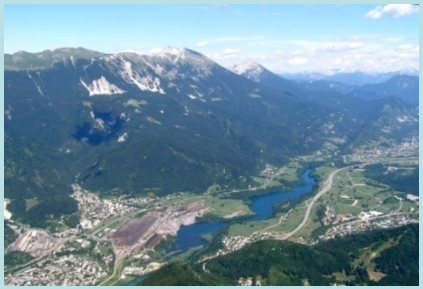
Rehabilitation and Development of Transport and Navigation on the Sava River Waterway

TRANSPORT
ENVIRONMENT
RIVER ENGINEERING WORKS



by
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INTERNATIONAL SAVA RIVER BASIN COMMISSION

Content of the Presentation

- Objective
- Scope of Work
- Challenges
- Project approach
- Characteristics of the Sava
- Identified projects
- Proposed works
- Investments
- Conclusions/Recommendations

Map No. 3740 Rev. 3 UNITED NATIONS
February 2003

Department of Public Information
Cartographic Section

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Objective of Feasibility Study

- Improve public and private investments into the transport on the river Sava, in accordance with adequate economic and financial analysis
- Propose enhancement of coordination of activities regarding to inland navigation and to set up the priorities of public interests;
- Obtain an integrated approach considering water management, energy production, flood control and environment in the Sava River basin;
- Propose infrastructure improvement;
- Results of the ***FS*** to be used as input for further ***DETAILED*** studies.

Scope of Work

Nr	Task	From	To
	MOBILIZATION on site ()	Monday 3/12/2008	
1	Inception Phase	01/12/2007	31/12/2007
2	Phase 1 - Rehabilitation of the waterway to Class IV (Task 1 – 9)	01/01/2008	30/04/2008
3	Phase 2 - Extension of Navigation from Sisak, rkm 586.0, to Brezice (Task 1 – 7)	01/03/2008	31/05/2008
4	Phase 3 - Improvement of the waterway to the Sava Commission (Task 1 – 4)	01/04/2008	30/06/2008
5	Phase 4 - Development of Action Plan	01/04/2008	30/06/2008
6	Phase 5 - (Task 10 of Phase 1): Preparation of Terms of Reference for Detailed Design Works and Studies	01/05/2008	30/06/2008
7	FINAL REPORT	01/07/2008	31/07/2008
	DEMOBILIZATION from site ()	Thursday 31/07/2008	

PHASE 1			
Task no	***Task subject***	***REF***	***Report title***
TASK 1	Data collection		
TASK 2	Traffic and transport study;	[Lit 01]	PHASE 1 TASKS 2 & 4 REPORT ON TRANSPORT AND CARGO AND ON PORT DEVELOPMENT
TASK 3	Inventory & Evaluation of Sava River (survey);	[Lit 02]	PHASE 1 TASK 3 REPORT ON THE INVENTORY AND EVALUATION OF SAVA WATERWAYS
TASK 4	Port development;	[Lit 03]	*Report integrated in the report for Task 2*
TASK 5	Preliminary design and cost estimate;	[Lit 04]	PHASE 1 - TASK 5 REPORT ON PRELIMINARY DESIGN AND COST ESTIMATE
TASK 6	Environmental impact assessment;	[Lit 05]	PHASE 1 - TASK 6 REPORT ON ENVIRONMENTAL IMPACT ASSESSMENT
TASK 7	River Information Services;	[Lit 06]	PHASE 1 - TASK 7 REPORT ON RIVER INFORMATION SERVICES
TASK 8	Cost Benefit Analysis; and	[Lit 07]	PHASE 1 - TASK 8 COST BENEFIT ANALYSIS
TASK 9	Institutional, policy & legal framework;	[Lit 08]	PHASE 1 – TASK 9 REPORT ON POLICY, INSTITUTIONAL AND LEGAL FRAMEWORK
TASK 10	TOR	[Lit 09]	PHASE 1 - TASK 10 REPORT ON TOR FOR DETAILED DESIGN
		[Lit 10]	PHASE 1 REPORT ON SAVA RIVER INLAND WATERWAY TRANSPORT SYSTEM
PHASE 2			
TASK 1	Traffic and cargo analysis	[Lit 11]	PHASE 2 – TASK 1 REPORT ON TRANSPORT AND CARGO
TASK 2	Assessment of waterway classification	[Lit 12]	PHASE 2 – TASK 2 REPORT ON SAVA IWT - section SISAK – BREŽICE
TASK 3	Preliminary design, cost estimate & implementation schedule;	[Lit 13]	PHASE 2 – TASK 3 REPORT ON PRELIMINARY DESIGN AND COST ESTIMATES
TASK 4	Environmental impact assessment;	[Lit 14]	PHASE 2 – TASK 4 REPORT ON ENVIRONMENTAL IMPACT ASSESSMENT
TASK 5	Cost Benefit Analysis	[Lit 15]	PHASE 2 – TASK 5 COST BENEFIT ANALYSIS
	No task related to this report (3rd party)	[Lit 16]	PHASE 2 - REPORT ON POLICY, INSTITUTIONAL AND LEGAL FRAMEWORK
PHASE 3			
		[Lit 17]	PHASE 3 REPORT ON SAVA IWT SYSTEM (rkm 0.0 - rkm 586.0)
TASK 1	Prepare Prelim. designs / costs estimate	[Lit 18]	PHASE 3 – TASK 1 REPORT ON PRELIMINARY DESIGN AND COST ESTIMATES
TASK 2	Environmental impact assessment	[Lit 19]	PHASE 3 – TASK 2 REPORT ON ENVIRONMENTAL IMPACT ASSESSMENT
TASK 3	Cost Benefit Analysis	[Lit 20]	PHASE 3 – TASK 4 COST BENEFIT ANALYSIS

CHALLENGES

- International river:
  - Four riparian states;
  - Border river (BiH, HR, SRB);
  - Division of investment amongst states;
  - Coordination;
- Obtaining data:
  - River maps and cross-sectional data;
  - Sediment;
  - Hydro-morphologic data;
  - Computer modelling;
  - Private investments.

Project Approach

- Data collection
- Sectioning of the river according to the locations of the ports along the river Sava (8 sections)
- Make use of results of previous studies
- Phasing of the study:
  - Phase 1: rehabilitation to Class IV (km 0.0 – 586)
  - Phase 2: extend navigation from Sisak - Brezice
  - Phase 3: rehabilitation to Class Va
  - Phase 4: development of action plan (implementation)
  - Phase 5: prepare ToR for further studies
- Transport Study – using port development
- Cost Benefit Analysis
- Environmental Studies

Use of the river Sava

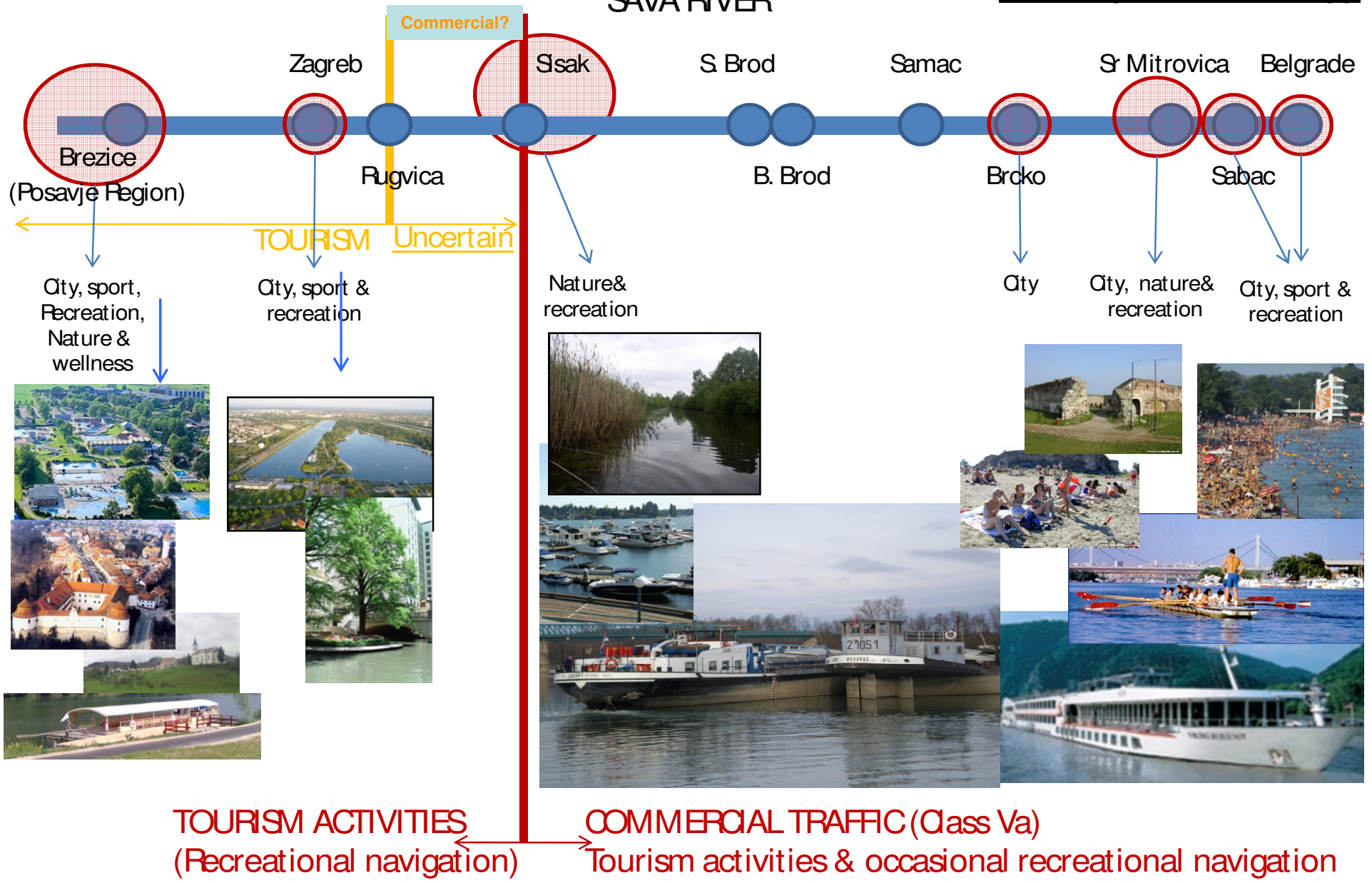
Available Data Base

- Master Plan and Feasibility Study - Inland Water Transport for Serbia (Part – River Sava km 0.0 - 207.0);
- Preliminary Design of the eight critical sections in Croatia and Bosnia and Hercegovina – river stretch Gunja - Sisak (km 210 – km 584) :
- Preliminary Design - Sava River waterway and regulation for the mean water-level Račinovci – Sisak (km 203.3 – 583.0);
- Hydrographic measurement of the Sava riverbed – section km 0.0 – km 225.0;
- Prefeasibility Study - Rehabilitation and Development of the Navigation on the Sava

SCC requirements for Class IV and Class Va

STUDY		Feasibility study 2008 (present study)	Feasibility study 2008 (present study)
WATERWAY	classification system	SCC	SCC
	class	IV	Va
MOTOR VESSELS AND BARGES	length (m)	80-85 70 (when pushed)	95-110 76.5-85.0 (when pushed)
	beam (m)	9.5 9.5 (when pushed)	11.4 11.4 (when pushed)
	maximum draught (m)	2.5 2.5 - 2.8 (when pushed)	2.5 - 2.8 2.5 - 4.5 (when pushed)
	tonnage (t)	1000 - 1500	1500 - 3000 1600 - 3000 (when pushed)
PUSHED CONVOYS	Convoy type		
	length (m)	85	95 - 110
	beam (m)	9.5	11.4
	maximum draught (m)	2.5 - 2.8	2.5 - 4.5
	tonnage (t)	1250 - 1450	1600 - 3000
DIMENSIONS OF FAIRWAY	Depth of fairway (m) (in case of reduced draught and for a water level that is exceeded 95% of the time)	2.3	2.4
	Depth of fairway (m) (in case of maximum draught and for a water level that is exceeded 65% of the time)	3.3	3.4
	Width of waterway in a stream (m)	55	55
	Width of waterway in a curve (m)	75	85 (for vessels with min length) 90 (for vessels with max length)
	minimal radius of curvature (m)	360	360
SAFETY CLEARANCES	Vertical clearance under bridged (m) (for water level that is exceeded 1% of the time)	7	7
	Horizontal clearance under bridges (m)	45	55
	Vertical clearance under the power lines (m) up to 110 kV up to 250 kV up to 400 kV	15.00 15.75 17.00	15.00 15.75 17.00
	Vertical clearance under cables (m)	12	12
	Horizontal clearance for cables and power lines (m)	width between river banks at high water levels	width between river banks at high water levels

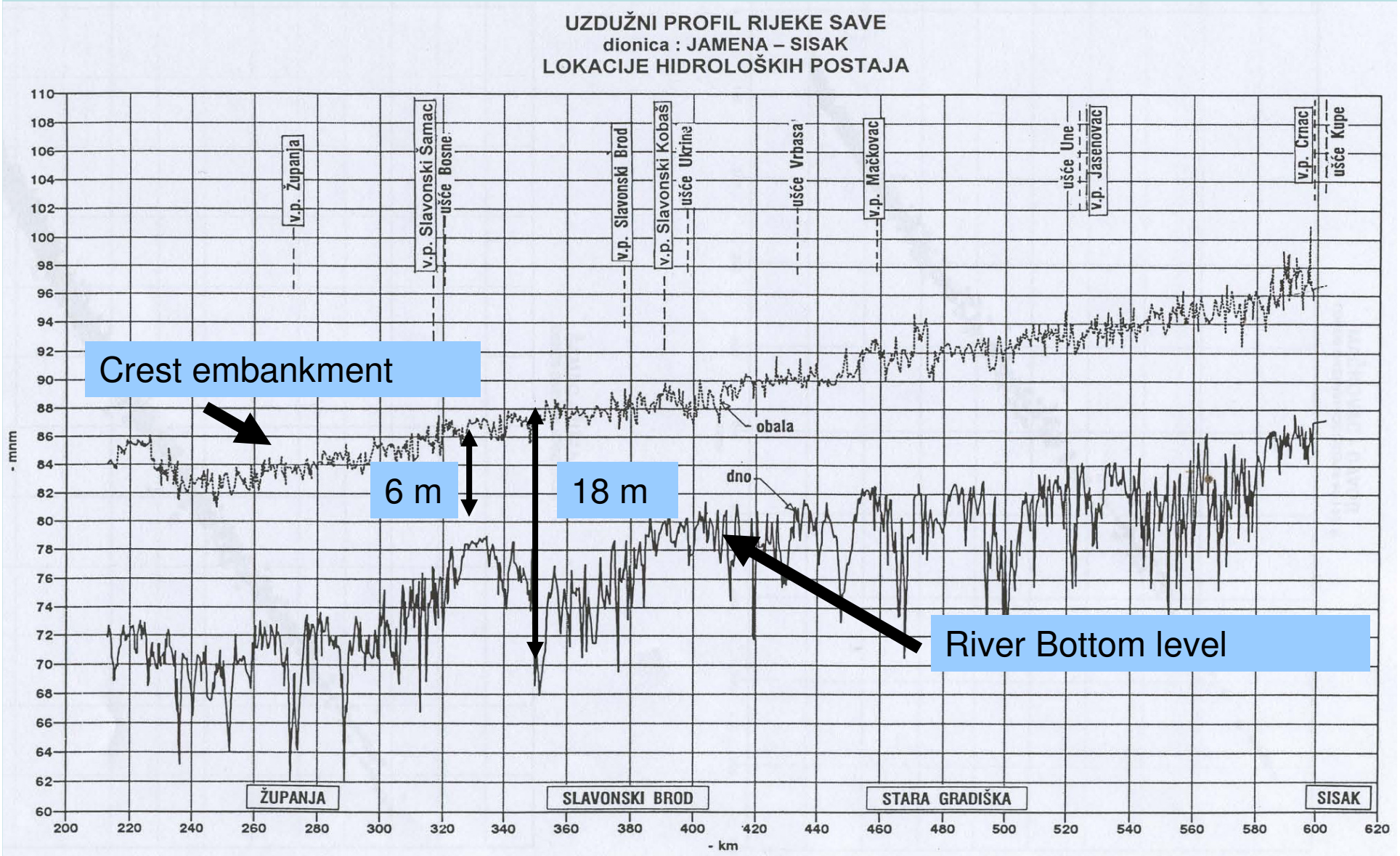
Development Strategy



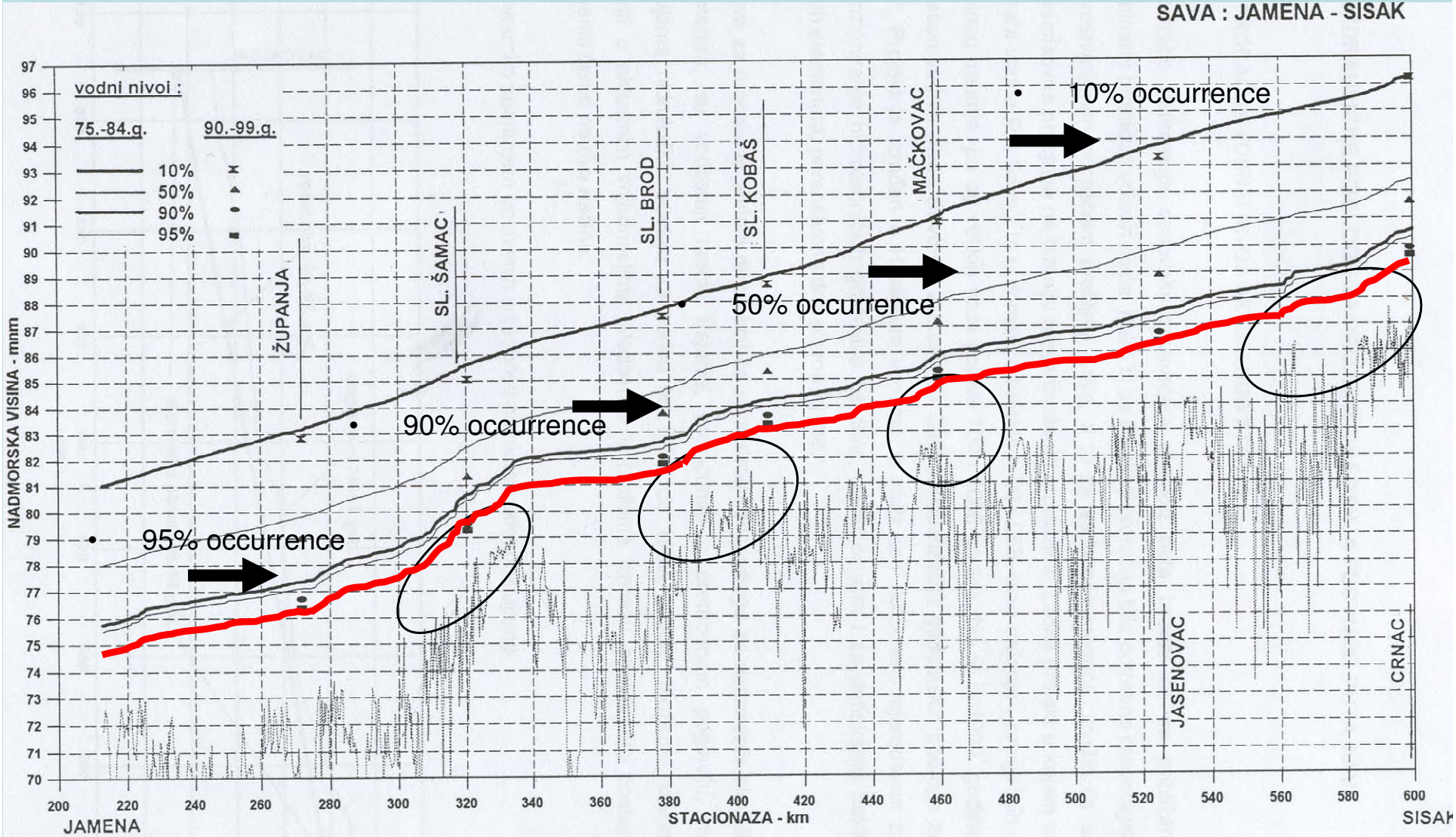
Sava waterway - Navigation problems

- The physical parameters of the Sava cause unfavourable navigation conditions related to:
  - limited draft during large periods;
  - sharp river bends limiting the length and width of vessels and convoys.
- Other problems for navigations are:
  - limited dimensions for passages under bridges;
  - insufficient marking.
- SCC requirement:
  - Navigation must be possible:
    - Reduced draft 95% of the time
    - Maximum draft 65% of the time

Sava - Longitudinal profile



Occurrence of water levels - Sava



Sava - Embankments

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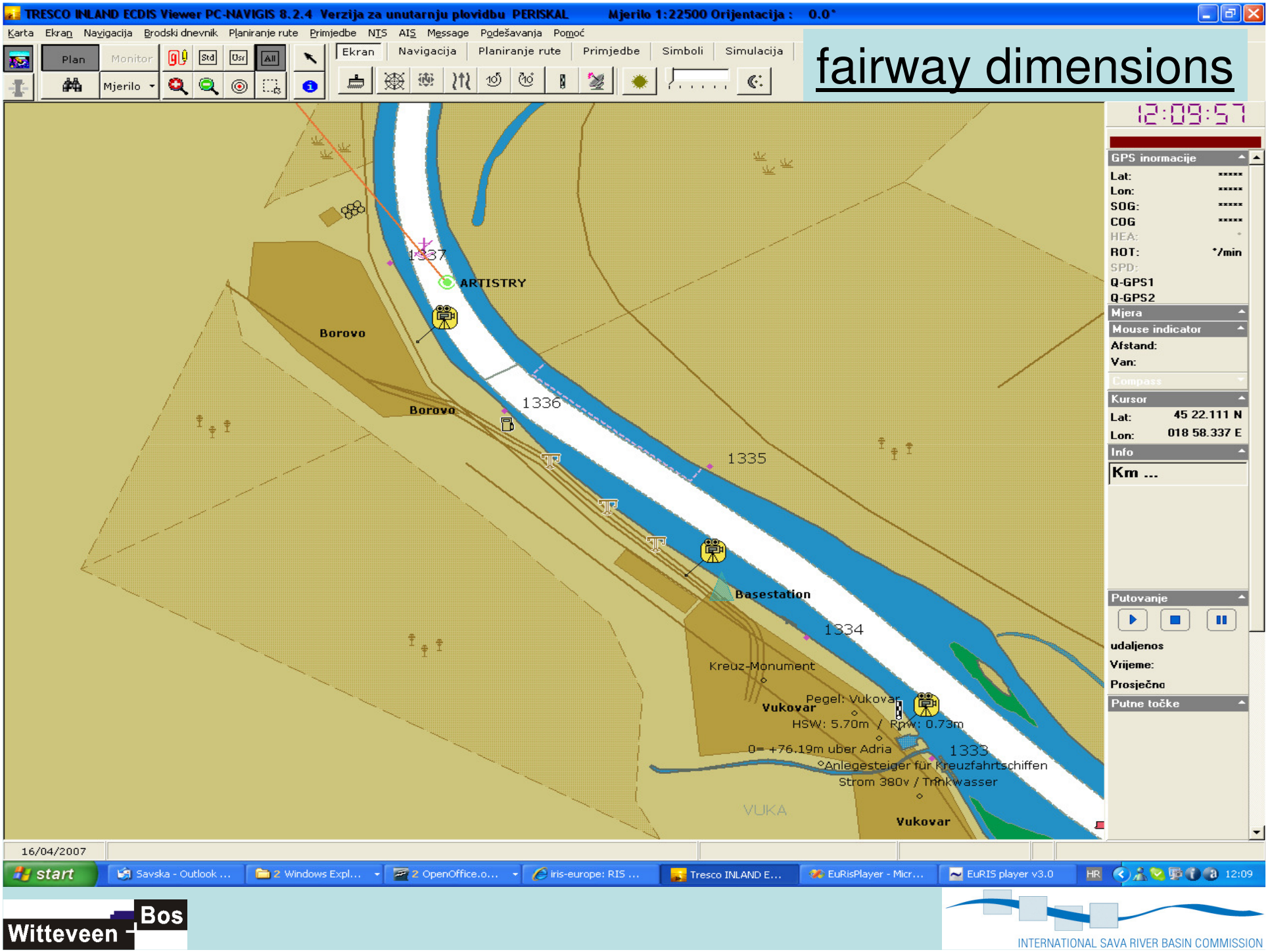

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Sedimentation and erosion

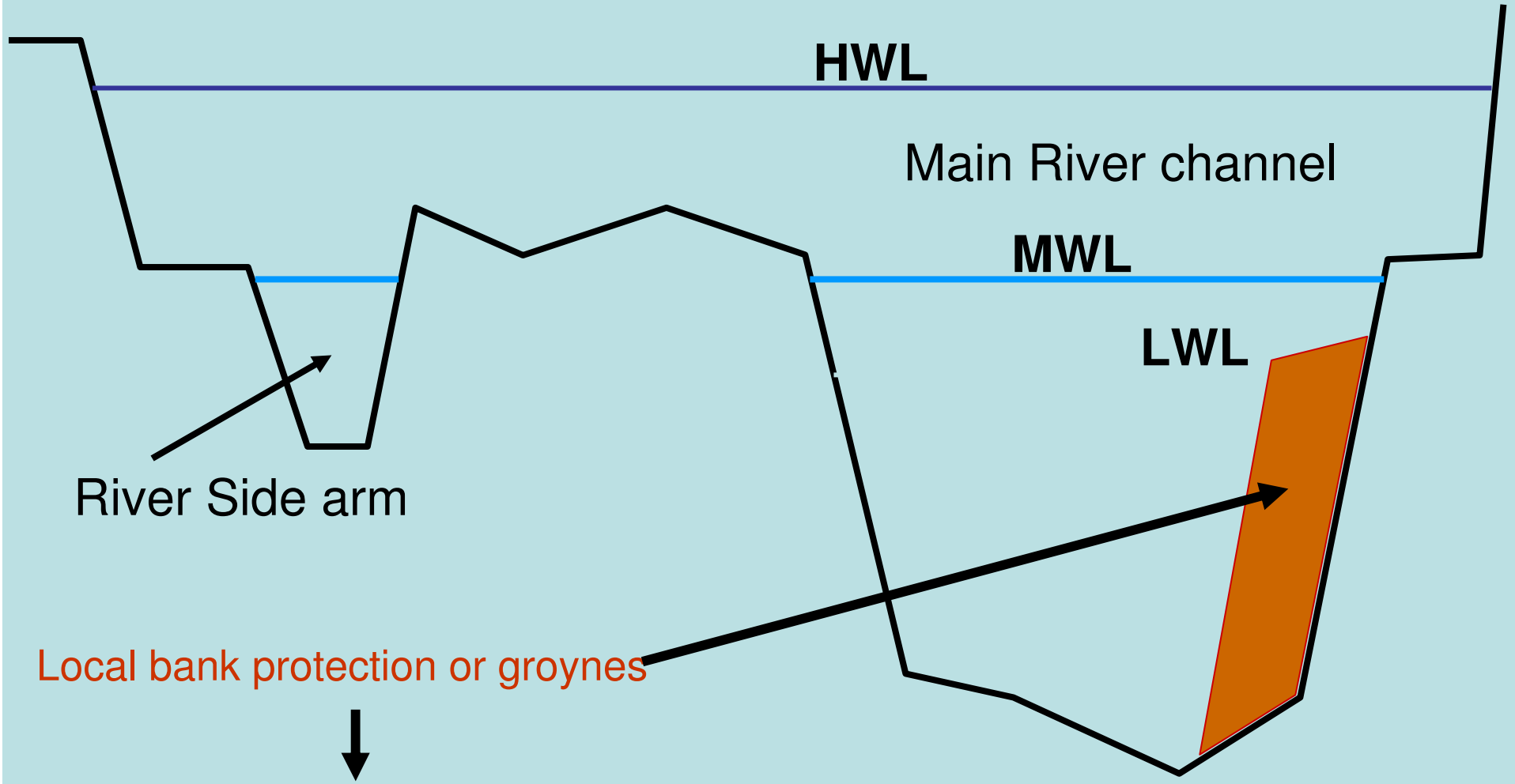
• Section km 0.0 – km 202.0

- The erosion rate is significant and causes alignment changes.
- At certain location the horizontal erosion rate appears to be order of magnitude of up to 4 meter per year,
- stabilization of the river alignment or frequent relocation of the fairway alignment is required.
- bed level degradation is ongoing along the entire Sava, except in section km. 120 and km. 130 (stable)
- average river bed degradation is approximately 2-3 cm per year.
- Excessive and uncontrolled sand and gravel mining may be one of the reasons for this.

• Section km 202.0 – km 579.5

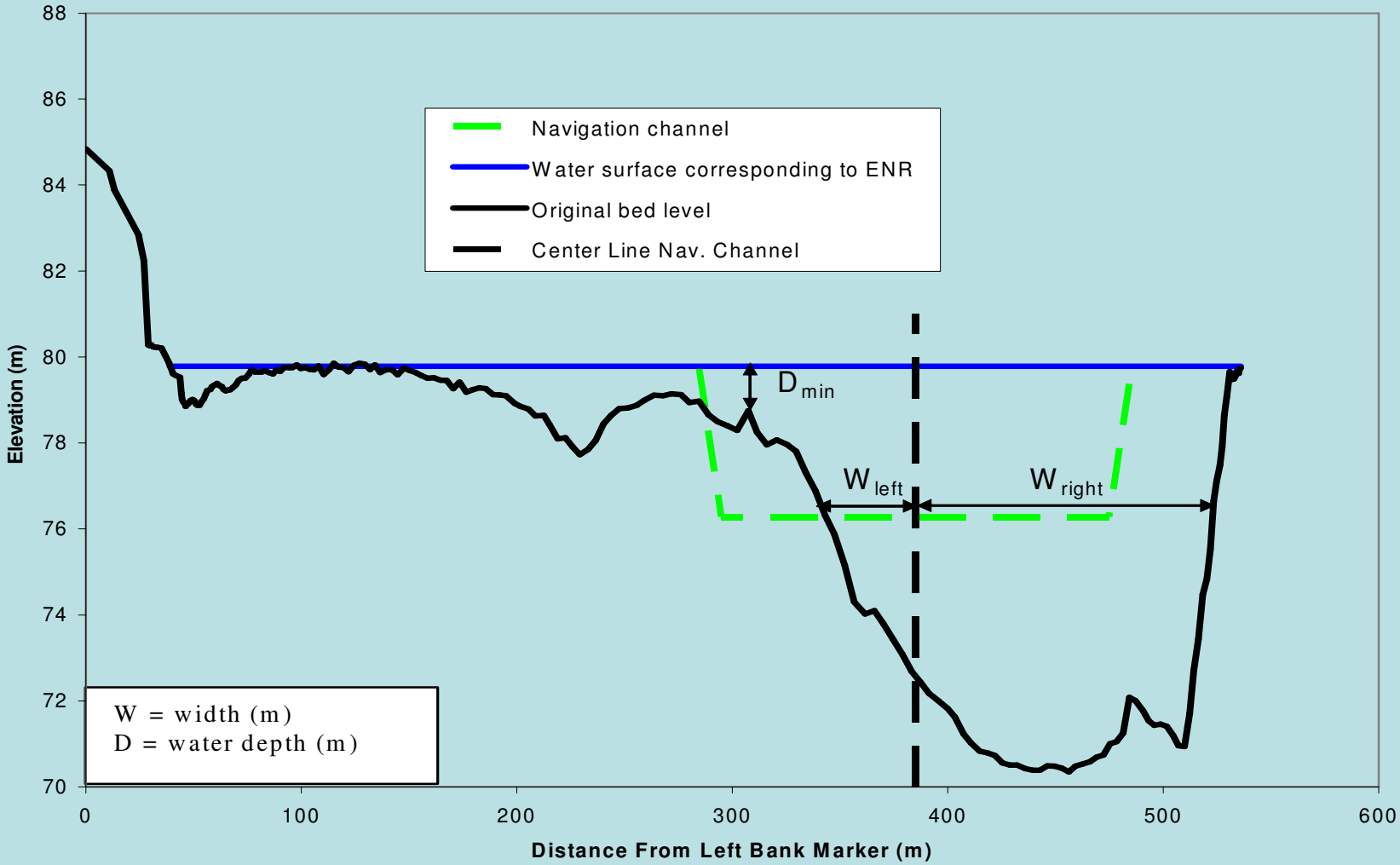
- Data on sediment or sediment transport is hardly available for this river section.
- Longitudinal profile available
- Cross sectional data not available, except for certain construction sites

River training works – limited depth



Little effects on morpho-dynamics and sediment balance

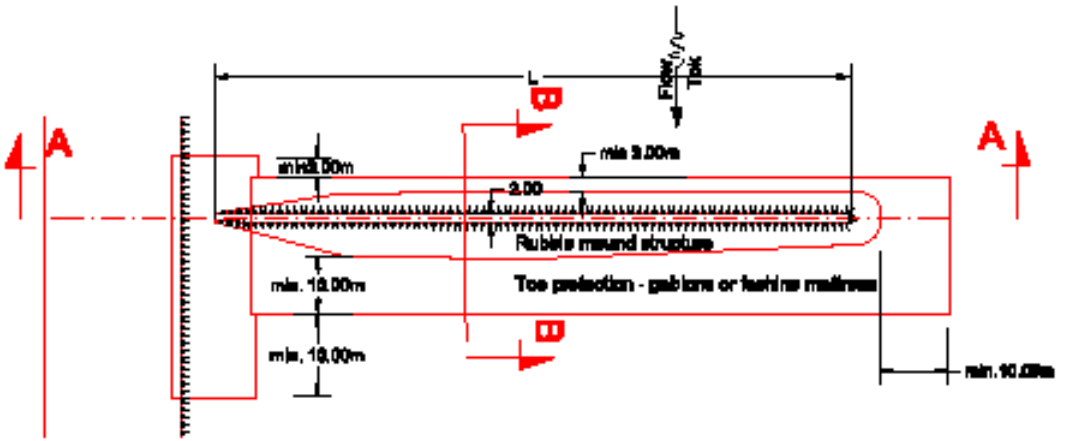
Limited cross sectional area



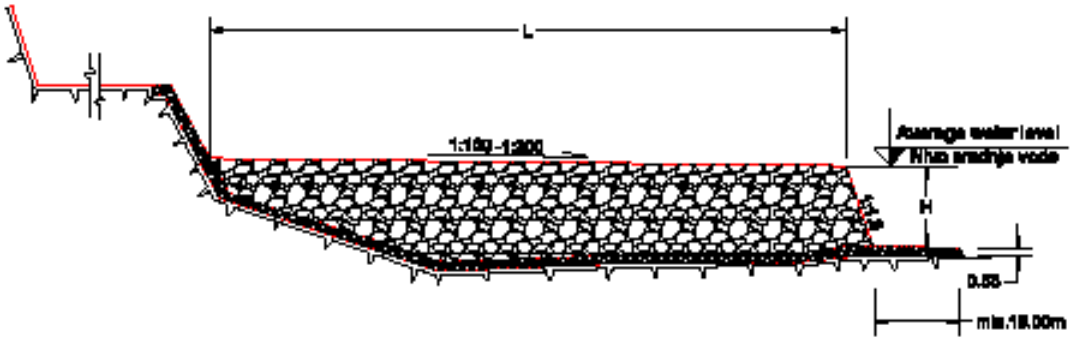
Proposed training works

- Groynes
- Submerged groynes
- Guiding bund
- Closure bund
- Embankment protection

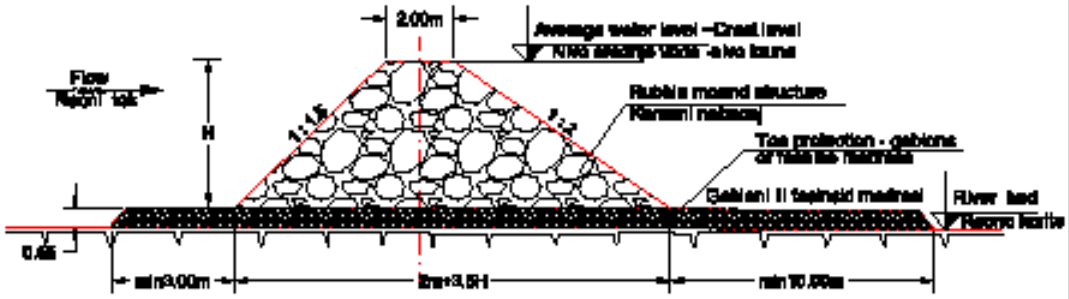
TOP VIEW OF GROYNE - OBNOVA NAPERA



LONGITUDINAL SECTION A - A PODUZNI PRESEK
L/H=1:10



CROSS SECTION B - B POPREČNI PRESEK



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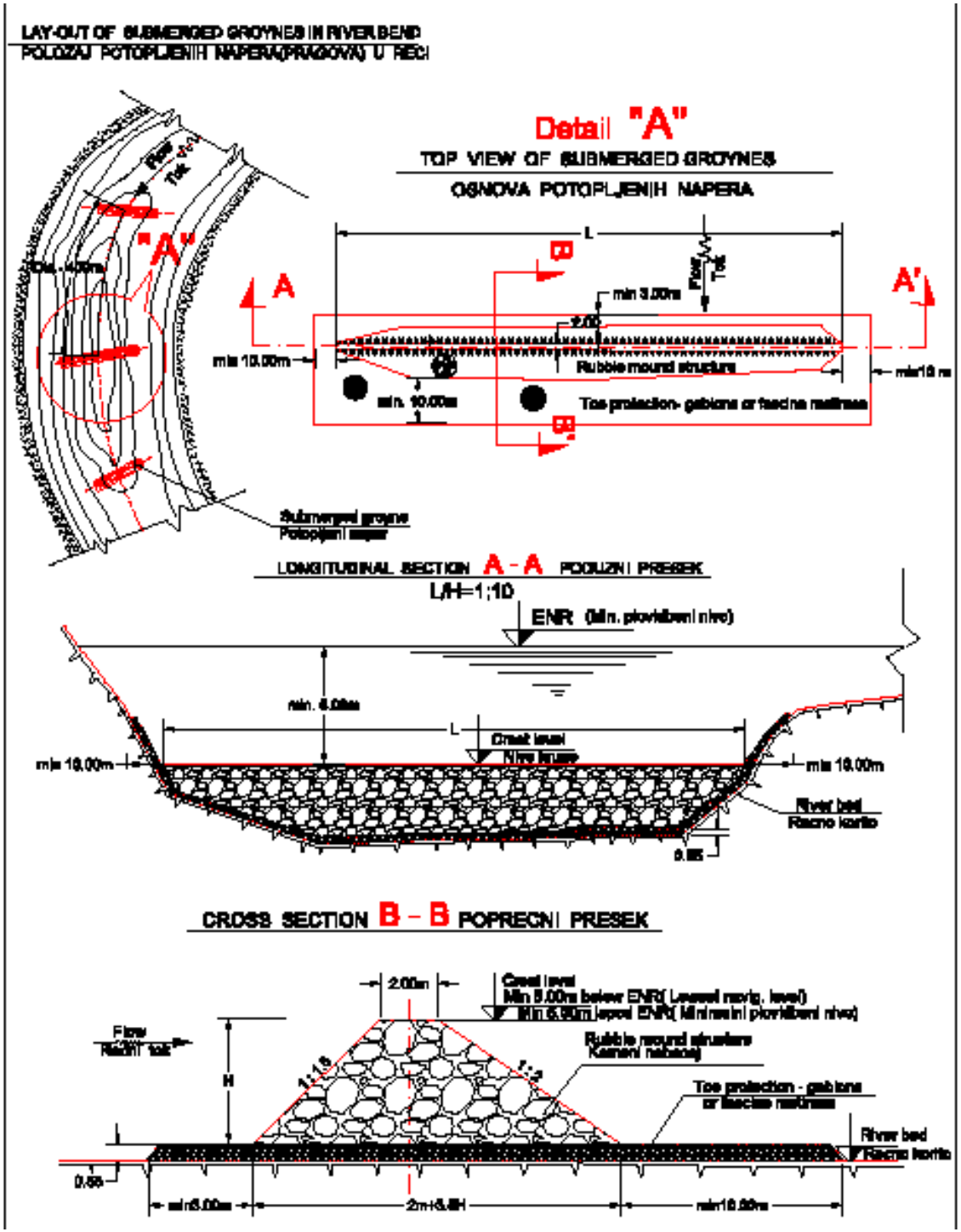

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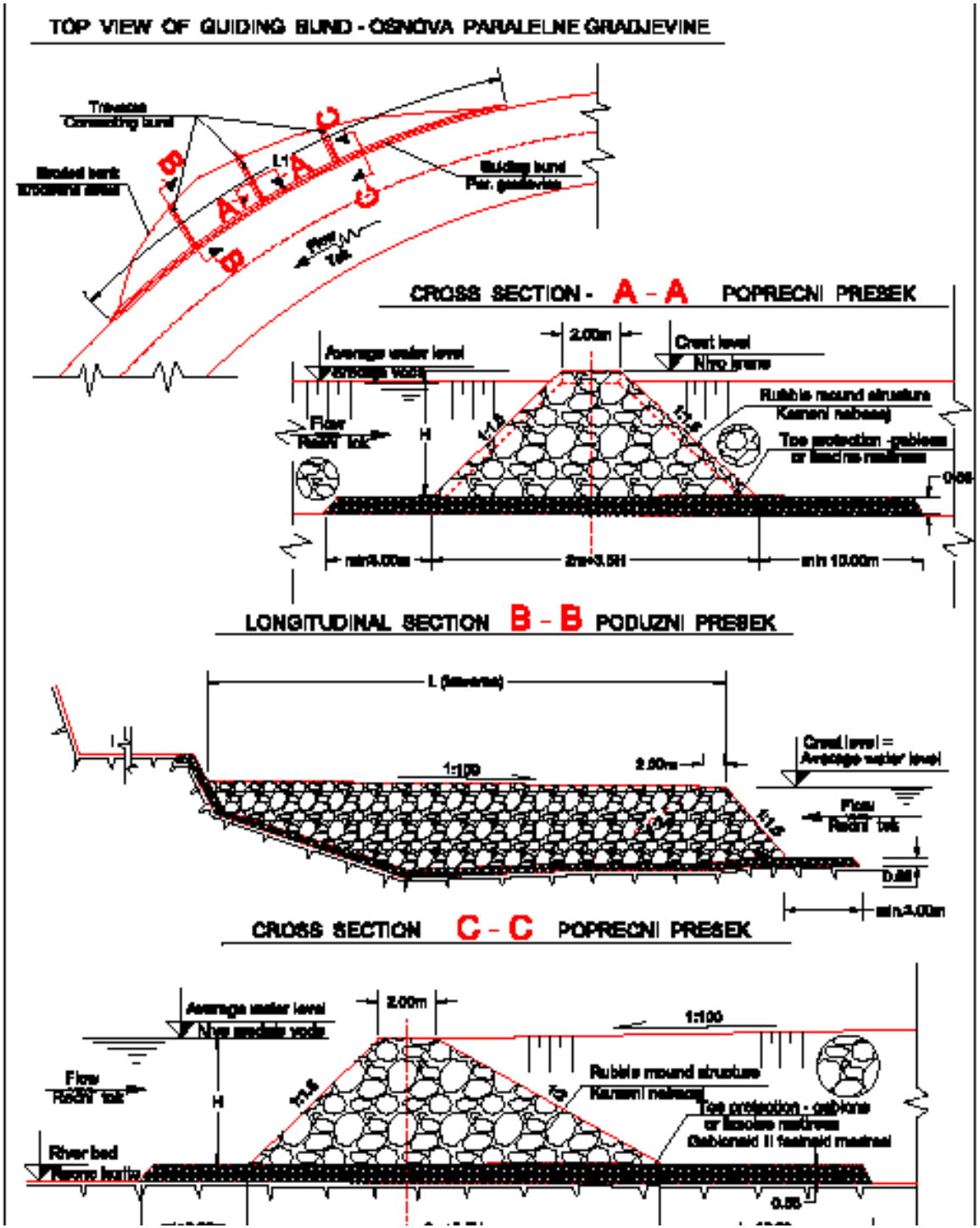

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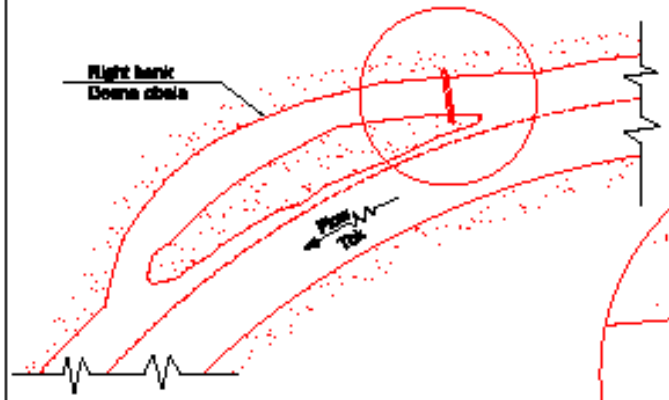
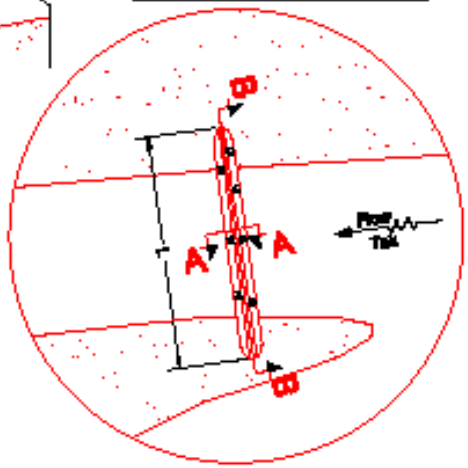
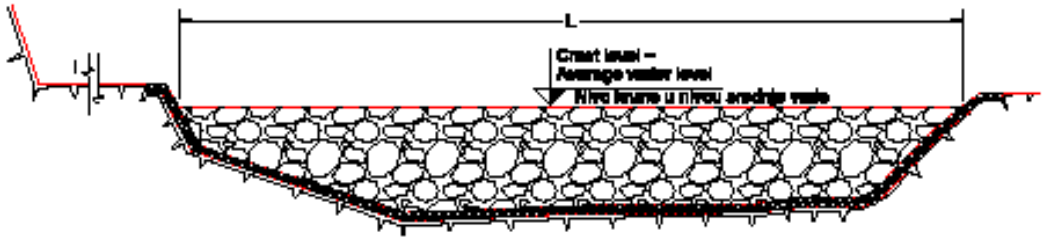
TOP VIEW OF CLOSURE BUND - OSNOVA PREGRADE



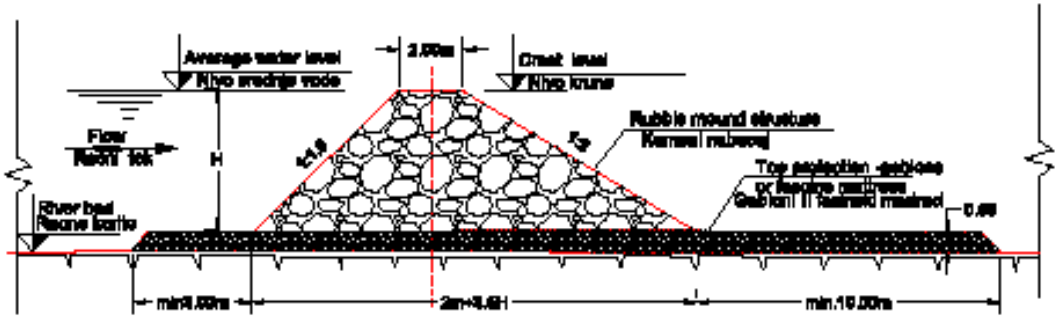
DETAIL - DETALJ



LONGITUDINAL SECTION B - B PODUZNI PRESEK



CROSS SECTION A - A POPRECNI PRESEK



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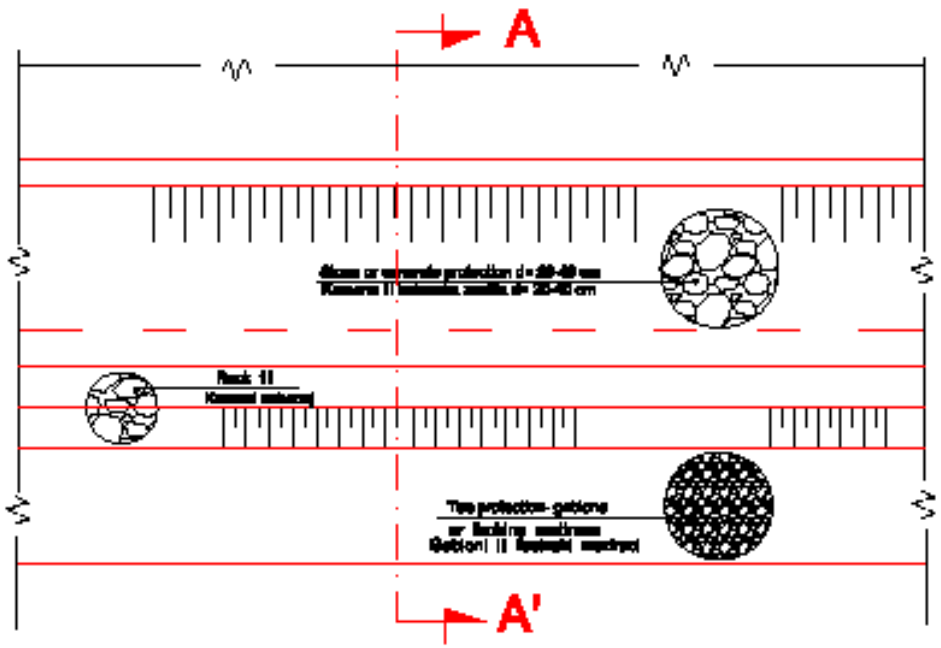
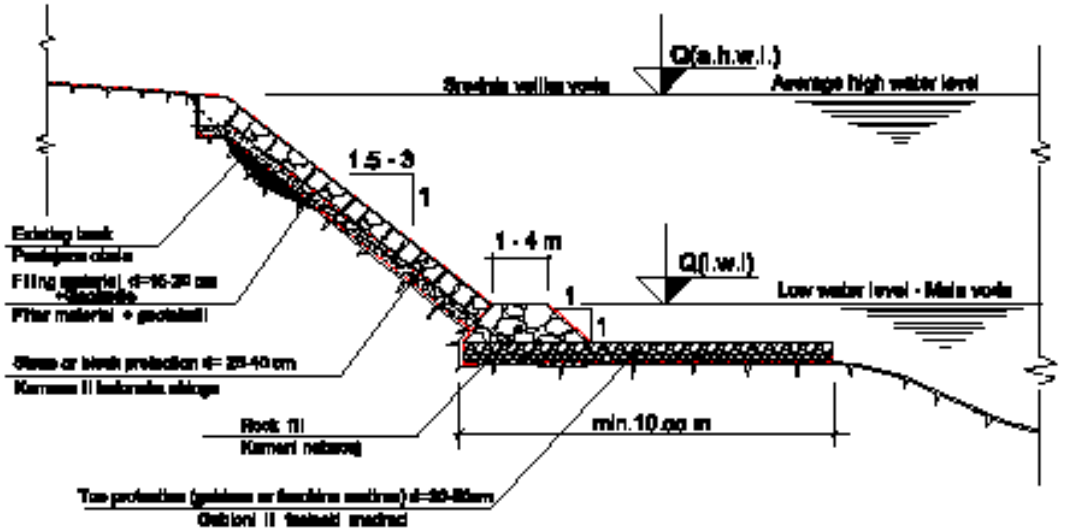
TOP VIEW OF BANK PROTECTION - OSNOVA OBALOUTVRDE



CROSS SECTION A - A' POPREČNI PREZEK



NOTE: Not to scale

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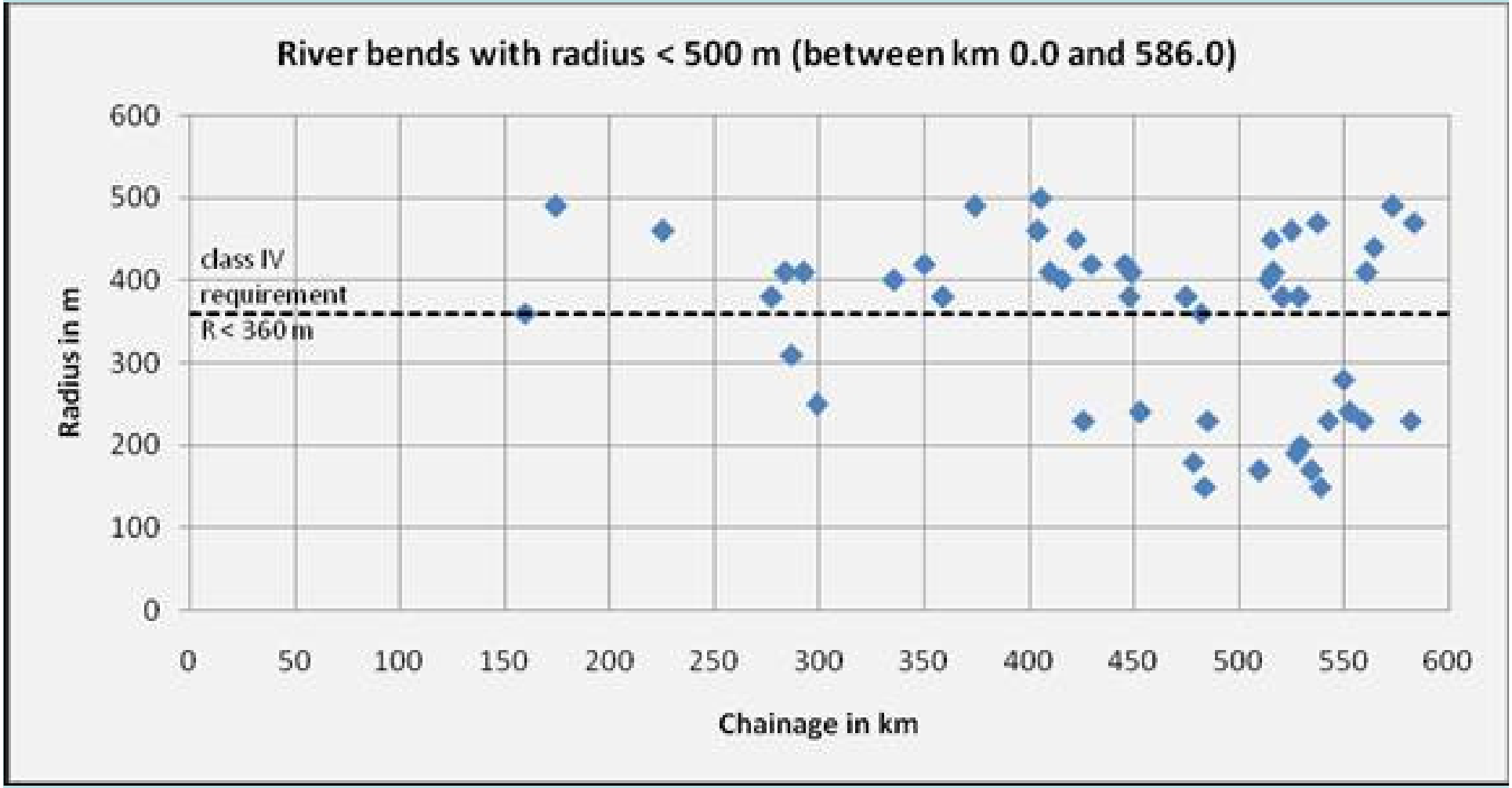
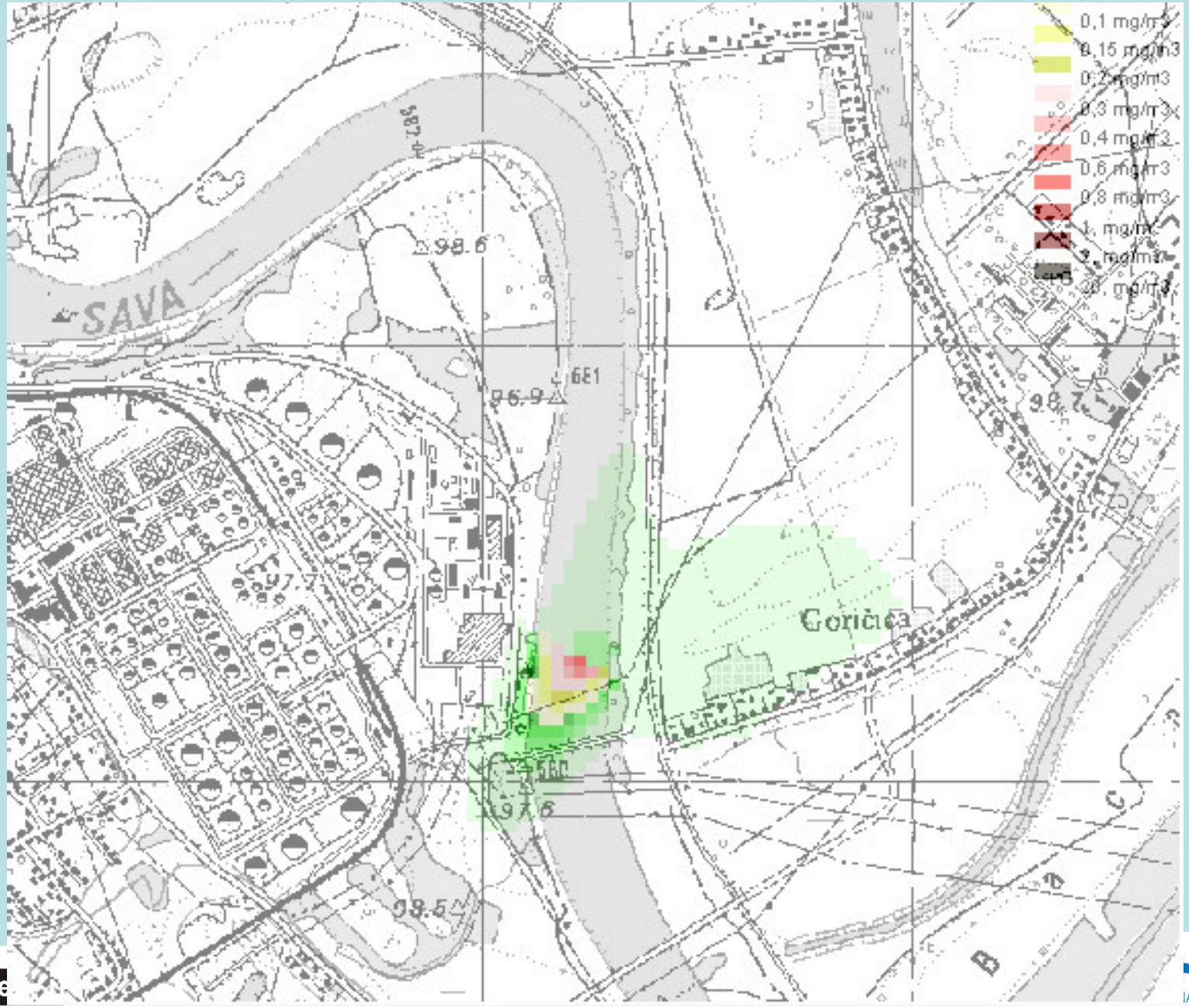
Location and radius of river bends with radius smaller than 500 m



River bend improvement

- Km 202 – km 586
  - 20 bends with R < 360 m
    - 12 bends with R < 240 m
    - 8 bends with 240m < R < 360m
  - One lane traffic: R >360 m
  - Two lane traffic: R > 240 m

Sample of river bend improvement



Identified improvement works – Class Va

Table 5-16 Overview of projects per port section

section nr	**Location**	**Chainage [km]**	Projects
1	Belgrade Sabac Intermodal	km 0.0 km 98.0	DTW1, DTW2 B1, M1 (98 KM), RIS (98KM)
2	Sabac Intermodal Sabac Industrial	km 98.0 km 103.0	DTW3, M1 (5KM), RIS (5KM),
3	Sabac Industrial Srmska Mitrovica	km 103.0 km 133.0	B2, S1 (ONE VESSEL) M1 (30KM), RIS (30KM),
4	Srmska Mitrovica Brcko	km 133.0 km 223.0	DTW4, DTW5, DTW6, DTW7, S1 (2 VESSELS) M1 (90KM), RIS (90KM),
5	Brcko Samac	km 223.0 km 305.0	DTW8, DTW9 RB1,RB2, M2 (82KM), RIS (82KM)
6	Samac Bosanski Brod	km 305.0 km 362.0	DTW10, DTW11 M3 (57KM), RIS (57KM)
7	Bosanski Brod Slavonski Brod	km 362.0 km 363.0	
8	Slavonski Brod Crnac (Sisak)	km 363.0 km 583.0	DTW12, DTW13, DTW14, DTW15, DTW16 DTW17, DTW18, DTW19, DTW20 RB3,RB4,RB5, RB6, RB7, RB8, RB9, RB10, RB11, RB12, RB13, RB14, RB15, RB16, RB17, RB18, RB19, RB20 B3, S2 (2 VESSELS), M (220 KM), RIS (220KM)

Table 5-17 Investment costs and O&M costs per port section - river stretch km 0.0 - 579						Port section	port section						total	yearly O&M
Project	**Chainage**	Construction costs (A)	Contingencies (B=10% of A)	Project realisation (C=15% of A+B)	D=A+B+C Investment (Euro)		km 0.0 - 98.0 1	km 98 - 103 2	km 103 - 133 3	km 133 - 223 4	km 223 - 305 5	km 305 - 362 6	km 362 - 363 7	km 363 - 583 8		cost
DTW1	79.9 - 85.8	232,400	23,240	38,346	293,986	1	293,986								293,986	11,620
DTW2	88.3 - 101.9	1,412,400	141,240	233,046	1,786,686	1	1,786,686								1,786,686	70,620
DTW3	103.5 - 109.8	400,000	40,000	66,000	506,000	2		506,000							506,000	20,000
DTW4	173.8 - 176.6	3,058,000	305,800	504,570	3,868,370	4				3,868,370					3,868,370	49,552
DTW5	177.8 - 187.4	716,800	71,680	118,272	906,752	4				906,752					906,752	35,840
DTW6	189.2 – 202.5	799,600	79,960	131,934	1,011,494	4				1,011,494					1,011,494	39,980
DTW7	202.5 - 225.1	1,190,000	119,000	196,350	1,505,350	4				1,505,350					1,505,350	59,500
DTW8	225.1 - 260.7	60,000	6,000	9,900	75,900	5					75,900				75,900	3,000
DTW9	260.7 - 306.8	600,000	60,000	99,000	759,000	5					759,000				759,000	30,000
DTW10	306.8 - 331.5	5,620,000	562,000	927,300	7,109,300	6						7,109,300			7,109,300	346,600
DTW11	331.5 - 364.4	50,000	5,000	8,250	63,250	6						63,250			63,250	2,500
DTW12	364.4 - 395.5	3,540,000	354,000	584,100	4,478,100	8								4,478,100	4,478,100	215,400
DTW13	395.5 - 417.1	-	-	-	-	8								-	-	-
DTW14	417.1 - 445.7	420,000	42,000	69,300	531,300	8								531,300	531,300	21,000
DTW15	445.7 - 459.9	110,000	11,000	18,150	139,150	8								139,150	139,150	5,500
DTW16	459.9 - 480.4	10,000	1,000	1,650	12,650	8								12,650	12,650	500
DTW17	480.4 - 511.8	90,000	9,000	14,850	113,850	8								113,850	113,850	4,500
DTW18	511.8 - 546.8	4,940,000	494,000	815,100	6,249,100	8								6,249,100	6,249,100	333,200
DTW19	546.8 - 568.8	8,490,000	849,000	1,400,850	10,739,850	8								10,739,850	10,739,850	543,800
DTW20	568.8 - 588.2	3,190,000	319,000	526,350	4,035,350	8								4,035,350	4,035,350	176,500
RB1	286 - 288	163,000	16,300	26,895	206,195	5					206,195				206,195	6,520
RB2	298 – 300	163,000	16,300	26,895	206,195	5					206,195				206,195	6,520
RB3	452 – 454	163,000	16,300	26,895	206,195	8								206,195	206,195	6,520
RB4	481 – 483	163,000	16,300	26,895	206,195	8								206,195	206,195	6,520
RB5	492 – 494	163,000	16,300	26,895	206,195	8								206,195	206,195	6,520
RB6	495 – 497	163,000	16,300	26,895	206,195	8								206,195	206,195	6,520
RB7	549 – 551	163,000	16,300	26,895	206,195	8								206,195	206,195	6,520
RB8	552 – 554	163,000	16,300	26,895	206,195	8								206,195	206,195	6,520
RB9	425.8 – 426.8	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB10	477.9 – 478.9	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB11	483.3 – 484.3	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB12	484.9 – 485.9	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB13	509.5 – 510.5	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB14	527.2 – 526.2	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB15	529.2 – 530.2	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB16	534.5 – 535.5	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB17	538.5 – 539.5	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB18	542.0 – 543.0	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB19	558.9 – 599.9	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120
RB20	581.4 – 582.4	978,000	97,800	161,370	1,237,170	8								1,237,170	1,237,170	39,120

Short term Action Plan

Project	Chainage	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DTW 1	69.7 - 72.9										
DTW 2	79.9 - 85.8										
DTW 3	88.3 - 101.9										
DTW 4	103.5 - 109.8										
DTW 5	173.8 - 176.6										
DTW 6	177.8 - 187.4										
DTW 7	189.2 – 202.5										
DTW 8	202.5 - 225.1										
DTW 9	225.1 - 260.7										
DTW 10	260.7 - 306.8										
DTW 11	306.8 - 331.5										
DTW 12	331.5 - 364.4										
DTW 13	364.4 - 395.5										
DTW 14	395.5 - 417.1										
DTW 15	417.1 - 445.7										
DTW 16	445.7 - 459.9										
DTW 17	459.9 - 480.4										
DTW 18	480.4 - 511.8										
DTW 19	511.8 - 546.8										
DTW 20	546.8 - 568.8										
DTW 21	568.8 - 588.2										
RB1	286 - 288										
RB2	298 – 300										
RB3	452 – 454										
RB4	481 – 483										
RB5	492 – 494										
RB6	495 – 497										
RB7	549 – 551										
RB8	552 – 554										
RB9	425.8 – 426.8										
RB10	477.9 – 478.9										
RB11	483.3 – 484.3										
RB12	484.9 – 485.9										
RB13	509.5 – 510.5										
RB14	527.2 – 526.2										
RB15	529.2 – 530.2										
RB16	534.5 – 535.5										
RB17	538.5 – 539.5										
RB18	542.0 – 543.0										
RB19	558.9 – 599.9										
RB20	581.4 – 582.4										
B1	2,6										
B2	104										
B3	509										
M1	0 - 202										
M2	202 - 335										
M3	335 - 579.5										
S1	0 – 202										
S2	202 – 579.5										
RIS 1	0 – 202										
RIS 2	202 – 579.5										

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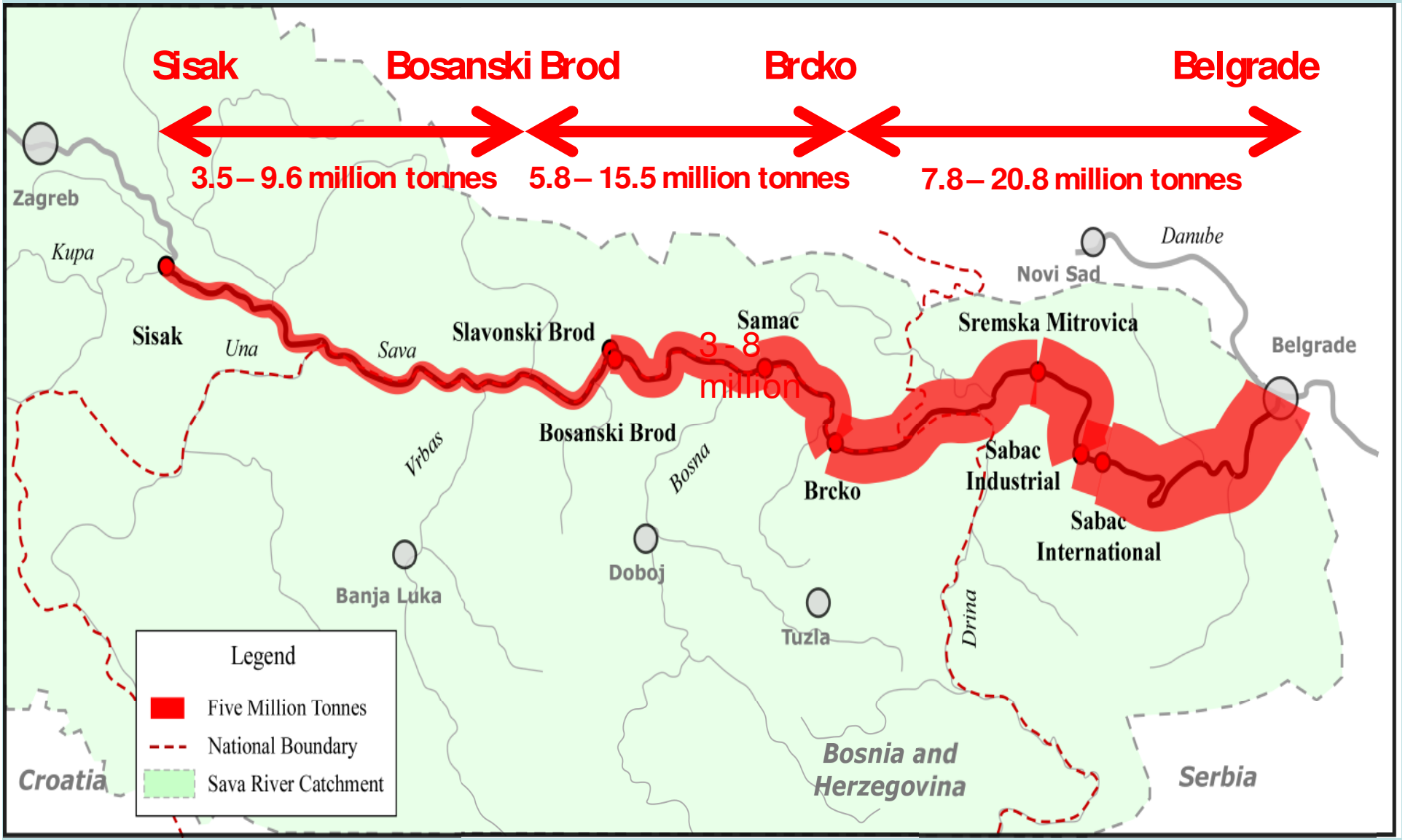
INTERNATIONAL SAVA RIVER BASIN COMMISSION

Implementation costs – Class IV vs Va

	Total for SCC Class IV	Total for SCC Class Va
	(Euro)	(Euro)
Dredging and training works	34,929,200	39,108,600
Environmental costs	1,005,000	1,340,000
Bridge replacements	8,880,000	8,880,000
River bend improvements (total)	11,360,000	11,360,000
Markings and sunken vessels	1,835,000	1,835,000
River Information Services	5,790,000	5,790,000
Net cost	**63,799,200**	**68,313,600**
Including contingencies (+10%)	70,179,120	75,144,960
TOTAL project costs (+15%)	80,705,988	86,416,704

Results transport study BELGRADE – SISAK (KM 0.0 – 586)



Cost Benefit Analysis

IRR per economic scenario	Class IV	Class Va
High volume scenario	13.9%	26.9%
Medium volume scenario	7.3%	20.2%
Low volume scenario	n.a.	11.6%

Net Present Value at 6% discount rate (million Euros)	NPV Class IV	NPV Class Va
High volume scenario	51.2	288.2
Medium volume scenario	6.8	157.9
Low volume scenario	-33.0	44.0

Net Present Value project 3% discount rate	NPV (million Euros)	
	Class IV	Class Va
High volume scenario	301.0	463.6
Medium volume scenario	166.3	267.4
Low volume scenario	43.4	92.6

Net Present Value project 9% discount rate	NPV (million Euros)	
	Class IV	Class Va
High volume scenario	113.7	179.5
Medium volume scenario	52.9	91.1
Low volume scenario	-0.3	15.3

Environmental Study

- Description of intervention and location
  - Infrastructure (training works, dredging, river bend improvement, marking, bridges, sunken vessels, etc.)
  - Tourism
- Estimation of intervention acceptability (using the JS)
- Executed Study is basic input for future detailed studies
- Listing of follow-up actions to obtain construction permits and approvals

Environmental costs - Class Va

Cost type and description	Class Va (EUR)
Environmental protection measures and monitoring:	
Air	30,000
Water	155,000
Soil	170,000
Flora and fauna	150,000
Cultural heritage	265,000
Traffic and infrastructure	25,000
Landscape	500,000
Accidents	25,000
Waste	20,000
TOTAL	**1,340,000**
MONITORING (annual cost)	37,500

Main Conclusions - Sava rehabilitation

Based on CBA results and the limitations caused by the level of detail of available information, the following conclusions can be drawn:

- The immediate implementation of rehabilitation works to upgrade Sava River to Class Va between Belgrade (km 0.0) and Sisak (km 586).
- To abandon the idea of upgrading Belgrade-Sisak to Class IV and in the future upgrade to Class Va if demand warrants such additional investment;
- Abandon upgrading of river Sava upstream Zagreb for commercial IWT and concentrate on tourism development and energy production;
- Abandon the idea of commercial traffic on the section Sisak – Rugvica because there is no economic or financial rationale for the investment.

Recommendations for navigation

1) Integral approach to the Sava

The development of the Sava for navigation should be considered on a river basin level (water supply, environment, agriculture, transport, etc.)

2) Environmental Impact Assessment

When morphological processes are considered it might show that the proposed dredging and training works might lead to further deepening of the Sava. Detailed hydraulic modelling, development of alternative technical solutions is required.

3) Cooperation between the riparian countries

A successful development of the Sava as a competitive, regional transport mode highly depends on the cooperation between the riparian countries.

Tourism development options

1. Ada Ciganlija and Veliko Ratno Ostrvo in Belgrade

Tourism development options

2. Nature reserve “Zasavica”

Tourism development options

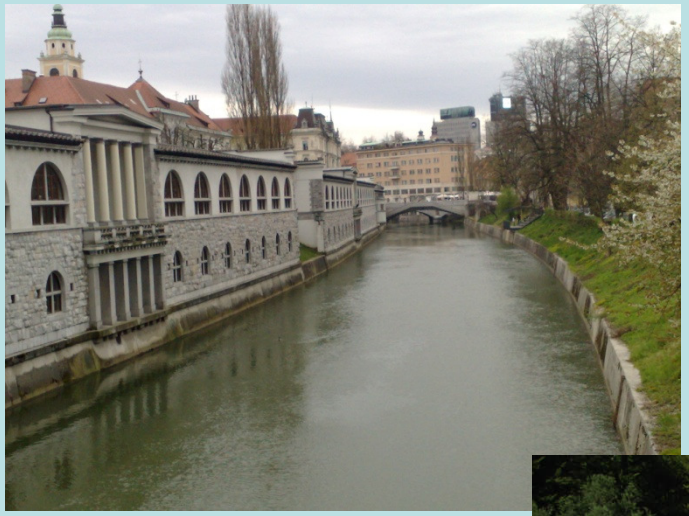
3. Sisak marina (under construction) and town center

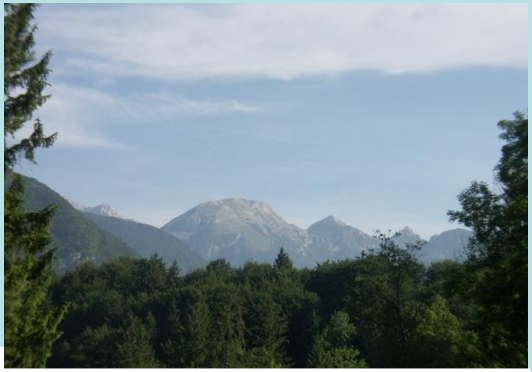
Tourism development options

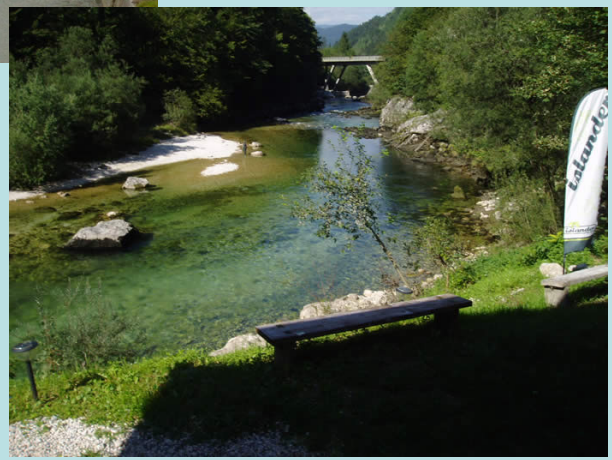
4. Lonjsko Polje Nature Park

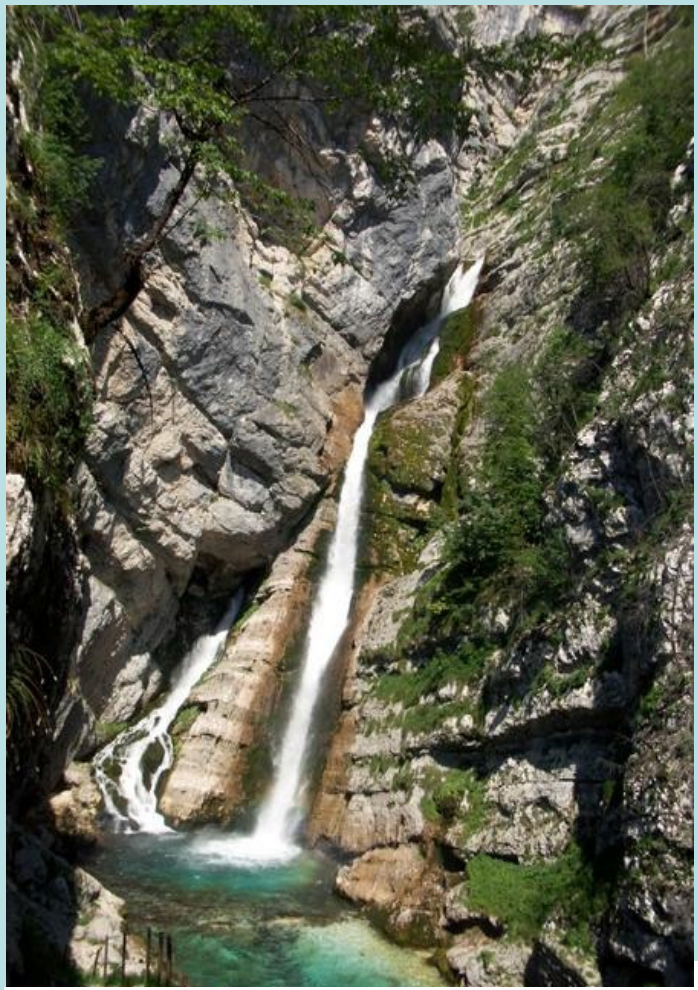
Tourism development options

5. Upstream to source of Sava River.









THANK YOU
for your
attention