Plugging the Gaps

The importance of getting it “right first time” in P&A

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Agenda

01 The legacy of the 2019 P&A campaign

- A leaking TTA plug

02 ALARP re-abandonment design

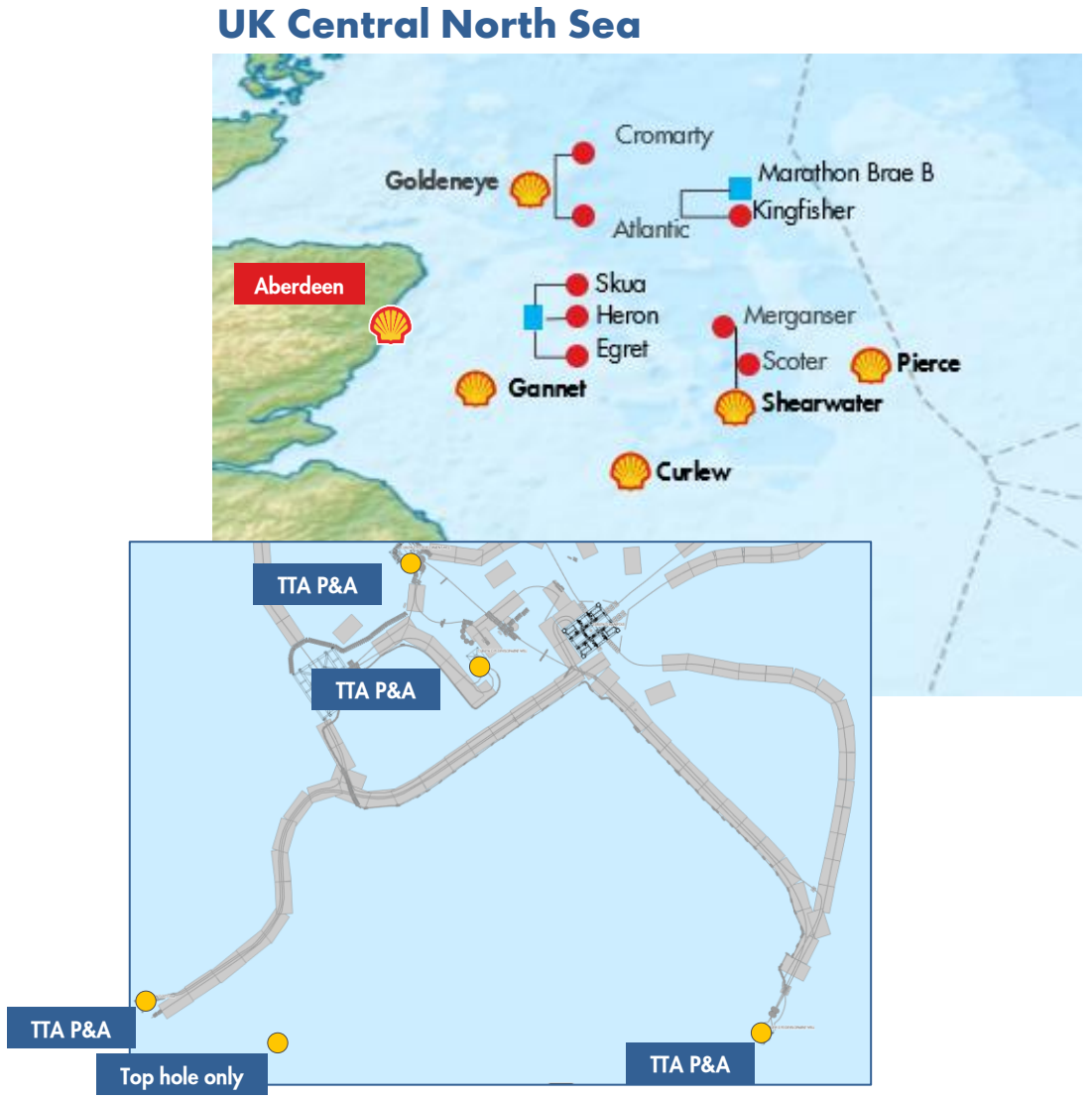
- Design evolution
- Demonstrating ALARP
- Resin: a novel solution for a leaking cement plug

03 Closeout

- Lessons learnt
- Key messages

The legacy of the 2019 P&A campaign

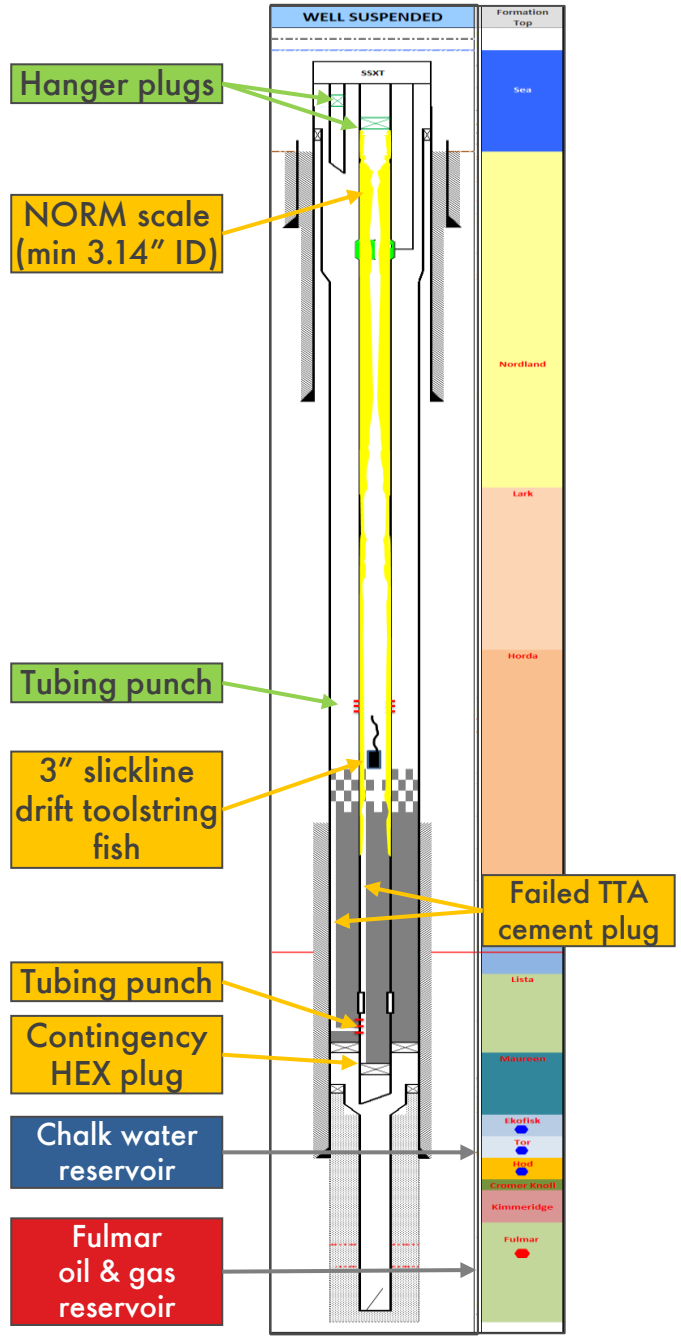
- Reservoir isolation (AB1) planned for 4 wells with Through-Tubing Abandonment (TTA) on LWIV
- Remaining scope scheduled for later execution
  - Environmental plugs (AB2) on MODU
  - Wellhead severance (AB3) on CSV
- Moderate savings estimated by executing TTA plugs rather than full tubing retrieval & internal plugs



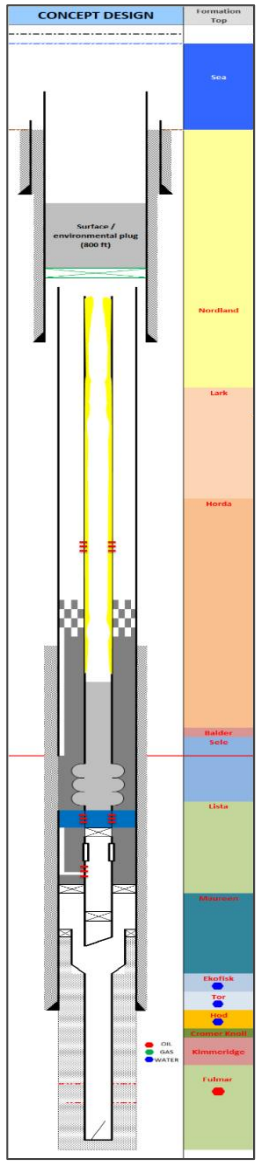
A leaking TTA plug

2019 LWIV operations

- Scale encountered in tubing
  - Contingency HEX plug set – initially unable to test
  - Tubing cut & agitator regretted
- Through-tubing abandonment (TTA) plug pumped under MOC
  - Successfully pressure tested after WOC
  - But flow observed from A-annulus
  - AHP & THP equalising at ~1,750 psi
- Diagnostics over several visits
  - Lost slickline drift toolstring & 474 ft wire in hole
  - Punched tubing above fish & circulated to ISW
  - Suspended well with hanger plugs & SSXT



ALARP re-abandonment design (design evolution)



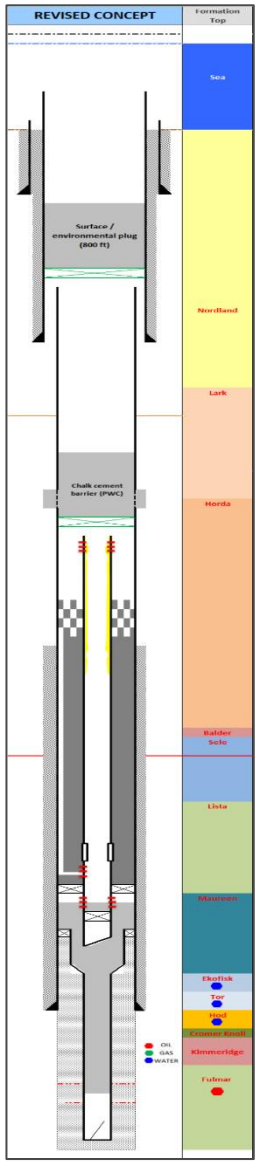
Initial "deep" design

- Wireline fishing
- CT drilling
- Repair of existing TTA plug
- Bismuth & tubing expander technologies

👍 Compliant depth

👎 Technology unused for reservoir isolation in UK

👎 High risk fishing, milling & new tech operations



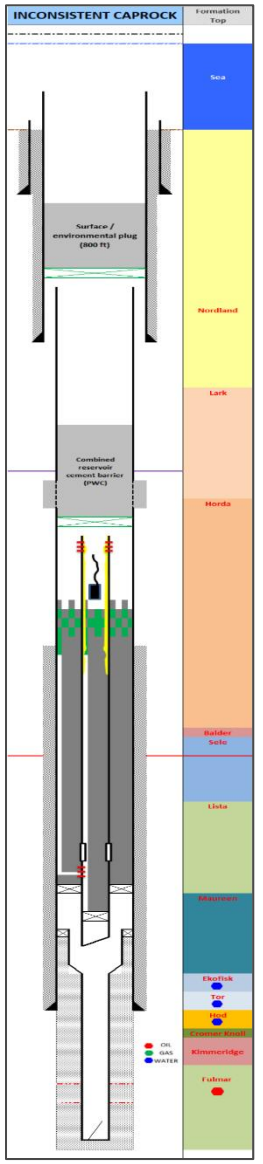
Revised "deep" design

- Wireline fishing
- CT drilling
- Bullhead cement into liner
- "Conventional" barrier above TTA plug

👍 Compliant depth

👍 More commonly used P&A techniques

👎 High risk fishing, milling operations



Inconsistent caprock design

- Resin placed for temporary reservoir isolation
- "Conventional" barrier above TTA plug

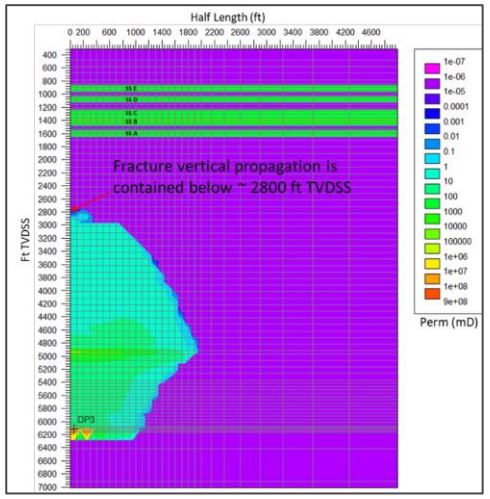
👍 More commonly used P&A techniques

👍 No deep access required

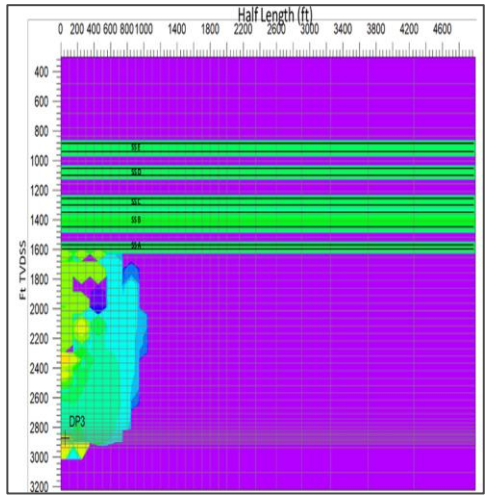
👍 Strategy approved with deviation, external review & regulatory engagement

Demonstrating ALARP

- Coupled fracture propagation and crossflow modelling completed
  - Built on work done & published by another UKCS operator
  - Results reviewed internally & externally
- Results showed containment even in unrealistic scenarios
- ALARP assessment completed
  - Several alternatives worked in detail & screened against inconsistent caprock design



Conservative case – containment in shale

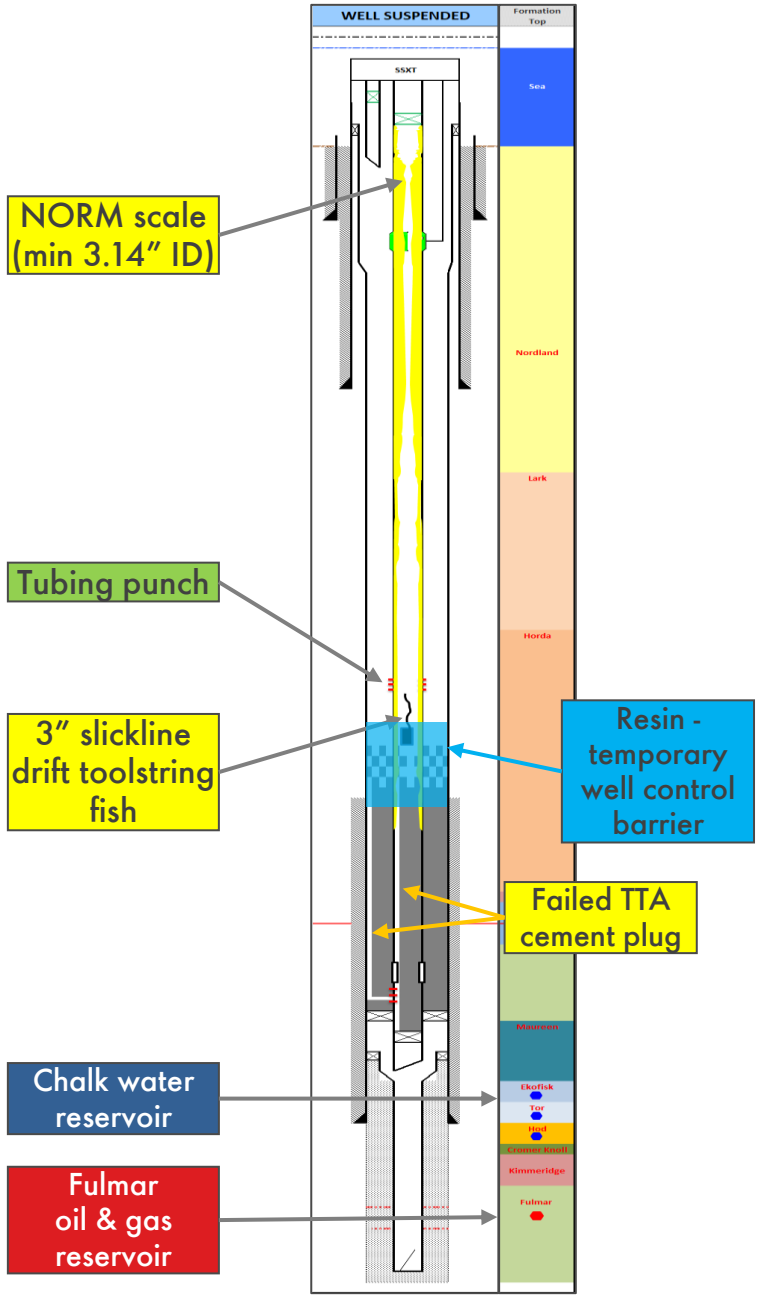


Ultra conservative case – containment in shallow sands

	Deep Access, CT mill out and Bullhead cement	Remediate the existing TTA cement defects (CT required)	Inconsistent Caprock restoration	Intercept Well and then chalk isolation (via DP3)	Intercept Well Only
Complies with Regulations					
Operational PoS					
Process Safety Risks					
Partner alignment					
Complexity (1-5)					
HSE Severity (1-5)					
Agreed timeframe					
Proven Technologies					
Long term risk for leak					

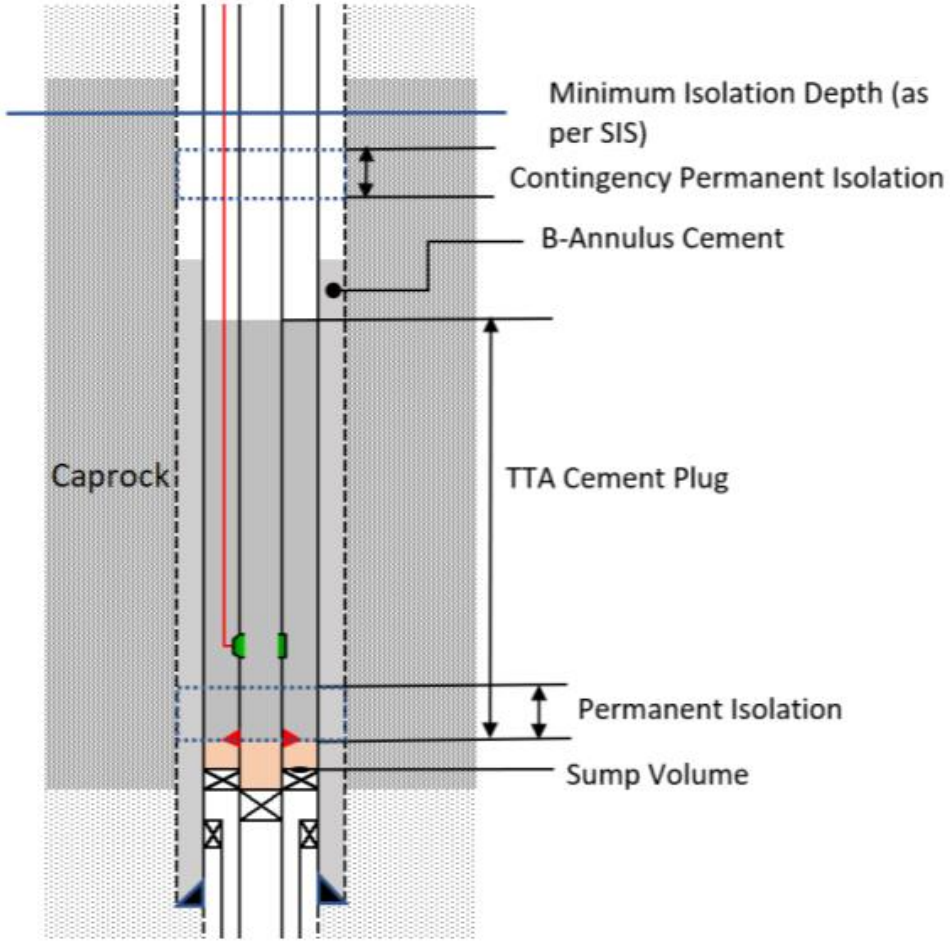
Resin: a novel solution for a leaking cement plug

- Density, viscosity and curing time can be adjusted
- Good barrier characteristics: Flexible, impermeable, high strength
- Can be pumped or gravitated in place – immiscible in water-based fluids, resistant to oil contamination
  - Does not require removal of slickline fish (inc. 474 ft of wire)
- Tested with solvent cleaner in the lab
  - Minimal risk to the wellbore integrity or the ability to complete the P&A operations
- Qualified after extensive lab testing
- Deployed successfully via intervention riser – world first?



Lessons learnt

- In completion design:
  - Place gauge >200 ft from packer / potential circulation point
  - Centralise length of tubing across potential plug interval
- Exclude from barrier length:
  - Sump below circulation point
  - Completion jewellery
  - Gauge cable (unless accelerated ageing testing & leak analysis complete)
  - Scaled tubing (unless demonstrated non-permeable)
- Ensure reservoir cannot flow
  - V0 plug and adequate verification
  - Maintain overbalance throughout cementation
- Consider sufficient space for a contingency barrier above the TTA in case it fails



Key messages

- Beware of increased risk for marginal savings – easy to offset with one failure
- Follow the TTA planning & execution guidelines
- Minimal scoping – avoid risks from non-routine operations where possible
- Resin: Effective product if risks can be managed – comprehensive lab testing required
- Engage stakeholders early – internal & external