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Restoring Meanders to Straightened Rivers

1.5 New meandering channel replacing concrete weirs

River Marden

Location – Town centre at Calne, Wiltshire ST998710

Date of construction – 1999

Length – 100m

Cost – not available

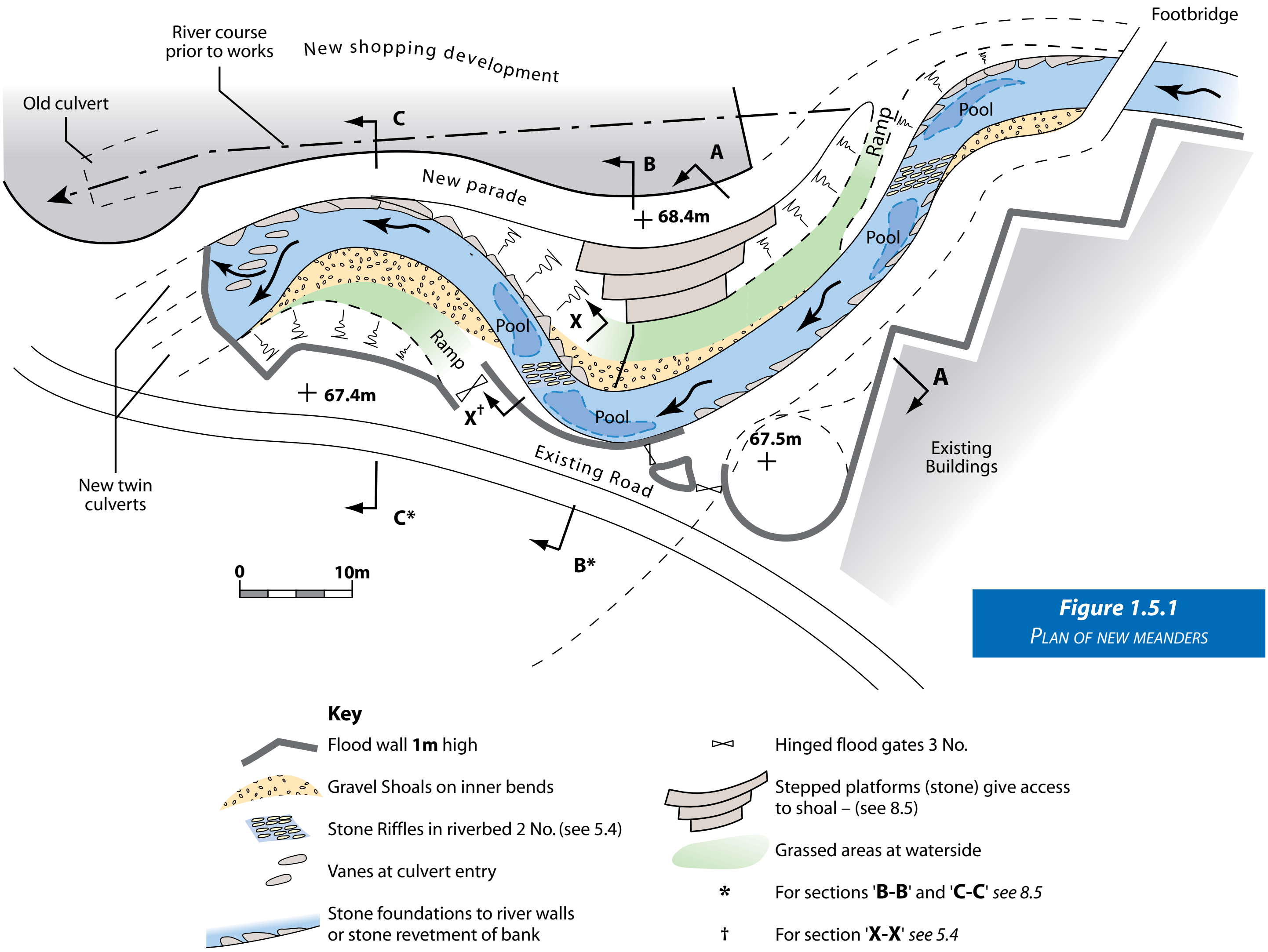


Figure 1.5.1
Plan of new meanders

Description

A town centre factory had been demolished leaving a reach of river flowing through the site in a straight, concrete channel. The channel bed dropped vertically in two places forming weirs that barred the passage of fish and were unsightly.

Redevelopment of the site required that the river be diverted south of its existing course and that its character be improved to create an attractive public amenity. The site is prominently located in the heart of an ancient market town.

The diversion was undertaken in the form of a double meander such that natural geomorphological features including shoals, riffles and pools could be incorporated, as well as good public access to the waterside and a variety of sustainable attractive habitats for flora and fauna.

Earlier proposals to create an impounded, canal-like waterway were dropped in favour of the relatively free flowing river regime described.

Restoring Meanders to Straightened Rivers

Design

The diversion necessitated the re-siting of the upstream part of twin box culverts that carry the river under the main road. *Figure 1.5.1* shows the location of old and new culverts. The double meander route between the existing channel and the new culverts was optimised within the constraints of the existing and new buildings shown.

The gradient of the new river bed became 'fixed' between the culvert invert and the existing upstream level. *Figure 1.5.2* shows the resultant longitudinal profile with a mean bed gradient of 1 in 140. This gradient is much steeper than arises naturally on this part of the river with consequent high water velocities when the river is in flood.

Hydraulic modelling indicated velocities of up to two metres per second and flood levels up to 0.8m above adjoining roads and property. These hydraulic parameters meant that flood walls would be needed to contain the river and that erosion of the river bed and banks would need to be rigidly controlled.

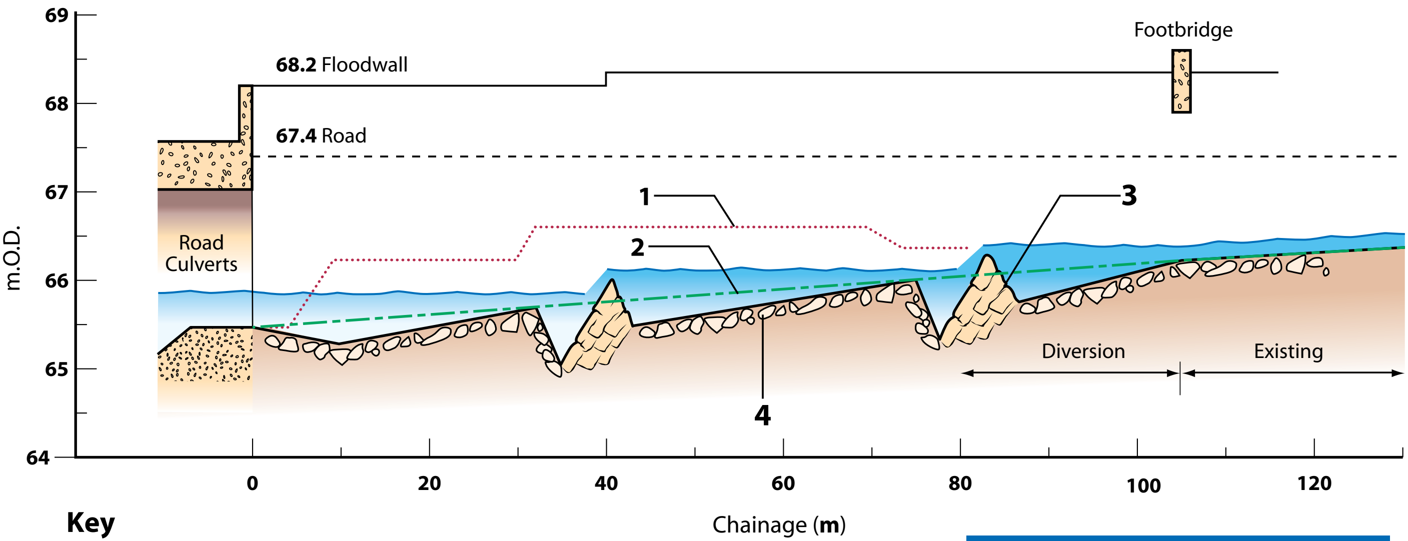
A design concept was needed that was sufficiently robust to meet these demanding hydraulic conditions but equally to meet the need for an attractive and sustainable environment.

The concept adopted was based on the premise that the gradient and alignment of the river were more typical of upland river locations where rock outcrops and gravel and cobble river bed substrates might be expected. Design of the many elements of the project began by developing a method of simulating stratified bedrock underneath the whole river diversion that would 'outcrop' to form river bank revetments, retaining wall foundations and river bed control cills.

Research was undertaken to select quarried rock that could be re-constructed on-site to simulate its natural characteristics. Purbeck Limestone from quarries at Swanage was chosen because it occurred in large, flat slabs of thickness between 0.1m to 0.9m. Slabs of rock could be laid securely, one above another, at consistent angles to recreate the 'dip and strike' of natural outcrops. The stone was sufficiently durable to withstand frost and could also be provided in cut building blocks for use in walls. Its colour and texture is similar to locally available Cotswold stone but its durability was much greater, an important factor in riverside locations.

The following lists the key locations where stone slabs were incorporated:

Within the foundations of all vertical riverside retaining walls
Slabs were laid at a consistent angle to project into and above the water creating the appearance of the walls being built on natural rock. Contrasting faces on opposite sides of the river were achieved by maintaining the 'dip' in the same direction i.e. smooth dip slopes one side and jagged escarpment faces on the other. As the river alignment approaches the culverts in the same direction as the selected dip-slopes, slabs were laid with the dip parallel to the retaining wall. This enabled a series of 'craggy' current deflectors to be incorporated into the foot of the wall.



Key

1. Original bed level – concrete channel with two drop weirs
2. New mean bed gradient at **1 in 140**
3. Two stone riffles built to stabilise river bed; pools upstream and downstream of each
4. Actual bed profile of gravel and cobble susbstrates

Figure 1.5.2
LONGITUDINAL PROFILE

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Before:
View downstream towards culvert

Completion:
View of the new river course

At the bottom of earth slopes on outer bends liable to erosion
Slabs were laid exactly as above with consistent direction of dip and strike to revet these banks with varying faces depending upon the channel alignment of each location. See section A–A, figure 1.5.3 for aspects of both wall foundations and bank revetments.

Outcrops in the riverbed to create low cills
The steepness of the river bed gradient needed to be checked by introducing two low barriers of rock to resist any tendency of the bed to scour downwards. These are shown as feature 3 on figure 1.5.2. They are located just downstream of each meander bend where underwater bars of river bed substrate e.g. gravels would naturally accumulate in the form of riffles. The stonework on adjacent walls and river bank was linked across the bed with stone laid at the same dip slope. Technique 5.4 shows details of these. They incorporate a gently sloping downstream face, much like a riffle. This enables the easy passage of migratory fish to be achieved and creates a 'tumbling' water feature rather than a sharp fall.

Building stone in walls and for amenity surfaces

Dressed stone was used to face and cap all retaining walls and flood walls as well as the headwalls on the new road culvert. These headwalls were designed with curving arched soffits to give the appearance of an older stone bridge, hiding the unsightly concrete boxes that carry the water under the road. On the inner bend fronting the new development, large stone slabs were laid to create stepped platforms down to the waterside shoal (*see 8.5 for details*).

Vertical vanes in the river upstream of the new road culverts

The twin culverts create an artificially wide river channel at entry with the consequential risk of the culvert on the inside of the bend attracting excessive silt accumulations. Four upright slabs of stone were concreted into the river bed to induce a sustained flow of water towards the inner culvert without barring the natural tendency of flow towards the outer culvert. The slabs project a nominal 0.15m above normal water levels and serve as 'vanes' that effectively modify the water currents at all stages of river flow, including flood flows.

All of the stone features described effectively define a precise and stable course to the river which was essential in this tightly developed urban location. The creation of the river bed and waterside shoals was an equally important aspect of design since both had to be similarly stable as well as being able to sustain flora and fauna.

Geomorphological calculations were undertaken to determine size, shape and distribution of the river bed substrates that were to be introduced in the differing hydraulic conditions generated by the double meander channel configuration. Two sources of material were selected for use either singly or in combination.

Stone rejects from nearby limestone gravel pits were used on the river bed upstream of chainage 40m (the lower riffle) where water velocities were highest. Sizes ranged from 40mm to 200mm and shape varied between rounded gravels and cobbles to flat pieces of stone. Elsewhere 40mm graded and washed gravels were used where water velocities were less severe. This included the inner bend shoals where the public would have easy access. A mixture of both was used in intermediate locations simulating the natural 'grading' of bed substrates that would arise had they been carried and deposited by the river.

The design was completed to accommodate floodwalls and floodgates and a range of public access and amenity features as well as a comprehensive landscape planting scheme sympathetic to the riverine environment. The introduction of marginal aquatic plants, etc. along soft edges and within the numerous interstices of the rock outcrops was deferred until floodwaters has passed through the newly created reach of the river. This enables the river to modify and soften the engineered work thereby revealing the most appropriate plant species for the multitude of different habitat niches expected.

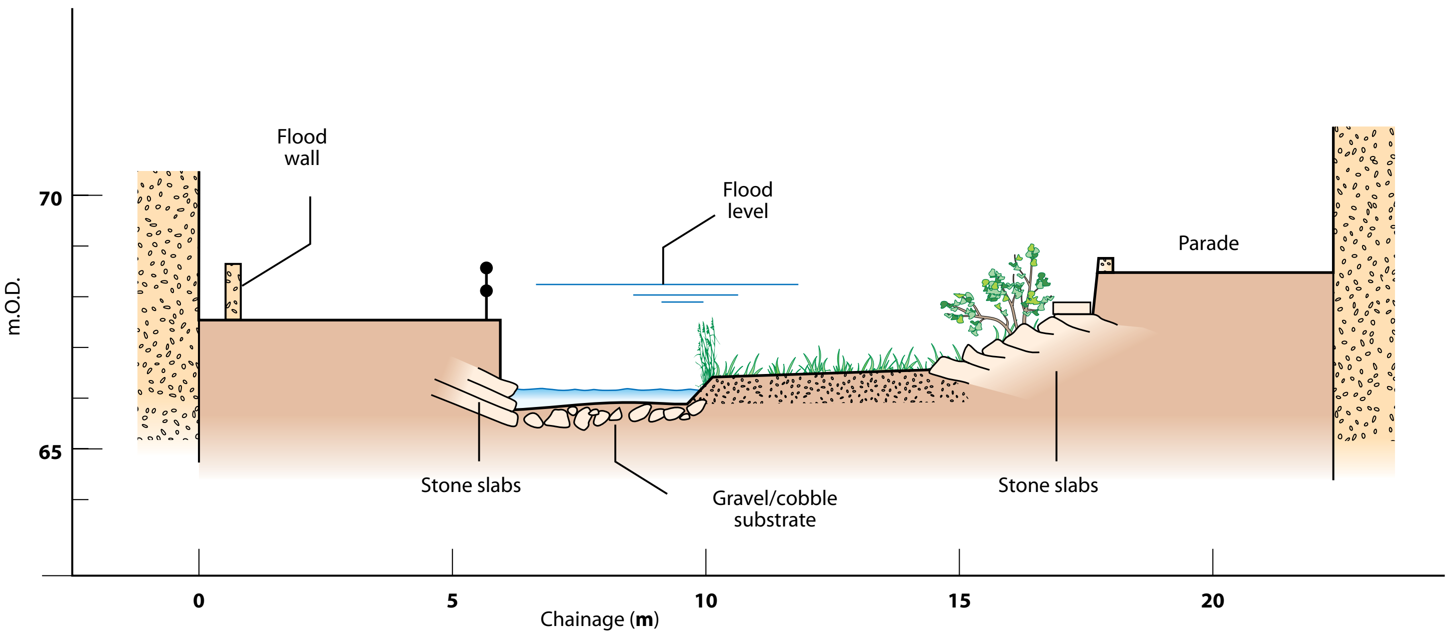

Figure 1.5.3
SECTION A THROUGH RIVER AND STONE SLABS

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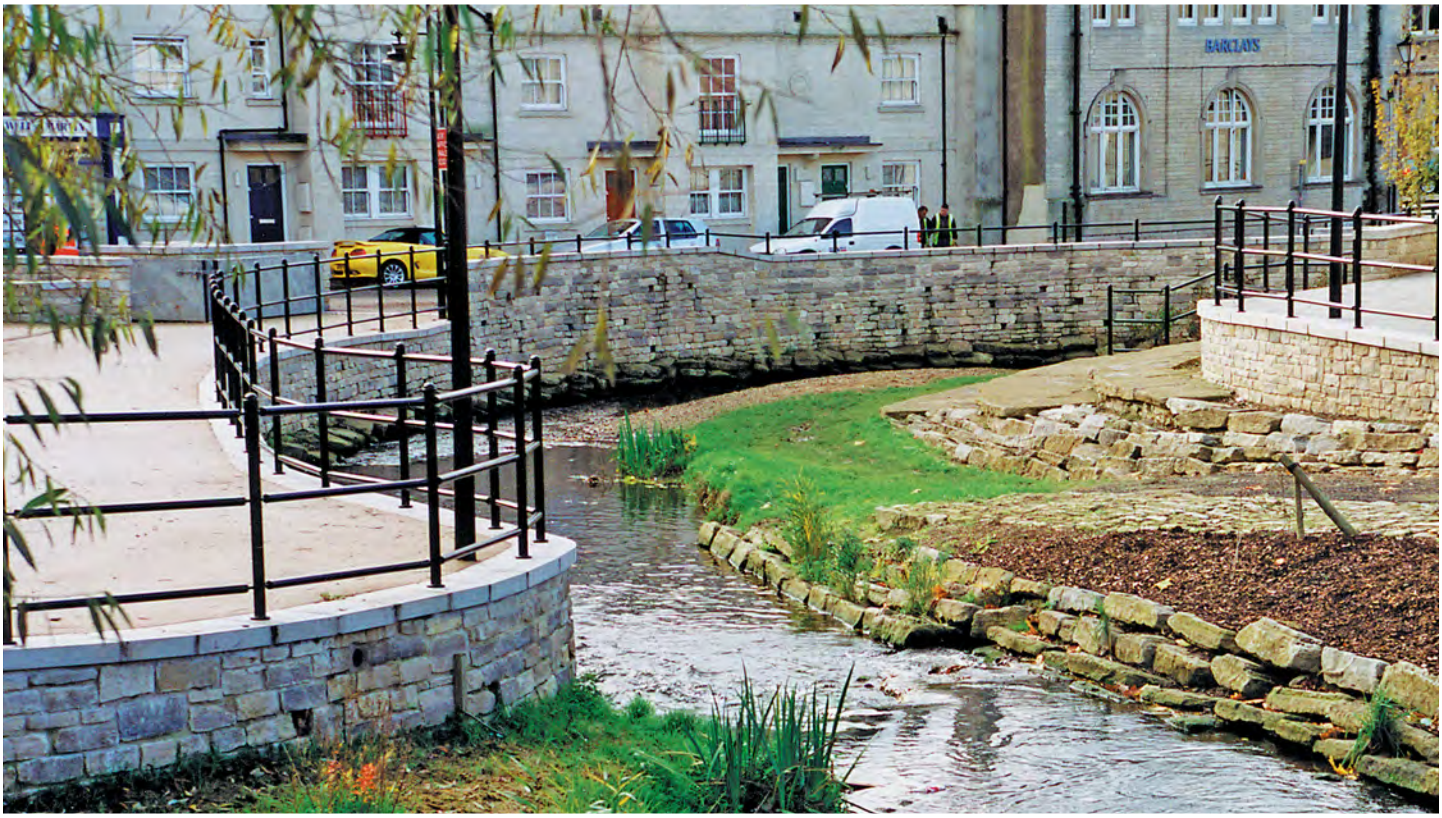
View of Section A (*fig 1.5.3*) on completion



View of Section A in November 2001

These techniques were developed to suit site specific criteria and may not apply to other locations

Restoring Meanders to Straightened Rivers

1

After: The new town centre in November 2001

Subsequent performance 1999 – 2001

The works have all remained remarkably stable bearing in mind that river bed substrates and shoal materials were all kept to minimum sizes, rather than 'over-sizing' to ensure stability.

The river has re-distributed some of the stone placed between the two riffles. This has created an additional riffle within the reach and the shoal at the front of the stepped platform has built up into an attractive, accessible beach.

The edge of the river channel between the two stone 'riffles' has slightly eroded along the un-revetted side. The latter can be easily controlled using pre-planted fibre rolls as part of the landscaping work and the former simply requires some gravel reject stone to be introduced into the soil that will then be grassed.

The four vanes at the culvert entry appear to be working well and sustain interesting current variations at low flows although some flood debris is attached to them. This debris is easily removed and is less problematic than it would be if it had entered the culverts.

The overall appearance of the riverworks is excellent and once the contractor finally clears the site and landscaping is completed it should naturalise well. Wildlife has occupied the site despite the intense building work with wagtails (*Motacilla spp*.), duck and fish being most obvious. The underwater rock and the sustained pools and faster flowing runs of water all promise to develop into valuable habitats.

Local comments are of young people enjoying 'messing about in the river' with no serious vandalism, partly due to the robustness of the design concept.

Original Information Provider:
RRC

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1.5 River Marden 2013 Update

River Marden	Medium energy, chalk
WFD Mitigation measure	Click Here to view details
Waterbody ID	GB109053022060
Designation	None
Project specific monitoring	None

The pools and shoals have remained fixed as designed and some redistribution of the bed gravels that were introduced has occurred. Whilst there has been some movement of bed material into the left hand culvert this has not been excessive (*see Figure 1.5.1*).

Great care was taken to ensure the risk of movement from bed material was reduced. As such a geomorphologist was involved during the design stages of the project. Although there was initial concern from the Environment Agency about the introduced gravels moving and causing a maintenance problem at the mouth of the culvert. This has been shown not to be the case.

The new meandering channel has performed well with no repair and little maintenance required. The grass area is part of the focal point for the town and was designed to allow access. It has therefore been mown for landscaping and amenity more than would be recommended to achieve ecological benefits.

The flood walls have not breached since construction. The photograph below illustrates the additional flood capacity provided by the scheme.

This was a relatively expensive project but this high level of investment has had a major impact in raising the image of the high street as witnessed by its central hub function and visitor attraction. It is used as a postcard image and the town's publicity material frequently features the scheme.

As a result of the project, there has been an increase in the diversity of aquatic marginal vegetation with brown trout (*Salmo trutta*) now inhabiting the river through the town centre.

The river in flood – the flood gates are closed and the much increased capacity protects the town centre – November 2012

These techniques were developed to suit site specific criteria and may not apply to other locations

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The designed channel and shallow grassed slopes hold up well over the winter period – early 2006

Mown green river edge to allow public access in summer. Here the river's appearance is heavily managed as part of the aesthetics of the new town centre – 2010

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