Integrating science and practice for the effective delivery of a 'nature-based' approach to the sustainable management of the freshwater resource

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"Valuing and protecting freshwaters: the role of science, policy and practice"

Talk Outline…

- Introduction to sustainable river management/ engineering
- Examples of what can go wrong!
- ‘Traditional’ vs sustainable river engineering/ bank protection measures
- Appropriate stable channel design/ restoration

Why 'sustainable'? 'designing with nature'

- 'Nature-based' solutions - working with (rather than resisting) river processes
- Sustainable management of the entire river environment
- The 'river' is defined as the functional floodplain and the approach considers the entire catchment
- Recognises 'natural capital' – intrinsic value of the natural environment for human life
- Improved resilience to climate change
- Carbon neutral/ negative (STORAGE) approaches – utilising natural materials where feasible

Hydromorphology (Fluvial Geomorphology)

Fluvial Geomorphology:

"The science relating to the understanding of the evolution of the physical form of rivers and their floodplains"

Controls on River Form:

Rivers transport:

Water

Sediment (of all sizes)

Wood

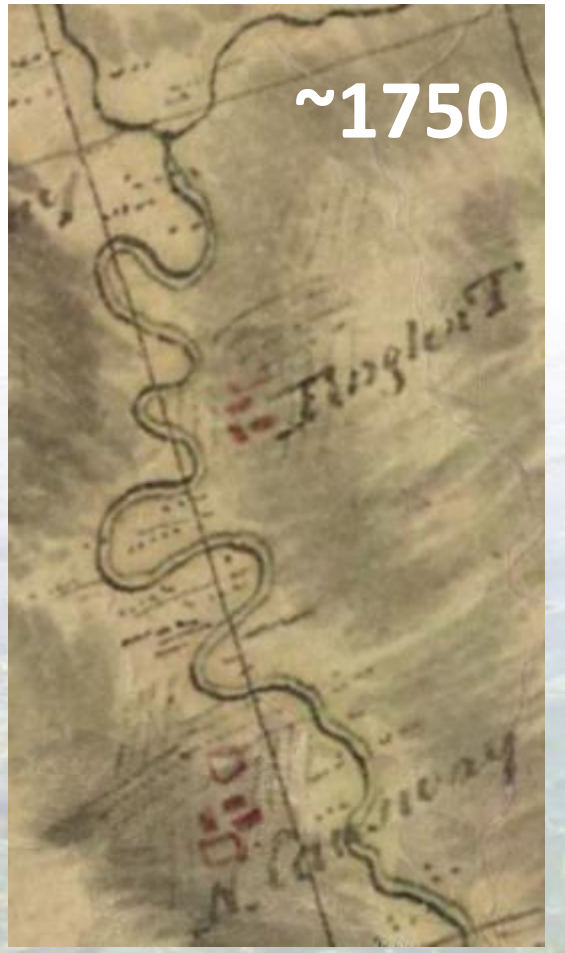
ALL OF THESE FACTORS INFLUENCED BY VEGETATION

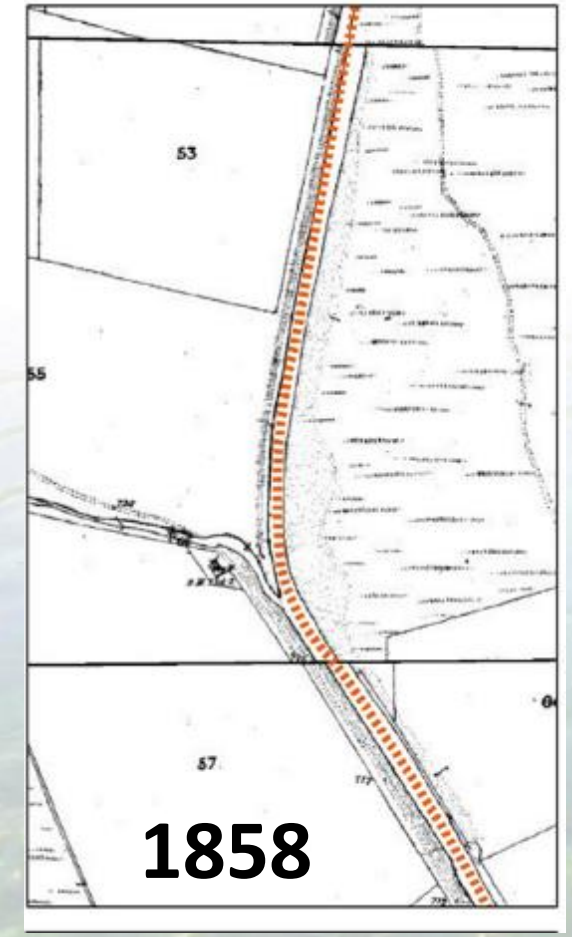
Natural Dynamic Process

26th Feb 2015

19th Feb 2016

Designed with Natural Dynamic Process





White Esk, Dumfries

Not Designed with Natural Dynamic Process


Head cut – the enemy of river design/ engineering!

Bank protection

- ***Sustainable*** Large wood structures
  - Natural material
  - More effective at energy dissipation*
  - 'Plastic' – deform/ adjust as channel shape evolves

- ***Traditional*** 'Rip-rap' (rock revetment, boulder placement etc)
  - Traditional approach – NOT natural (or sustainable)
  - Required in some locations

Problems with 'traditional' hard bank protection

Bank failure

'Traditional' hard bank protection is not designed with nature

Bank failure - riprap

Bank failure – steel sheet piling

Bank failure –gabions unzipped

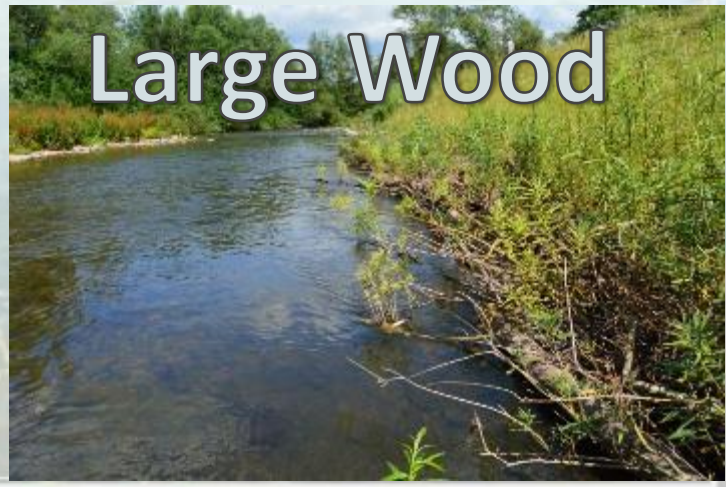
Alternative sustainable bank protection using large wood

Benefits of Using Large Wood

Increasingly being used in river management projects, world-wide.

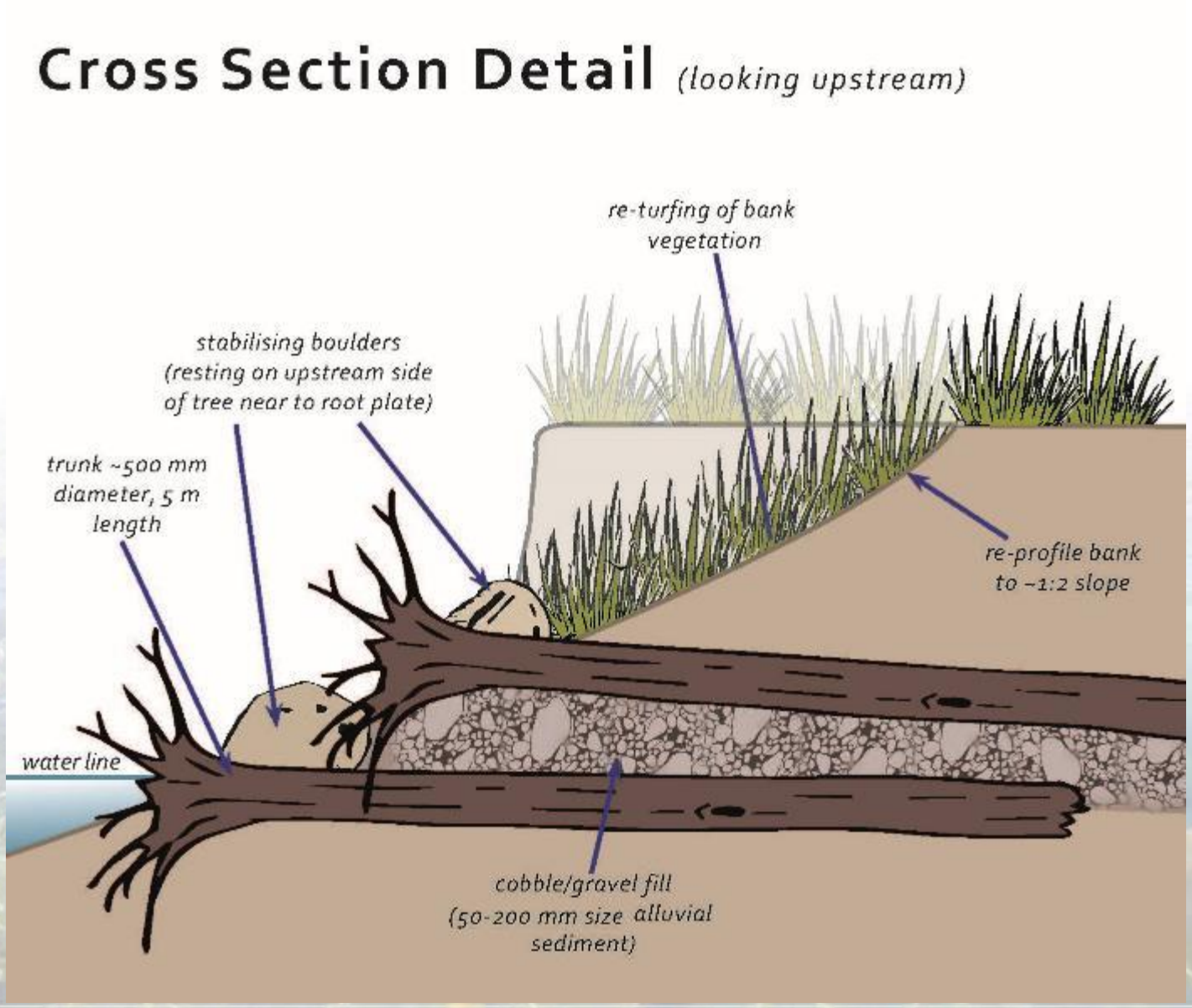
Advantages over traditional (often rock-based) approaches:

- **Works with natural processes**
- **Integrates with bank over time**
- **Provide direct habitat/ cover**
- **Assists in developing increased channel physical diversity (ecological improvement)**
- **Resilience to climate change – evolves to changing environment**
- **Environmental regulators like it!**
- **BUT how to encourage implementation?**



Examples of bad practice – little consideration of natural process

Sustainable bank protection



The problem

The construction material

The implementation

The nature-based solution

The problem

The implementation

The nature-based solution

The self-sustaining nature-based solution

Rock Roll & Live Willow Stakes & Brushwood Mattress

Implementation

Another self-sustaining solution

'Stable' Channel Design

Fundamental design approach:

Reproduce natural physical processes as much as is practicable ('designing with nature')

‘Stable’ Channel Design

- As much as is practicable, allow the river to do the work. Likely to be more stable/ sustainable
- Provides greater resilience to climate change and more environmentally sensitive
- More likely to be approved by regulator
- However, very different approaches depending on geomorphic setting (importance of sufficient assessment and design)

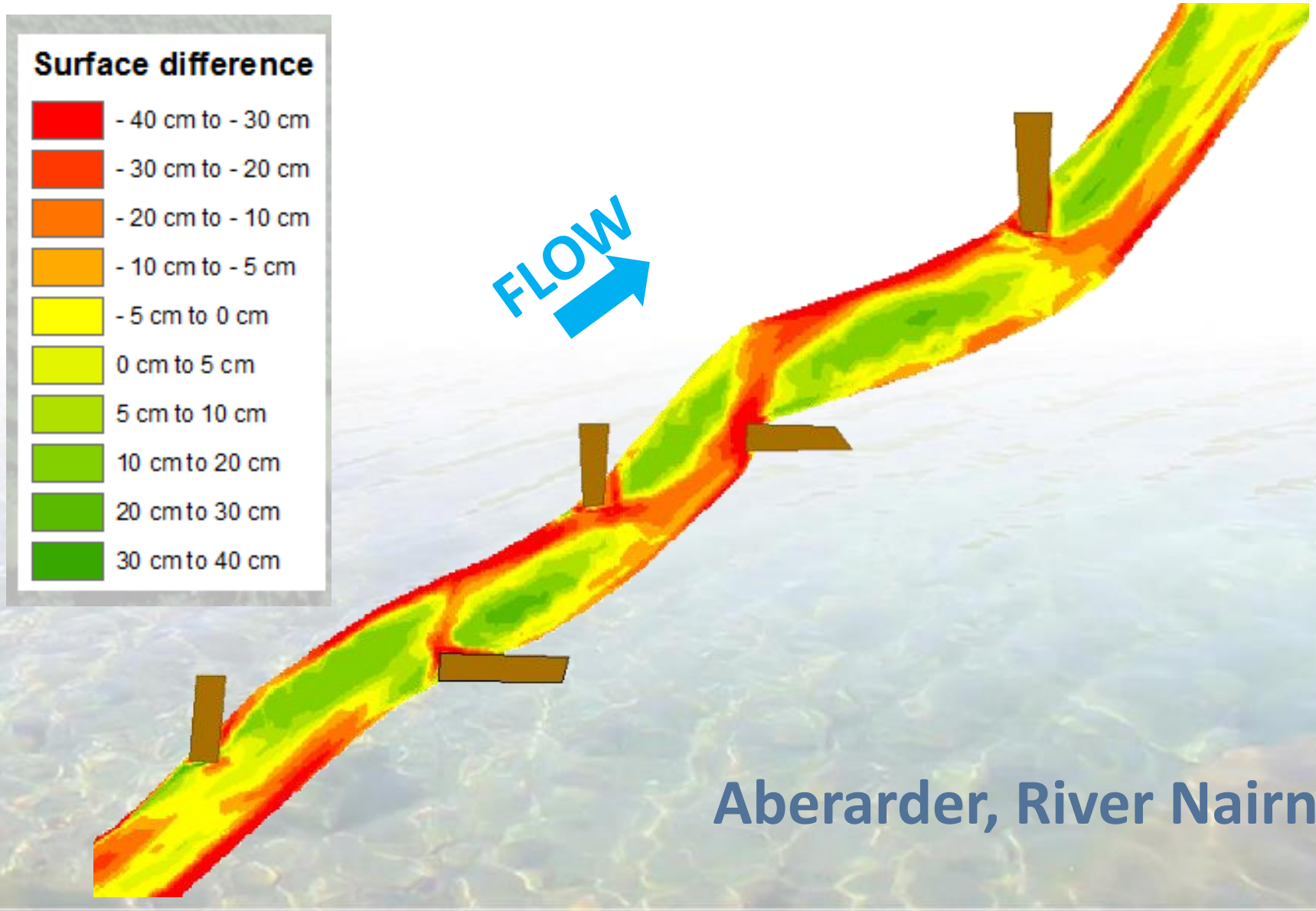
Low risk: natural or ‘assisted’ recovery

Remove artificial constraints to nature river processes - river ‘rewilding’ for ecological benefit

Low risk: natural or 'assisted' recovery

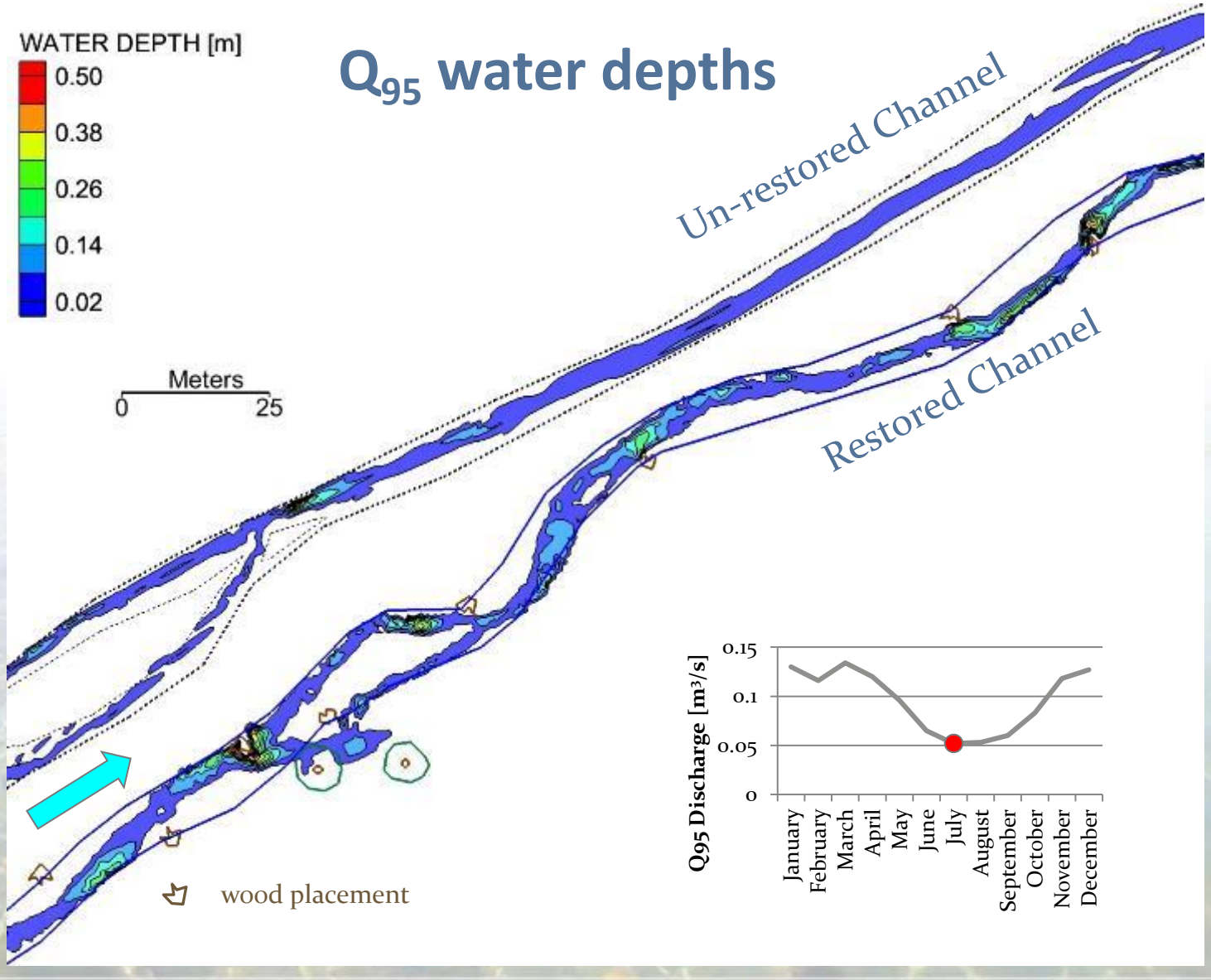
Large Wood Structures (LWS) and channel realignment for ecological enhancement and sediment management/ land drainage

Assisting channel evolution

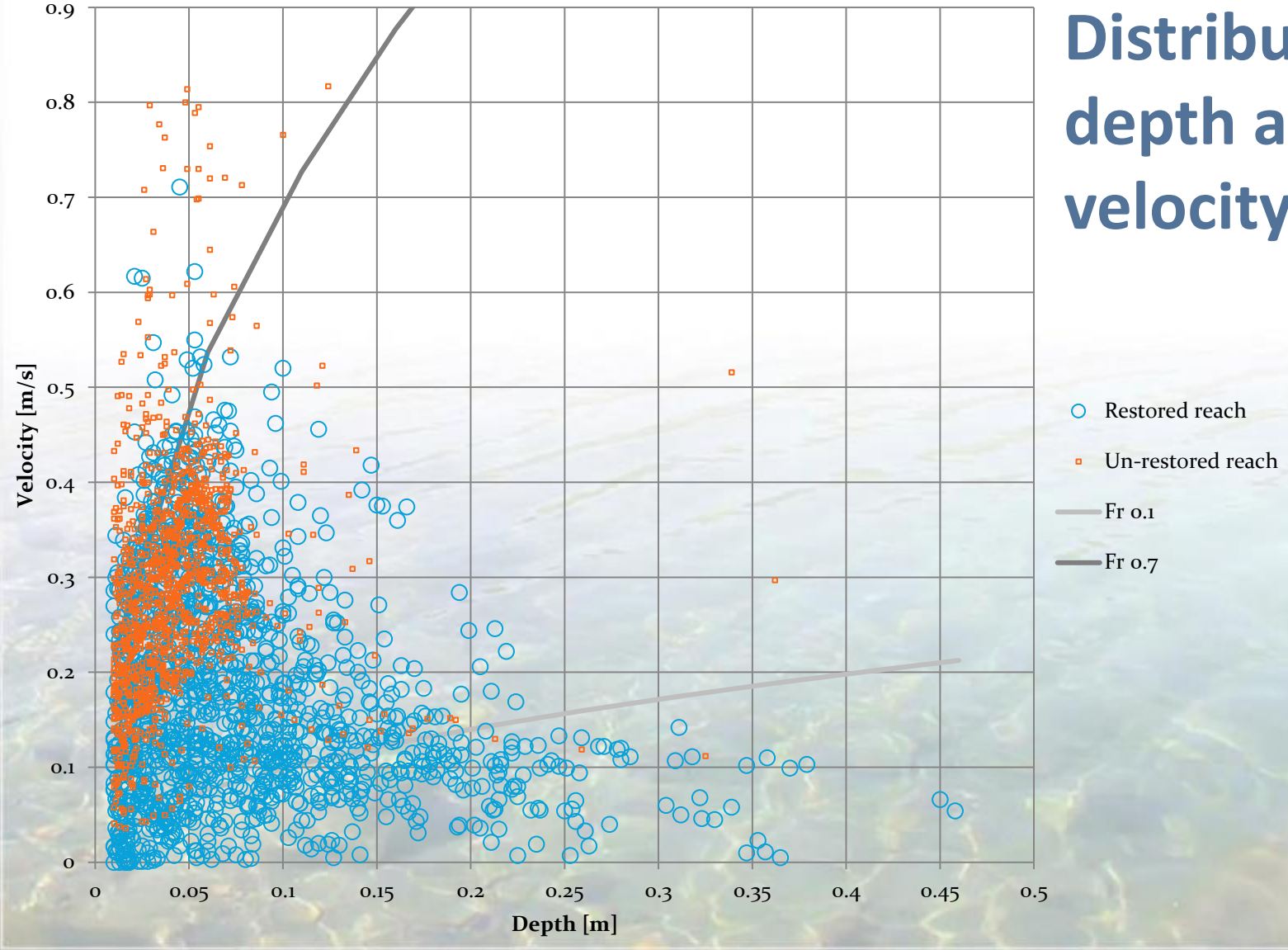


Aberarder, River Nairn

Q_{95} water depths



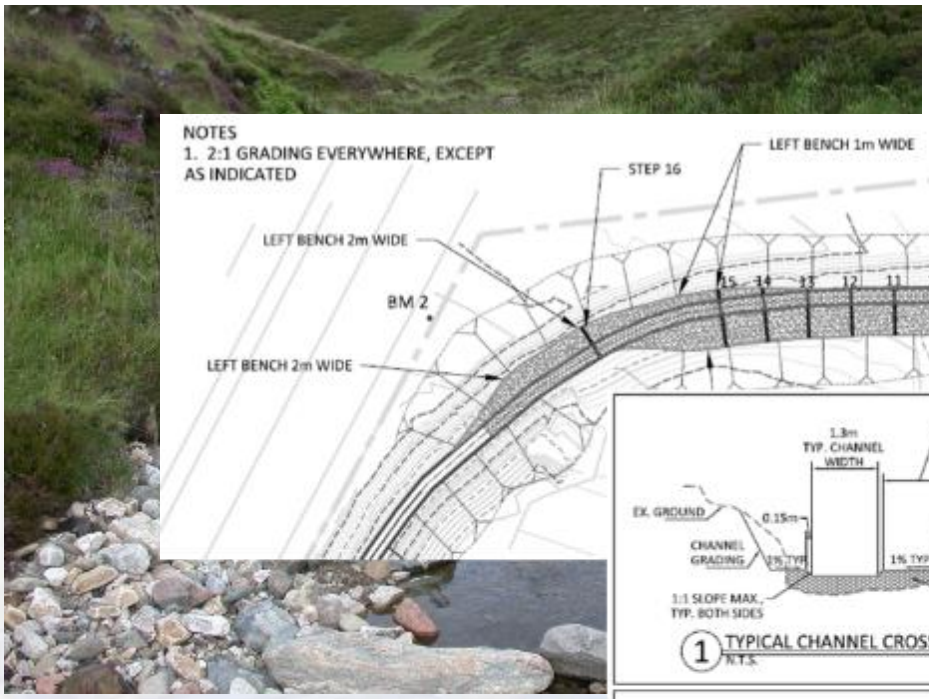
Distribution of depth and velocity at Q_{95}

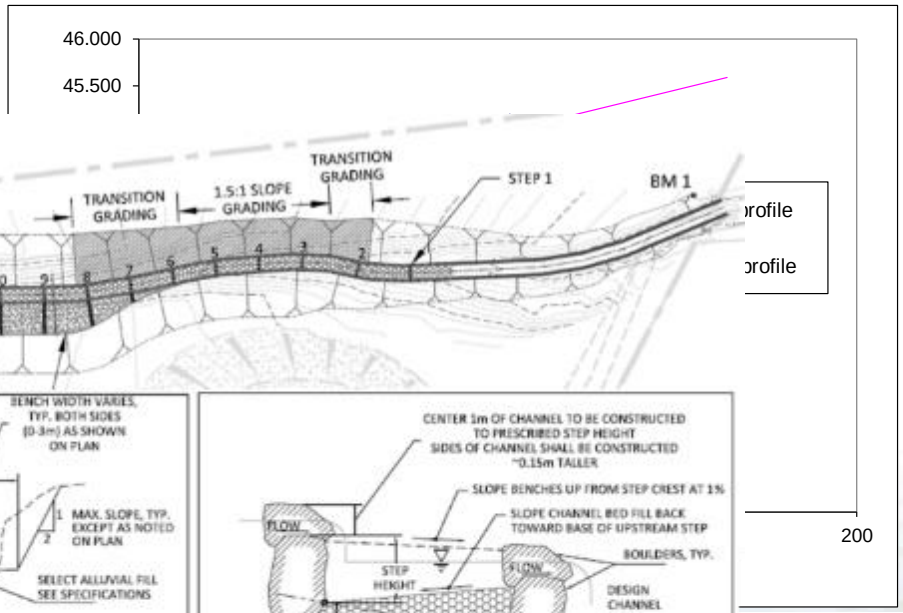


Increasing risk: ‘initial conditions’ design

High risk: ‘functional design’ for asset protection

Reproduce natural morphology of ‘step-pool’ type channels, given high imposed slope (> ~3%)





$$(H/L) \times S = C$$

$$C = 1 \text{ to } 2$$

High risk: stable ‘functional design’ in high gradient channels

Lessons Learned

trees sufficiently deep
→ less energy dissipation
→ structure undercut and erosion of downstream bank

lessons learned

Take home points…

- Multiple benefits to a sustainable approach
- Understanding physical processes is key to successful design
- Rivers are naturally dynamic – this must be considered in the design process
- Reinstating natural process and form is the most effective design strategy
- Different types of solution/ design are required in different river environments – may require detailed assessment
- Although rock can be suitable, consider using large wood structures where appropriate

Thank-you for your attention!
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Stabilisation of Large Wood

- Use whole trees (or at least with root plates still intact)
- Use large enough trees (relative to size of channel)
- Use sufficient amount of wood (wood stabilises wood)
- Orientate appropriately relative to flow (for engineered wood structures)
- Partly bury into bed/ bank of river and/or back-fill with soil/ sediment/ rock
- Cabling/ anchors etc (last resort!)
- Conduct fluid dynamic assessment of structure stability