



Project part-financed by the European Union (European Regional Development Fund)



## **‘Restoration of a tidal foreland in the Werderland region – Feasibility study’**

Measure analysis 29  
in the framework of the Interreg IVB project TIDE

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## Part 1: Measure description

Measure Category: Ecology/Biology

Estuary: Weser

Salinity zone: limnic

Pressure: Habitat loss and degradation

Measure status: implemented

River-km: Weser-km 14 – 15, 5

Country: Germany

Specific location: Free Hanseatic City of Bremen, Niederbüren

Responsible authority: The Senator for Environmental Affairs, Construction and Transport Bremen

Costs: 20.000 €

Cost category: 10.000 – 50.000 €

Picture/Map:

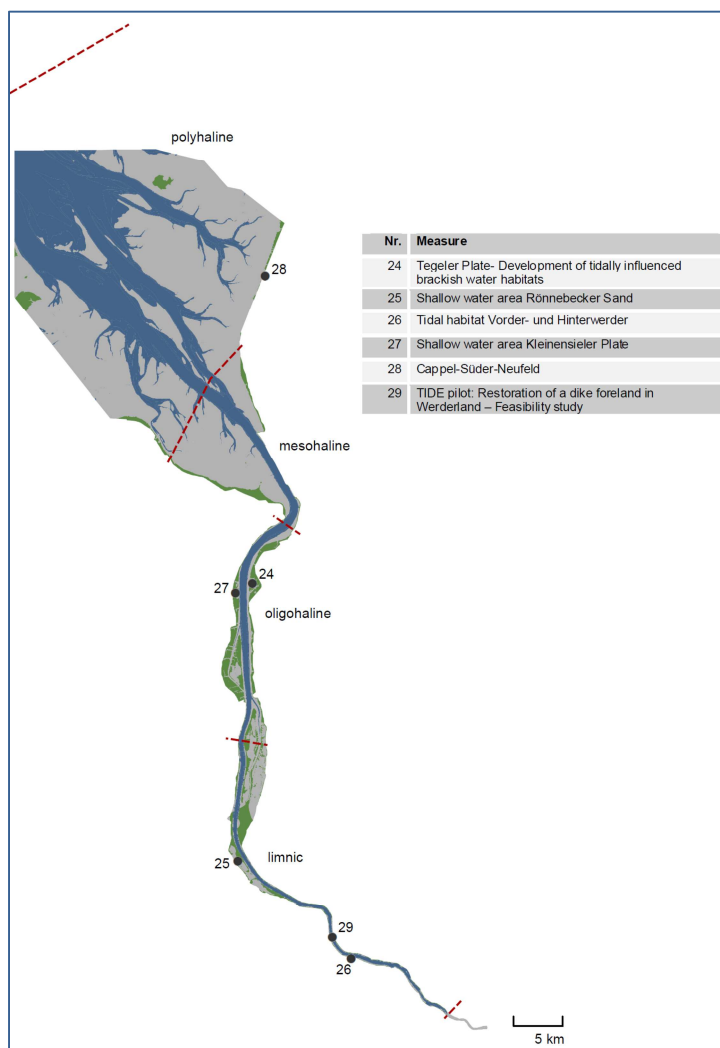


Figure 1: Location of planned measure in Werderland (Measure 29)



## 1.1 Project description

This pilot project realized in the frame of TIDE includes a feasibility study on the restoration of a dike foreland in Werderland (Bremen, Niederbüren). The foreland restoration is planned to be partly realized as a compensation measure after national environmental law for coming main dike reinforcements at Weser and Lesum (right bank). According to present knowledge, the expected compensation requirements due to the necessary reinforcement measures are not claiming the entire potential project area (Figure 2). In terms of sustainability and effective use of available resources and means, the study however aimed at developing an overall concept suitable to be realized in partial steps.



Figure 2: Aerial photograph of potential project area

The study development can be described as iterative process with the involvement of a stakeholder group consisting of client (SUBV), water management, nature conservation and federal waterways administrations (NLWKN, WSV) as well as dyke and nature conservation associations (BUND Bremen).

The following development targets were defined for the potential project area:

- Functional development of tidal floodplains with focus on fish fauna (especially migrating species like Sea lamprey (*Petromyzon marinus*) and European river lamprey (*Lampetra fluviatilis*)
- Development of typical estuarine, tidally influenced foreland habitats (shallow water zones, flooding pools and fresh water mudflats, alluvial forests and reeds)
- Highest possible enhancement in terms of nature conservation according to guidelines on impact regulation after nature protection law for the federal state of Bremen (UNIVERSITÄT HANNOVER, INSTITUT FÜR LANDSCHAFTSPFLEGE UND NATURSCHUTZ 2011)
- Long term functionality with low maintenance effort

After analyzing the present situation, evaluating other comparable compensation measures (e.g. Vorder- und Hinterwerder) and discussing the constructional and technical boundary conditions, six development scenarios were deduced. The main differences between these scenarios are:

- Extent of shallow water zone
- Composition of water regime (contact period between shallow water zone on project area and river and height of overflow barriers)
- Percentages of aimed at habitats (shallow water zone, mudflats and reeds)



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As a result, a **preferential scenario** and a **sub scenario** were specified. The **preferential scenario** (Figure 3) includes the lowering of bank reinforcements over a length of 350 m (-2.42 m MHWL). Furthermore, a subplot of the project area on a ground level up to 1.35 m above sea level is prepared in order to promote long term establishment of fresh water mudflats and a 2 ha shallow water zone as habitat with various functions to the benefit of fish fauna (spawning, residence, resting, overwintering) is created. The contact period between river Weser and shallow water area comprises 4.5 hours per tidal cycle. The mudflat areas at the outer border of the project area adjacent to the river Weser are flooded approximately 8 hours per tidal cycle. Plantings are only intended on a small scale in order to promote spontaneous development. Initial plantings of softwood species in the north of the project area will be compared to an unplanted area to the south. The observation of both areas is expected to allow general conclusions on the effectiveness of initial plantings. In order to protect the main dike of the river Weser, a line of willow plantings is used to catch flotsam. As a co-benefit, the decomposing flotsam promotes structure diversity in favor of insects and small animals. The remaining area not affected by alteration and profiling activities is left to natural succession. Mowing or grazing is not foreseen. The preferential scenario can be implemented in partial steps. The **sub scenario** (Figure 4) comprises the removal of bank reinforcement and the installation of an additional overflow barrier. The study ends with estimating the enhancement potential according to the guidelines on impact regulation after nature protection law for the federal state of Bremen. Even more crucial than this habitat related assessment is the expected functional benefit in view of adjacent Natura 2000 sites. The study results are principally applicable to comparable projects in the fresh water zone of the Weser estuary and other estuaries of the North Sea region.



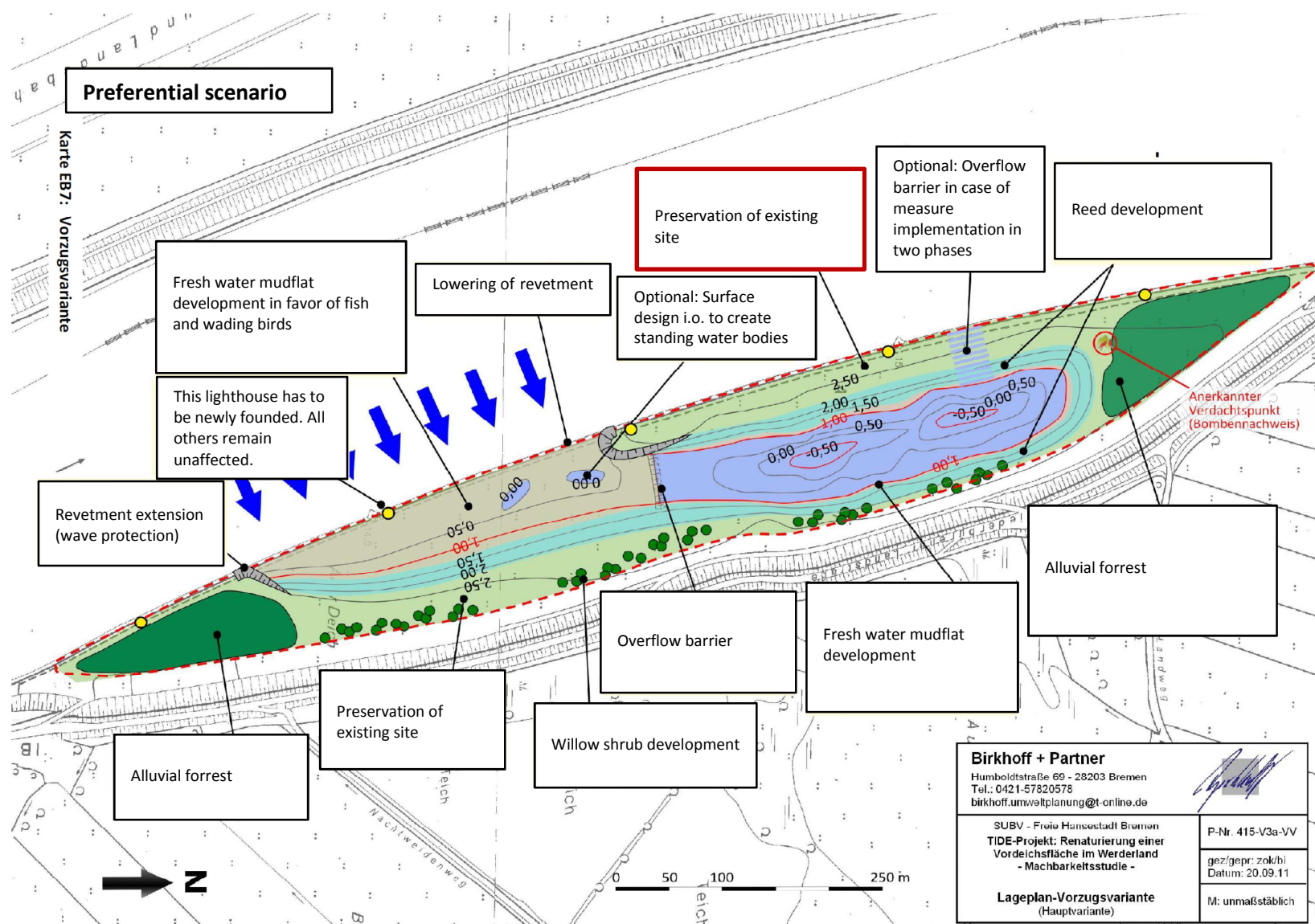


Figure 3: Preferential scenario (DIPL.-ING. M. BIRKHOFF + PARTNER 2011)



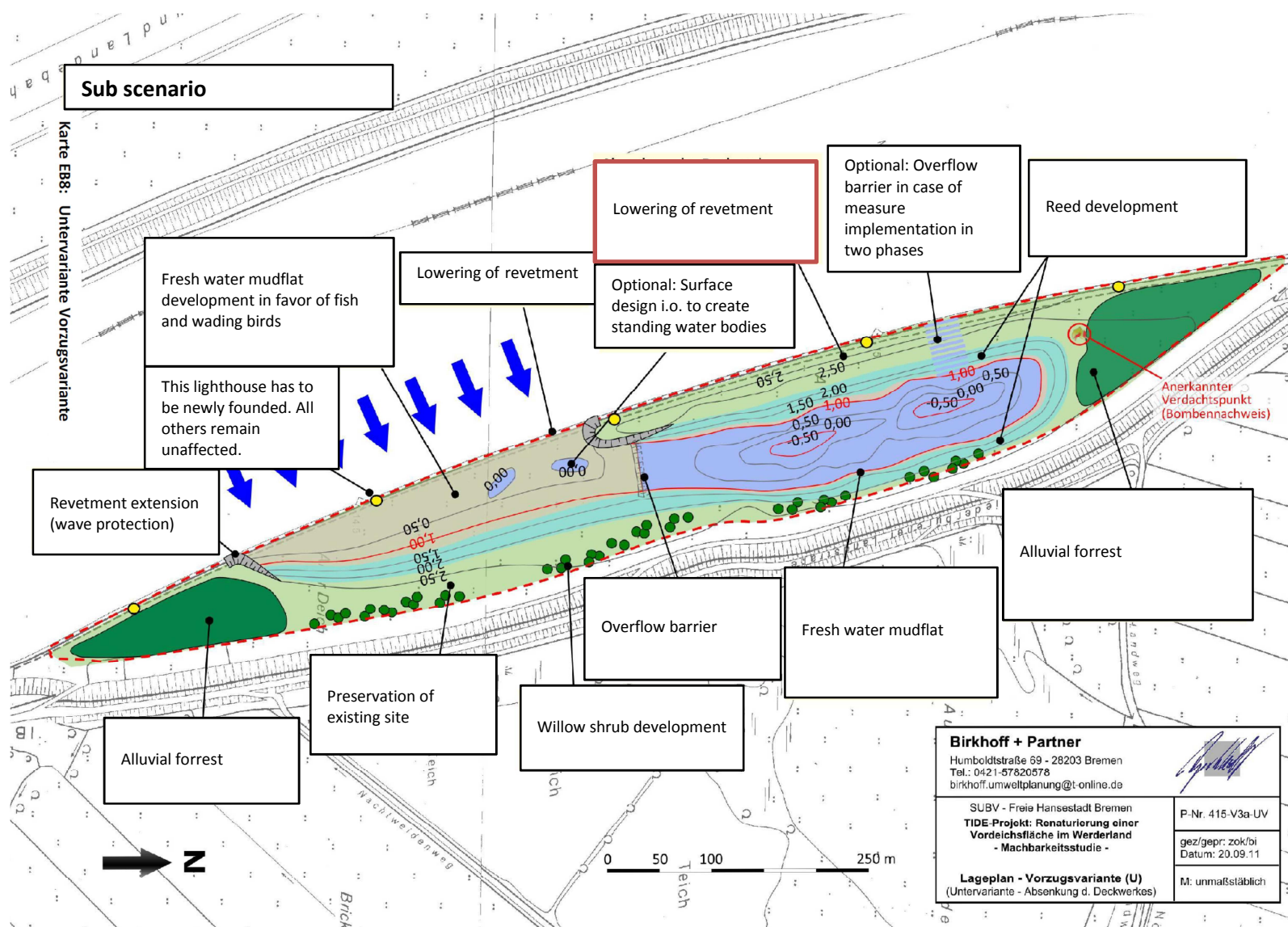


Figure 4: Sub scenario (Dipl. - Ing. M. BIRKHOFF + PARTNER 2011)

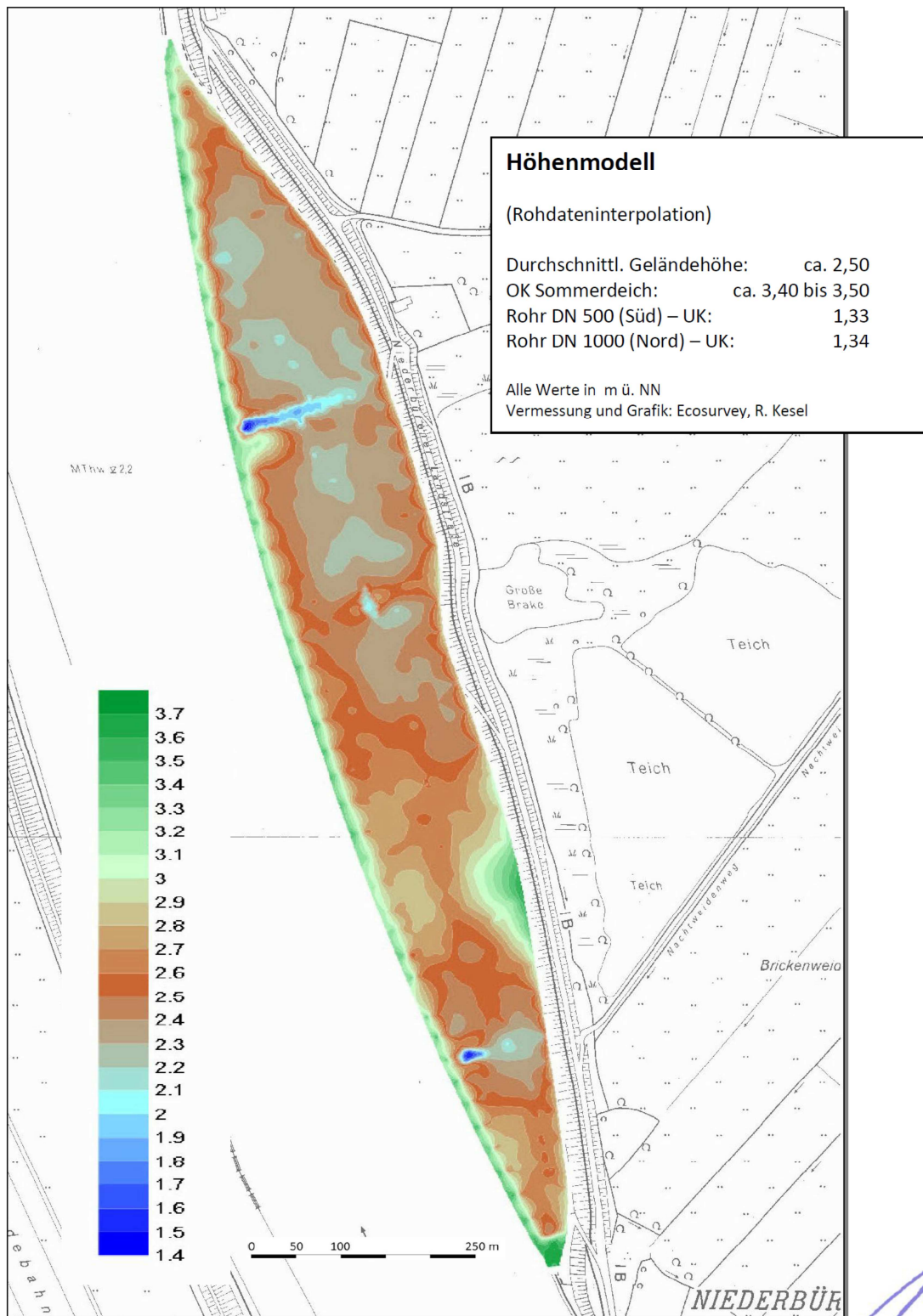


Figure 5: Elevation model of project area; Interpolation of raw data for current situation before measure implementation (DIPL. – ING. M. BIRKHOFF + PARTNER 2011)



## 1.2 Monitoring

Considerations on monitoring requirements were not part of this TIDE pilot project. Nevertheless, the target achievement of the compensation measure on a structural level will be monitored in accordance with national impact regulations. The area will also become part of the Integrated Monitoring Program of the Free Hanseatic City of Bremen comprising the mapping of key species and habitats.

## Part 2: Execution of main effectiveness criteria

### 2.1 Effectiveness according to development targets of measure

#### **-Step 1: Definition of development targets**

- Functional development of tidal floodplains with focus on fish fauna (especially migrating species like Sea lamprey (*Petromyzon marinus*) and European river lamprey (*Lampetra fluviatilis*)
- Development of typical estuarine, tidally influenced foreland habitats (shallow water zones, flooding pools and fresh water mudflats, alluvial forests and reeds)
- Highest possible enhancement in terms of nature conservation according to guidelines on impact regulation after nature protection law for the federal state of Bremen (UNIVERSITÄT HANNOVER, INSTITUT FÜR LANDSCHAFTSPFLEGE UND NATURSCHUTZ 2011)
- Long term functionality with low maintenance effort

#### **-Step 2: Degree of target achievement**

Since the measure is currently in the planning stages, the degree of target achievement can only be estimated based on the contents and results of the feasibility study realized in the frame of TIDE (DIPL. – ING. M. BIRKHOFF + PARTNER 2011).

To construct a shallow water zone on the project area means creating another close-to-nature element within a section of the river Weser today characterized by a high percentage of bank fixations. A permanent water body serving as a habitat for spawning, residence, resting and overwintering closes the gap between the tidal habitat Vorder- and Hinterwerder and the river mouths of Ochtum and Lesum. The development of fresh water mudflats complements the fresh water mudflats along the river Lesum. The expected reed development supplements existing populations on the neighboring Schönebecker Sand.

Structure and habitat diversity are generally improved on the project area. As a consequence, improved living conditions are created in favor of a larger spectrum of species.

Additionally, the barrier effect of the existing dike is reduced due to the coming dike reinforcement measures at Weser and Lesum. The existing sheet pile is covered in order to make it easier to overcome for soil organisms. The connection between project area and Werderland will be improved.

Altogether, the restored foreland delivers a functional added value regarding adjacent Natura 2000 areas.

The expected degree of target achievement is high.



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## 2.2 Impact on ecosystem services

The measure ‘TIDE pilot: Restoration of a dike foreland in Werderland – Feasibility study’ in the polyhaline zone of the Weser estuary was about the creation of estuarine habitats by transforming adjacent land into marshland with subtidal shallow habitat as well as intertidal habitat connected with a very high change in the habitat quality (Figure 6). From the ecosystem services (ES) assessment it is concluded that this measure generates overall a positive expected impact for many ES, mainly for ‘biodiversity’, the cultural services and various regulating services (erosion and sedimentation regulation by water bodies, water quality regulation: reduction of excess loads coming from the catchment, erosion and sedimentation regulation by biological mediation, water quantity regulation: landscape maintenance, climate regulation: carbon sequestration and burial). The expected impact on the development targets (‘biodiversity’) is very positive. The expected impact for the different beneficiary groups is overall positive, with a very positive expected impact for future use and for local use (Table 1).

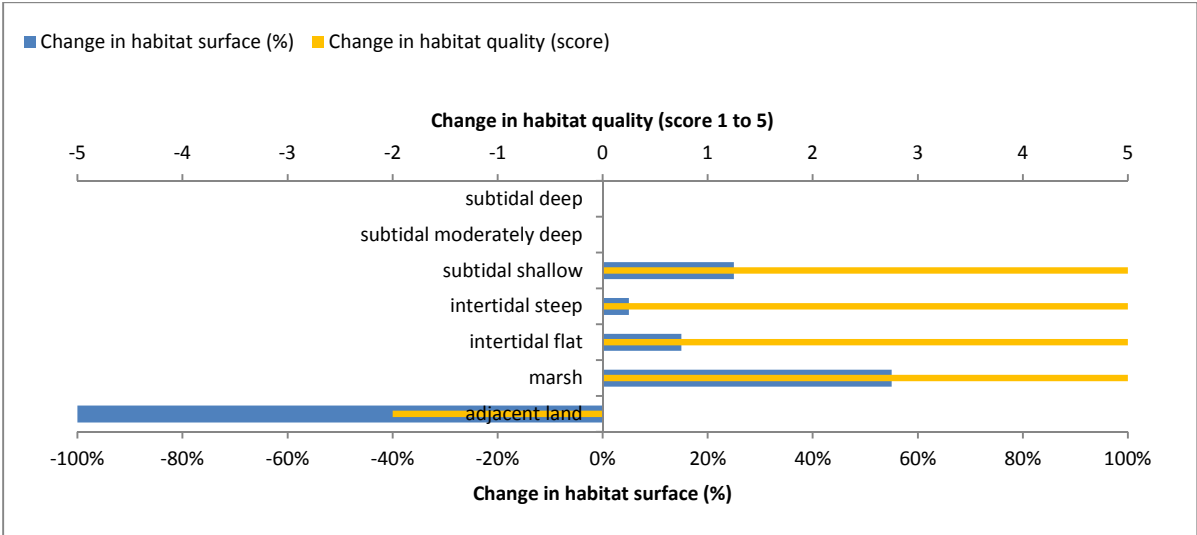


Figure 6: Ecosystem services analysis for measure 29: Indication of habitat surface and quality change, i.e. situation before versus after measure implementation.

Table 1: Ecosystem services analysis for measure 29: (1) expected impact on ES supply in the measure site and (2) expected impact on different beneficiaries as a consequence of the measure.

TIDE pilot: Restoration of a dike foreland in Werderland – Feasibility study		
Cat.	Ecosystem Service	Score
S	"Biodiversity"	3
R1	Erosion and sedimentation regulation by water bodies	3
R2	Water quality regulation: reduction of excess loads coming from the catchment	3
R3	Water quality regulation: transport of pollutants and excess nutrients	1
R4	Water quantity regulation: drainage of river water	0
R5	Erosion and sedimentation regulation by biological mediation	3
R6	Water quantity regulation: transportation	0
R7	Water quantity regulation: landscape maintenance	3
R8	Climate regulation: Carbon sequestration and burial	3
R9	Water quantity regulation: dissipation of tidal and river energy	2
R10	Regulation extreme events or disturbance: Wave reduction	1
R11	Regulation extreme events or disturbance: Water current reduction	1
R12	Regulation extreme events or disturbance: Flood water storage	1
P1	Water for industrial use	0
P2	Water for navigation	0
P3	Food: Animals	0
C1	Aesthetic information	3
C2	Inspiration for culture, art and design	3
C3	Information for cognitive development	3
C4	Opportunities for recreation & tourism	3

Beneficiaries:	
Direct users	0
Indirect users	2
Future users	3
Local users	3
Regional users	2
Global users	1

Legend: expected impact*	
3	very positive
2	positive
1	slightly positive
0	neutral
-1	slightly negative
-2	negative
-3	very negative

X Targeted ES

\*: Indicative screening based on ES-supply surveys and estimated impact of measures on habitat quality and quantity. Quantitative socio-economic conclusions require local supply and demand data to complement this assessment.

### 2.3 Degree of synergistic effects and conflicts according to uses

The project area is currently used for cattle pasture and local agriculture. As a pre-condition for realizing the measure, the Free Hanseatic City of Bremen has already acquired the land. In addition, the project area is sporadically used for recreational purposes by cyclists and local residents. Main recreational activities are sunbathing or reading on benches in coupures as well as dog walking. Due to lacking attractiveness of the project area, nature watching rarely takes place. According to statements of local residents, the project area was previously used for clay extraction. These statements could be confirmed by inhomogeneous drill samples taken from the project area. In contrast to first assumptions, the excavation material is partly usable for the coming dike reinforcement measures. This will result in a decrease of costs in terms of transport and disposal as well as in reducing potential conflicts with nature conservation.

According to national environmental law, the planned foreland restoration in Werderland represents an ideal compensation measure for the coming dike reinforcements in terms of position and function. This contributes to facilitating the approval procedure for the dike reinforcements. The bank of the river Weser is fixed by revetments. The measure is supposed to not affect their stabilizing function for the shipping lane.

The implementation area was reduced in order to leave sufficient space for the coming dike reinforcements and potentially necessary future adaptations to climate change. By means of this, negative effects on coastal defense interests will be prevented.

The dike association uses the ecological and aesthetic improvements on the project area for a positive self-portrayal in direct connection with the dike reinforcement project.

Summarizing, a medium degree of conflicts according to uses can be stated. The feasibility study provided the basis for a reconciliation of interests.



## Part 3: Additional evaluation criteria in view of EU environmental law

### 3.1 Degree of synergistic effects and conflicts according to WFD aims

The pilot project considers the requirements of the Water Framework Directive (WFD) as a frame condition, but is not specifically designed to contribute to fulfilling WFD aims. However, the measure covers five of six main pressures the limnic zone of the river Weser is affected by and therefore will presumably have considerable synergistic effects in view of WFD aims (Table 2).

Table 2: Main pressures of the limnic zone of the Weser estuary

Indicator Group	Code	Main pressures <b>limnic</b> zone Weser	Effect?					Description
			--	-	0	+	++	
S.I.	-	Habitat loss and degradation during the last 100 years: Subtidal					X	Additional subtidal area (shallow water zone) will be created.
S.I.	1.1	Habitat loss and degradation during the last 100 years: Intertidal					X	Intertidal habitats will be developed (e.g. fresh water mudflats).
S.I.	1.4/ 1.5	Gross change in morphology/hydrographic regime during the last about 100 years					X	Due to Weser deepening, many side habitats of the river including shallow water got lost. The measure creates new side habitats and therefore contributes to mitigating negative effects of the gross changes in morphology/hydrographic regime.
D.I.	1.3	Land claim during the last about 100 years					X	Today, the project area is not connected to the river Weser. After measure implementation, the project area will be reconnected to the river and the tidal influence will increase which means that land is given back to the river.
D.I.	1.7	Relative Sea Level Rise					X	Project area provides additional holding capacity.
D.I.	2.6	Capital dredging			X			There are no direct effects to be stated, but measure generally contributes to mitigating the negative effects of capital dredging.

### 3.2 Degree of synergistic effects according to Natura 2000 aims

The project area is located in a Special Protection Area (SPA) after the Birds Directive (Site name: Werderland, site code: DE 2817-401) and borders on three SPAs after the Habitat Directive. According to the Integrated Management Plan Weser (IBP Weser), the project area is assigned to operational area 3. The pilot project refers to the specifications of the IBP Weser as a frame condition for the planning and therefore meets Natura 2000 aims. Potential positive effects on several conservation objectives defined for operational area 3 (Table 3) and for the entire investigation area of the IBP Weser (Table 4) can be stated.



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## -Step 1: Estimate potential measure effects on conservation objectives for certain special units

Table 3: Natura 2000-objectives with specifications for operational area 3 (source: simplified after NLWKN, SUBV 2012)

Operational area 3: Fresh water zone in the lower Weser (Weser km 12 - 32)				
Specifications for operational area 3	Effect of measure 29 on conservation objectives			Short explanation
	positive effect	no effect	negative effect	
<b>Conservation and development of specific estuarine habitats and (tidal) floodplains and their dynamic changes</b>				
Development, enlargement and upgrade of shallow water zones with moderate current climate	++			A shallow water zone will be created.
Development of passable shore structures	++			The revetment at the Weser bank will be lowered and the project area will be reconnected to the river.
Conservation and development of typical habitats of operational area 3 (e.g. river flats, reeds and typical shore vegetation not being affected by neophytes, tidal floodplains and extensively used grasslands) in a dimension, spatial distribution and interconnection ensuring long-term appearance of typical species	++			Typical habitats of operational area 3 will be developed (e.g. mudflats and tidal floodplains)
Conservation and development of tidal floodplains at the upper tidal border	++			The measure aims at developing tidal floodplains to the west and the east of the project area.
<b>Conservation and development of habitats for viable populations and estuary and (tidal) floodplain specific species as well as species after Annex II Habitats Directive and bird species after Birds Directive</b>				
Conservation of typical breeding bird communities and associated habitats (breeding birds of grasslands, reeds and tidal floodplains)	++			Project area is currently of low importance for breeding birds. The development potential e.g. for breeding birds of reeds is estimated to be high and increases with the extent of the shallow water zone.
Conservation and development of undisturbed resting and moulting areas for migratory bird populations (high diversity, many individuals) considering all necessary functions	+			Due to spatial connection with neighbouring resting areas of water and wading bird, the development potential is estimated to be high and increases with the extent of the shallow water zone.
Conservation and development of well-structured bordering waters and shore areas with wood, typical shore vegetation and reeds as hunting and feeding ground for Pond bat ( <i>Myotis dasycneme</i> )	+			Feasibility study does not consider this aspect.
Preservation and development of spawning ground function for Twaite shad (e.g. by avoiding disturbances during spawning season)			0	The main spawning area of the Twaite shad is located between Weser-km 20 to 32. The Twaite shad has not yet been found upstream at the potential project area.
Conservation and development of spawning ground function for Smelt ( <i>Osmerus eperlanus</i> ) (e.g. by avoiding disturbances during spawning season)			0	Feasibility study does not consider this aspect.



## **-Step 2: Estimate potential measure effects on overall conservation objectives**

Table 4: Natura 2000-objectives with specifications for the entire investigation area of the Integrated Management Plan Weser (IBP Weser); source: simplified after NLWKN, SUBV 2012

Specifications for entire investigation area of IBP Weser	Effect of measure 29 on conservation objectives?		
	positive effect	no effect	negative effect
<b>Conservation and development of specific functions and processes of estuaries and (tidal) floodplains to reach favourable abiotic conditions and typical hydromorphological structures</b>			
Conservation and development of favourable water structures and water bed dynamics	+		
Development of evenly distributed and reduced current energy and tidal parameters	+		
Conservation and development of favourable gradients of specific aspects regarding estuaries and (tidal) floodplains (e.g. salinity, sediments, current conditions, tidal range, close-to-nature zonation of shore vegetation...); refers to inner estuary and to area between estuary and floodplain within fresh water zone.	+		
Improvement of water and sediment quality	+		
<b>Conservation and development of specific estuarine habitats and (tidal) floodplains and their dynamic changes</b>			
Conservation and development of habitats and communities which strongly depend on the natural dynamics of morphological processes (e.g. mudflats, shallow waters, creeks... )	+		
Development of balanced area percentages regarding mudflats, shallow waters, shallow and deep sublittoral	+		
Conservation and development of tidal floodplains with typical vegetation structures and biocoenosis and favourable tidal and flooding dynamics; especially floodplain enlargement	+		
<b>Conservation and development of habitats for viable populations and estuary and (tidal) floodplain specific species as well as species of Annex II Habitats Directive and bird species of Birds Directive</b>			
Conservation of habitat functions for breeding and migrant birds especially as feeding grounds (also for bordering or networked areas)	+		
Conservation and development of habitat requirements for migratory fish stocks and cyclostomata within present territories and networked areas	+		
Conservation and development of habitat requirements for autochthon fish communities with typical age composition and typical percentage of estuarine species and diadromous migratory fish species	++		
Conservation and development of long-term viable populations of typical fish species and cyclostomata (estuarine and diadromous guilds)	+		
Reaching of favourable water quality for reproduction, larval development and viability of typical fish communities of different salinity zones	+		





Conservation and development / reestablishment of passability of the tidal river Weser and its tributaries for migratory fish and benthic invertebrates	+		
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## Part 4: Crux of the matter

### Gaps of knowledge

During the approval procedure following the feasibility study, some experts from nature conservation authorities and associations generally doubted the ecological effectiveness of fresh water mudflats in the upper part of the Weser estuary. One main argument was that mudflat development in this estuary section is mainly due to an anthropogenically induced increase of the tidal amplitude. Although potential positive effects in view of invertebrates and birds (e.g. as feeding grounds) were confirmed, the experts preferred to reduce the aimed at mudflat area expansion on the project area in favor of an expansion of the shallow water zone. The respective new project scenario will result in a lower diversity of tidal habitats and a smaller contact zone between river and project area. However, the overall target achievement of the measure will not be affected or –with regard to fish fauna- even be improved. Basically, a lack of knowledge regarding the ecological functioning of anthropogenic freshwater mudflats has to be stated clearly.

### Lessons learned

The agreement on the preferential scenario of the feasibility study reached and recorded in the frame of the final stakeholder meeting should additionally have been formally fixed by the heads of respective departments and associations.

## Part 5: Literature

-NLWKN, SUBV (2012): IBP. INTEGRIERTER BEWIRTSCHAFTUNGSPLAN WESER FÜR NIEDERSACHSEN UND BREMEN 2012.

[HTTP://WWW.NLWKN.NIEDERSACHSEN.DE/NATURSCHUTZ/NATURA\\_2000/INTEGRIERTE\\_BEWIRTSCHAFTUNGSPLAENE\\_AESTUARE/WESER/FEBRUAR2012/97504.HTML](http://www.nlwkn.niedersachsen.de/naturschutz/natura_2000/integrierte_bewirtschaftungsplaene_aestuar/weser/februar2012/97504.html) .

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