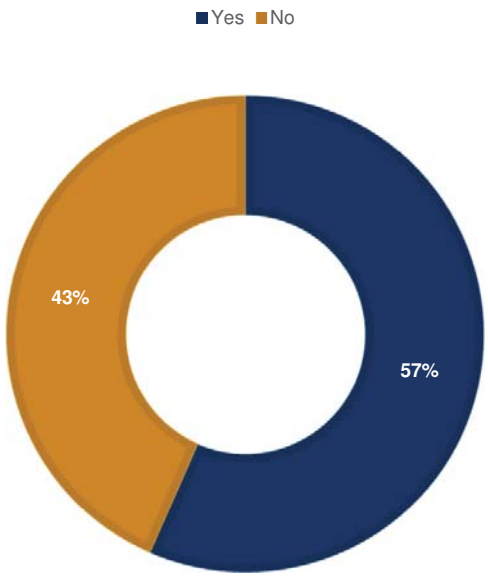
Environment Agency Illustrated handbook of DNAPL transport and fate in the subsurface
R&D133, 2003

- composed of chlorinated solvents
- extending to a depth of 5 to 10 m
- between 2,500 – 10,000 m^2 in plan view
- in Made Ground and Drift, more in sands than clays
- in a Secondary Aquifer

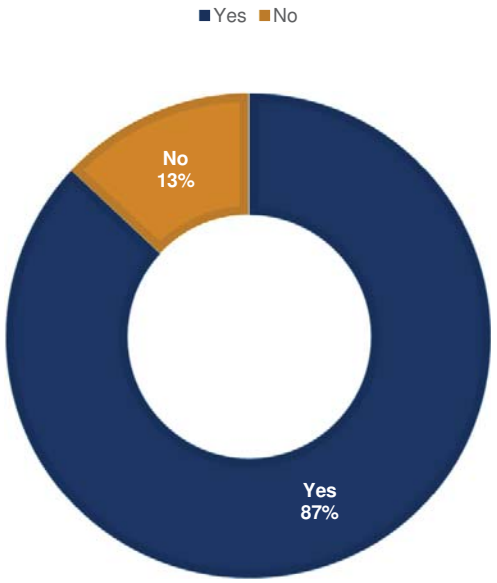
- Notable exceptions:
  - Small, shallow source area in clays
  - Very large, very deep source area in fine-grained fractured bedrock

Remedial Drivers

Was there a risk from NAPL?

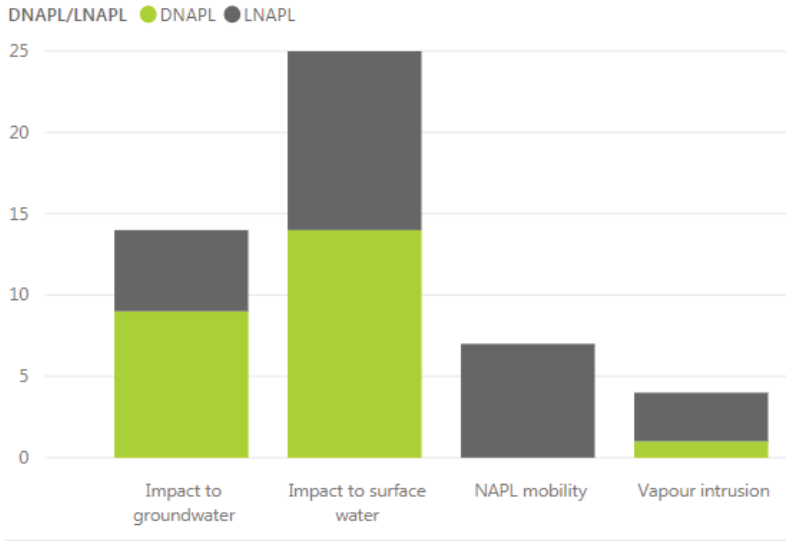


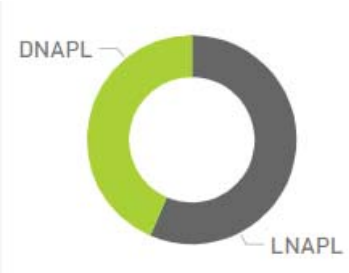
Was remediation of the NAPL undertaken?



What were the risk drivers at NAPL Sites?

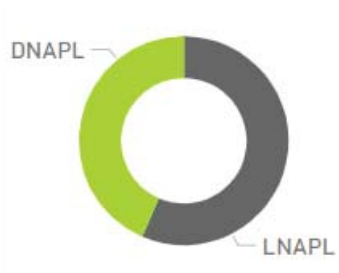
Typical ERM UK NAPL site risk driver is **impact to surface waters**:

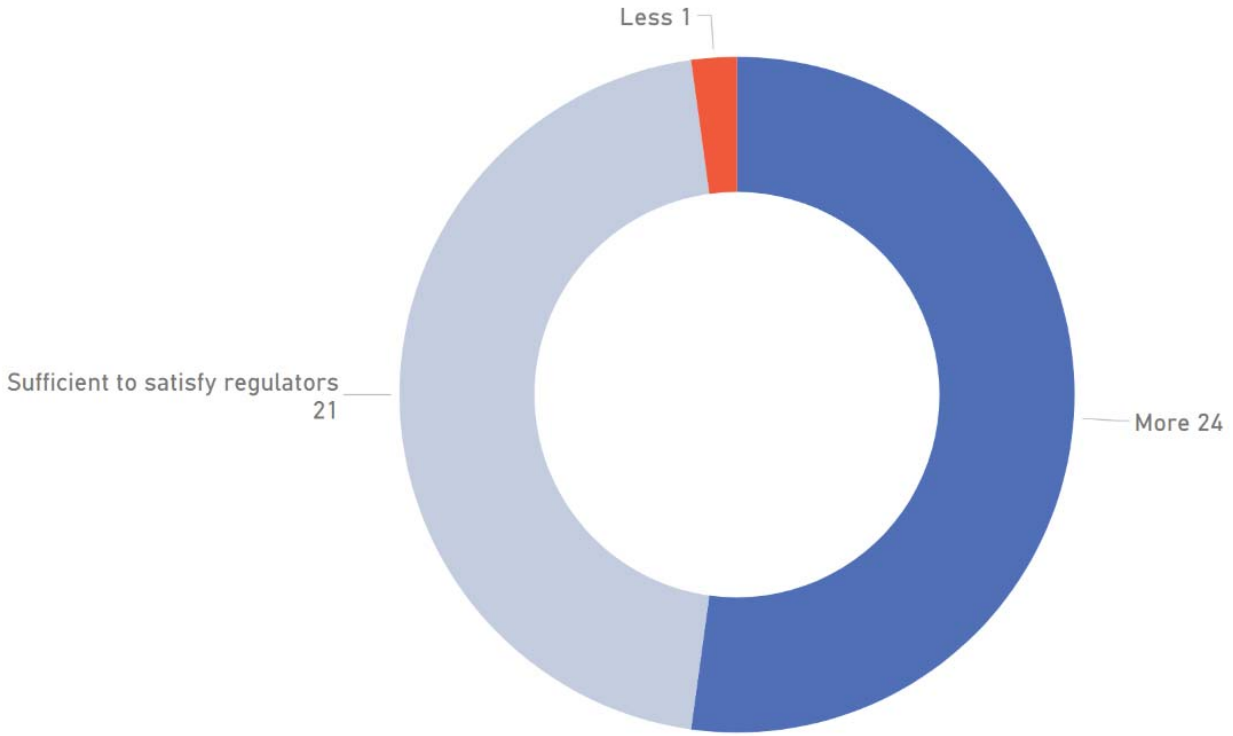




Also permit surrender and client perspective alone were remediation drivers

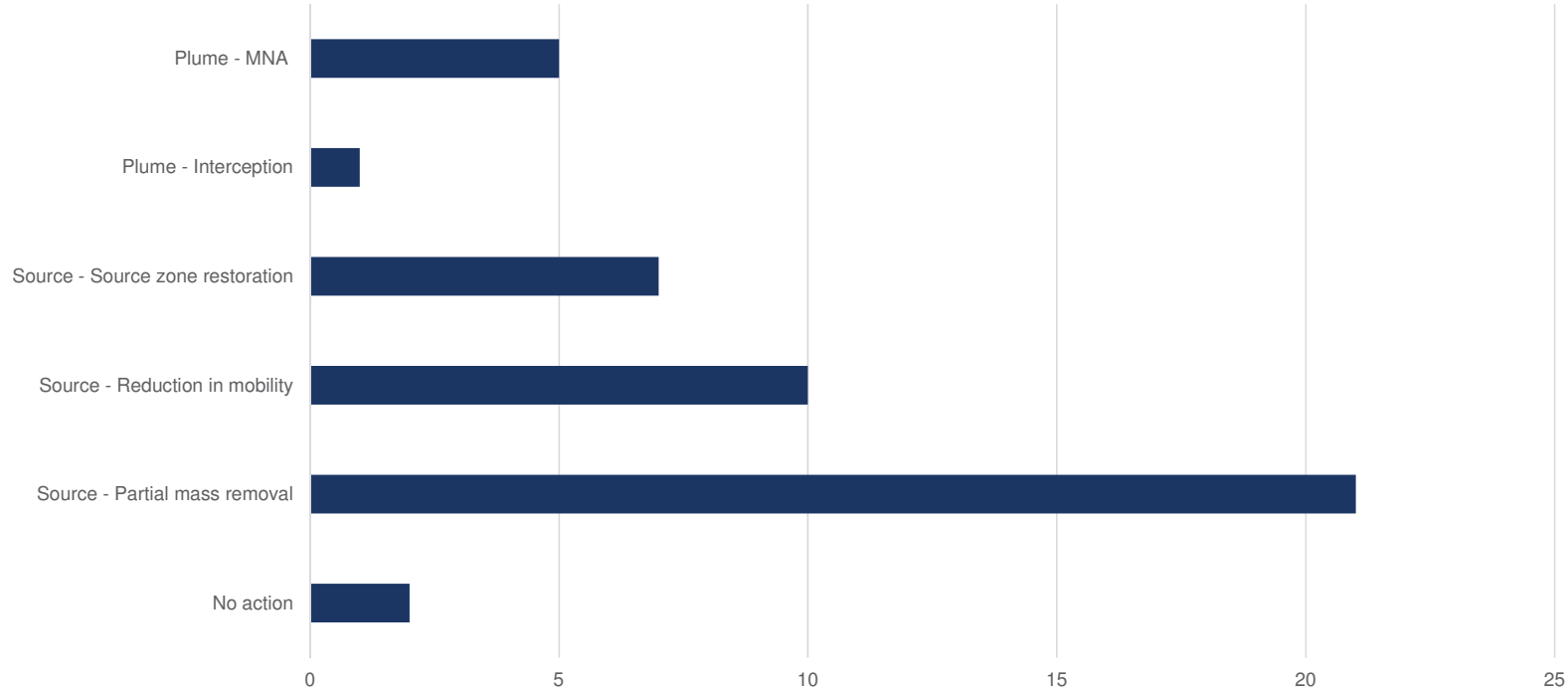
Client's attitude to the degree of remediation



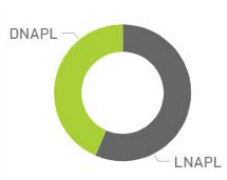


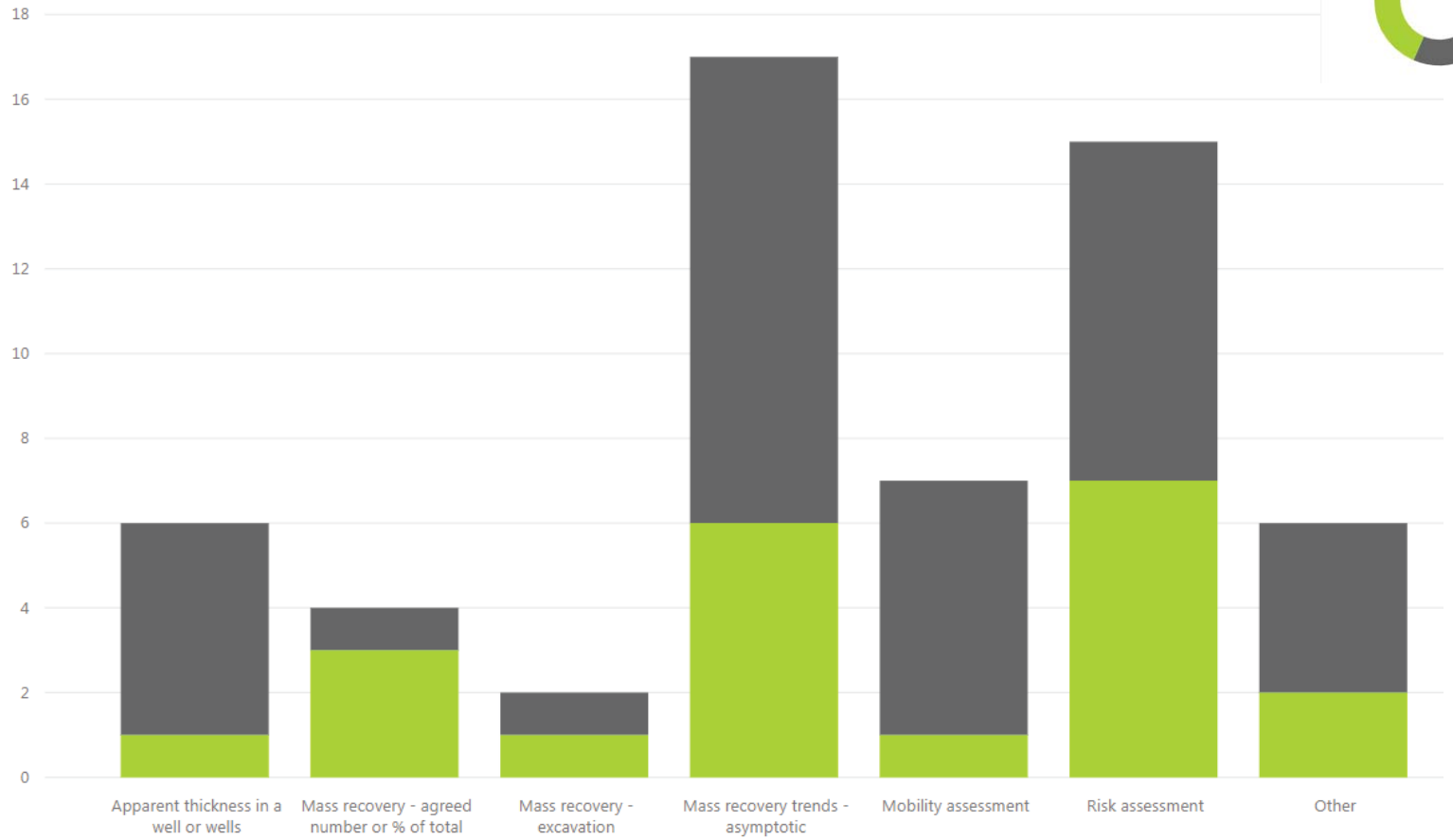
- Client corporate requirement & reputation
- Property legal (lease condition)
- Redevelopment related
- Long Term Certainty
- Combination of above

Where did we focus our efforts - Remedial Strategies

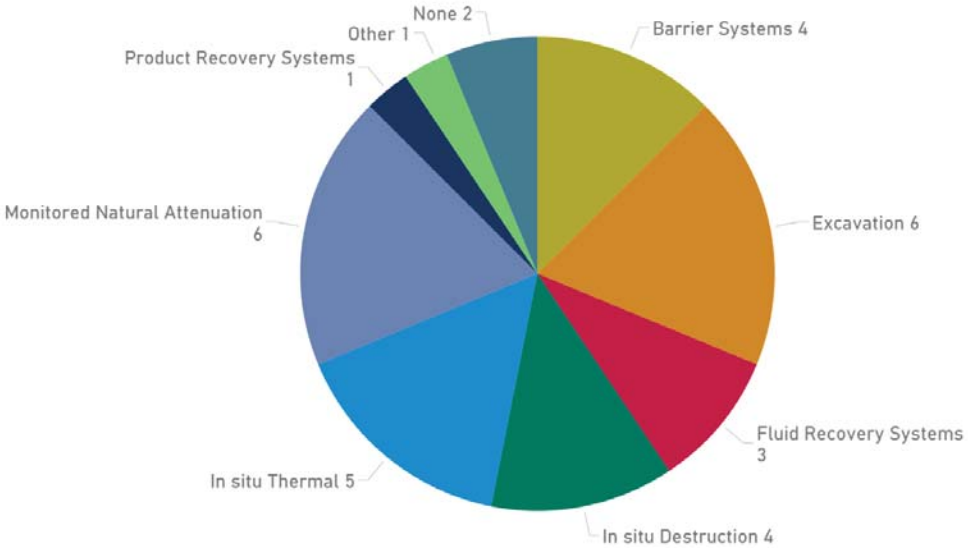


What were the Remedial Endpoints

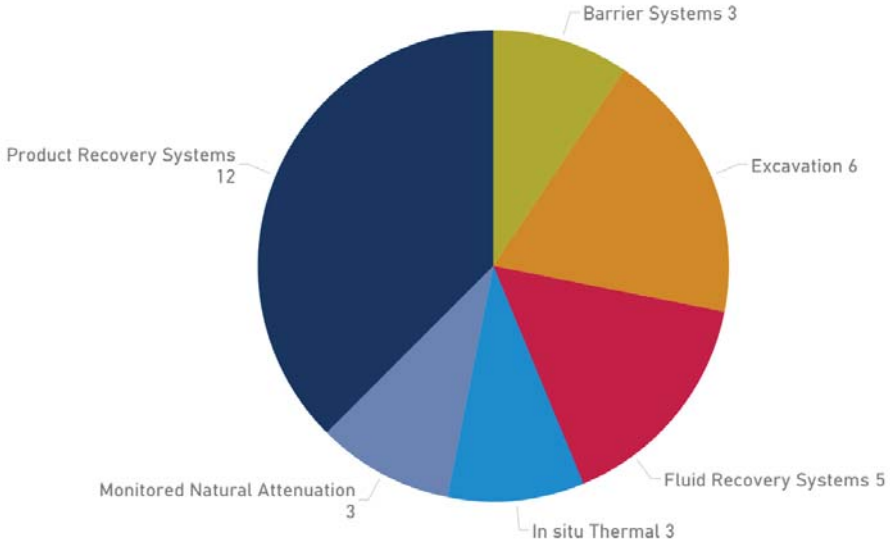




What remedial technologies were employed?



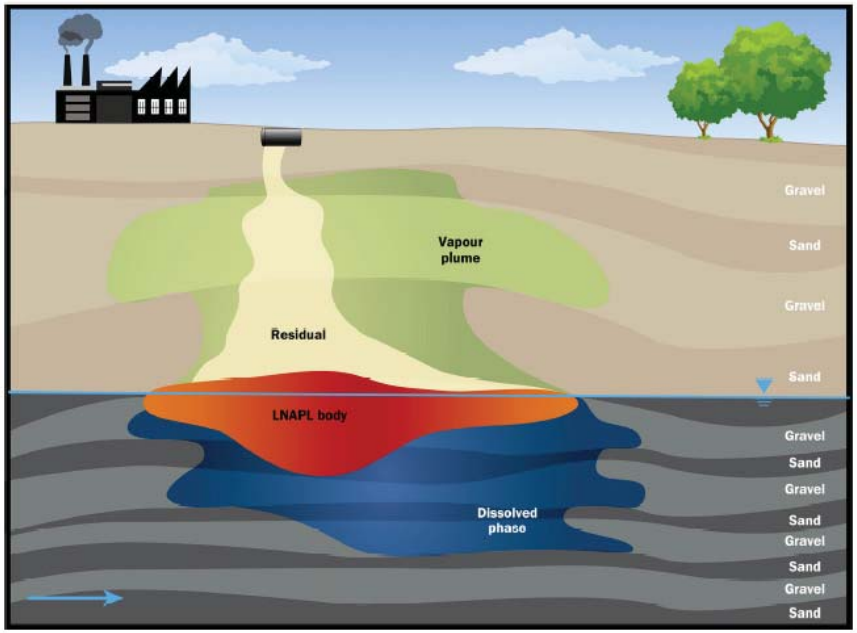
DNAPL sites



LNAPL sites

What does remediation of our typical NAPL site look like?

Typical ERM UK **LNAPL** Site is:

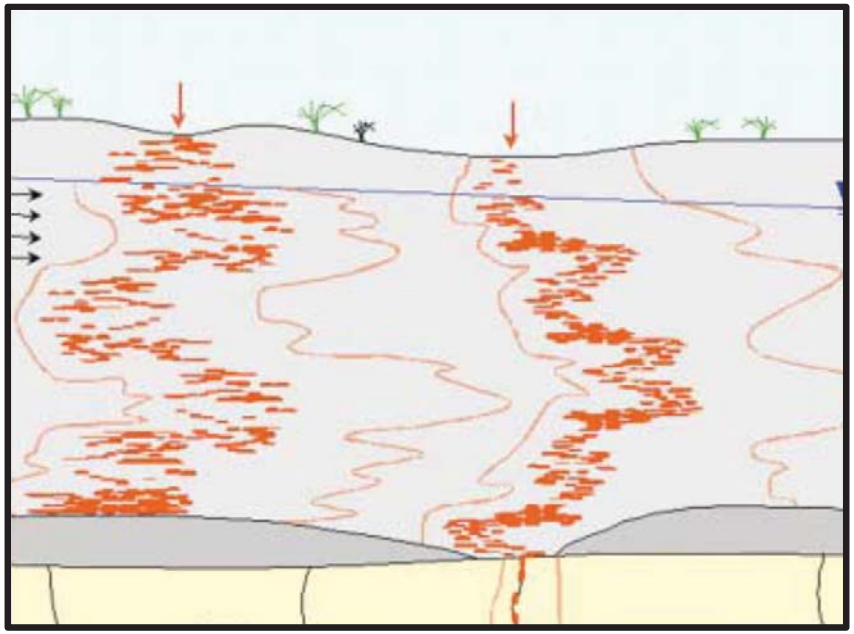


CL:AIRE, 2014. An illustrated handbook of LNAPL transport and fate in the subsurface. CL:AIRE, London. ISBN 978-1-905046-24-9. Download at www.claire.co.uk/LNAPL

- Risk driver is dissolved phase impact to surface water and NAPL mobility
- Strategy is based in partial mass recovery and / or risk assessment
- Technology used - Product recovery alone and / or with enhancements
- Cost of remediation typically < £200k
- Notable exceptions:
  - Large complex sites within this dataset - £2.0M - £4.0M

What does remediation of our typical NAPL site look like?

Typical ERM UK **DNAPL** Site is:



Environment Agency Illustrated handbook of DNAPL transport and fate in the subsurface
R&D133, 2003

- Risk driver is dissolved phase impact to surface water and groundwater
- Strategy is based in partial mass recovery and / or risk assessment
- Mass recovery - excavation, vacuum or thermally enhanced rather than in situ destruction
- Cost of remediation in £500k - £1.0M
- Notable exceptions:
  - Large complex sites within this dataset - £4.0M+

NAPL: Does it Matter ?

Conclusions

Conclusions

- Current guidance for historic contamination is clear – risk based – and not mere presence of NAPL alone.
- Risk is defined by both NAPL mobility ***and*** dissolution either to aqueous or gaseous phase
- The NAPL resulted in a risk in approx. ~60% of sites
- In these case studies then in 52% of sites client perceptions/commercial requirements have driven remediation beyond what was required by our technical assessment. An important factor that we can't ignore.
- In terms of remedial endpoints then mass recovery most frequently employed - partial mass recovery to an agreed endpoint
- No clear trends in remedial technology selection – there is a broad range of solutions that need to be reviewed technically and then evaluated to match broader site circumstances – client needs, timescale and sustainability
- Did guidance change our approach? Not fundamentally as overarching principles haven't changed but technical documents have helped considerably in providing better understanding of science supporting our overall approach
- Does NAPL matter? – yes but overall significance can only be answered on a site specific basis. In this data set remediation was driven by broader issues not merely technical risk