European Commission

Natural Water Retention Measures

NWRM

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

Individual NWRM

Basins and ponds

ACTeon environment research & consultancy

Office International de l'Eau

amec foster wheeler · BEF Latvia · enveco Environmental Economics Consultancy · I.A.CO Ltd Environmental & Water Consultants · imdea water institute · Regional Environmental Center · REKK · SLU · SRUC

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

Detention basins and ponds are water bodies storing surface run-off. A detention basin is free from water in dry weather flow conditions, whereas a pond (e.g. retention ponds, flood storage reservoirs, shallow impoundments) contains water during dry weather, and is designed to hold more when it rains.

II. Illustration

Example of pond

Source: from Dr. Ernst Segatz: "Beitrag von Landesforsten für die Entwicklung der Gewässer im Pfälzerwald"

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	Yes	Basins and ponds require a large accessible area that is relatively flat and with an appropriately-sized drainage catchment. They can be installed in any type of area (urban, forest, agricultural…). Account should be taken of natural features that could be used to form the basin and/or provide additional storage areas in order to minimise the need for artificial landscaping.
Agricultural Areas	Yes	
Forests and Semi-Natural Areas	Yes	
Wetlands	Yes	

Region	Applicability	Evidence
Western Europe	Yes	No specific climatic or geographic condition required. Nevertheless, the negative externalities that can be caused by ponds in southern part of Europe (Mediterranean region) such as proliferation of mosquitos. may lead to recommend using basins in preference to permanent ponds. In other parts of Europe ponds (re)create additional aquatic environment space that may be favourable for hosting aquatic species.
Mediterranean	Yes	
Baltic Sea	Yes	
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	Basins and ponds may treat large catchment areas and there is no maximum catchment area that can limit their use. Nevertheless the sizing of the basin/pond has to be adapted to the drainage area. For very small drainage areas (<3 hectares), outlet throttle diameters would be very small (<150mm) in order to achieve the desired reduced outflow rates. This may result in an increased risk of blockage. More than one basin/pond can also be installed to treat large drainage areas.					

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	High	Volume of runoff storage: Total volume of the basin/volume available in the pond (total volume minus the volume of water already there before the rain event). No long term storage for the basins. For the pond, the potential storage is equal to the total volume of the pond. Peak flow reduction estimated to be between 15-30% for the Northumberland (Rural runoff attenuation in the Belford catchment, UK) project
	Slow Runoff	High	
	Store River Water	None	Storing of surface runoff only (system not connected to a river)
	Slow River Water	None	Storing of surface runoff only (system not connected to a river)
Reducing Runoff	Increase Evapotranspiration	None	
	Increase Infiltration and/or groundwater recharge	Varies: None-High	Depending on the design of the basin or pond and the underlying geology and water table, this measure can increase infiltration. However in some cases, for example if the underlying geology is impermeable, or if there is a risk of contaminated runoff, then the pond or basin can be designed with an impermeable bed.
	Increase soil water retention	Low	The capacity to retain soil water improves by increasing the organic matter in the soil which decants from the storage water.

Reducing Pollution	Reduce pollutant sources	None	
	Intercept pollution pathways	Medium	Ponds and basins can be effective at pollutant removal, as a result of settling of particulate pollutants and uptake by vegetation. Literature reviews of the effectiveness of detention basins at pollutant removal have been carried out by Environment Agency (2012) and DTI (2006). Wide ranges of effectiveness were found: - Suspended solids reduction: EA (2012) 30-90%; DTI (2006) 61% - Total phosphorus reduction: EA (2012) 14-70%; DTI (2006) 19% - Total nitrogen reduction: EA(2012) 15-45%; DTI (2006) 31% - Metals: DTI (2006) 26-54% It is likely that achieving high effectiveness at pollutant removal will be improved by good design and adequate maintenance.
Soil Conservation	Reduce erosion and/or sediment delivery	Low	Linked to runoff storage. The design of basins and ponds may integrate a sediment trap.
	Improve soils	None	
Creating Habitat	Create aquatic habitat	Low	Basins are empty most of the time. Ponds, on the other hand, can be planted with trees, shrubs and other plants, providing habitats for wildlife.
	Create riparian habitat	None	
	Create terrestrial habitat	None	
Climate Alteration	Enhance precipitation	None	
	Reduce peak temperature	None	
	Absorb and/or retain CO_2	None	

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	High	The water gets storage in the ponds and can be used afterwards for other purposes like irrigation. Basins and ponds also help storing water in case of flooding
	Fish stocks and recruiting	Low	An aquatic ecosystem is created with this measure and, depending on the size, could keep a valuable fish stock.
	Natural biomass production	Low	Keeping the water for longer period stimulates vegetation.
Regulatory and Maintenance	Biodiversity preservation	Low	Due to new ecosystem, it will increase habitat diversity and thereby biodiversity, for aquatic and terrestrial species.
	Climate change adaptation and mitigation	None	
	Groundwater / aquifer recharge	Medium /High	An active wetland enables better surface-groundwater exchange, which will also beneficiate the water body during droughts. However in some cases, for example if the underlying geology is impermeable, or if there is a risk of contaminated runoff, then the pond or basin can be designed with an impermeable bed.
	Flood risk reduction	High	Regulation of floods is also an ecosystem benefits this measure entails due to the retention of water.
	Erosion / sediment control	Low	The runoff is stored and the sediment within it gets deposited in the basin and ponds (in case of urban measures, erosion control is not very significant because the runoff does not contain a relevant amount of sediment)
	Filtration of pollutants	Medium	Pollutants can be absorbed and/or degraded in the basins and ponds before ending up in the water body
Cultural	Recreational opportunities	Medium	Possibilities of recreational opportunities can increase after the creation of basins and ponds due to different reasons like creation of riparian or green spots in urban areas.
	Aesthetic / cultural value	Medium	Mostly in urban and rural areas, water zones give an aesthetic value, more natural and enjoyable.
Abiotic	Navigation	None	
	Geological resources	None	
	Energy production	None	

VII. Policy Objectives

<table>
<tr><th colspan="2">Policy Objective</th><th>Rating</th><th>Evidence</th></tr>
<tr><td colspan="4">Water Framework Directive</td></tr>
<tr><td rowspan="4">Achieve Good Surface Water Status</td><td>Improving status of biological quality elements</td><td>Low</td><td>By increasing habitat diversity and thereby biodiversity, for aquatic and terrestrial species, this measure has some impact on biological quality elements. In exceptionally warm areas (i.e. southern Spain and Portugal), water may heat up in excess, thus impacting downstream aquatic habitats.</td></tr>
<tr><td>Improving status of physico-chemical quality elements</td><td>Low</td><td>Potential to improve water quality in receiving water bodies through reduction in sediment loading and addressing urban diffuse pollution. Potential to reduce chemical pollution and improve the chemical status of surface water downstream as it can control pollution related to pesticides and others, adsorbing it in soil particles that are eroded and end up in surface aquatic environments.</td></tr>
<tr><td>Improving status of hydromorphological quality elements</td><td>Low</td><td>Reduction in peak runoff rates may reduce channel erosion during storm events.
On the other hand, in case of water flow after the measure, basins and ponds decrease sediment transport downstream, which might in some rare cases lead to erosion.</td></tr>
<tr><td>Improving chemical status and priority substances</td><td>Low</td><td></td></tr>
<tr><td rowspan="2">Achieve Good GW Status</td><td>Improved quantitative status</td><td>Low</td><td>As this measure can increase infiltration, it can improve quantitative status of GW</td></tr>
<tr><td>Improved chemical status</td><td>Low</td><td>Pollution by pollutants infiltration into the groundwater is possible, especially in urban areas: basins may be made impervious to avoid this, and pre-treatment added where infiltration is desirable.</td></tr>
<tr><td rowspan="2">Prevent Deterioration</td><td>Prevent surface water status deterioration</td><td>Low</td><td>As this measure can play a role in improving biological, physical and chemical status of water surface, it can prevent surface water status deterioration</td></tr>
<tr><td>Prevent groundwater status deterioration</td><td>Low</td><td>As pollutants filtration is possible, this measure can prevent groundwater status deterioration</td></tr>
<tr><td colspan="4">Floods Directive</td></tr>
<tr><td colspan="2">Take adequate and co-ordinated measures to reduce flood risks</td><td>High</td><td>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.</td></tr>
</table>

Habitats and Birds Directives		
Protection of Important Habitats	None	
2020 Biodiversity Strategy		
Better protection for ecosystems and more use of Green Infrastructure	Low	As a green infrastructure component, increased application of detention basins will contribute to meeting the objectives of the 2020 Biodiversity Strategy, particularly in urban areas.
More sustainable agriculture and forestry	Low	Where used to intercept and store runoff from low permeability surfaces in agricultural areas (i.e. as rural SuDS components) detention basins can contribute to more sustainable agricultural practices.
Better management of fish stocks	Low	As an aquatic ecosystem is created with this measure and, depending on the size, could keep a valuable fish stock, this measure can allow better management of fish stocks
Prevention of biodiversity loss	Low	By providing green space in urban areas, detention basins can make a contribution to the prevention of biodiversity loss.

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	Typical depth: 3-5 m. Typical sizing: around 500-5000 m3. But it mostly depends on the drainage area to treat, and these figures can be increased a lot.
Space required	The size is dependent on several factors such as topography, the effective contributing area, and the relationship between the amounts of incoming and discharged water. Basins and ponds are relatively high land-take measures, but it is possible to use the land for other purposes (e.g. recreational areas) through imaginative site design.
Location	Basins and ponds require a large accessible area that is relatively flat and with an appropriately-sized drainage catchment. They are installed in any type of area (urban, forest, agricultural…)

Site and slope stability	The basin/pond floor should be made as level as possible to maximise storage and infiltration potential and minimise the risk of erosion. This will also reduce flow velocities within the basin and maximise pollution removal. It is advised not to install basins and ponds on slopes greater than 30°. Basins and ponds should not be sited on unstable ground and ground stability should be verified prior to construction. It is particularly important to avoid siting in areas where water storage and infiltration may cause slope stability or foundation problems, e.g. in areas of landslides or at the top of slopes unless a full engineering risk assessment has been carried out by a suitably qualified geotechnical engineer or engineering geologist.
Soils and groundwater	There is no specific condition on soil permeability or depth. Basin floors are sometimes made impervious to avoid pollutants infiltration into the ground.
Pre-treatment requirements	This measure is most effective when primary treatment is provided upstream, as it is also the case in wastewater treatment. Any measures that retard runoff and control pollutants at source will enhance the pond or wetland's overall retention of pollutants.
Synergies with Other Measures	Usually set-up along with numerous other NWRM.

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition		Basins and ponds are rather high land-take measures. One of the primary costs is therefore the cost of land acquisition or the opportunity cost of not using that land for development. This will depend on the land values at the site under considerations and cannot be generically quantified.
Investigations & Studies		
Capital Costs	~44 000€ /ha	Construction costs scale with the storage volume of the basin/pond are approximately 44000€ per hectare. Costs will be higher where additional retaining bunds are required and lower where greater use is made of natural or existing topographic features.
Maintenance Costs	~60€/ha/year	Since these basins have long lifespan, once in operation only minimal maintenance costs arise. Quarterly inspections of inlets and outlets as well as sediment and trash dredging might be required. Mowing around the basin margins would be possible but it may increase costs.
Additional Costs	/	N/A

X. Governance and Implementation

Requirement	Evidence
Definition of the responsibilities	The effective planning, design, construction, operation and maintenance of basins and ponds may require 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). This requires alignment between stakeholders from planning authorities through to developers and land owners, and to clearly define who will be in charge of each step of the process, especially maintenance in the long-term.

XI. Incentives supporting the financing of the NWRM

Type	Evidence
CAP	The GAEC standards include retention of landscape features (including ponds) and establishment/retention of habitats
LIFE + Nature and Biodiversity	Article 10 of the Habitats Directive promotes the ponds which are "essential for the migration, dispersal and genetic exchange of wild species", and highlights that "stepping stones (such as ponds)" are of the utmost importance for those species
Public funding	Funding of runoff attenuation project in UK was provided by the Environment Agency and Northumbrian Regional Flood Defence Committee (public funding).

XII. References

Reference	Comment
"Costs, benefits and climate proofing of natural water retention measures"	Stella Consulting, NWRM Final Report - May 2012
"Performance of Stormwater Ponds and Wetlands in Winter",	Gary Oberts, Article 71, Technical note #16 from Watershed Protection Techniques http://yosemite.epa.gov/r10/water.nsf/0/159859e0c556f1c988256b7f007525b9/$FILE/Performance%20of%20SW%20Ponds%20and%20Wetlands%20in%20Winter.pdf
"Ponds vs Wetlands - performance considerations in Stormwater quality management"	Wong-Breen-Somes, 1999, proceedings of the 1st South Pacific Conference on Comprehensive Stormwater and Aquatic Ecosystem Management, Auckland, New Zealand, 22-26 February 1999, Vol 2, pp. 223-231 http://www.northinlet.sc.edu/training/media/resources/Ponds%20V%20Wetlands%20SW%20Quality%20Mgmt.pdf

"Design guidelines: Stormwater pollution control ponds and wetlands."	Ian Lawrence & Peter Breen, 1998. Cooperative Research Centre for Freshwater Ecology. http://ewater.com.au/archive/crcfe/freshwater/publications.nsf/827558d21061a2f2ca256f150011f4da/74f3301b658b1245ca256f19000dd3d1/$FILE/Stormwater%20ponds%20%26%20wetlands.pdf