European Commission

NWRM

Natural Water Retention Measures

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

Case Study

De-culverting London

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

institute IMdea water

REGIONAL ENVIRONMENTAL CENTER

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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 Key words: Biophysical impact, runoff, water retention, effectiveness - Please consult the NWRM glossary for more information.

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Table of content

I. Basic Information

Application ID	*United Kingdom_02*			
Application Name	De-culverting_London			
Application Location	Country:	United Kingdom	Country 2:	
	NUTS2 Code *(select from list in Annex 1)*		*UKI1-Inner London*	
	River Basin District Code		*UK06-Thames*	
	WFD Water Body Code		GB106039023290	
	Description		*The case study is located in south eastern part of the United Kingdom, in south east London. A heavily urbanised area, at an altitude of approximately 70m AOD.*	
Application Site Coordinates *(in ETRS89 or WGS84 the coordinate system)*	Latitude: 51.455042 *- ETRS89 or WGS84? Specify: WGS84*		Longitude: 0.030134 *- ETRS89 or WGS84? Specify: WGS84*	
Target Sector(s)	Primary:	Urban		
Implemented NWRM(s)	Measure #1:	*N4*		
	Measure #2:	*N3*		
	Measure #3:	*U11*		
Application short description	The River Quaggy had a suite of NWRM features implemented as part of a flood alleviation scheme between 1990 and 2005. The main components included: - In the upper reaches this included returning to the surface a culverted underground section of the river and creating associated floodplain (Sutcliffe Park). - A detention basin was created at Weigall Road sports grounds for flood storage - Further downstream, set-back flood defences were constructed in private gardens adjacent to the river, and channel re-profiling undertaken. A map of the locations of measures along the River Quaggy can be seen in section 12.			

II. Policy context and design targets

Brief description of the problem to be tackled	As urban development in the River Quaggy river valley and natural flood plain, near Lewisham in central London, is increasing, fluvial flooding experienced by local residents and businesses has increased. In 1968 the centre of Lewisham flooded to a depth in excess of 1m, and more recent flood events have occurred. A flood alleviation scheme was required to prevent further loss to the remaining floodplain within the catchment.		
What were the primary & secondary targets when designing this application?	Primary target #1:	Flood control and flood risk mitigation	
	Secondary target #1:	Regulation of hydrological cycle and water flow	
Which specific types of pressures did you aim at mitigating?	Pressure #1:	Other non EU-Directive (specify)	*Natural Exceedence - Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands.*
	Pressure #2:	Other non EU-Directive (specify)	*Physical alteration of channel/bed/riparian area/shore of water body for flood protection*
	Pressure #3:	Other non EU-Directive (specify)	*Diffuse - Urban runoff - Storm overflows and discharges in urbanized areas not identified as point source*
	Remarks	The flood alleviation scheme was implemented between 1990 and 2005, prior to WFD and FD, but subsequent comparison shows compliance with and benefits to a number of the Directives.	
Which specific types of adverse impacts did you aim at mitigating?	Impact #1:	Other non EU-Directive (specify)	*Property- Adverse consequences to property and businesses.*
	Remarks	The flood alleviation scheme was implemented between 1990 and 2005, prior to WFD and FD, but subsequent comparison shows compliance with or support for those directives.	
Which EU requirements and EU Directives were aimed at being addressed?	Requirement #1:	Floods Directive-mitigating Flood Risk	*Address risk of flooding to local and downstream properties.*
	Requirement #2:	WFD-mitigation of significant pressure	*De-culverting*
	Remarks As noted above, the WFD and FD were not in place at the time of implementation. Nevertheless the measures directly contribute to the FD and WFD objectives.		
Which national and/or regional policy challenges and/or	The WFD and FD were not in place at the time of implementation, but comparison has subsequently been made with these and a		

requirements aimed to be addressed?	number of local policies for which the scheme is complaint. A number of these policies include: - London Green Infrastructure Policy - Thames catchment flood management Plan - London Green Infrastructure blue ribbon network Policy - London Borough of Lewisham River Policy.

III. Site characteristics

Dominant Land Use type(s)	Dominant land use	*111 - Continuous urban fabric*
	Secondary land use	*142 - Sport and leisure facilities*
	Other important land use	*141 – Green urban areas*
	Remarks	
Climate zone	cool temperate moist	
Soil type	Gleysols/ Luvisols	
Average Slope	gentle (2-5%)	
Mean Annual Rainfall	600 - 900 mm	
Mean Annual Runoff	150 - 300 mm	
Average Runoff coefficient (or % imperviousness on site)		40 - 60%
	Based on estimate of the Urban extent across the catchment.	
Characterization of water quality status (prior to the implementation of the NWRMs)	Although it is known that water quality monitoring was undertaken prior to the implementation of the measures, the report with this information was not available.	
Comment on any specific site characteristic that influences the effectiveness of the applied NWRM(s) in a positive or negative way	*Positive way:* The existing open spaces for recreation etc within the urbanized catchment were crucial to the effectiveness of the measures. The available green space at Sutcliffe Park ensured that bringing the culverted channel to the surface and creating operational flood plain worked effectively within the urban area. The availability of gardens adjacent to the watercourse, downstream of Manor Park, allowed the effective implementation and operation of the set back flood defences in a highly residential area.	
	Negative way: None identified	

IV. Design & implementation parameters

Project scale	Medium (eg. public park, new development district)	*Tributary catchment scale*
Time frame	Date of installation/construction (MM.YYYY)	*Implementation between 1990 and 2005*
	Expected average lifespan (life expectancy) of the application in years	*Lifespan of the individual NWRMs varies, but overall expected to be 50+ years with occasional maintenance.*

<table>
<tr><td rowspan="6">Responsible authority and other stakeholders involved</td><td>Name of responsible authority/ stakeholder</td><td>Role, responsibilities</td></tr>
<tr><td>1.Environment Agency</td><td>Implementation; co-ordination; financial</td></tr>
<tr><td>2. Quaggy Waterways Action Group</td><td>Co-ordination, implementation and continued support for the scheme</td></tr>
<tr><td>3. Local Residents</td><td>Provision of land; support for scheme</td></tr>
<tr><td>4. London Borough of Greenwich</td><td>Support for the scheme and maintenance.</td></tr>
<tr><td>5. London Borough of Sutton</td><td>Support for the scheme and maintenance.</td></tr>
<tr><td>The application was initiated and financed by</td><td colspan="2">Environment Agency and Quaggy Waterways Action Group</td></tr>
<tr><td>What were specific principles that were followed in the design of this application?</td><td colspan="2">The primary principle was to ensure effectiveness in managing downstream flooding. As part of this aesthetic benefit was a key requirement to ensure no loss of the green areas already limited within the urban environment. In order to enable this, it was also important to have landowner acceptability and involvement.</td></tr>
<tr><td rowspan="2">Area (ha)</td><td>Number of hectares treated by the NWRM(s).</td><td>1750ha</td></tr>
<tr><td colspan="2">This is the catchment area of the River Quaggy upstream of its confluence with Ravensbourne River. The NWRMs are upstream of this point so the overall area that is treated by the NWRMs is slightly less.</td></tr>
<tr><td>Design capacity</td><td colspan="2">For this site a suite of NWRMs are operating in combination. The overall storage capacity is not specified, but the capacity of individual measures includes:
- Sutcliffe park floodplain has capacity for 85,000m^3 of flood water. Designed to accommodate 1 in 30 year flows
- Weigall Road detention basin has capacity for 65,000m^3 of floodwater, and the inflow maximum is designed for a 1 in 70 year flood event, with maximum inflow of 5m^3/s through the flume.</td></tr>
<tr><td rowspan="6">Reference to existing engineering standards, guidelines and manuals that have been used during the design phase</td><td colspan="2">Reference</td><td>URL</td></tr>
<tr><td>1.</td><td></td><td></td></tr>
<tr><td>2.</td><td></td><td></td></tr>
<tr><td>3.</td><td></td><td></td></tr>
<tr><td>4.</td><td></td><td></td></tr>
<tr><td>5.</td><td></td><td></td></tr>
<tr><td>Main factors and/or constraints that influenced the selection and design of the NWRM(s) in this application?</td><td colspan="2">Previous flood alleviation downstream of Manor park (dense number of properties backing directly onto the river) was concrete channels and walls. The original plan was to further raise the existing walls. However this would have resulted in the loss of a large number of well established trees. Large resistance to this approach resulted in set- back flood defences being designed into the gardens of the properties.
There was strong political and local desire for have a flood storage</td></tr>
</table>

	area to help safe guard the trees. The borough councils resisted this due to concerns that their parks, that currently did not flood, would be flooded and result in a loss of amenity value. Surveys were completed to show that it would be a positive effect for amenity. At Sutcliffe park the river was already culverted underground so any further flood attenuation would require new approaches. Taking a catchment-scale approach was key to enabling measures to be implemented. In particular, providing the flood storage measures upstream reduced the flood risk downstream. This created greater flexibility in being able to provide in-channel measures further downstream, where otherwise there may have been concern about increased flood risk.

V. Biophysical impacts

Impact category (short name) Select from the **drop-down menu** below:	**Impact description** (Text, approx. 200 words)	**Impact quantification** (specifying units)	
		Parameter value; units	% change in parameter value as compared to the state prior to the implementation of the NWRM(s)
Runoff attenuation / control	*Increased flood storage and meandering channel will provide additional capacity to retain water in the upper reaches of the River Quaggy catchment for longer.*		
Peak flow rate reduction	*The increase in floodplain within Sutcliffe Park, and the storage capacity of the detention Basin will result in reduced peak flows, as water will be slowed and contained in the upper part of the River Quaggy catchment for longer.*		
Impact on groundwater		*n/a*	
Impact on soil moisture and soil storage capacity		*n/a*	
Restoring hydraulic connection	*The connectivity between the River Quaggy and its floodplain has been restored within Sutcliffe Park by removing the watercourse from its underground culvert, and improving associated flood plain capacity.* *The use of set back defences downstream of Manor Park has reconnected the watercourse to floodplain area adjacent to the channel*	*Sutcliffe park floodplain capacity of* 85,000m^3.	
Water quality Improvements	*There is data available as part of the Environmental Impact assessment, but this report has not been obtained. An*		

	improvement in the wildlife habitats and biodiversity is indicative of improved water quality.		
WFD Ecological Status and objectives	*2009 WFD data indicates that the River Quaggy is of Poor Ecological Potential. Mitigation Measures already identified in the RBMP as being 'in place' to support achieving good ecological potential include* appropriate channel maintenance strategies through minimising disturbance to channel bed and margins. These are likely to have been achieved through the implementation of the measures discussed here.		
Reducing flood risks (Floods Directive)	*The Sutcliffe Park measure (bringing the channel out a culvert to a meandering channel and floodplain) reduces flood risk to 600 homes and businesses in the area. The standard of flood protection has been improved.*		*Flood protection changed from 1 in 5 years (20% probability) to a minimum of 1 in 70 years (1.4% probability*
Mitigation of other biophysical impacts in relation to other EU Directives (e.g. Habitats, UWWT, etc.)	*Describe any other biophysical impacts related to pressures and objectives (the biophysical related ones) of other EU Directives, e.g. Habitats Directive, UWWT Directive, etc.*	*None*	
Soil Quality Improvements	*Has the NWRM impacted the overall soil quality? In which way? Please provide some explanatory text. Provide details on specific pollutants (N, P, soil carbon/organic matter, physical properties-bulk density, etc.)*	*No*	
Other		*None*	

VI. Socio-Economic Information

What are the benefits and co-benefits of NWRMs in this application?	The use of a network of NWRMs in a predominantly urban landscape provides a cost effective and adaptable means to reduce flood risk, while providing amenity value to highly populated area. Additional benefits include: - Creating meandering river and detention basin provides new habitat for wildlife. - The increased habitat and biodiversity in the catchment, which is also indicative of improved water quality. - 73% increase in the number of visitors to Sutcliffe Park, and visitors generally stay longer than previously		
Financial costs	***Total:***	*approximately €14,700,000*	*Sutcliffe Park and John Roan School site: €4,700,000 to construct.* *Weigall Road and Eltham Palace Road: €2,600,000 to construct.* *Downstream of Manor park flood defences: €7,200,000.* *This does not include consultancy costs.*
	Capital:		*No information*
	Land	*€0*	*Land is still owned by residents or Boroughs.*

	acquisition and value:		
	Operational:		*The NWRMs were designed so that operational costs are minimal. No costs provided.*
	Maintenance:		*Some maintenance will be required (e.g. trash screen clearance) but no costs provided*
	Other:		
Were financial compensations required? What amount?	*Was financial compensation required: No*		
	Total amount of money paid (in €): N/A		
	Compensation schema: N/A		
	Comments / Remarks:		
Economic costs	*Actual income loss: None*		
	Additional costs: None		
	Other opportunity costs: None		
	Comments / Remarks:		
Which link can be made to the ecosystem services approach?	Flood security and protection. Amenities (associated to habitat protection): fish and plants, tourism, recreation, and others.		

VII. Monitoring & maintenance requirements

Monitoring requirements	A number of parameters were monitored during different stages of the scheme. Prior to construction, eleven baseline surveys were carried out including surveys of riverine flora, trees, bats, fish, invertebrates, birds and mammals to inform designs in progress and enable the process of environmental impact assessment. Water Quality and Sediment sampling was also undertaken during the work. Socio economic surveys have been undertaken since the completion of the scheme to monitor visitor numbers to the site following the NWRM implementation. Other Social, economic and heath studies have been undertaken. The scheme was implemented pre WFD, but for maintenance monitoring, standard monitoring points associated with the WFD are now used, however no information was available on the location.
Maintenance requirements	Maintenance is now undertaken by the associated Borough of the Park. For example London Borough of Greenwich for the Sutcliffe site. Maintenance will ensure public safety during and after each flood event and maintain amenity value of the site. For Sutcliffe Park: - Flow control structures within the park have been designed to be maintenance free. - Annual inspections of vegetation within channels. - During Flood events, maintenance requirements include park gates to be locked and to remain locked whilst park is flooded, and warning notices to be posted at park entrances to advise the public why the park is closed. - As flood waters subside, litter picking is required of the entire

	flood storage area and clearing of excess debris from habitat areas and structures. Clearing excess silt from all areas is required, - Similar long term managment approaches are used for the grasslands, wetlands and lake A siltation problem was expected at some upstream locations in the scheme, however siltation occurred more quickly than expected, and resulted in footpaths being flooded. This was a localised issue that did not affect the overall scheme but was acted on swiftly and is now maintained to prevent recurrence.
What are the administrative costs?	Monitoring undertaken as part of the ongoing WFD monitoring program will not require any cost beyond existing costs. No other information available.

VIII. Performance metrics and assessment criteria

Which assessment methods and practices are used for assessing the biophysical impacts?	Monitoring before and after implementation
Which methods are used to assess costs, benefits and cost-effectiveness of measures?	A Health Study was undertaken in 2005 on the increased usage of Sutcliffe Park. A Economic study was undertaken in 2005 on the benefits of the works at Sutcliffe Park, and considers other housing proposals in the area. An MSc was undertaken in 2004 looking at the methods of public participation in the restoration of Sutcliffe Park - Bringing the river to life? Myths, motivations and practicalities of community involvement in urban river restoration.
How cost-effective are NWRM's compared to "traditional / structural" measures?	In this case, the NWRM suite approach was identified as the preferred option, in combination with some more 'traditional/structural' measures at Manor Park. The costs are generally lower than 'traditional' measures, although costs associated with re-meandering a channel and creating a detention basin are not small, but a greater range of benefits is achieved.
How do (if applicable) specific basin characteristics influence the effectiveness of measures?	There are no specific basin characteristics necessary for this type of measure. It could be widely applicable to urban catchments.
What is the standard time delay for measuring the effects of the measures?	The primary benefit of the measures, i.e. flood regulation, will have been achieved as soon as the measures were installed (.e. no time delay). However benefits and improvements in sediment regime and nutrient levels , seen as a result of the detention basin implementation and de-culverting the watercourse, are likely to take longer to become established. Any benefits in terms of changes to habitats and biodiversity will take time for habitat and species establishment.

IX. Main risks, implications, enabling factors and preconditions

What were the main implementation barriers?	A desire to protect the existing established trees along the watercourse, directly behind properties, ensured that a concrete wall raising option was disregarded, and alternative set back garden features were constructed. There was a local pressure group and political desire for a storage area, to safeguard the trees that line the River banks. The Borough Councils resisted this plan as there was a belief in a loss in amenity value when a park floods that did not previously. Surveys and investigations were undertaken to show that storage option was a positive and would not cause a loss in Amenity value.
What were the main enabling and success factors?	Engagement with the public from the start was critical to success of these measures. A full-time public engagement officer was employed. Related to this : - The desire of the residents and political for a more natural option than traditional defences. - Involvement of the residents etc in the 'soft works' e.g. Bird boxes and the design of set back defences in residences gardens downstream of Manor Park. - Formation of groups e.g. Local residents groups to bring people together but also act on local issues before they become a problem (e.g Japanese knot weed removal.) - A multidisciplinary team of engineers, landscape architects, and ecologists worked on the design to ensure that opportunities for major visual, social and ecological enhancements were optimised at the same time as managing the flood risk. - Regulatory support throughout the scheme. Taking a catchment-scale approach was also key. Some measures could not have been implemented in isolation, but required the benefit of upstream measures in order to provide the flexibility and public acceptance of downstream alterations.
Financing	Funding for the majority of the works was provided by the Environment Agency (Government funding). The downstream river restoration measures also received local partnership funding.
Flexibility & Adaptability	Some steps were taken within the Manor Park restoration work to account for climate change, for example selection of Mediterranean plants that require less water. The measures will still be effective for flood management with climate change, although the standards of protection may reduce
Transferability	The approach seen on the River Quaggy is suited to similar Urban catchments. It is dependent on available green areas, although some measures can be implemented in very limited space, especially if agreement can be reached with riparian property owners.

X. Lessons learned

Key lessons	The implementation of a number of NWRM within an urban environment has shown how effective measures can be implemented within an already constrained environment that provides multiple benefits to the environment and local residents. Although developed specifically for the River Quaggy the approach has generic applicability to many other catchments. Key lessons identified are that : - Communication and a positive attitude are key for this type of project. Early consultation is important as well as continued consultation. This includes active residents/ stakeholder engagement and involvement during design and construction including partnerships, schools and groups, as it not only ensures comprehension of the work but following implementation ensures a feeling of 'ownership' and responsibility that continues for the length of the NWRM lifespan. A full-time public liaison officer was employed during the planning and implementation phases - Design involved multi disciplinary teams of engineers, architects etc that all contributed their specialties to the Quaggy project ensuring visual, social and ecological enhancements were optimised at the same time as managing the flood risk. - Taking a catchment-scale approach allows greater overall improvement and enabled some measures that could not have been implemented in isolation.

XI. References

1. Source Type	
Source Author(s)	*The River Restoration Centre*
Source Title	*River Quaggy at Sutcliffe Park: Techniques: Re-meandering, backwater creation, de-culverting*
Year of publication	
Editor/Publisher	
Source Weblink Direct weblink(s) of the reference	*http://www.therrc.co.uk/case_studies/sutcliffe%20park.pdf*
2. Source Type	
Source Author(s)	
Source Title	River Quaggy Flood Alleviation Scheme
Year of publication	*2009*
Editor/Publisher	
Source Weblink	
3. Source Type	
Source Author(s)	*Environment Agency*
Source Title	*A river reborn: Restoring the Quaggy River and tackling flooding*

Year of publication			
Editor/Publisher	*Environment Agency*		
Source Weblink			
4. Source Type			
Source Author(s)			
Source Title	Weigall Road and Sutcliffe park		
Year of publication			
Editor/Publisher			
Source Weblink			
5. Source Type			
Source Author(s)			
Source Title	Sutcliffe Park Briefing pack - External		
Year of publication			
Editor/Publisher			
Source Weblink			
6. Source Type	*Grey Literature*		
Source Author(s) *)*	Greenwich Council		
Source Title	Sutcliffe Park Management Plan - Draft		
Year of publication	2007		
Editor/Publisher	Greenwich Council		
Source Weblink			
Key People		*Name / affiliation*	*Contact details*
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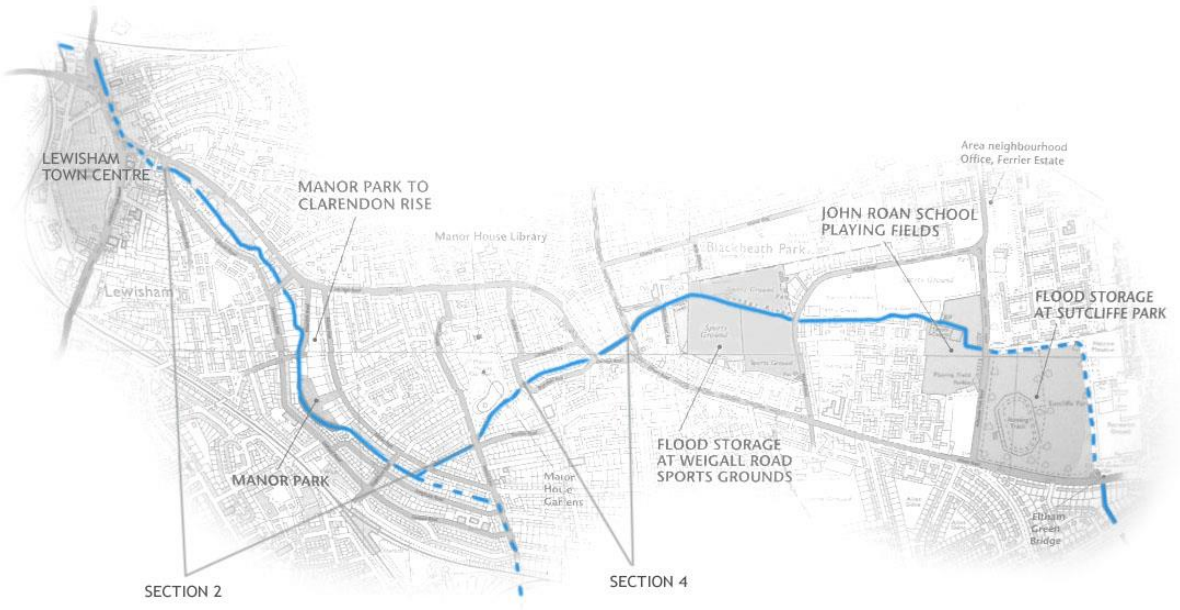
	2.	Heather Williams, AMEC	Heather.williams2@amec.com
	3.		
	4.		

XII. Photos Gallery

Sutcliffe Park. Photo provided by Dave Webb, Environment Agency.

Set back flood defences in private gardens, downstream of Manor Park. Photo provided by Dave Webb, Environment Agency

Weigall Road structure. Photo provided by Dave Webb, Environment Agency



Map of the River Quaggy. From the River Quaggy Flood Alleviation Scheme report, Environment Agency (2009)