Delivering River Restoration: Recipes for Success

13th Annual Network Conference

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DAY-LIGHTING OF A CULVERTED CHANNEL IN DYCE, ABERDEEN

River Restoration Centre Conference, University of Nottingham, 19th April, 2012

Dr. Hamish Moir, Dr. Chris Bowles, Mr. Sam Diaz
Case study of ‘constrained process restoration’

‘PROCESS RESTORATION’

- Over-arching philosophy: restore catchment-scale river processes as much as possible
  - Operate at largest feasible spatial scales
  - Aim to restore process rather than specific local-scale design
  - Think at longer temporal scales – not ‘quick fix’ approach
  - More sustainable approach – let the river do the work!
Practical constraints limiting scale of restoration

- Development and land-use pressures
- Fragmented land ownership and management
- Lack of catchment-scale management plans
- Inappropriate management time-scales
- Lack of sufficient funding
- Lack of knowledge and perception
‘Domain of the process restoration continuum’

Degree of Restoration of Natural Process

Spatial Scale

Local/unit
Reach/segment
Catchment

Partial process restoration
Full process restoration

‘river gardening’

process/form construction

Mains of Dyce Restoration, April 2012
Case study of ‘constrained process restoration’

Mains of Dyce, Aberdeen

- Housing development – significant constraints to spatial scale and process
- Stream previously culverted under industrial site
- Requirement by SEPA to ‘daylight’ the stream, using expert advice
- Housing developer decided to do it themselves (not so much river gardening as river abuse!)
- Result = unstable design (leading to disaster!)
- CBEC contracted to design stable channel
Study site: Mains of Dyce, Aberdeen
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Mains of Dyce burn characteristics (at site):

- Catchment area: 1.1 km$^2$ *
- Length of channel: 165 m
- Channel bed slope: 2.6% (mean), 7.9% (max)
- $Q_{50\text{yr}}$: 1.8 m$^3$s$^{-1}$ *

* highly dubious!
The site with initial channel realignment (NOT us!)
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High flow events prior to further analysis

Two flood events occurred on 31\textsuperscript{st} Oct and 5\textsuperscript{th} Nov 2009.

Nearby gauge on mainstem River Don indicated magnitudes of \sim 10 year return interval.

Site estimate indicated discharge of 2.0 – 2.5 m\textsuperscript{3}s\textsuperscript{-1} (i.e., design $Q_{50}$ underestimated).
Site after high flow events

Mains of Dyce Restoration, April 2012
Site after high flow events

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Site after high flow events

- Incision of the channel bed of up to 2.7 m
- Upstream head-cut migration of 7.5 m due to 05/11/09 event
- Total cut of 539 m$^3$ of material
Design process

• New design concept produced based on reproducing natural fluvial process and form given imposed conditions

• Main aspects of design to reduce forces applied to the channel bed:
  • step-pool design where basal bed slope > 3%
  • inset ‘benches’ adjacent to the channel (where site allowed)
  • appropriately sized bed material introduced

• Step-pool design based on established procedures reviewed by Chin, et al (2009) :

\[(H/L) \quad S = 1.25\]

• Iterative process of modelling of design and then refinement
Design process

Mains of Dyce Restoration, April 2012

Design conditions
(Q = 3.0 m$^3$s$^{-1}$)
Design detail

Mains of Dyce Restoration, April 2012
Construction Process

1. Staking out
Construction Process

2. Bed and bank profiling
Construction Process

3. Step construction
Post-construction

1. Newly completed
Post-construction

2. Under high flow
Post-construction

4. Ten months after construction
Conclusions and Lessons Learnt

• Always room for some consideration of natural process and form in river restoration design, no matter how constrained a site is.

• Drainage of urban/industrial areas – don’t rely totally on empirical design discharge assessments!

• Monitoring during and post construction is essential to ensure design fitting

• Some of those ‘managing’ rivers require a greater understanding of basic river process!
Post-construction test of design fit

Mains of Dyce Restoration, April 2012