Remediation of Stoke Brook and the River Derwent, Derbyshire

Gerard Hawley
Pete Worrall
Chris Chapman
Penny Anderson Associates Ltd

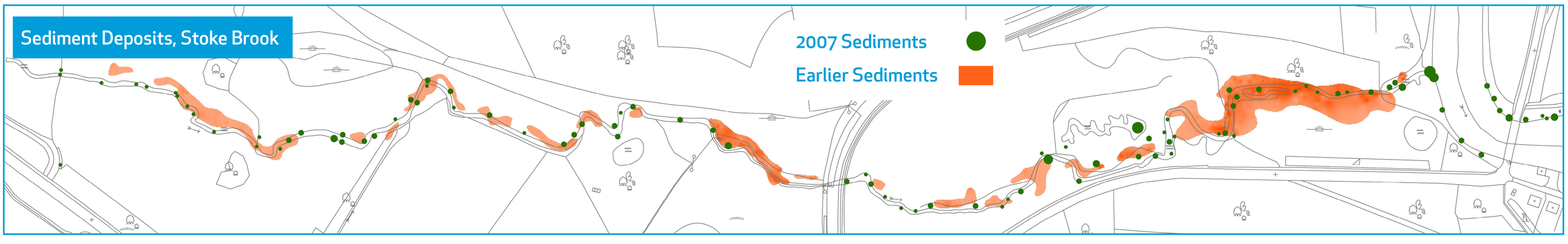
The failure of a tailings lagoon at the Cavendish Mill fluorspar mine in Derbyshire on 22nd January 2007 sent a torrent of metal-laden sediments into the village of Stoney Middleton and on into Stoke Brook and the River Derwent. The visual impact of the event was recorded further downstream along the Derwent beyond Derby and into the River Trent.

These rivers support important salmonid and coarse fisheries and are one of the few sites in the region to have breeding populations of brook lamprey. In addition, the rivers have large populations of water vole, water shrew and otter and the adjacent wooded banksides, marshes and wet grassland support great crested newts and a rich invertebrate fauna.

The impact of the dam failure was to smother the riverbeds and banks with a dense coating of tailings material that posed a significant risk to the integrity of the ecology of these highly diverse rivers within the Peak District National Park.


Gravel bed 'concreted' by tailings sediment

Sediment Deposits, Stoke Brook



Site Location

Conundrum; To Remove or Leave Well Alone?

The processing of fluorspar generates fine silt contained metals such as lead, zinc, cadmium as well as arsenic, mercury and fluoride, which are all potentially harmful to human health and ecosystems. The presence of large quantities of lagoon tailings in the rivers and on the floodplain is evidently unnatural and unwanted. But would the attempt at remediation and removal of the sediment cause more environmental damage than if it were left to disperse and degrade naturally?

A chemical risk assessment found that removing the tailings would not improve background levels of heavy metal contaminants. However, the physical impacts of sediment deposits were more severe - the riverbed gravels had been effectively 'cemented', compromising the stream's ability to support breeding brook lamprey and trout, reducing oxygen transfer within the gravels, and reducing numbers and diversity of invertebrates. There had been a number of high discharge events since the tailings failure and, although it is likely that some sediment was washed away, a conspicuous quantity remained. It was for these reasons that removal was considered necessary.

The Approach

- Betamag P100 Walking Excavator, to avoid damage to the river banks
- Rotating Hydraulic Excavator Head
- Riddle Bucket, to remove fines <4mm
- Vector Vacuum Excavator, for sites inaccessible by the Betamag Excavator
- Permeable silt curtain, to prevent sediment transport downstream of the works site


Betamag Walking Excavator


Riddle bucket

Remediation of Stoke Brook

On-site remediation began on 9th June 2008. Sediments were excavated, riddled to remove the fine tailings, and then replaced and raked on the river bed. Additionally, a new floodplain pond and wetland were created. A total of 797 tonnes of tailings were removed.

797 tonnes of tailings sediment removed from Stoke Brook SSSI

Remediation of the River Derwent

Work on the removal of sediments behind Calver Weir commenced on 6th August 2008. A small excavator on a floating pontoon was used to remove bankside and riverbed sediments between the Stoke Brook confluence and the weir. The riverbed was dredged and 41 tonnes of tailings removed. Finings were also removed from beneath an arch of the road bridge at Calver Mill (27 tonnes), and from fish spawning sites between Calver Weir and Calver Mill (7 tonnes).

75 tonnes of tailings sediment removed from River Derwent

Good to Very Good

Macro-invertebrate water quality score post-works


New floodplain pond, February 2016

Conclusions

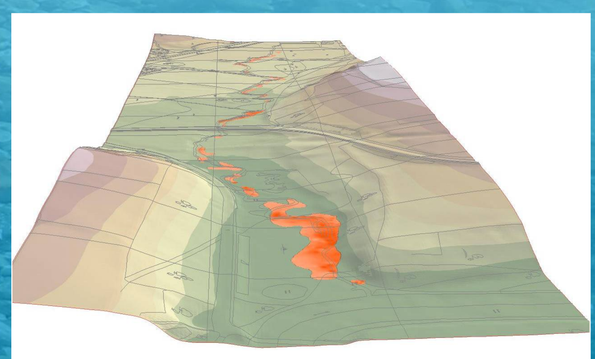
The experience at Stoke Brook and the River Derwent shows that it is feasible to remediate and restore rivers impacted by fine sediments without causing wide-scale habitat disruption, provided a commitment is made to use the best possible technology. However, the success of remediation cannot solely be attributed to the use of special equipment and ecologically sensitive techniques. Stakeholder engagement was critical and the involvement and participation of the Environment Agency, Natural England, Derbyshire Wildlife Trust, Peak District National Park, Cavendish Mines, Angling clubs and land owners was essential.

Evidence of Earlier Lagoon Failure

It became evident during surveys and further confirmed when works began, that there was a deposit of silty sand below the present day soil surface. This was often visible in the river banks that exposed the soil in profile. The texture and colour was identical to the 2007 tailings at the surface suggesting that this deposit was the result of an earlier lagoon failure.


Pre-2007 tailings sediment in soil profile

Using an augur and Differential GPS, the depth and thickness of the pre-2007 sediment was measured, and an estimated 2,857m^3 was found to be deposited within the Stoke Brook floodplain. However, it has not been possible to determine when this occurred but it must be since the Cavendish Mill opened in 1959.


Extent of pre-2007 sediment deposits

Penny Anderson Associates Ltd
Consultant Ecologists