Marsh zones

- *Type: uses biobuilders;*
- *Application: fresh and salt waters, behind and in front of the dike;*
- *Species: water and bankside flora, and marsh vegetation (low and high);*
- *Contributes to:*
  - Natura 2000 habitats [7]: 'Pioneer saltmarsh vegetation', 'Spartina swards', 'Wet dune slacks' with various types of vegetation, 'Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels', 'Transition mires and quaking bogs', 'Degraded raised bogs still capable of natural regeneration', 'Bog woodland' and 'Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)';
  - Natura 2000 species [8]: include fish, marsh birds, dragonflies, butterflies, mammals;
  - Water Framework Directive (WFD) [9]: river banks, transitional waters, lakes;
- *This measure can contribute to the National Ecological Network (EHS).*

A marsh zone consists of a variety of water features and vegetation with roots that are submerged permanently or periodically. Due to the water storage capacity, these zones are extremely suitable for use as water buffers. In addition, they help to clean up the water and they supply other public and natural services. The presence of water makes them important for amphibians and dragonfly-type species and as breeding grounds for many species of bird.

We make a distinction between two types:

- A water-treatment marsh (also known as an artificial marsh zone, urban wetland or helophyte filter) in which the focus is on cleaning water. In general, this type consists of[13] an inlet zone (pre-sedimentation of large particles), a macrophyte zone (zone with dense vegetation that removes small particles and some dissolved contaminants) and a channel to encourage the flow of water through the zone. The soil layers can often be structured in such a way that polluted water is cleaned up to a large degree by soil processes;
- Natural wetlands: These are natural or artificial marshes in polders or alongside lakes, rivers and tidal waters (whether salt, brackish or fresh) where the focus is on wave attenuation, water storage, covering toxic landfills, peat development or nature development. You are referred to the Natural embankments fact sheet for the restoration of bankside marshes. The marshes in polders can be developed by raising the water level, and possibly planting seeds, roots and cuttings for marsh vegetation.

The marsh can therefore be used for multiple purposes and it fits into a range of landscapes. The ecosystem services and benefits are comparable with those of natural embankments (see Natural embankments fact sheet), with the difference being that the focus is on another location. A water-treatment marsh will be created primarily to purify water. Furthermore, marshes are more suitable for water storage and, for example, capturing carbon in biomass. If the marsh is large enough, it will be ideal as a breeding ground for many types of fauna (birds, amphibians, insects, fish).

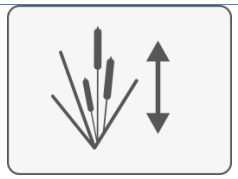
It is possible to develop saltwater marshes. They will not be used for water treatment, but more likely for nature development and for wave attenuation. They are very different from freshwater marshes in shape and appearance. They are home to other types of flora and fauna and, in terms of vegetation, they are less dense and high.

Specimen projects:

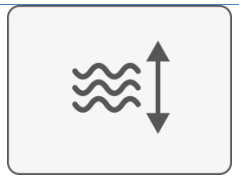
- Eendragts polder, marsh development, Province of South Holland[1];
- Oostvaardersplassen, marsh restoration;
- Louisiana, large-scale marsh restoration;
- Wetland Restoration Wallasea, UK, marsh restoration[2];
- Alexandra Canal, Singapore, urban wetland[3].

Spatial aspects

Flowering season: spring & summer



Maximum height of bankside flora in fresh water: 3 to 4 m, salt or brackish water 1-1.5 m



Maximum water depth: 0.3 m-1.5 m. Natural fluctuation in water level of at least 30 cm is advisable

Services [10, 11, 12]

Ecosystem services generate benefits if people can exploit the services and capitalise them.

Cleaning[2,3,4,5,13]

During a flood, the vegetation will slow the flow and sediment will be captured, improving the quality of the water and leaving substances bonded to sediment behind. The vegetation absorbs nutrients and the water undergoes bacteriological treatment. To ensure that there is a significant effect, the flow rate should not be too high. If there is a problem with the structure or if maintenance gets overdue, however, a marsh can turn into a source of nutrients and other substances. Care is therefore required with design and management. Types of vegetation that are often used include reeds and other bankside plants. Good results have also been achieved with willows.

Biodiversity[2,3,5]

Important for amphibians, dragonfly-type species, as a spawning ground for fish and as breeding grounds for many species of bird. The water should be clear and rich in plants and the water level will preferably be natural (high in the winter, low in the summer), fluctuating by at least 30 cm.

Water dynamic

Acts as a buffer for intense rainfall. Attenuates waves and acts as a water buffer, improving flood risk management. Water buffers and biodiversity cannot always be combined. The inflow of nutrient-rich water can have a severe adverse effect on water quality in time.

Urban climate

Vegetation and water provide cooling and cleaner air. When marsh zones cover a large area, they can improve the local microclimate.

Erosion control[5]

Marshes form soft bank and coastal defences.

Benefits and cost savings [10,11,12]

The ecosystem services referred to above generate benefits if people can exploit the services and capitalise them.

Leisure value [5]

Marshes are valuable ecologically, they attract tourists and they serve as leisure areas for urban residents, generating income for business and government (through tax).

Aquaculture [6]

The fishing and shellfish industry can use marshes as locations for the breeding and selling of fish.

Reed harvesting

Commercially-managed reed marshes produce approximately 900 sheaves of reeds per hectare annually, generating income of approximately 2 euros per sheaf. When managed for nature-conservation purposes, marshes can produce 250 sheaves per hectare annually.

More appealing habitats

Natural views improve residential quality and push up property values. The urban climate may improve, and this has a favourable impact on public health. Depending on the number of residents, this can become a major benefit.

Education

Children and adults come into contact with nature in the immediate vicinity.

Natura 2000 and WFD measures

Marsh zones could be used for mitigation or compensation. The cost savings depend on the local Natura 2000 and WFD objectives.

Measures for flood risk management

Marsh zones can serve as rainwater buffers and therefore reduce peaks in river discharges. Lower peak discharges result in a lower flood risk and a reduction in the need for flood prevention measures. Considerable cost savings may be made as a result.

Both costs and benefits are location-specific and difficult to extrapolate. Cost-benefit analyses will therefore have to be conducted for each individual location.

Implementation costs

There are a number of factors for determining the costs, with the important factors being:

- The planned surface area;
- The earthmoving work required (in other words, quantities to be brought in or removed);
- Accessibility (working from land or water);
- Equipment required (hydraulic pumping or transportation by road/rail);
- Possible use of seeds or cuttings;
- Possible fencing to prevent damage by birds, muskrats or crayfish.

Eendrachts polder[1]	€ 70 million for 300 ha
• Costs of development:	€ 40 million
• Cost of land:	€ 30 million
• Total surface area:	300 ha
• Water retention volume:	4 million m^3
• Leisure facilities:	Cycle paths and footpaths with bridges

Management and maintenance[2,4]

First two years

Planting, mowing, waste removal, management of water level and removal of shoots (regular removal of small trees).

Regular monitoring and maintenance

Vegetation, keeping inlet zone free of obstacles, good water flow, waste removal, removal of shoots.

Every two to five years

Drainage and removal of sludge from the inlet zone. Repairs to edges of marsh, prevention of isolated pool formation. Prevention of terrestrialisation by scraping away bankside vegetation and/or mowing and removal of water and bankside vegetation.

If the marsh starts to produce nutrients rather than capture them, the marsh vegetation should be removed, together with roots and sludge, to start afresh.

Monitoring is recommended after storms and high water.

Physical boundary conditions

Low flow rate

Furthering of sedimentation in the inlet zone.

Continuous through-flow [3,4]

Water in a marsh meanders through channels, maximising the residence time of water in the marsh. However, stagnant pools should be prevented to maintain water quality and combat mosquitoes. The ideal residence time is 72 hours in artificial marsh zones (12 hours in inlet zone and 60 hours in macrophyte zone).

Fluctuations in water level [3, 14]

Large variations in the water level will reduce the diversity of flora and fauna. One or more overflows should be used if the area is closed off. Small differences in water levels have an adverse effect on the development of bankside vegetation. A natural fluctuation of at least 30 cm is desirable (high in the winter, low in the summer).

Water quality

Water quality has to be acceptable for the purposes of nature development. There should be no toxic substances and the nutrient load should be kept low enough. It is advisable to conduct a system analysis for this purpose, for example using the ecological key factors method (ESF method) 16.

Potential sites

Marsh zones can be created along all sections of a river (salt and fresh) where there is enough room, for example as part of a natural embankment (see Natural embankments fact sheet). Marshes can also be created behind the dike as long as they are within the reach of the river water dynamic (tidal or seasonal). This can be done by installing culverts under the dike. Finally, polders with high groundwater levels are suitable. Here, it is generally possible to optimise the water level and to adjust it in line with the principal function of the marsh.

1. *Helmer, J. Eendragtspolder, grootschalig multifunctioneel ruimtegebruik. PowerPoint.*
2. *Maunsell, F. (2006) Wallasea Wetland Creation Project - Submission for RSPB/CIWEM Living Wetlands Award 2007.*
3. *PUB (2011) ABC Water Design Guidlines.*
4. *Pötz, H. en Bleuzé, P. (2012) Groenblauwe netwerken voor duurzame en dynamische steden. Published by: Coop for life, Delft.*
5. *Melbourne Water. City of Melbourne WSUD Guidelines. Applying the Model WSUD Guidelines. An Initiative of the Inner Melbourne Action Plan.*
6. *Rijkswaterstaat (2009) Zachte werken met harde trekken, Toepassingen van eco-engineering in de waterbouw.*
7. *Janssen, J.A.M. and Schaminée, J.H.J. (2003) Habitattypen. Europese Natuur in Nederland. KNNV Uitgeverij, Utrecht.*
8. *Janssen, J.A.M. and Schaminée, J.H.J. (2004) Soorten. Europese Natuur in Nederland. KNNV Uitgeverij, Utrecht.*
9. *Siebelink, B. (2005) Overzicht natuurlijke watertypen. Foundation for Applied Water Management Research (STOWA). STOWA report no: 2005-08.*
10. *Penning, E. and van der Vat, M. (2007) Batenstudie WFD-WB21. Baten van natuurvriendelijke oevers. WL Delft Rapport.*
11. *Witteveen+Bos (2012) TEEB in de Stad, handleiding bij het rekeninstrument voor de baten van natuur en watermaatregelen. Rijkswaterstaat and 11 municipal authorities. Reference GD215-2-1/kiru/005.*
12. *Ruijgrok E.C.M., Brouwer, R. and Verbruggen, H. (2004) Waardering van Natuur, Water en Bodem in Maatschappelijke Kosten-batenanalyses. Aanvulling op de Leidraad OEI. Ministry of Agriculture, Nature and Food Quality.*
13. *Van den Boomen R, Kampf, R. (2013) Waterharmonica's in Nederland (1996-2012). Van effluent naar bruikbaar oppervlaktewater. Foundation for Applied Water Management Research (STOWA). STOWA report 2013-07.*
14. *Witteveen+Bos (2014) Flexibel peilbeheer voor de KRW. Waterschap Rivierenland. Reference: TL230-2/rijm3/003.*
15. *Otte, A., Boosten, M. (2014) Nieuwe kansen voor duurzame biomassa: afvalwater zuiveren met wilgen. Innovatienetwerk, Utrecht.*
16. *Schep, S. Geest van, L. Ouboter, M. (2011) De stoplichtenmethodiek: toepassing in stilstaande wateren. Waternet. Document versie 1.0. Hydrotheeknummer: 2046378.*