

Inventory of historical contaminated sediment in Rhine Basin and its tributaries



(Foto: BfG)

Final report

October 2004

Technical University Hamburg Harburg
in Cooperation with the University Stuttgart

This report was written on behalf of the Port of Rotterdam
by

Dr. Susanne Heise,
Consulting Centre for Integrated Sediment Management at the TUHH
(BIS)
Hamburg, Germany

Prof. Ulrich Förstner,
Technical University Hamburg-Harburg (TUHH)
Hamburg, Germany

in Cooperation with

Prof. Bernhard Westrich,
Thomas Jancke
Joachim Karnahl
from the „Institut für Wasserbau“
University of Stuttgart, Germany

Prof. Wim Salomons,
University Amsterdam
The Netherlands

Dr. Harald Schönberger,
Regierungspräsidium Freiburg
Germany

Table of contents

Executive Summary (W. Salomons & S. Heise).....	I
Introduction (S. Heise & U. Förstner)	1
1. Characterization of Key Processes (U. Förstner)	5
1.1. Interaction of Key Processes in Fluvial Systems (U. Förstner)	6
1.2. Erosion and Transport: From Sediment to Suspended Matter	7
(B. Westrich)	
1.2.1. Beginning and Intensity of Erosion.....	7
1.2.2. Sediment Erosion Stability Tests.....	8
1.2.3. Sediment Depth Profiles.....	9
1.2.4. Transport of Resuspended Sediments.....	10
1.3. Mobilization of Sediment-Associated Contaminants (U. Förstner)	12
1.4. Availability of Contaminants from Sediment and Suspended Material to Organisms (S. Heise)	13
1.5. Processes Related to Remediation Measures on Contaminated Sediments (U. Förstner)	16
1.5.1. Risk Reduction by Ageing Processes.....	17
1.5.2. Enhanced In-Situ Stabilization based on Natural Processes.....	18
1.5.3. Processes Underlying Conventional Treatment Techniques.....	19
2. Requirement on Sediment Data Quality (U. Förstner)	27
2.1. Strategies for Water Quality Assessment: Particulate Matter	27
(U. Förstner & B. Westrich)	
2.1.1. Types of Assessment Programmes.....	27
2.1.2. Water Quality Assessment using Particulate Matter Data.....	27
2.1.3. Strategy of the Present Study.....	29
2.2. Quality Control of Field and Laboratory Chemical Data	31
(U. Förstner & B. Westrich)	
2.2.1. Quality Control and Quality Assurance in Water and Sediment Monitoring Data.....	31
2.2.2. Quality Control in the Analysis and Monitoring of WFD-Priority Substances.....	32
2.3. Quality Control of Chemical Sediment Analysis – Traceability Concept Extended to Secondary Sources	39
(U. Förstner)	
2.3.1. Surveillance Investigations.....	40
2.3.2. Monitoring.....	40
2.3.3. Resuspension – Secondary Source.....	41
2.3.4. Sampling and Filtration of Suspended Matter.....	43
2.4. Deriving Ecological Risk from Chemical Data (S. Heise)	44
2.5. Hydraulic Data Quality (B. Westrich)	47
2.5.1. Flood and Sediment Transport Parameters.....	47
2.5.2. Uncertainties and their Origin.....	49
3. Sediment Management at the Catchment Scale (U. Förstner)	61
3.1. Legal Aspects ¹	61
3.1.1. European Directives on Water, Soil and Waste (Landfills)	61
3.1.2. International Commission for the Protection of the Rhine (ICPR)	64

¹ compiled from Dutch-German Exchange on Dredged Material, Part I

3.1.3. National Legislation and Guidelines on Dredged Material.....	66
3.1.4. Dredged Material – Where Does Waste Term Apply and End?	68
3.1.5. Relocation of Dredged Material in German Inland Waterways.....	70
3.1.6. Subaqueous Disposal of Dredged Material.....	72
3.2. Management Practice in The Netherlands and Germany².....	73
3.2.1. Management Practice in The Netherlands.....	73
3.2.2. Management Practice in Germany.....	76
3.3. Biological Effects-based Sediment Quality in Ecological Risk Assessment for Dutch and German Waters³.....	77
3.3.1. In situ Effect-Based Assessment.....	78
3.3.2. Ex situ Effect-Based Assessment.....	81
3.3.3. Outlook.....	82
3.4. Sediment Management Issues in the WFD-Strategies for Monitoring and Emission Controls of Priority Substances (U. Förstner)	83
3.4.1. Recommendations of the Expert Group on Analysis and Monitoring of Priority Substances (AMPS)	84
3.4.2. AMPS Drafting Group on Sediment Monitoring.....	85
3.4.3. Quality Standards for Sediments and Biota: Response of the Scientific Committee on Toxicity, Ecotoxicity and Environment.....	85
3.4.4. Priority Substances in Historical Contaminated Sediments.....	86
3.5. New Challenges for Catchment Scale Management.....	88
3.5.1. Risk Management at the Catchment Scale ¹ (S. Heise)	88
3.5.2. Sources and Measures at the Catchment Scale (U. Förstner)	91
3.5.3. Future Research on Soil-Sediment Contaminants at the Catchment Scale (W. Salomons)	94
4 Substances and Areas of concern.....	99
4.1 Introduction to the risk assessment approach for the Port of Rotterdam (S. Heise)	99
4.2.1 What substances are of concern for the Port of Rotterdam?	102
4.2.2. Assignment of hazard classes (HCC) to “substances of concern”	106
4.3 “Areas of concern” (S. Heise)	111
4.3.1 Methods to assign hazard indexes to areas of concern based on sediment data.....	111
4.3.2 Identified Areas of concern.....	114
4.4 Potential sources for contamination (S. Heise)	119
4.4.1 Industrial/diffuse sources in general.....	119
4.4.2 Historical sources for areas of concern.....	120
4.5 Special case area 1: Heavy metals in the Ruhr area (Th. Jancke)	134
4.6 Special case area 2: The Contamination of River Rhine with Hexachlorobenzene (H. Schönberger)	139
4.6.1 Introduction.....	139
4.6.2 Identification of the HCB source in the seventies – according to	140
4.6.3 Manufacture of chlorosilanes and the formation of HCB.....	141
4.6.4 Development of HCB emissions and of the immission situation.....	143
4.7 Ecotoxicological assessments along the River Rhine (S. Heise)	146
4.7 Summary (S. Heise)	149

² compiled from Dutch-German Exchange on Dredged Material, Part II

³ Compiled from den Besten et al. (2003)

5. Quantification of the Risk for the Port of Rotterdam.....	155
5.1 Introduction to the approach of risk quantification (S. Heise)	155
5.2 The hydrological regime, flood events, and sediment dynamics of the Rhine catchment area.....	159
(B. Westrich, T. Jancke, J. Karnahl & S. Heise)	
5.2.1 The hydrological regime and flood events.....	159
5.2.2 Sediment dynamics.....	163
5.3 Erosion thresholds in reservoirs of Rhine, Main and Neckar.....	168
(B. Westrich, T. Jancke & J. Karnahl)	
5.4 Estimated risk to the Port of Rotterdam due to substances of concern (S. Heise)	170
5.4.1 Introduction to the approach.....	170
5.4.2 Indication of risk by simulation of sediment transport from contaminated sites.....	177
5.5 Indications for resuspension and transport of contaminants in suspended matter – exemplarily described for Cadmium and HCB... .	181
(B. Westrich, T. Jancke, J. Karnahl & S. Heise)	
5.5.1 Introduction.....	181
5.5.2 Evidence for Cd-resuspension.....	182
5.5.3 Evidence for HCB-resuspension.....	185
5.5.4 Other evidence for resuspension events.....	193
5.6 Summary – areas of risk for Rotterdam (S. Heise)	197
5.7 Sediment management at the areas of concern.....	200
(S. Heise)	
5.7.1 Institutional framework in water and sediment management.....	200
5.7.2 Planned and implemented measures for areas of concern.....	203
5.8 References Chapter 5.....	205
6 Summary and Conclusions (S. Heise)	207
6.1. Identification of areas risk in the Rhine catchment area and its tributaries for the Port of Rotterdam due to historic contamination.....	207
6.1.1 Identification and classification of substances of concern (chapter 4.2)	207
6.1.2 Identification and classification of Areas of Concern (chapter 4.3)	208
6.1.3 Identification and classification of Areas of Risk (chapter 5)	209
6.1.4 The processes.....	211
6.2. Knowledge Gaps and Uncertainties.....	212
6.3. Historical Contaminated Sediments under the WFD.....	212
6.4. Sustainable Sediment Management at the Catchment Level.....	213
Abbreviations	217
List of boxes	220
List of tables	221
List of figures	223
Acknowledgement	
Annexe	

