European Commission

NWRM

Natural Water Retention Measures

www.nwrm.eu

Service contract n°07.0330/2013/659147/SER/ENV.C1

Individual NWRM

Riverbed material restoration

Environment

This report was prepared by the NWRM project, led by Office International de l'Eau (OIEau), in consortium with Actéon Environment (France), AMEC Foster Wheeler (United Kingdom), BEF (Baltic States), ENVECO (Sweden), IACO (Cyprus/Greece), IMDEA Water (Spain), REC (Hungary/Central & Eastern Europe), REKK inc. (Hungary), SLU (Sweden) and SRUC (UK) under contract 07.0330/2013/659147/SER/ENV.C1 for the Directorate-General for Environment of the European Commission. The information and views set out in this report represent NWRM project's views on the subject matter and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this report. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which may be made of the information contained therein.

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I. NWRM Description

Riverbed material represents the sediment eroded upstream, transported by the river and deposited on the river floor. It can be composed of coarse and/or fine material. Its re-naturalization consists in recovering the nature-like structure and composition of the bed load, in particular the equilibrium between coarse and fine sediment. In case of deficit of coarse sediment leading to river incision, the main objective is to level-up the riverbed with this type of sediment, by reactivating bank erosion in terrains contributing to this type of sediment. It should be noticed that in case of excess of fine sediment causing inundations, silting of hydro-electric dams or degradation of fish habitats, the main objective is to control erosion on slopes and riverbanks providing this type of sediment.

II. Illustration

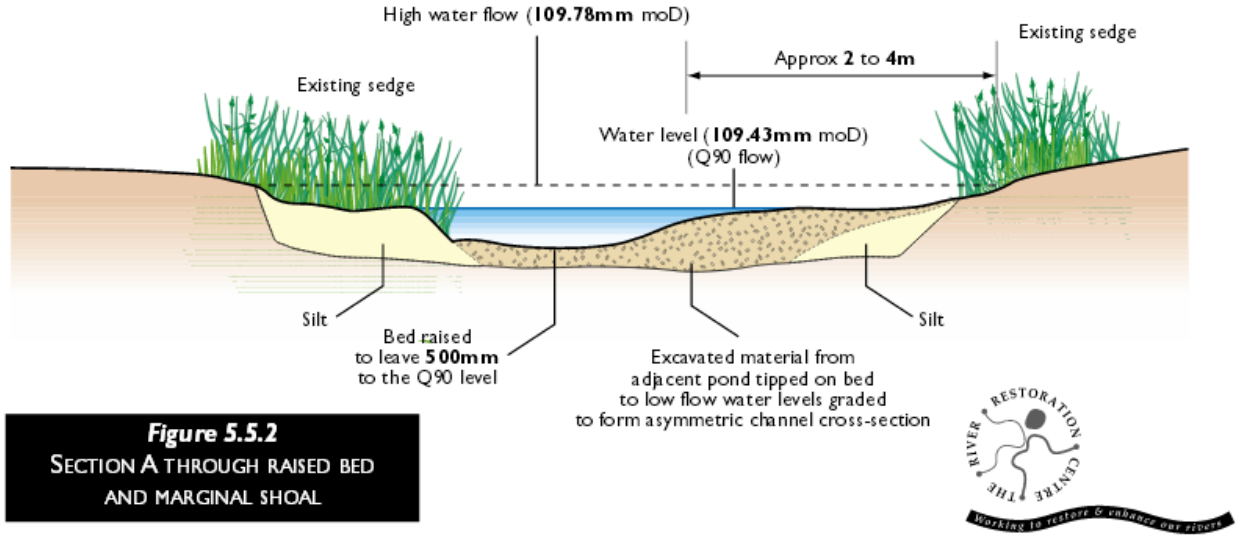

Figure 5.5.2
SECTION A THROUGH RAISED BED AND MARGINAL SHOAL

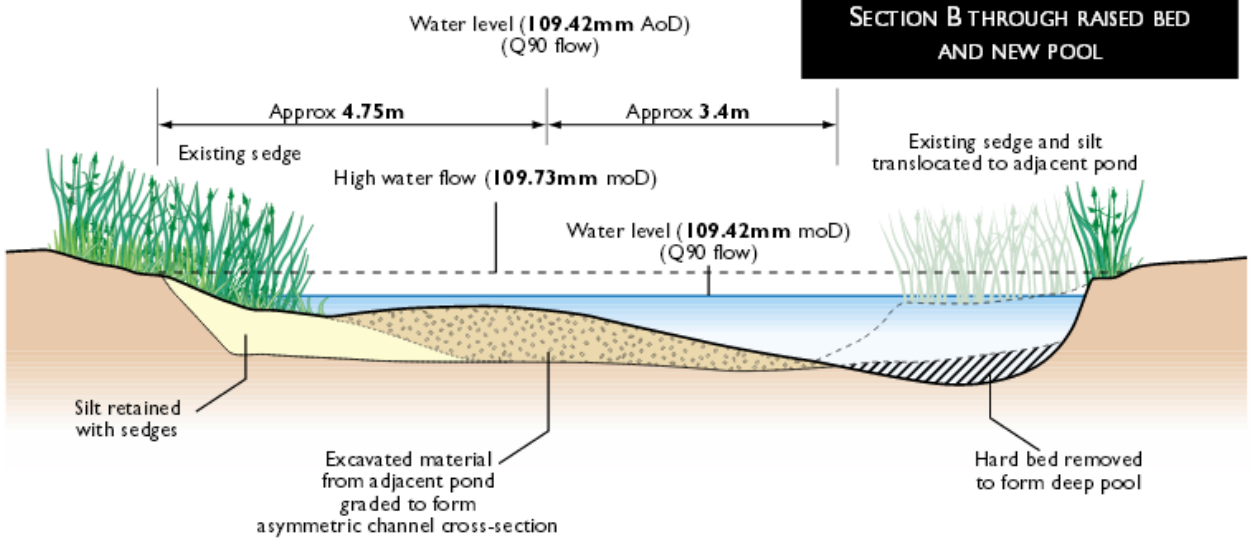

Figure 5.5.3
SECTION B THROUGH RAISED BED AND NEW POOL

Source : http://www.therrc.co.uk/pdf/manual/MAN_5_5.pdf

River Restoration Center, UK

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	No	
Agricultural Areas	No	
Forests and Semi-Natural Areas	No	
Wetlands	Yes	

Region	Applicability	Evidence
Western Europe	Yes	
Mediterranean	Possible	
Baltic Sea	Possible	
Eastern Europe and Danube	Yes	

IV. Scale

	0-0.1km²	0.1-1.0km²	1-10km²	10-100km²	100-1000km²	>1000km²
Upstream Drainage Area/Catchment Area			✓	✓	✓	✓
Evidence						

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	Medium	By slowing down runoff, the latter will be increasingly stored
	Slow Runoff	Medium	Runoff will be slowed down during flood events, due to a better connectivity with the floodplain
	Store River Water	Medium	By allowing a better connection to tributaries and restoring a natural shape to the river bed, its storage capacity is increased.
	Slow River Water	Medium	Slower drainage due to reconnection with the functional floodplain.

Reducing Runoff	Increase Evapotranspiration	None	
	Increase Infiltration and/or groundwater recharge	None	
	Increase soil water retention	None	
Reducing Pollution	Reduce pollutant sources	None	
	Intercept pollution pathways	Medium	The reconstitution of the alluvial mattress constitutes new obstacles to pollutants. By being restored to its natural features the riverbed balances itself and recovers its initial filtration and purification features.
Soil Conservation	Reduce erosion and/or sediment delivery	Low	In case of deficit of coarse sediment leading to river incision, the main objective is to level-up the riverbed with this type of sediment, by reactivating bank erosion in terrains contributing to this type of sediment, thus decrease in alluvial mattress erosion. But in case of excess of fine sediment causing inundations, silting of hydro-electric dams or degradation of fish habitats, the main objective is to control erosion on slopes and riverbanks providing this type of sediment
	Improve soils	None	
Creating Habitat	Create aquatic habitat	High	Aquatic ecosystem improvement due to continuity between water and floodplain, provision of spawning grounds for fish, and the diversification of the river bed and the river depth, which offer new aquatic habitats.
	Create riparian habitat	High	The diversification of the riverbed leads to different river depth and river flow velocity, creating new riparian habitats.
	Create terrestrial habitat	None	
Climate Alteration	Enhance precipitation	None	
	Reduce peak temperature	None	
	Absorb and/or retain CO2	None	

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	Medium	The improvement of connection to the floodplain, and the tributaries increases the water storage capacity of the river.
	Fish stocks and recruiting	Medium	The diversification of fish habitats, the slowing down of runoff and the increase of water storage help the increase of fish stocks.
	Natural biomass production	Medium	Natural biomass production is enhanced by the creation of new habitats (aquatic, riparian and terrestrial).
Regulatory and Maintenance	Biodiversity preservation	High	The protection of the river (slowing down the water and storing water) along with the creation of habitats helps biodiversity preservation.
	Climate change adaptation and mitigation	None	
	Groundwater / aquifer recharge	None	
	Flood risk reduction	Medium	Since it increases the total water storage capacity of the river and its floodplain, this measure improves flood risk reduction.
	Erosion / sediment control	High	Giving back its natural shape and composition to the river bed helps controlling erosion. In particular, reactivating erosion for coarse sediment has to be favoured in case of deficit of such material in the river bed. Moreover, slowing down the river during flood events also contributes to favour sedimentation of bedload material.
	Filtration of pollutants	Medium	Since it intercepts pollutants pathways and slows down water flow, thus improving the natural purification capacity of the water, this measure does improve pollutants filtration.
Cultural	Recreational opportunities	None	
	Aesthetic / cultural value	Low	By improving the life conditions and the habitat diversity, this measure contributes to this feature.
Abiotic	Navigation	None	
	Geological resources	None	

	Energy production	None	

VII. Policy Objectives

Policy Objective		Rating	Evidence
Water Framework Directive			
Achieve Good Surface Water Status	Improving status of biological quality elements	High	The temporal dynamics in naturally functioning floodplains ensure the survival of many habitats and species identified as important biological quality.
	Improving status of physico-chemical quality elements	Medium	Likely positive impact on the water good ecological status, nutrient removal and denitrification.
	Improving status of hydromorphological quality elements	High	This measure allows deposition of sediment, in particular coarse sediment, as well as particle-bound substances such as phosphorus
	Improving chemical status and priority substances	Medium	Since the pollutant pathways are intercepted, this objective has the potential to be improved.
Achieve Good GW	Improved quantitative status	None	
	Improved chemical status	None	
Prevent Deterioration	Prevent surface water status deterioration	High	By reducing the pollution threat, improving fish habitats and diversifying the river flow, this measure does indeed improve the surface water status.
	Prevent groundwater status deterioration	Low	Since the river bed is returned to a more natural state, the infiltration and purification feature of the river bed is improved, supporting the prevention of groundwater status deterioration. The effect is yet low due to the absence of real effect of the measure on groundwater recharge
Floods Directive			
Take adequate and co-ordinated measures to reduce flood risks		Medium	Reduction and storage of surface runoff will contribute to reduced peak flows in receiving watercourses, reducing flood risk as an alternative to hard flood defence.
Habitats and Birds Directives			
Protection of Important Habitats		Medium	The slowing down of the water flow, the diversification of habitats and the interception of pollutants help protecting the habitats.

2020 Biodiversity Strategy		
Better protection for ecosystems and more use of Green Infrastructure	Medium	This measures helps the diversification of river depth, river flow velocity and hence aquatic, terrestrial and riparian habitats, protecting the ecosystems.
More sustainable agriculture and forestry	None	
Better management of fish stocks	Medium	By providing more favourable aquatic life conditions and protecting fish habitats, this measure can improve stock management.
Prevention of biodiversity loss	Medium	All in all, by the protection and diversification of habitats and the creation of a more favourable context, this measure prevents biodiversity loss.

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	The bed levels have to be raised to leave a maximum water depth based on the level at which flows are exceeded 90% of the time. This ensures that under very low flows the bed-width would be constricted to sustain at least some clean gravel at all times.
Space required	n/a
Location	Any watercourses that have become over-deepened over time.
Site and slope stability	n/a
Soils and groundwater	Any type of soil, but reactivated erosion has to concern only coarse sediment. The material used for the alluvial mattress is recommended to be from the alluvial plain or the high water bed of the river. It can be created from a basin or pond in the bank where to take the soil from. The optimal gravel-size differs between fish species and conditions at the restoration site (e.g. discharge, cross-section form, and natural grain size in nearby natural reaches) so that a high flow rate would be required to move them.

Pre-treatment requirements	Stakes must be placed in the river to mark the level as a guide to the contractor during the gravel placement process. The work is better to commence at the end of summer when river flows are at an annual low, but with sufficient time to allow completion of the work before any winter floods commence. The sustainability of the material must be checked beforehand by the inspection of machine-excavated trial pits. The backwater effect has to be considered in the design and development of the project, regarding to the maximum high of the gravel bed placed on the glide. When gravel is added at one degraded riffle, the water rises upstream and may flood the next upstream riffle, which can lose its functionality.
Synergies with Other Measures	Levelling-up the water level can help to other measures like • floodplain restoration • re-meandering, reconnection of hydraulic annexes • basin and ponds • streambed re-naturalization

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition	n/a	
Investigations & Studies	n/a	
Capital Costs	n/a	
Maintenance Costs	n/a	
Additional Costs	n/a	

X. Governance and Implementation

Requirement	Evidence
Definition of the responsibilities	The effective planning, design, and operation of this type of measure requires the involvement of a wide range of stakeholders. This include local planning authorities, environmental regulators, private landowners and land managers, farmers and other bodies with responsibilities water management (e.g. irrigation bodies, drainage boards, etc). "Involving stakeholders like farmers, fishermen and (local) citizens (during the design phase, through consultation meetings and sessions is) one the key factors of (this kind of) project.

XI. Incentives supporting the financing of the NWRM

Type	Evidence
n/a	

XII. References

Reference	Comment
Liebault, F. Gomez, B. Page, M. Marden, M. Peacock, D. Richard, D. Trotter, C. M. 2005. Land-use change, sediment production and channel response in upland regions. River Research and Applications 21(7): 739-756.	Paper on land-use change, sediment production and channel response in upland regions
http://www.sedalp.eu/	European project focusing on the integrated management of sediment transport in Alpine basins. It is directed towards an effective reduction of sediment-related risk while promoting the enhancement of riverine ecosystems and reducing the impacts of hydropower plants