

Remediation as a Contribution for a sustainable Sediment Management in the River Rhine

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- **Introduction**
- **Sediment management in fresh water systems**
- **Case study – Upper Rhine, Germany**
- **Possible solutions**
- **Summarizing remarks**



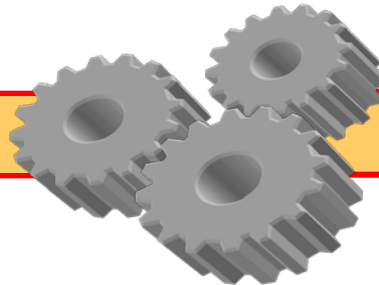
Introduction 1

available quantity of sediments;
Erosion-, transport-
and sedimentation processes



Aquatic structures,
Grain size distribution,
Discharge (dynamic),
River banks characteristics
Biological quality elements

Sediment balance



Hydromorphology

Nature

Habitats, aquatic communities

Diversity, health

Human

High water

Protection

Traffic

Transport, infrastructure

Safety and efficiency;
improve the environment.

Introduction 2



Protection of the environment – Enhancing the water quality
while maintaining the functions of the river

sediment management

active

passive

Removal

Relocation

River engineering

Excavation / immobilization

Transport

Sediment balance

Protection of the environment – Enhancing the water quality
while maintaining the functions of the river

sediment management

active

passive

Removal

Relocation

River engineering

Excavation / immobilization

Quality of sediments

Transport

Sediment balance

Case Study - River Rhine (1)



East: Black forest

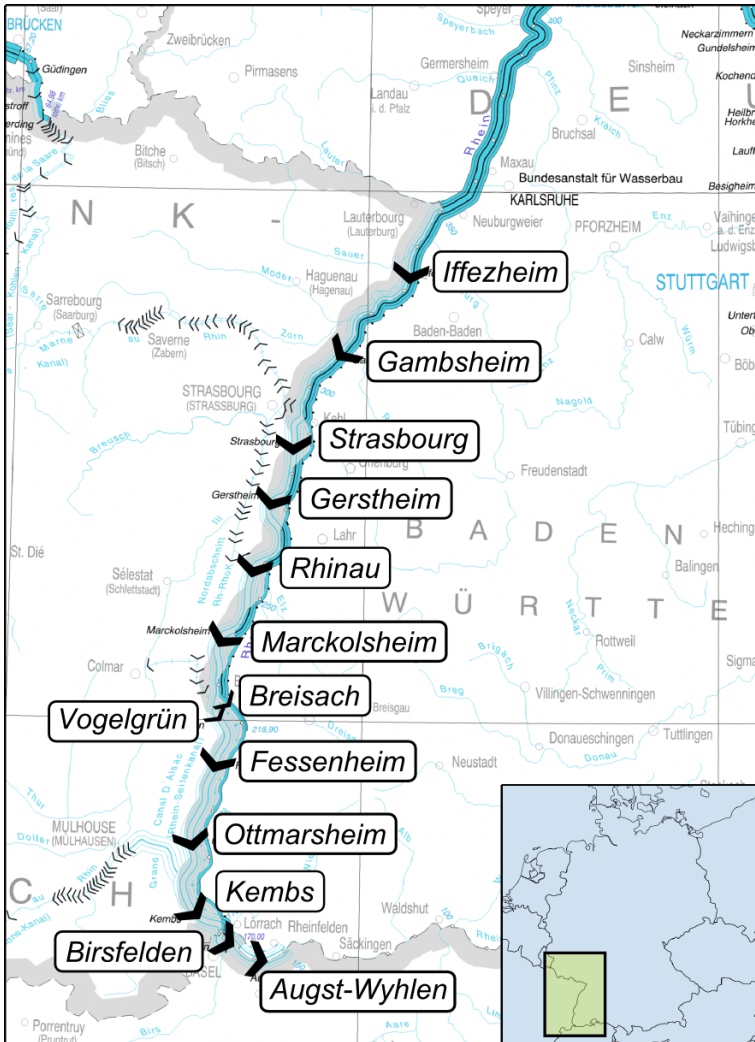
West: Alsace (France)

South: Switzerland

**Impounded stretch of
the Rhine**

12 impoundments

Case Study - River Rhine (2)



Impounded stretch of the Rhine

Impoundment of Iffezheim (aerial view)

Rhine-km 334



Case Study - River Rhine (3)

Management requirements:

1. Sedimentation rate in Iffezheim about 150.000 m³/y due to its geometry. Dredging is necessary each second/third year to guarantee the safety of the dams and the flood discharge.
2. German quality recommendations for relocation are exceeded. Measures for disposal are very expensive, situation in Iffezheim is always recurring.

Historical event: Discharge of tons of hexachlorobenzene (HCB) during 1960-1985 near Rheinfelden (km 148)

Present conditions: High contamination of sediments in the barrages up to Rhinau (km 248)

100 km in 30-50 years



Management requirements:

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Historical event: Discharge of tons of hexachlorobenzene (HCB) during 1960-1985 near Rheinfelden (km 148)

Present conditions:

High contamination of sediments in the barrages up to Rhinau (km 248)

100 km in 30-50 years




Measures:

- Identification of highly contaminated sediments
- Prevention of further contamination of the aquatic environment caused by remobilization (high floods or dredging activities)

Rule-based assessment of risk:

- Rhine relevant pollutants, concentration levels and its classification (ICPR)

Target value




Parameter	unit*	Classification of sediment pollution				
		Class 1	Class 2	Class 3	Class 4	Class 5
Cd	mg/kg	• 1	> 1 - 2	> 2 - 4	> 4 - 8	> 8
Hg	mg/kg	• 0,5	> 0,5 - 1	> 1 - 2	> 2 - 4	> 4
Zn	mg/kg	• 200	> 200 - 400	> 400 - 800	> 800 - 1600	> 1600
HCB	µg/kg	• 40	> 40 - 80	> 80 - 160	>160 - 320	> 320
CB 153	µg/kg	• 4	> 4 - 8	> 8 - 16	>16 - 32	> 32

* All results related to dry substance

Rule-based assessment of risk:

- Rhine relevant pollutants, concentration levels and its classification (ICPR)

Target value



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* All results related to dry substance

sediment management in ICPR

Rule-based assessment of risk:

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Target value
↓

relevant sediment contamination

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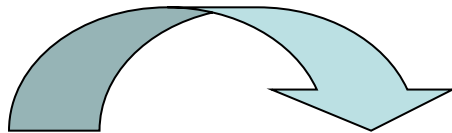
* All results related to dry substance

- Mass inventory of contaminated sites

> 1000 m³

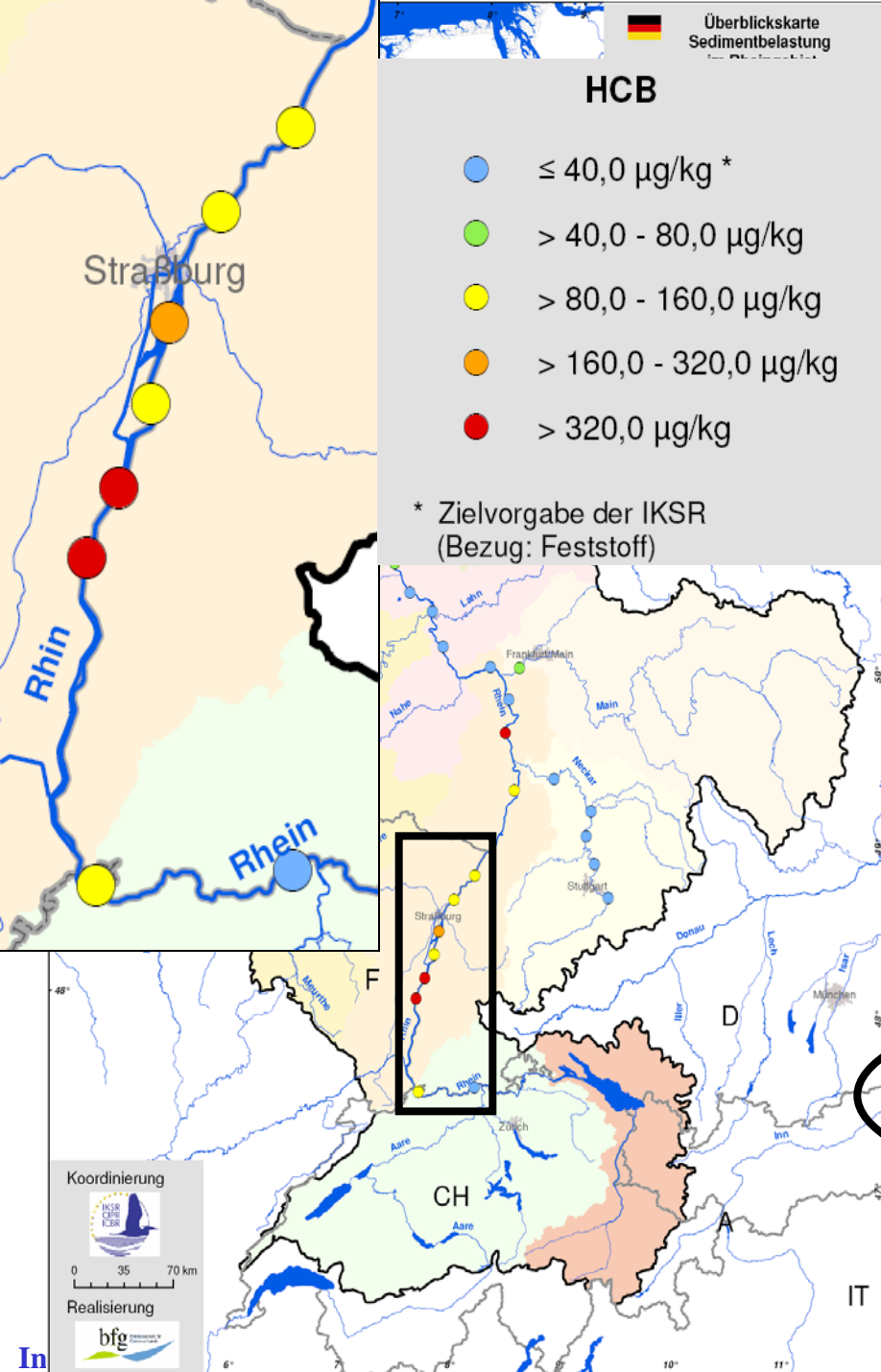
- Potential risk of remobilization

due to dredging activities,
shipping traffic influence,
natural reasons



Identification of **areas of risk**

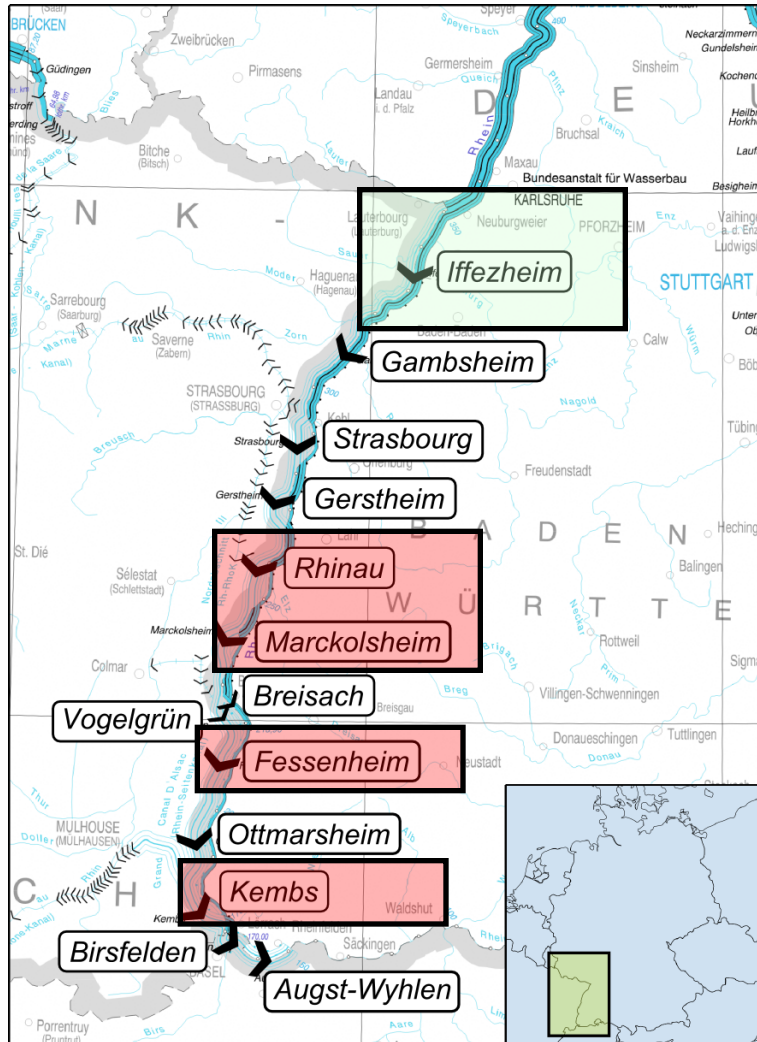




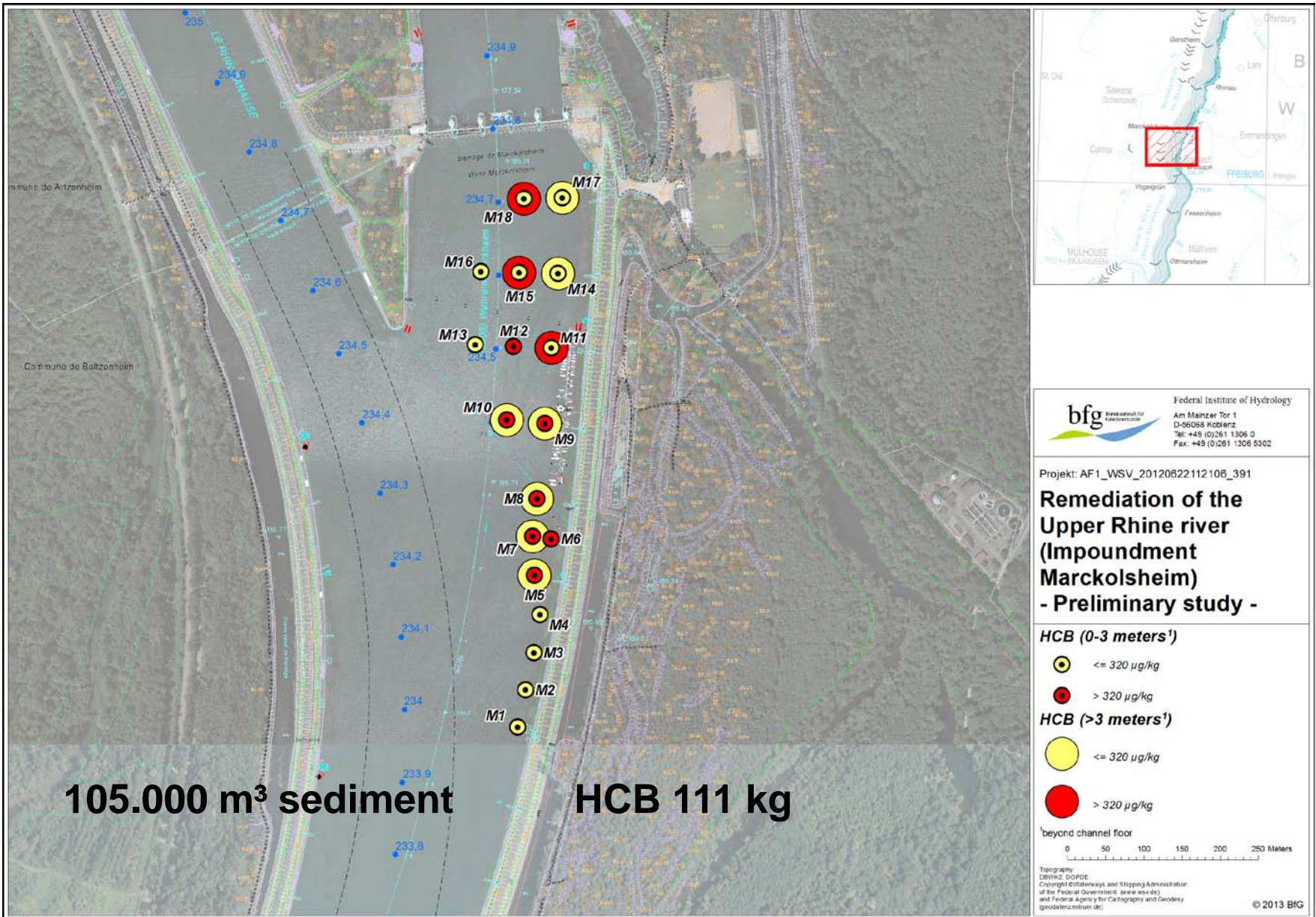
HCB concentrations of sediments in impoundments of the Upper Rhine (in µg/kg) in 2005-2008

Impoundment	Mean value	Maximum value
Iffezheim	158	910
Gambsheim	127	400
Strasbourg	223	2300
Gerstheim	135	1500
Rheinau	1110	3400
Marckolsheim	609	4100
Birsfelden	83	280
Albbruck-Dogern	1,6	4,3

Case Study - River Rhine (4)



Impounded stretch of the Rhine



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Projekt: AF1_WSV_20120622112106_391

Remediation of the Upper Rhine river (Impoundment Marckolsheim) - Preliminary study -

HCB (0-3 meters¹)

- Yellow circle: ≤ 320 µg/kg
- Red circle: > 320 µg/kg

HCB (>3 meters¹)

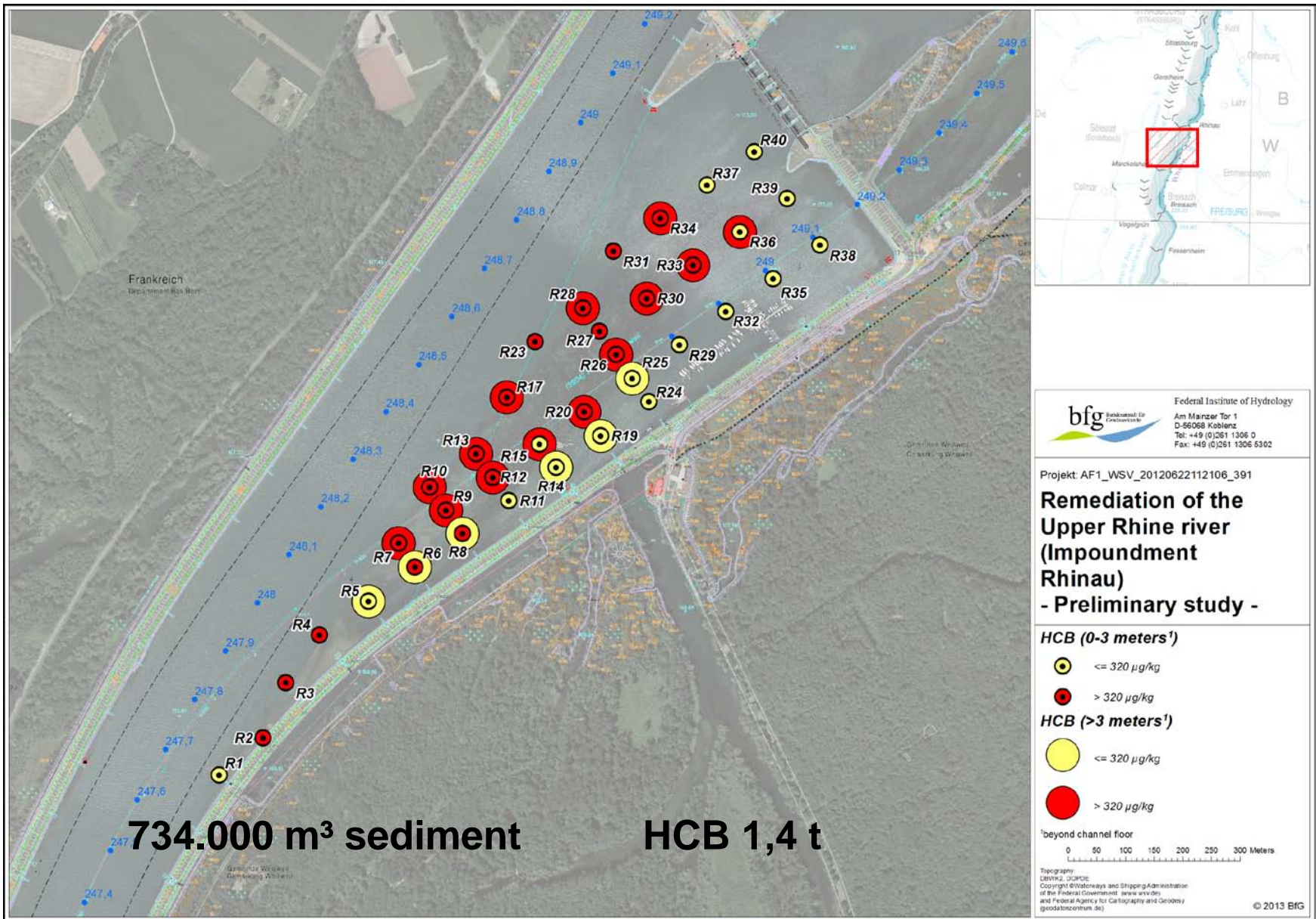
- Yellow circle: ≤ 320 µg/kg
- Red circle: > 320 µg/kg

¹beyond channel floor

Scale: 0 50 100 150 200 250 Meters

Topography: OBINK2, DOPPE
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**Remediation of the
Upper Rhine river
(Impoundment
Rhinau)
- Preliminary study -**

Removal (dredging) of contaminated sediment

Usage options for untreated contaminated mud are generally limited

→ could possibly be used for construction of moles or other aquatic structures in the vicinity (e.g. contained aquatic disposal site)

→ recently transport to a Confined Disposal Facility in the Netherlands (costly due to long distance)



Remediation Options (2)

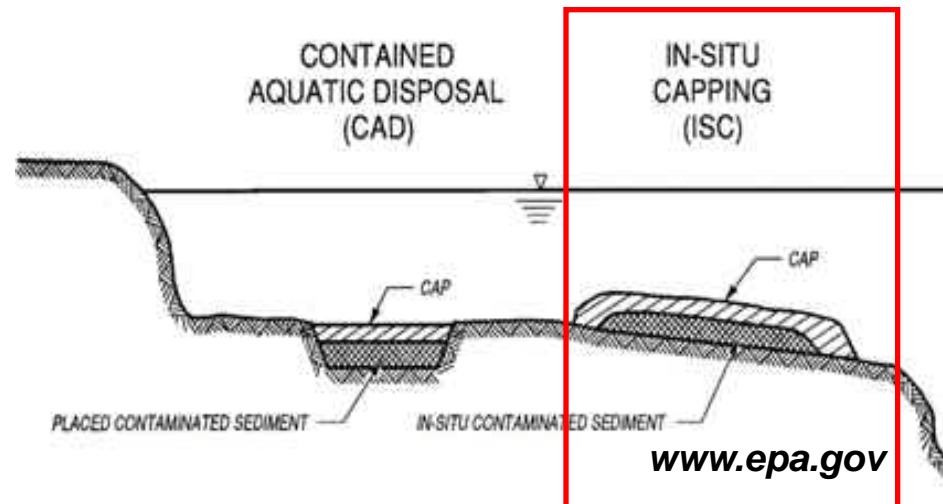
In-situ capping

Functional components of a cap (EPA 2005)

Physical isolation of the contaminated sediment (e.g. geotextile, construction material for hydraulic engineering)



Stabilization of contaminated sediment
erosion protection



Removal (dredging) of contaminated sediment and treatment

Drainage (naturally/mechanically)

- reduce water content, improve texture (fluid → pulpy → semi-solid)
- drained mud may be used for the construction of dikes, noise barriers, landfill sites etc.



Next step: Political decision

Feasibility study for:

- **Excavation (+ transport and disposal)**
- **Partial removal (+ transport and disposal) and capping of the contaminated site (geotechnical covering)**
- **Capping of the contaminated site - renaturation/Re-naturalisation**

Final decision by the responsible authorities:

**Permanent Commission (for development of the Upper Rhine)- D/F
ICPR (implementation of the sediment management plan)–CH/D/F/NL**

**Germany: Ministry of Transport, Building and Urban Development
France: Regional Department of the Environment, Planning and
Housing**

- **Sediments are part of the aquatic system – management objectives in the river basin should be supported by sediment management**
- **Development of management options for contaminated sediments in order to broadly accepted solution**
 - protect the water bodies down stream
 - preserve ecosystem services – maintain human uses, e.g. navigation
- **Identification of contaminated sites**
- **feasible management options**

Due to high remediation effort and costs political decisions are necessary





Thanks go to

Thank you for listening to the Waterways and Shipping Agency Freiburg, facilitating the sampling

- **the BfG - colleagues for intensive discussion**