E.4 GROUNDWATER AND SOIL

(1) Geochemical atlas project for soil and groundwater

The sampling points of soil and ground water in Geochemical Atlas of Slovakia are shown in Map E.4-1 and E.4-2. Regarding groundwater quality, Map E.4-3,4,5,6 and7 show comparison between the result or this project and the drinking water standard (STN 75 7111) for major indicators of groundwater pollution such as NO3, NH4, As, Cd and Pb.

(2) SHMU groundwater monitoring

The monitoring points of groundwater quality by SHMU is shown in Map E.4-8. Further, long-term change in groundwater quality was analyzed based on the following formula for each elements. These results are shown on the Figure E.4-1,2,3,4,5 and 6.

$$Cfi = Cai / Cni - 1$$

where

Cfi : contamination factor of i component

Cai : anallytical value of the i-th component

Cni : value of the i-th component permitted by Slovak Standard

(3) Groundwater analysis methodology

To explain methodology of groundwater analysis, flow chart is shown in Figure E.4-7. As the essence of the analysis, groundwater vulnerability analysis was conducted.

(4) Prioritization of Public Water Supply Connection Development

Public water supply (PWS) connection rate in Banska Bistrica Krej is relatively high at more than90%. However, PWS connection rate in Nitra kraj is relatively low at around 70%. Most of the households which are not connected with PWS use shallow groundwater from their own well. To supply clean drinking water for every house by improvement of PWS connection rate in the whole area is highly recommended. The priority and urgency of the PWS development shall be judged based on the following 4 factors.

1) PWS connection rate (P)
2) Current groundwater quality condition (C)
3) Groundwater quality change with time (G)

4) Vulnerability for groundwater contamination (V)

The area which PWS connection rate is low, groundwater condition is bad, groundwater quality is going bad and vulnerability is high, shall be given high priority for the improvement of PWS connection rate. As an example, priority for the PWS connection improvement for each Okres was calculated by using following formula. Ratings, varying from 1 to 10, are intended to reflect the condition of each factor.

Priority rate = P+C+G+V

The calculation result is shown on the Table E-4-1 Priority for Public Water Connection Rate Improvement. As shown on this table, Okres Levice and Nove Zamky is rated bad and priority for PWS connection improvement is high. On the contrary, Okres Brezno and Revuca are rated good and priority is low.

This example was conducted for each Okres levels, but this methodology can be applied for each Obec levels. The rate for each factor in each Obec levels can be estimated from same figure above and priority can be judged by the same method. In this Study, GIS spacial analysis technique was not used for this calculation, but these figures shall be given by digital forms. The estimation of each factor can be calculated by using this GIS spacial analysis technique.

Table E.4 - 1 Priority for Public Water Connection Rate Improvement

	PWS Connection Rate	Current groundwater quality	Groundwater quality change with time	Vulnerability	Rating	Priotity
Brezno	4	5	4	3	16	Very low
Banska Bistrica	4	4	4	2	14	Middle
Zvolen	3	3	3	1	10	High
Revuca	3	5	4	5	17	Very Low
Detva	3	3	3	3	12	Middle
Banska Stiavnica	4	2	3	2	11	High
Ziar nad Hronom	4	3	3	3	13	Middle
Zarnovica	4	3	3	4	14	Low
Zlate Molavce	1	4	3	4	12	Middle
Levice	2	2	2	1	7	Very High
Nove Zamky	3	2	2	1	8	Very High

Rating table

<Connection rate>	<Groundwater quality>	<GW quality change>	<Vulnerability>
100% : 5	Very good : 5	Going well : 5	Very Low : 5
90 – 99% : 4	Good : 4	Slightly going well : 4	Low : 4
80 – 90% : 3	Moderate : 3	Stable : 3	Moderate : 3
70 – 80% : 2	Bad : 2	Slightly going bad : 2	High : 2
less than70% : 1	Very bad : 1	Going bad : 1	Very High : 1

(5) Condition of Old Mining Areas

1) Banska Stiavnica

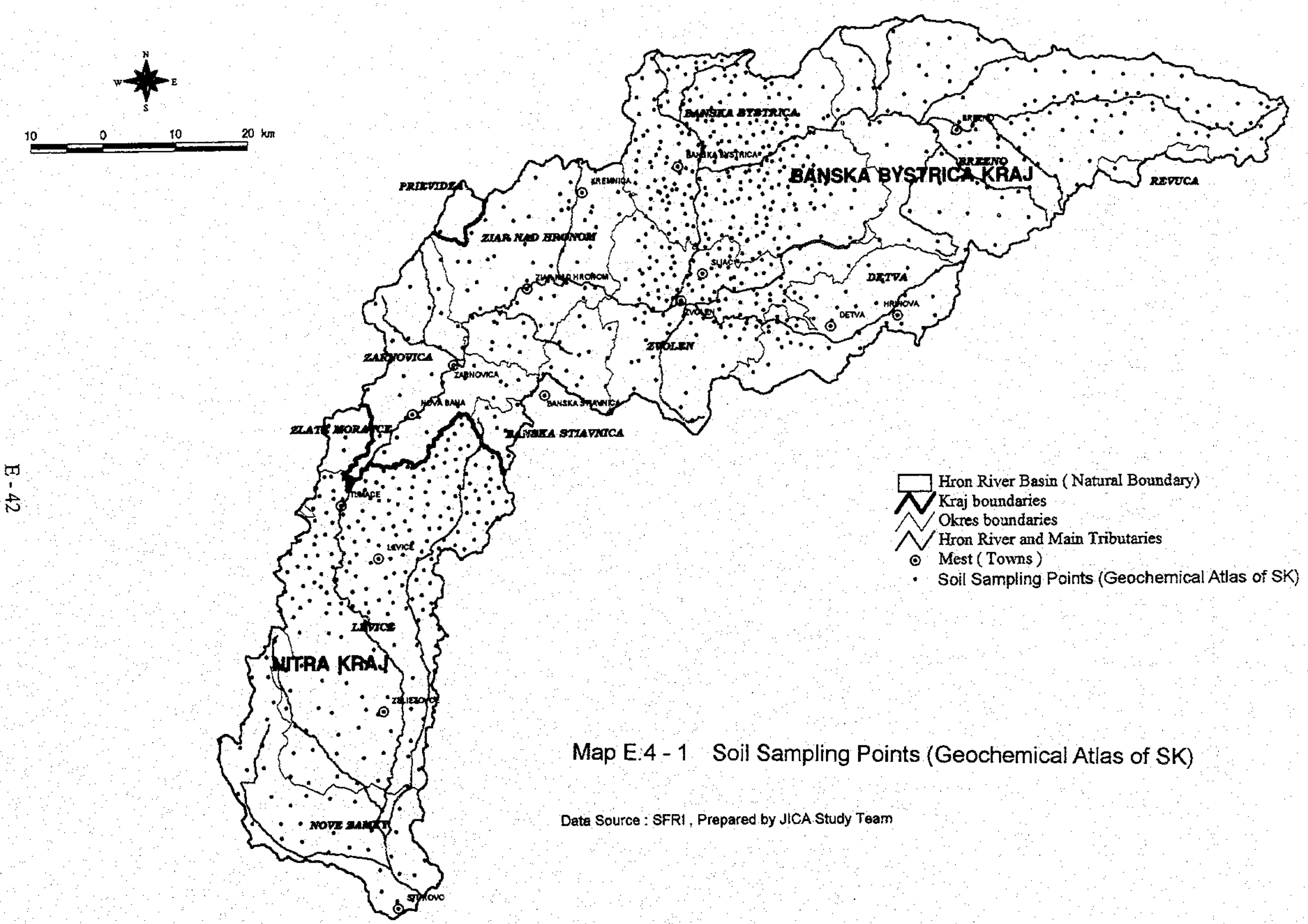
Banska Stiavnica and surroundings are the historical mining area having history of more than 1000 years. The main mineral sources in this area are Au, Ag, Pb, Zn, Sb and Cu. These minerals are produced from ore of sulfide, carbonate and oxide. Most of the mining was stopped in the beginning of 90-ties and only one mining works has been continued in Banska Hodrusa. There is many patchy information about soil and groundwater quality contamination in this area. Highly polluted soils by heavy metals (Pb, Zn, Cd, As and Se) and high acidic soils area found to be distributed in the Alluvial soils in this district (Ref.to 16-6). Very High concentration of Zn, Cd and Pb was found in the river sediments (GSSR data). Very strongly acid water came out from some dumps. However, main groundwater discharge to the Hron river through tunnel from the central mining area is pH-neutral and dose not contain heavy metal. Further, many old dumps can be found in this area (some one is recorded some one can only distinguished from topographic features), but many old dump site has been covered by green and can be distinguished slight plant difference from other site.

2) Vajskova

There was big antimony mine and smelting factory in this area. The mining activity has been stopped already. In this site some study was conducted and some contamination by As znd Sb was found in soil and groundwater.

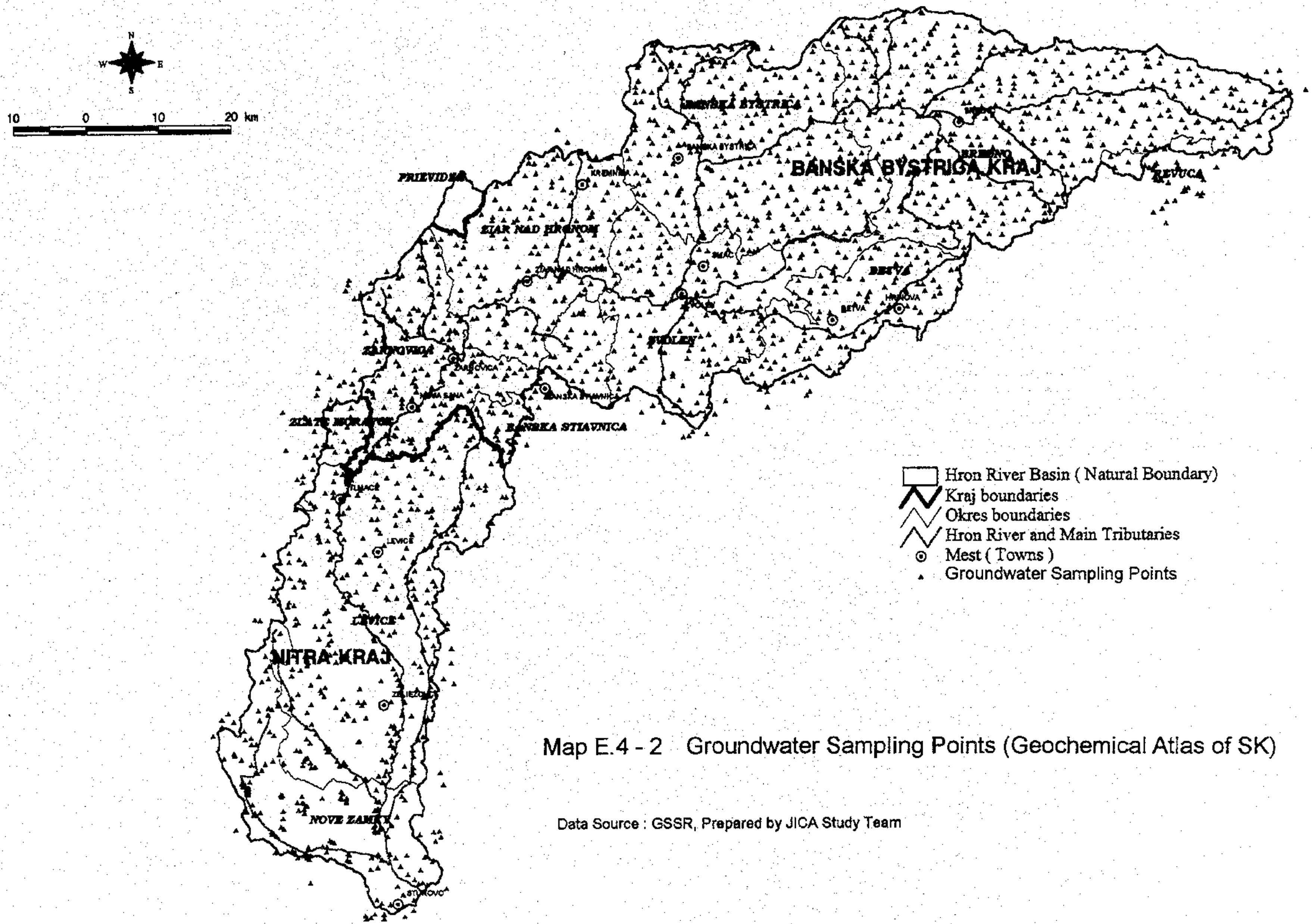
3) Spaia Dolina and Lubietova

Spania Dolina is a historical mine from 15 centuries but activity has been stopped already. The main products of his mine is copper. The dump in this area is very big because more than 500 years material has been accumulated. However, effluent from this dumping site shows relatively high alkaline and electrical conductivity around 10 000μs/cm. In other countries, most of the mine effluent shows very high acid and it is most harmful matter for the surroundings. However, in the study area, only few effluent shows high acidic. There may be only little sulfide in the ore in the study area, it may be the reason of the acidity of effluent from mining dump. Lubietova is also the old historical mine from 15 centuries and it was the one of typical mining site in the western Carpatians. However, also this mining was closed now. The main products of the mine is copper too. It is said that around 2 % of copper has been remain in the mining dump. On the surface of the stone near the dump, some green copper mineral can be found. The concentration of its copper was not clear but it may cause some pollution for the surface water and groundwater.



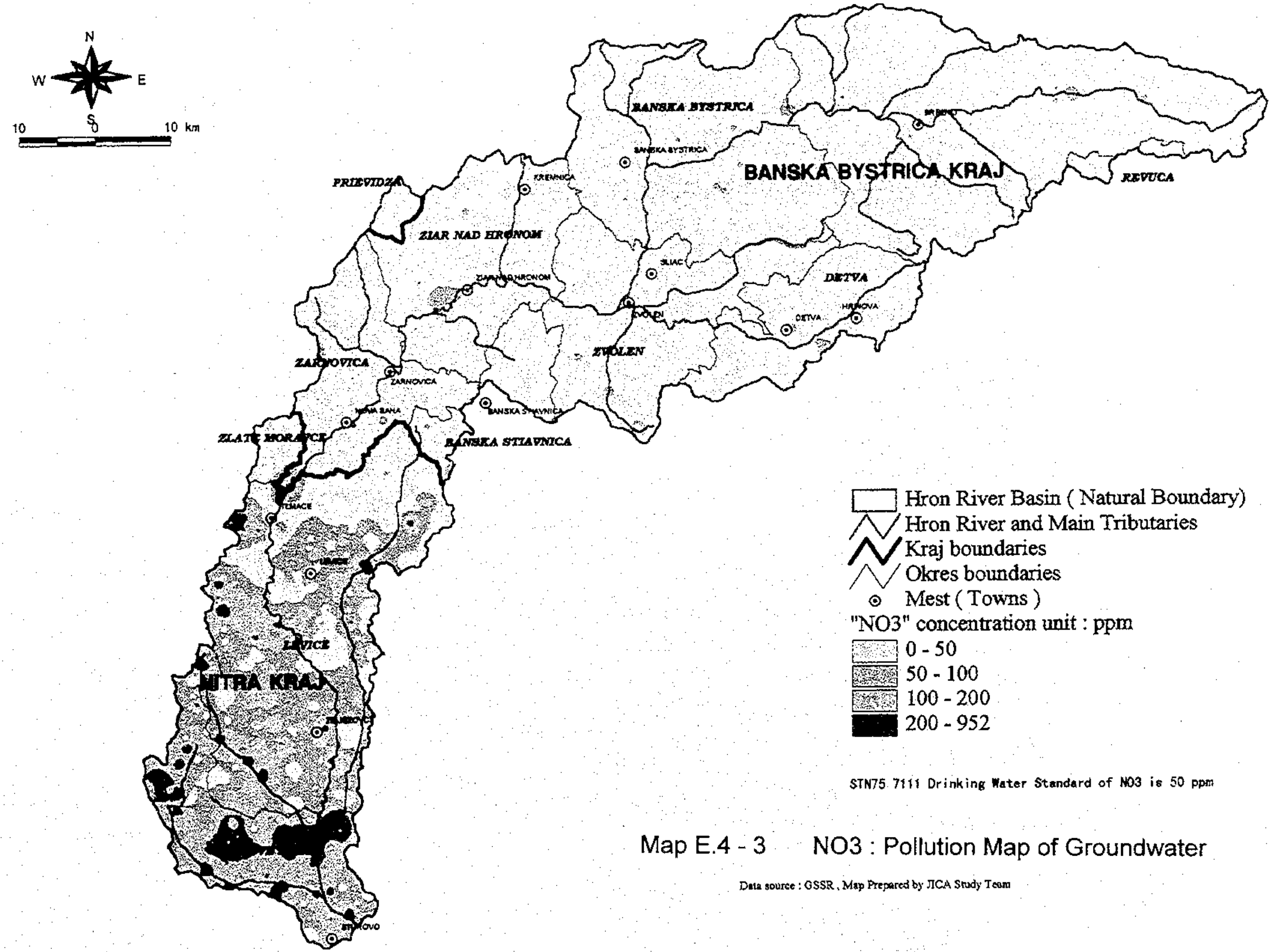
Map E.4 - 1　Soil Sampling Points (Geochemical Atlas of SK)

Data Source : SFRI , Prepared by JICA Study Team



Map E.4 - 2 Groundwater Sampling Points (Geochemical Atlas of SK)

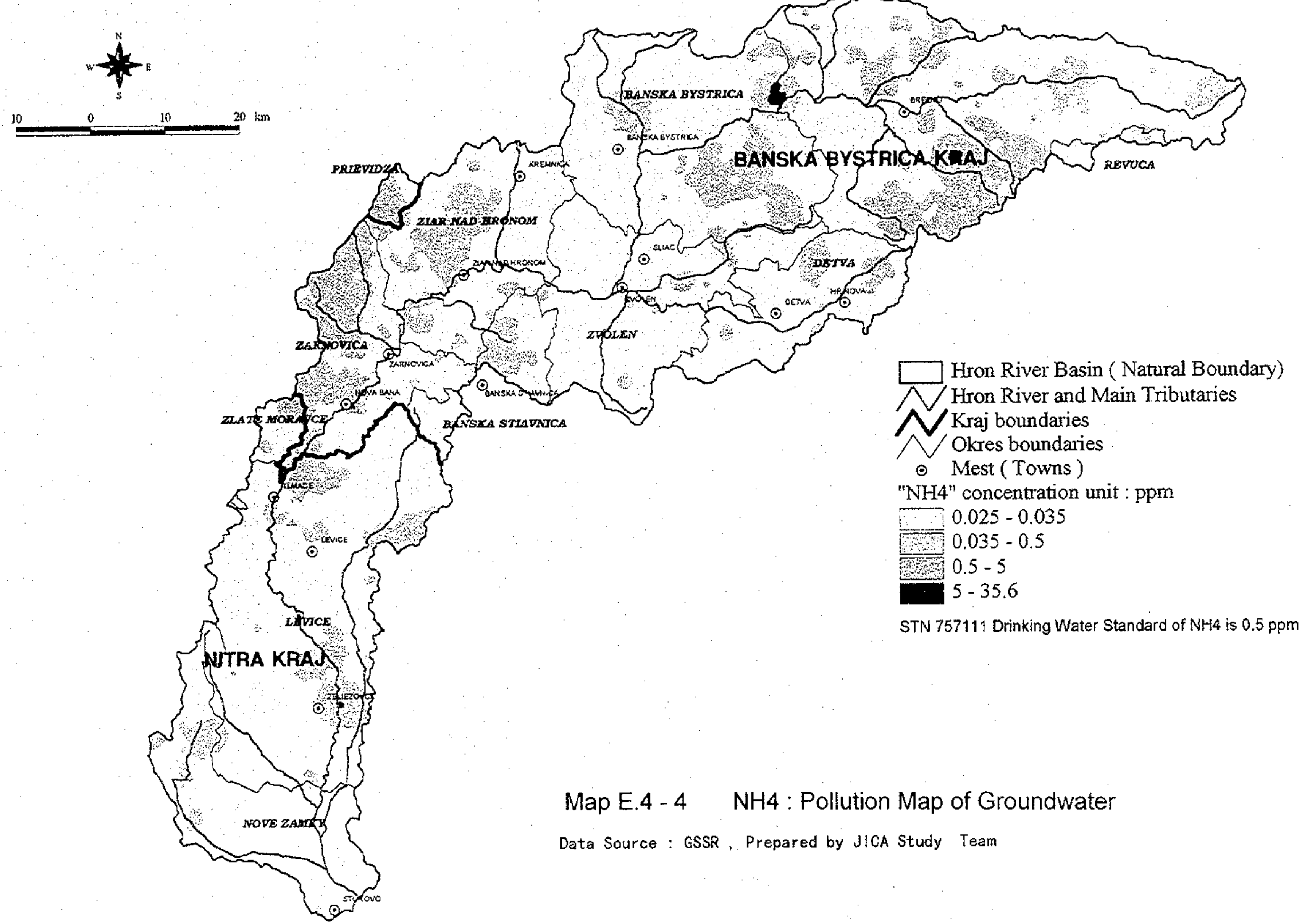
Data Source : GSSR, Prepared by JICA Study Team



STN75 7111 Drinking Water Standard of NO3 is 50 ppm

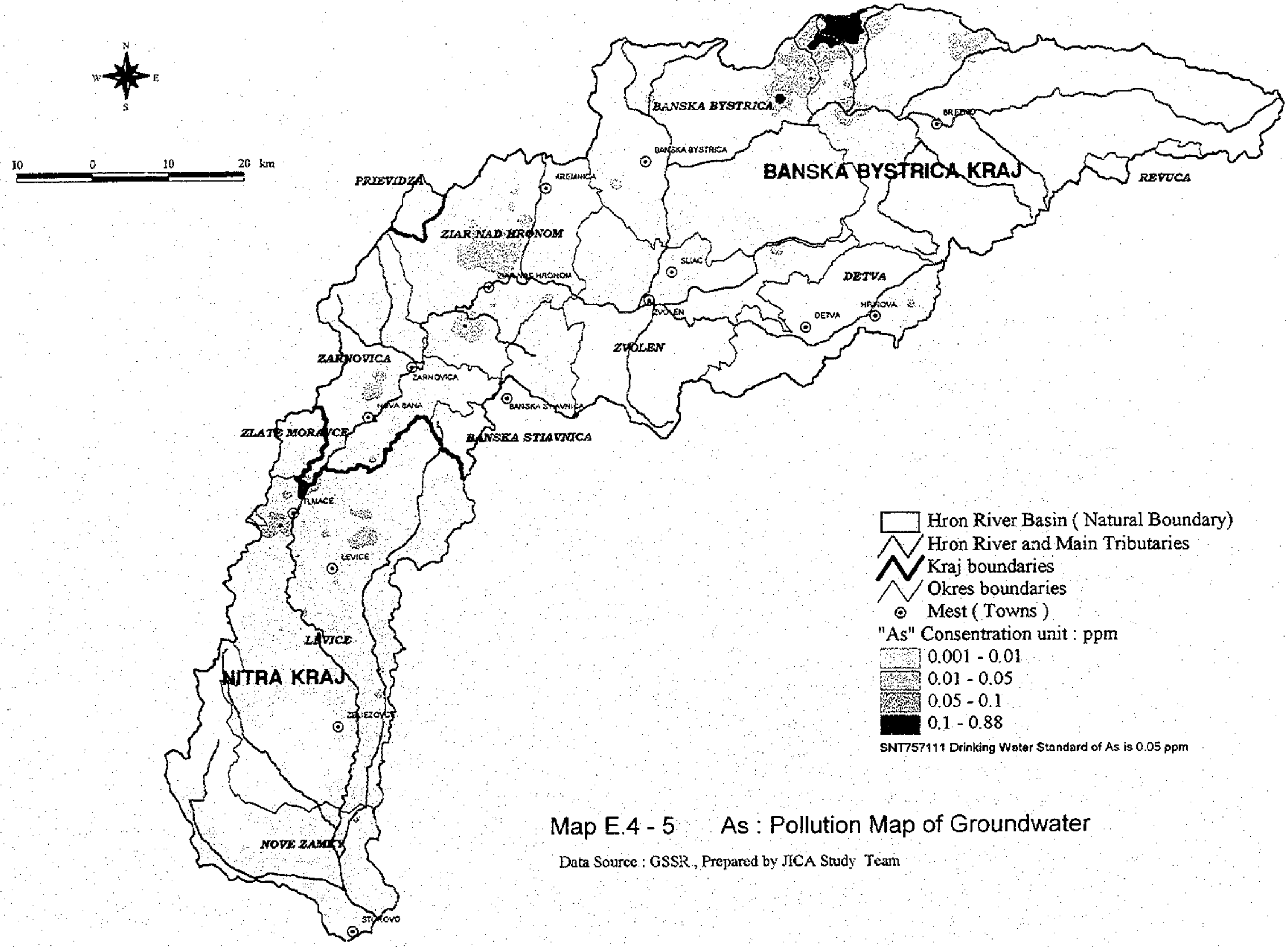
Map E.4 - 3 NO3 : Pollution Map of Groundwater

Data source : GSSR , Map Prepared by JICA Study Team



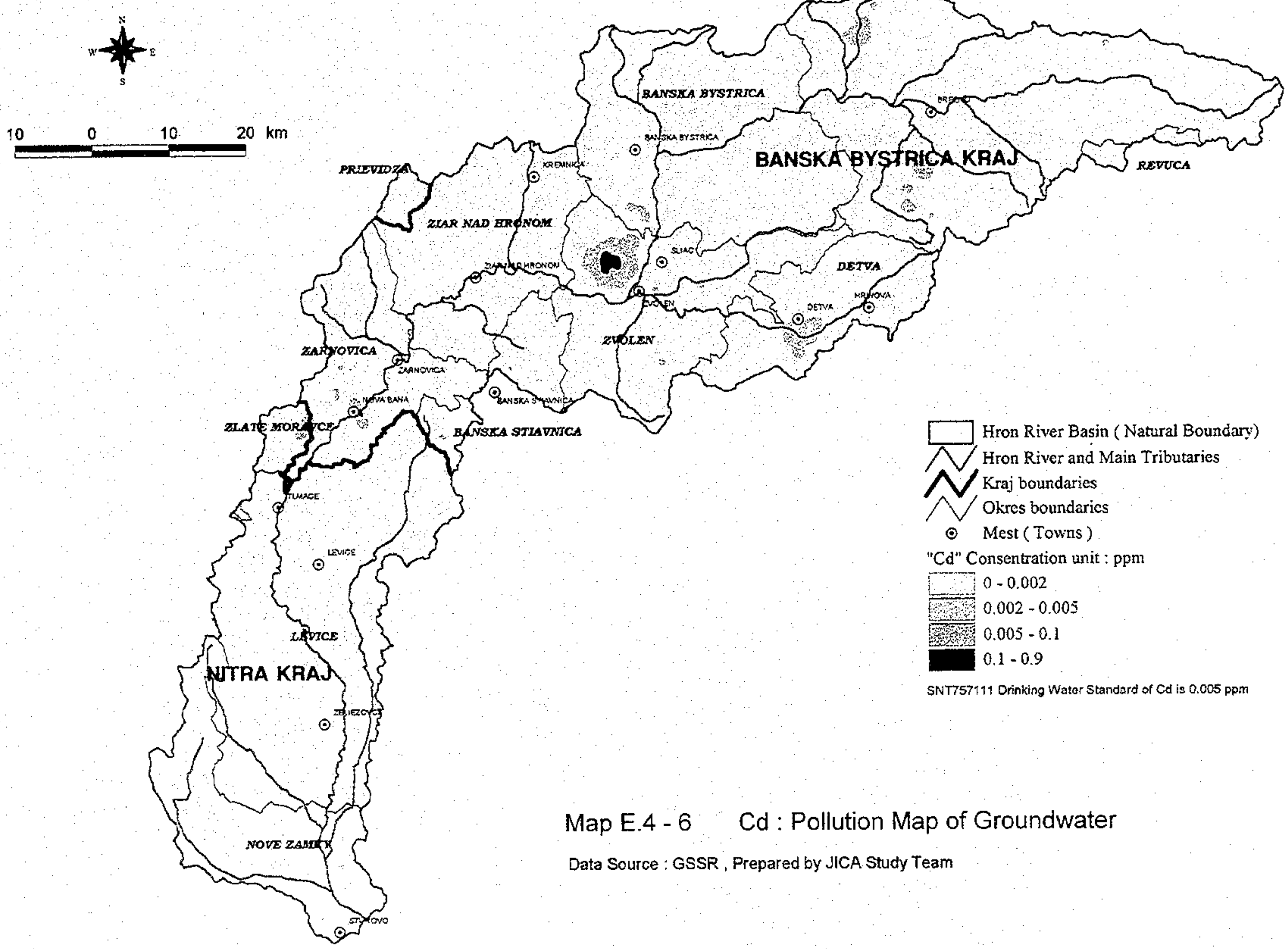
Map E.4 - 4 NH4 : Pollution Map of Groundwater

Data Source : GSSR , Prepared by JICA Study Team



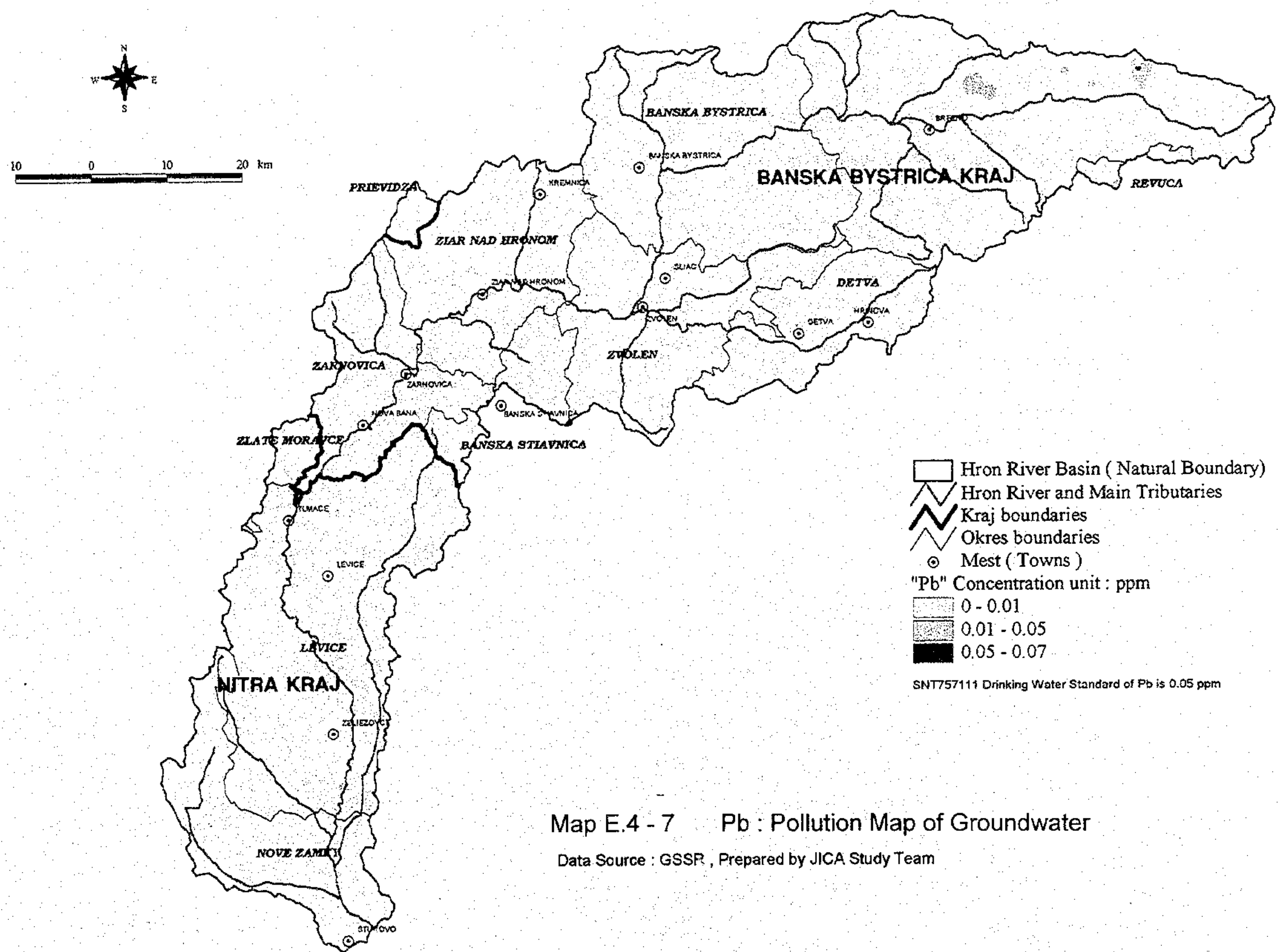
Map E.4 - 5   As : Pollution Map of Groundwater

Data Source : GSSR , Prepared by JICA Study Team



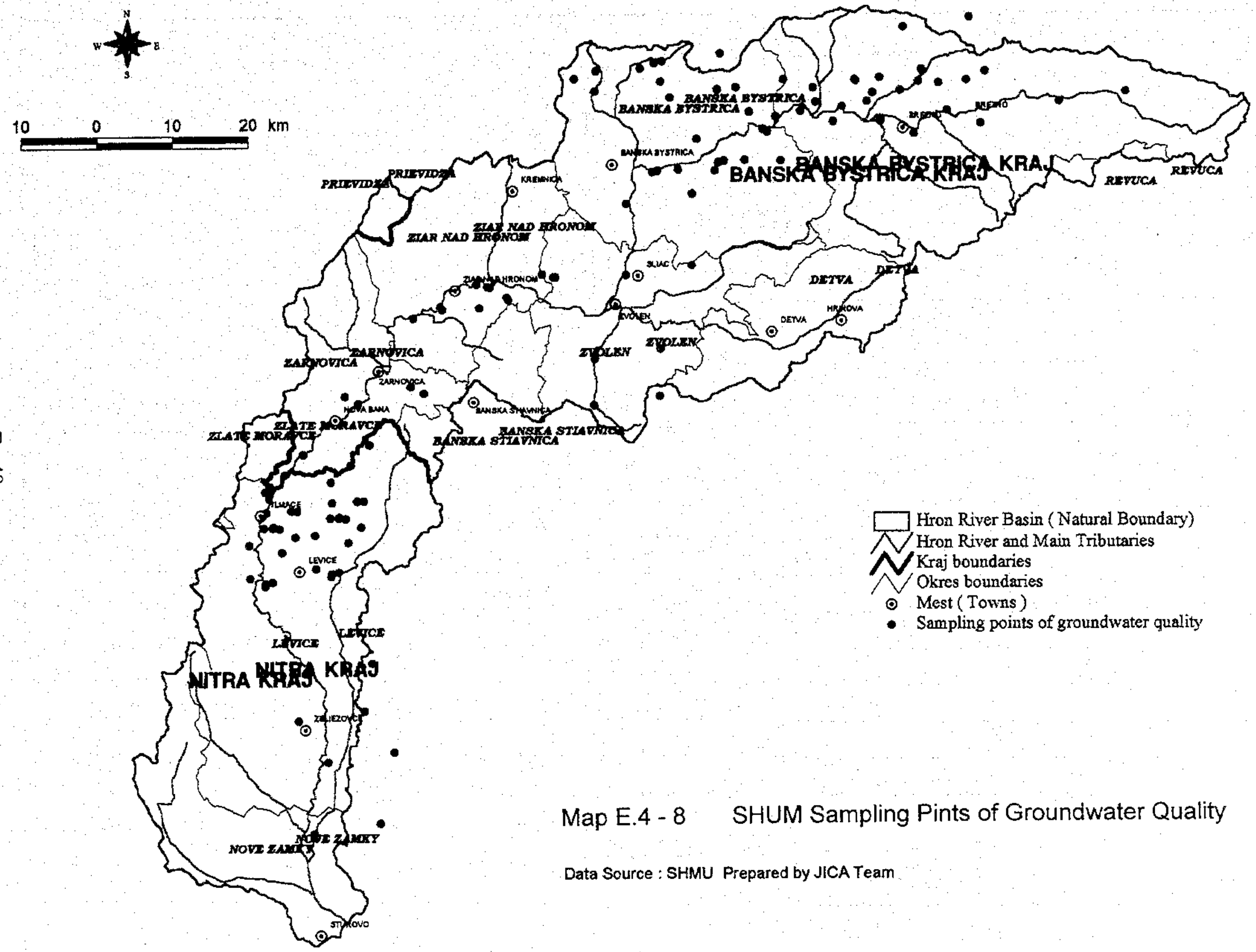
Map E.4 - 6 Cd : Pollution Map of Groundwater

Data Source : GSSR , Prepared by JICA Study Team



Map E.4 - 7 Pb : Pollution Map of Groundwater

Data Source : GSSR , Prepared by JICA Study Team



Map E.4 - 8 SHUM Sampling Pints of Groundwater Quality

Data Source : SHMU Prepared by JICA Team

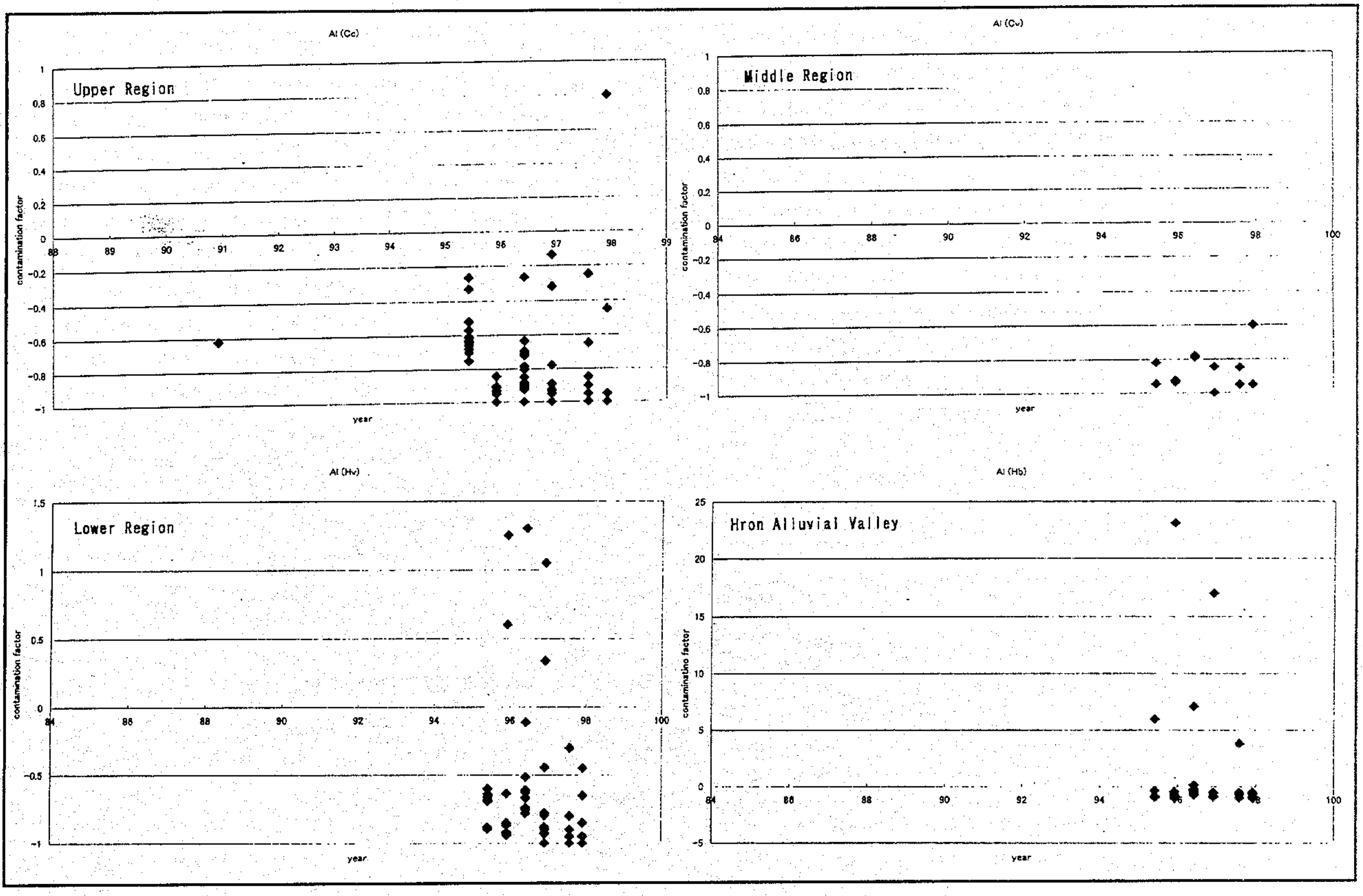


Figure E.4 - 1 Groundwater Quality Change by Time (Al)

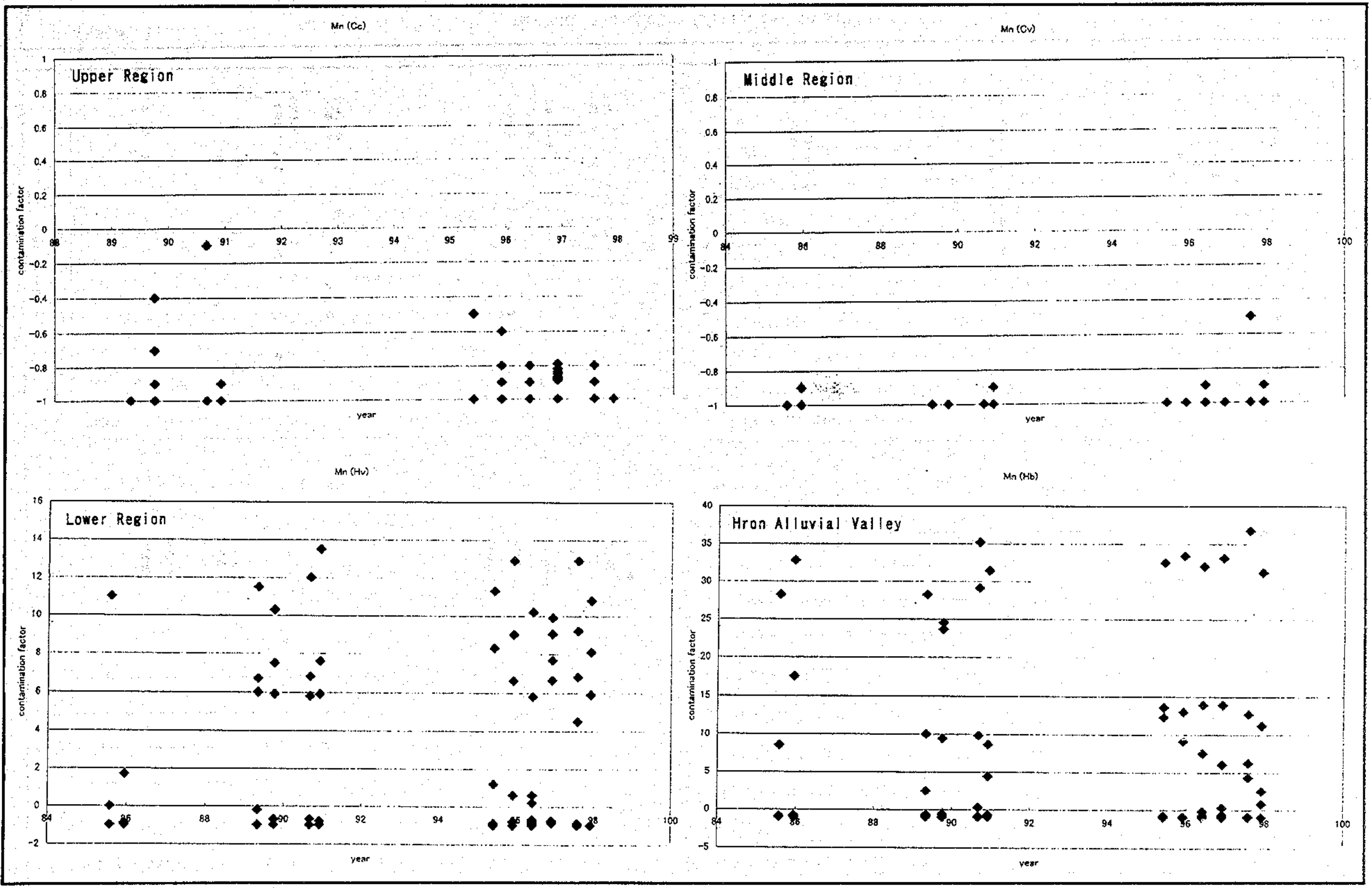


Figure E.4 - 2 Groundwater Quality Change by Time (Mn)

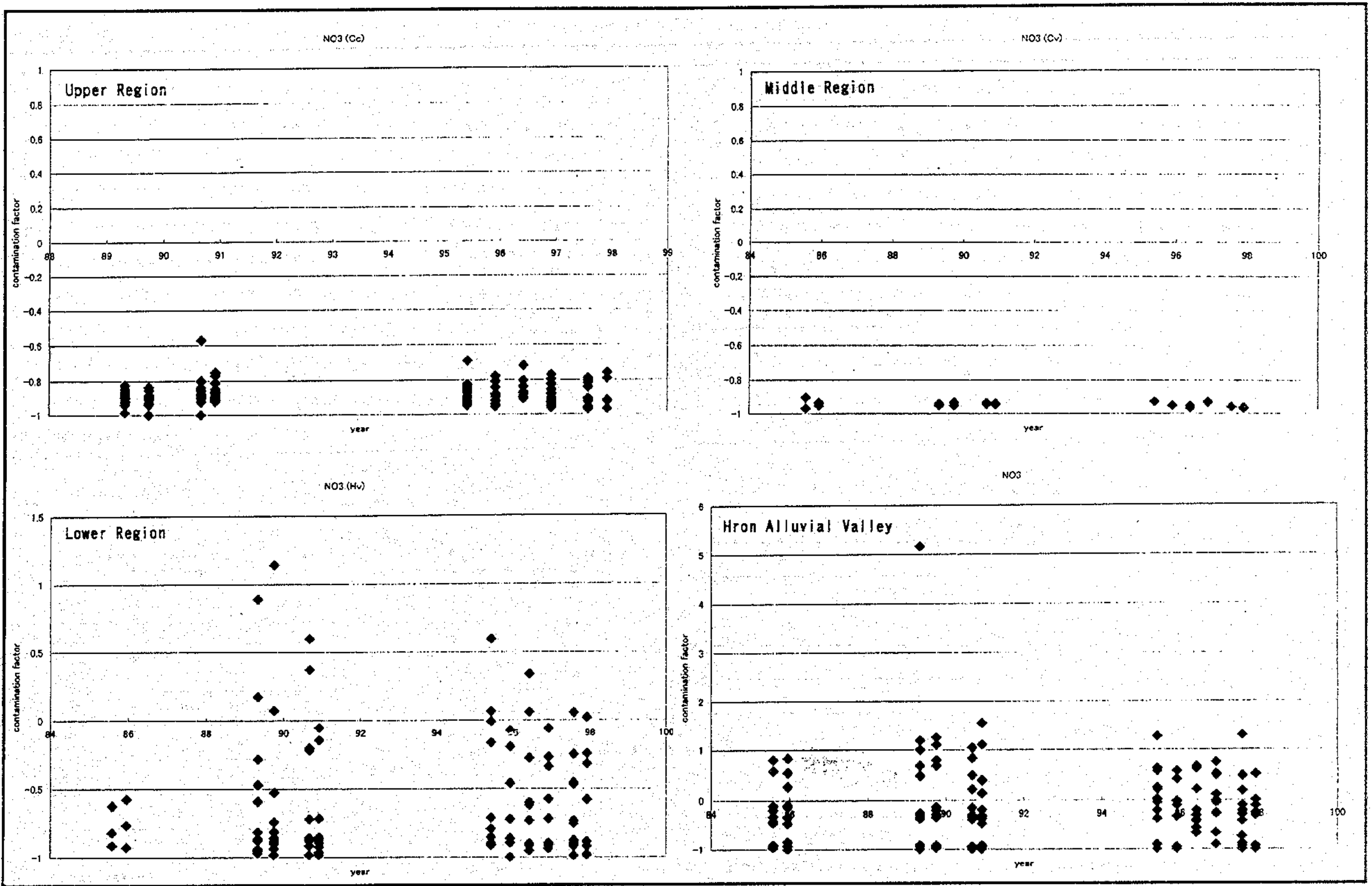


Figure E.4 - 3 Groundwater Quality Change by Time (NO3)

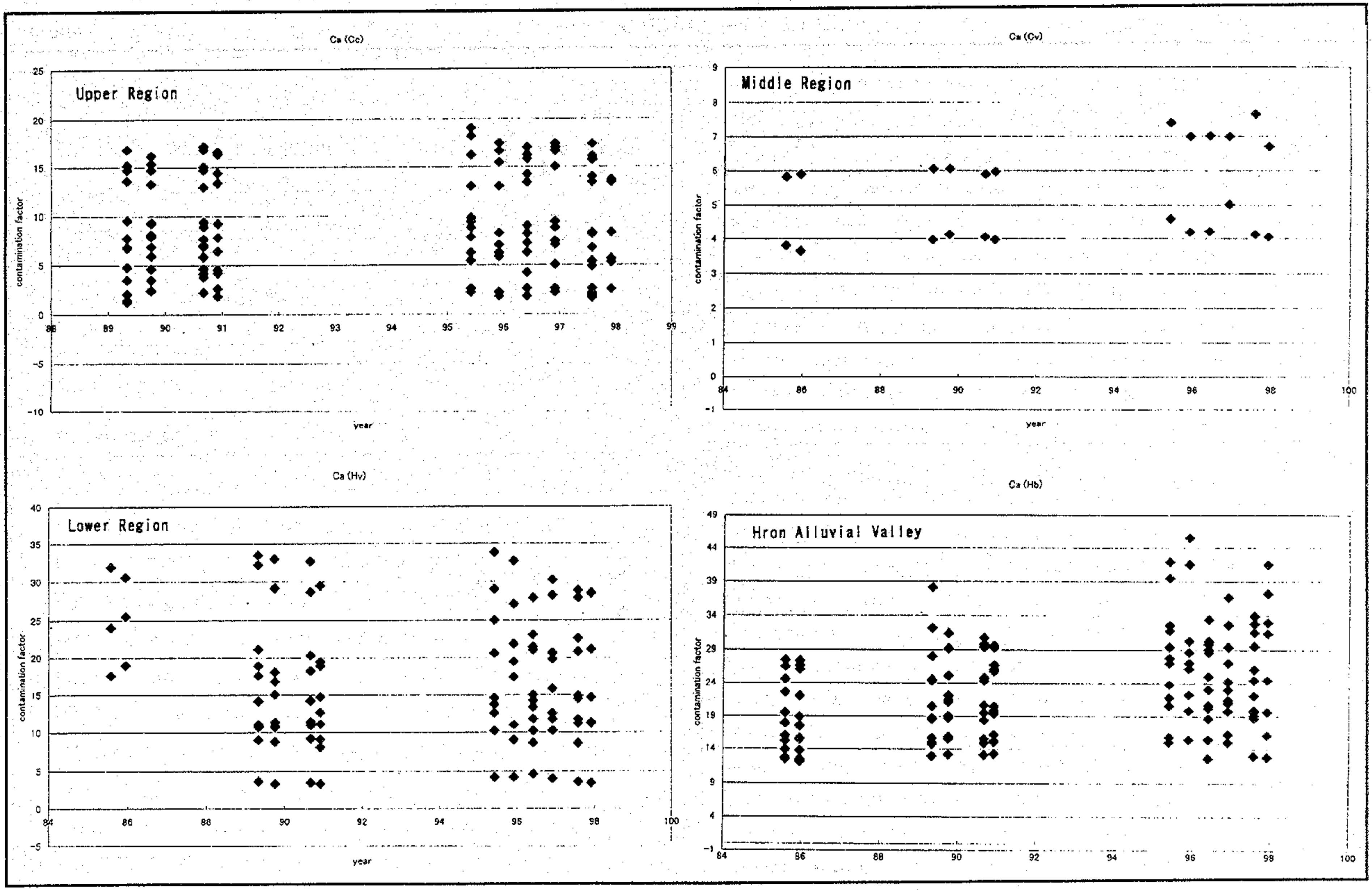


Figure E.4 - 4 Groundwater Quality Change by Time (Ca)

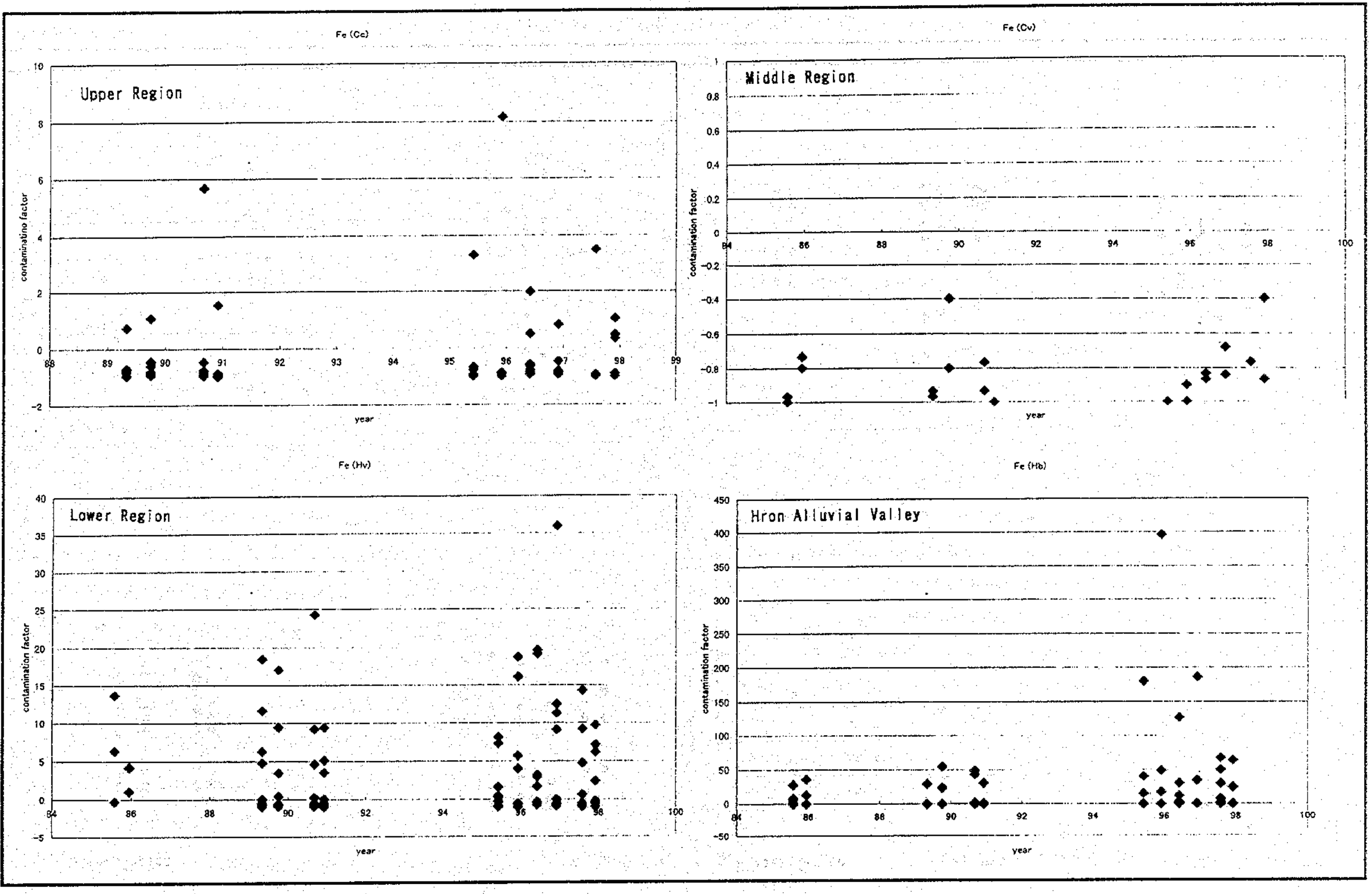


Figure E.4 - 5 Groundwater Quality Change by Time (Fe)

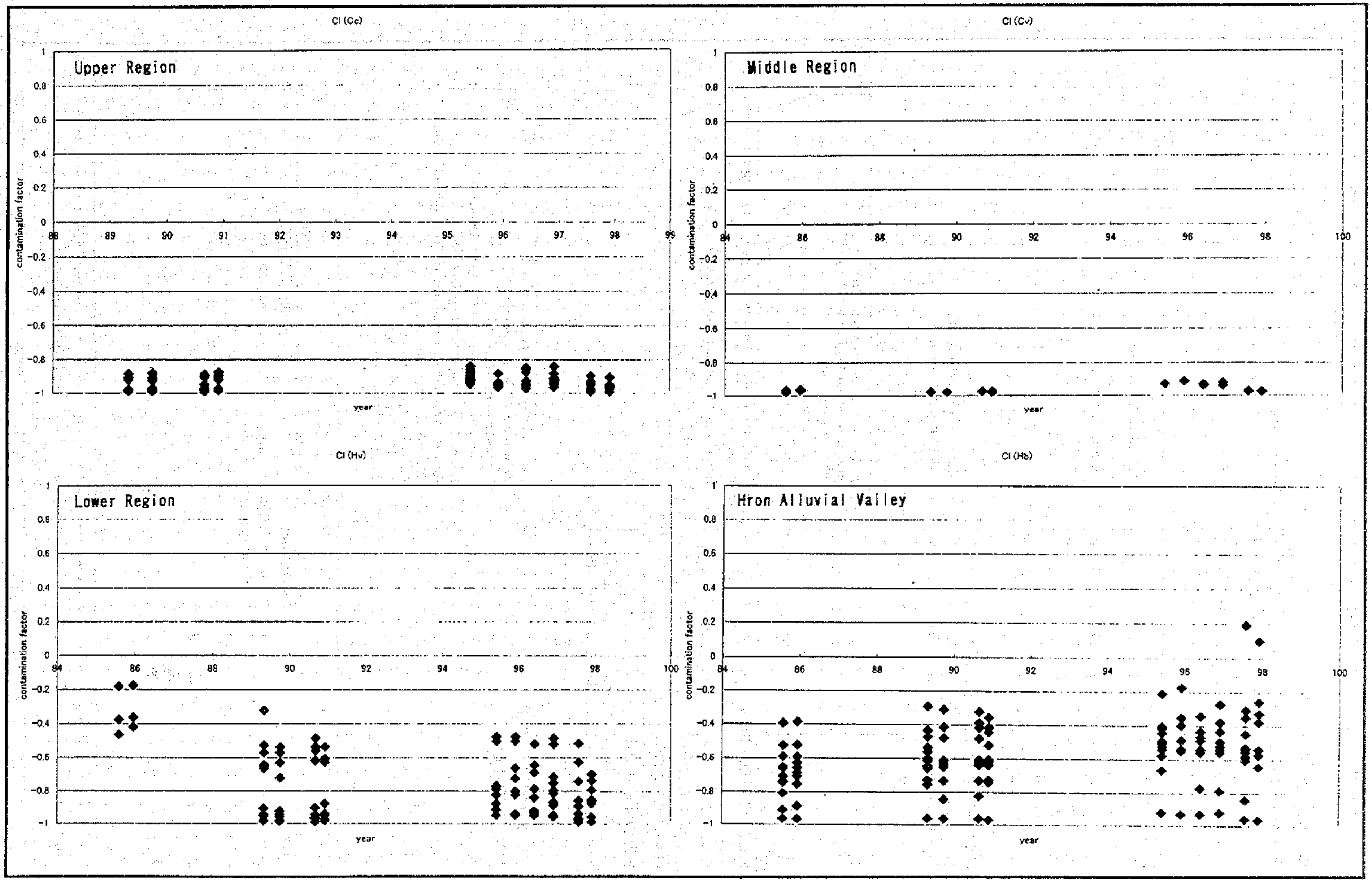


Figure E.4 - 6 Groundwater Quality Change by Time (Cl)

INDICATOR / EVALUATION MAP

GW Contamination Map

- Evaluation Map (all elements exceed standard)
- Pollution Index Map (elements related pollution source)

<Data source>

- Geochemical Atlas Data

Pollution Source Map

- Mining
- Ore deposit
- Factory (selected by groundwater related source)
- Agriculture
- Land fill
- Etc. (Gas station, etc)

Data source:

- Digital geological map
- Mineralogical map
- Data from Mr. Lyba
- Land use map
- Statistic data

GROUNDWATER UTILIZATION MAP

- Location of the well and spring
- Connection rate of PWS (each obec)

Data source:

- State Health Institute data
- Land fill suitability map

Additional input:

- Quality of spring and borehole (SHMU)
- Drinking water quality for each obec(SZU)
- Published study paper

POLLUTION MECHANISM

- Character of each pollution source (ore deposit ,mine, factory)
- Soil character (absorption, pH, etc)

THEMATIC MAP MAKING

ENDANGERED MAP

- Shall be prepared based on the GW quality evaluation map considering GW utilization, pollution source etc.

VULNERABILITY MAP
(DRASTICMMETHOD)

- Permeability of the ground (DGM)
- Continuity of the ground (DGM)
- Groundwater level (BDB)
- Absorption character of the ground (DGM)
- Inclination of the ground surface (DTD)
- Average groundwater recharge (DTD and rainfall data)
- Surface soil character (DSM)
  - DGM : digital geological map
  - DTD : digitalized topography
  - DSM : digital soil map
  - BDB : borehole data base

PRIORITAZATION

1 Utilized, endangered, vulnerable
2 Utilized, endangered, not-vulnerable
3 Utilized, not-endangered, vulnerable
4 ....

MONITORING

1 Additional monitoring point
2 Additional monitoring item

RECOMMENDATION

1 Area protection
 1) Utilized, vulnerable
 2) Not-utilized, vulnerable
2 Pollution control

Figure E.4 - 7 Flow Chart for Groundwater Analysis Methodorogy

E.5 ENVIRONMENTAL WATER QUALITY STANDARDS

Table E.5 - 1 Comparison of Surface Water Quality Standards Between Slovakia and Japan (No.1)

			AA	A	B	C	D	E
Japan	Category		AA	A	B	C	D	E
	Suitable use		Domestic water supply through primary treatment.	Domestic water supply through normal teratment (sedimentation and filtration). 1st class for water quality of fishieries.	Domestic water supply through advanced treatment (with preliminary treatment). 2nd class for water quality of fisheries.	3rd class for water quality of fisheries. 1st class for industrial water supply through normal treatmen (sedimentation).	2nd class for industrial water supply through advanced treatment (with preliminary treatment). Agricultural water.	3rd class for industrial water supply through special treatment.
	Biological water quality grade by indicator organism		clean			polluted	highly polluted	
			oligo-saprobic water			β- meso-saprobic water	α- meso-saprobic water	
Slovakia	Category		I	II		III	IV	
	State of water quality		very clean	clean		polluted	highly polluted	very highly polluted
	Suitable use		Domestic water supply, industries requiring high quality water, swimming pools, salmon fish farming. High landscape value	Domestic water supply, water sports, fish farming, industrial supply. Landscape value		Usually suitable only for industrial supply. Domestic supplies require full treatment. Low landscape value.polluted	Limited use	Not usually suitable for any purpose.
PH	Japan	limit values	≦8.5; ≧6.5				≦8.5; ≧6.0	
	Slovakia	limit values	< 8.5; > 6.0				< 9.0	< 5.5; > 9.0
		category	I	II		III	IV	
BOD	Japan	limit values	≦1.0	≦2.0	≦3.0	≦5.0	≦8.0	≦10.0
	Slovakia	limit values	< 2			< 5		< 10 / < 15 / > 15
		category	I			II		III / IV /
SS	Japan	limit values	≦25			≦50	≦100	-
	Slovakia	limit values	< 20		< 40	< 60	< 100	> 100
		category	I		II	III	IV	
DO	Japan	limit values	≧7.5		≧5		≧2	
	Slovakia	limit values	> 7		> 6	> 5	> 3	< 3
		category	I		II	III	IV	
Coliform Bacteria	Japan	limit values	≦50	≦1000	≦5000	-	-	-
	Slovakia	limit values	< 100	< 1000	< 10000		< 100000	> 100000
		category	I	II	III		IV	

Sources: Slovakia: STN 75 7221 Classification of Water Quality
Japan: Environmental quality standard for water pollution in Japan

Table [illegible] Comparison of Surface Water Quality Standards Between Slovakia and Japan (No. [illegible])

			AA	A	B	C	D	E
Japan	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]		clear			polluted	[illegible]	
	[illegible]		[illegible]			[illegible]	[illegible]	
Slovakia	category		I	II		III	IV	V
	[illegible]		very clean	clear		polluted	highly polluted	very heavily polluted
	[illegible] use		Domestic water supply, industries requiring high quality water, swimming pools, salmon fish farming. High landscape value	Domestic water supply, water sports, fish farming, industrial supply. Landscape value		Usually suitable only for industrial supply. Domestic supplies require full treatment. Low landscape value polluted	Limited use	Not usually suitable for any purpose
pH	Japan	limit values	6.5 – 8.5				[illegible]	
	Slovakia	limit values	6.5 – 8.0				[illegible]	[illegible]
		category	I	II		III	IV	V
BOD	Japan	limit values	1	2	3	5	8	10
	Slovakia	limit values	[illegible]			5		10 / 15 / >15
		category	I			II		III / IV / V
SS	Japan	limit values	25			50	100	-
	Slovakia	limit values	20		30	50	100	[illegible]
		category	I		II	III	IV	V
DO	Japan	limit values	7.5		5			[illegible]
	Slovakia	limit values	[illegible]		6	5	3	[illegible]
		category	I		II	III	IV	V
Coliform Bacteria	Japan	limit values	50	1,000	5,000	-	-	-
	Slovakia	limit values	100	1,000	[illegible]		[illegible]	[illegible]
		category	I	II	III		IV	V

Sources. Slovakia. STN 75 7221 Classification of Water Quality
Japan. Environmental quality standard for water pollution in Japan

Table E.5 - 2 Comparison of Surface Water Quality Standards Between Slovakia and Japan (No.2)

Permissible water quality in surface water based on the Slovak Government Order No. 232/1994					**Environmental quality standard for water pollution in Japan**
			Valid values		
Indicator	Symbol	Unit	in water courses	in other surface waters	Valid values for public water
Nitrite nitrogen	N-NO2-	mg/l	0.005	0.02	10
Nitrate nitrogen	N-NO3-	mg/l	3.4	7	
Fluorides	F-	mg/l	0.5	1	0.8
Cyanides total	CN-	mg/l	*	0.2	*
Mercury	Hg	μg/l	0.1	0.5	0.5
Cadmium	Cd	μg/l	5	10	0.01
Lead	Pb	μg/l	20	50	10
Arsenic	As	μg/l	20	50	10
Chromium (VI)	CrIV	μg/l	10	20	50
Selenium	Se	μg/l	10	50	10
Benzene	BZ	mg/l	0.01	0.05	0.01

Notes :

* Below the limit of sensitivity of specification

E.6 WATER QUALITY NUMERICAL MODEL

1. OUTLINE OF THE MODEL

A water quality simulation model for BOD have been established based on the following equation which is a modification of the Phelps equation.

$$Ll = \left(L_u - \frac{L_a}{K_r} \right) \exp(-K_r t) + \frac{L_a}{K_r}$$

Where,

L: Ultimate BOD (mg/l)
Subscripts :
u: Value at an upstream point
l: Value at a downstream point
K_r: BOD diminution rate of river water (/day)
($=K_1+K_3$)
K_1: Diminution rate associating the consumption of dissolved oxygen (/day)
K_3: Diminution rate including sedimentation without consumption of dissolved oxygen (/day)
L_a: BOD supplied from the river bed (mg/l/day)

It is difficult to apply the above equation directly for water quality simulation of a river having many inflows from tributaries and drains that frequently increase the river flowrate. Since the above equation can be only applied to a reach with a constant flowrate, many reaches have to be defined in accordance with such inflows.

To simplify and to establish a concrete simulation model, it is assumed that there are many water flows in a reach. These water flows consist of a basic flow from an upper reach, inflows from tributaries and drains, and inflow/outflow of subsurface water, that have constant flowrates. BOD concentration (L) cab be interpreted as the pollution load on the basis of such assumptions. Pollution load of the base flow decreases as it flows down to a lower end of the reach. This change can be simulated by the above equation. Flowrates and pollution loads of water flows are summed up separately for the reach. Finally, the summed pollution load is divided by the summed flowrate to obtain a water quality value at the lower end of the reach.

The concept of the above-mentioned method for the BOD simulation model is described below.

River flowrate Q_n in a reach "n" is described by the following equation.

$$Q_n = Q_0 + \sum_{i=1}^{n} (Q_i + Q_{0i} - Q_{1i})$$

$$Q_i = \sum_{j=1}^{m} Q_{ij}$$

Where,

Q_n : River flowrate in a reach "n"
Q_0: River flowrate at the upper end of whole reaches
Q_i: Total flowrate of inflow tributaries in reach "i"
Qij : Flowrate of inflow tributary "j"
m : Number of tributaries in reach "i"
Q_{0i} : Flowrate of inflow subsurface tributary "j"
Q_{1i} : Intake volume in reach "i"

Pollution load run-off L_n in reach "n" is described by the following equation.

$$L_n = L_{n-1} \exp(-K_m t_n) + \sum_{j=1}^{m} L_{nj} \exp(-K_m t_{nj}) + L_{0n} - L_{1n} \qquad (1)$$

Where,

L_n : Pollution load run-off (ultimate BOD) in reach "n"
L_{n-1} : Pollution load of run-off (ultimate BOD) in reach "n-1)
L_{nj} : Pollution load of inflow tributary "j"
t_n : Flow time in reach "n"
t_{nj} : Flow time from the inflow point "j" to the lower end of reach "n"

$$t_{nj} = d_{nj} / v_n$$

Where,
d_{nj} : Flow length between inflow point "j" and the lower end of reach "n"
v_n : Average flow velocity in reach "n"

K_{rn} : BOD diminution rate of river water in reach "n"

$$K_r = K_1 + K_3$$

Where,
K_1 : Deoxygenation coefficient
K_3 : Diminution rate including sedimentation without consumption of dissolved oxygen

L_{0n} : Pollution load of inflow subsurface water in reach "n"
L_{1n} : Pollution load of intake volume in reach "n"

Then, river water quality in reach "n" is estimated by the following equation.

$$C_n = L_n / Q_n$$

Where,

C_n: Concentration of BOD (uultimate BOD) in reach "n"

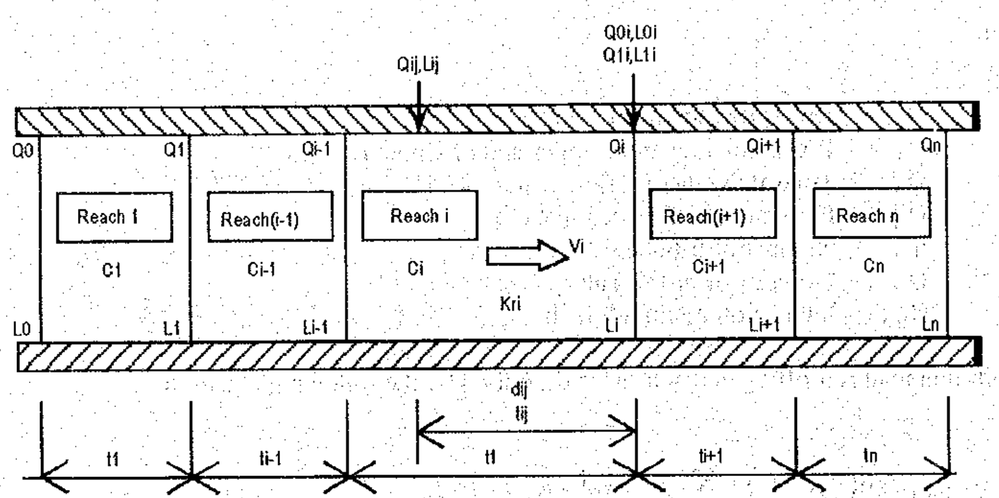


Figure E.6 - 1 Concept of Modelling

Based on the above concept, the study team simulated the annual average BOD concentration of the Hron River in 1996.

2. MODEL DEVELOPMENT

(1) Catchment Description

The entire basin of the Hron Rive was divided into 13 sub-basins as shown in Figure E.6 - 2 and Table E.6 - 1 in order to evaluate BOD concentration of the main stream which flows through 8 basins of A, B, C, E, G, I, J, and K. The lower ends of each segments are the points of water quality and flowrate measurement conducted by SHMU. These points are also the representative points to evaluate the water quality in these segments.

In this model, the final reach of Hron River Basin is assumed to be "K". Sub-Basins "L" and "M" were ignored, because available flowrate and water quality data at the estuary do not exist for the year 1996.

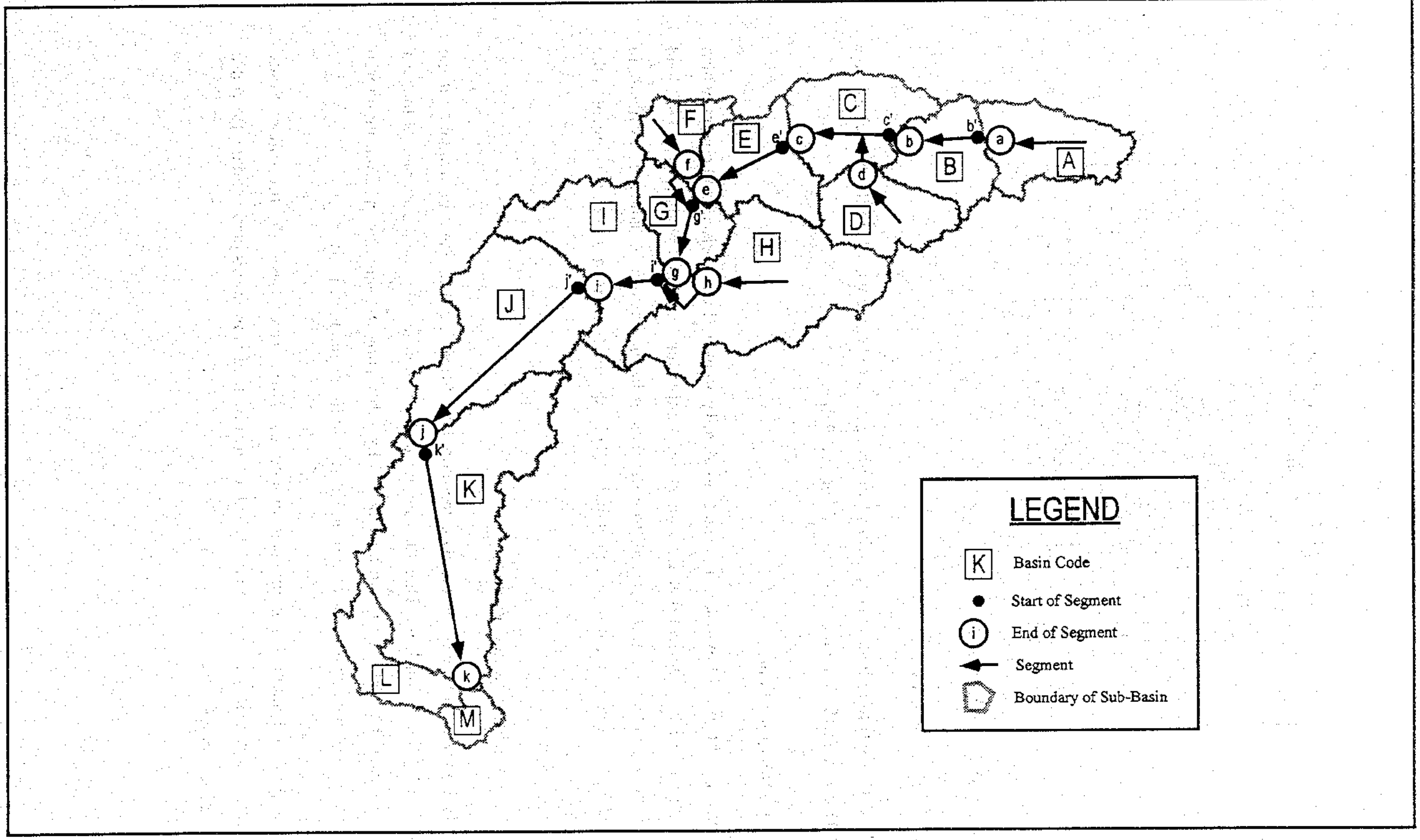


Figure E.6 - 2 Sub-catchments and Segments

Table E.6 - 1 List of sub-basins

Basin	Segment	Representative Point (code of monitoring station)	Remarks
A	source - a	a (6995, R014000D)	
B	b'-b	b (7015, R025010D)	
C	c'-c	c (7081, D048000D)	
D	source - d	d (7045, R036500D)	flow into C
E	e'-e	e (7160, D09510D)	
F	source - f	f (7155, R095020D)	flow into G
G	g'-g	g (n/a, R112000D)	
H	source - h	h (7230, R153500D)	flow into I
I	i'-I	I (7260, R185000D)	
J	j'-j	j (7296, R234000D)	
K	k'-k	k (7335, R340000D)	

(2) Data Background

1) Point Sources

GIS data determines locations of effluent discharging into segments, where the annual average BOD values in 1996 monitored by SUMU are available.

2) Non-point Sources

Corline Land Cover Map makes it possible to identify areas of 4 categorised land covers, which are artificial surface, agricultural area, forest and semi-natural area and wetland. The Unit load for each of 4 categories was referred from the data in Japan because no data were available in Slovakia. It is assumed that these calculated BOD loads are discharged into each segment at the middle.

3) River Flowrate and Velocity

Yearly flowrates are based on the data monitored by SHMU, but no data are available at the points of "g" and "h" in 1996. Then the fowrate at "h" was assumed ro be the average of the past 10 years data. The data at "g" can be acquired by subtracting the value of "h" from monitored value at "7240" located downstream from "h" (i.e. in the segment of i' - i).

The Report of Danube Environmental Programme Hron River Basin Pre-Investment Study presents a flow-velocity curve. Velocity values are obtained is from this curve and the flowrates as identified above.

4) BOD Diminution Rate (K_r)

The BOD reduction in the river water is described as a function of BOD diminution rate (K_r) and flow time (t). The values of K_r can be estimated by substituting the measured values of BOD and flowrate into Equation (1).

(3) Model Calibration

The values for K_r were determined through the calibration of the model as 0.1 through 0.6 (/day). The value was assumed to be appropriate if the simulated BOD value was within the range of monthly monitored BOD concentration values at each point in 1996.

3. RESULT OF THE MODEL

(1) Simulated BOD Concentration

Table E.6 - 2 and Figure E.6 - 3 summarise the result of the simulation after the calibration. The detailed description of each segment is given in Table E.6 - 3 through E.6 - 9.

Table E.6 - 2 Summary of Simulated BOD Concentration

Basin	Segment Data			Observed Data		Flow Velocity	Kr	BOD Load in Segment					Simulated BOD Concentration	Estimated Un-monitored Load
	From	To	Distance	Ave. BOD	Flow Rate			Inflow from Previous Basin	Non-point Source	Point Source	Inflow from Other Basin	Total		
	(km)	(km)	(m)	(mg/l)	(m3/s)	(m/s)	(1/day)	(kg/day)	(kg/day)	(kg/day)	(kg/day)	(kg/day)	(mg/l)	(kg/day)
B	243.4	223.3	20 100	2.4	8.3	0.8	0.20	921	236	4	0	1 161	1.6	560
C	223.3	200.8	22 500	3.0	14.7	1.0	0.20	1 527	754	386	769	3 436	2.7	375
E	200.8	175.2	25 600	6.0	28.6	1.2	0.10	3 401	685	697	0	4 783	2.0	9 811
G	175.2	154.1	21 100	7.6	30.6	1.3	0.10	14 199	539	2 991	945	18 673	7.1	1 421
I	154.1	131.5	22 600	4.4	43.7	0.9	0.59	13 539	932	582	1 484	16 537	4.4	76
J	131.5	74.2	57 300	4.3	50.0	0.9	0.10	14 020	1 421	241	0	15 683	3.6	2 894
K	74.2	10.9	63 300	3.9	53.0	0.9	0.10	12 894	2 477	946	0	16 316	3.6	1 542

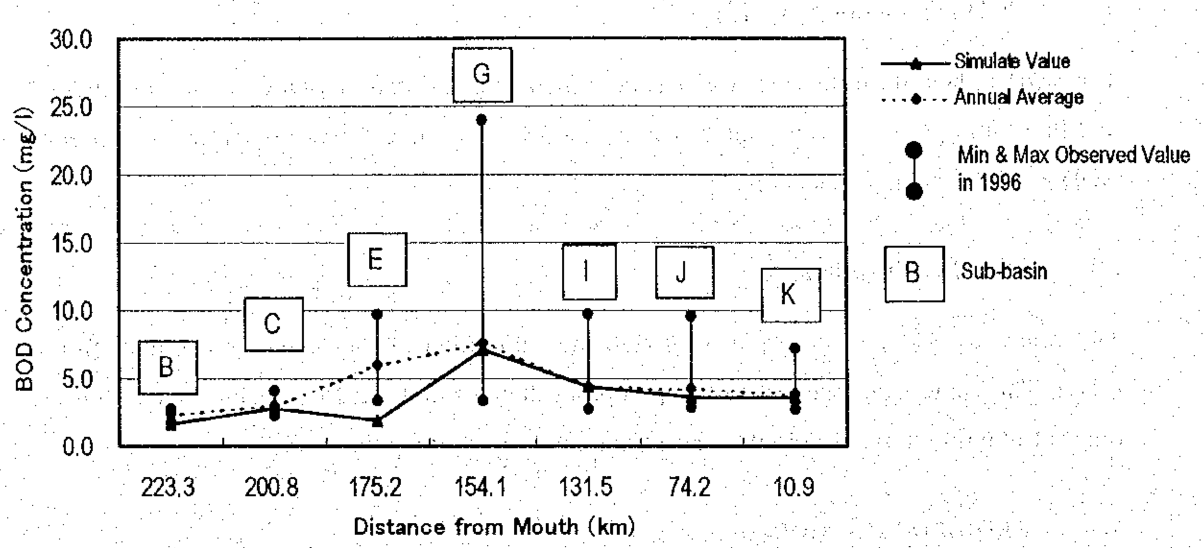


Figure E.6 - 3 Comparison of Simulated and Observed BOD Concentrations

(2) **Discussion**

1) Basin B (Segment b' - b) and Basin C (Segment c' - c)

Although the simulated values are within the range of observed the data, the monitored load is too small as compared with the estimated un-monitored load. These basins have no large factories and sewerage treatment plants, then un-treated domestic sewage is likely to be a main source of un-monitored load.

2) Basin E (Segment e' - e)

The simulated result at Basin E has a big difference from observed values. And its change in the BOD value from the upper basin is opposite; observed values show increase and simulate one show decrease, although a minimum value of K_r was used and the estimated un-monitored load is more than 10 times as much as monitored one. It is evident that a large amount of BOD load remains un-monitored in this basin.

3) Basin G (Segment g' - g)

In this basin, there is no big difference between simulated and monitored values, the estimated un-monitored load was calculated to be about a half of the monitored load. Its source may be direct inflows of un-treated domestic sewage from urbanised area in Banska Bystrica.

4) Basin I (Segment i' - i)

A high diminution rate (K_r) has been applied to this basin as a result of the calibration. It means that this basin has a high self-purification capacity. It seems that un-identified small tributaries inflows exist in this segment.

5) Basin J (Segment j' - j) and Basin K (Segment k' - k)

Although there are no large differences between the simulated and the monitored values of BOD concentration, estimated un-monitored BOD loads are high as compared with other basins. These basins are dominated by agricultural areas, and the BOD unit load might be higher than assumed one.

(3) Conclusion

This water quality simulation study was attempted with an original intention of developing a reliable model to be used mainly for evaluating the effects of water quality improvement measures such as strengthening the wastewater treatment. However, it became apparent during this study that more accurate data were needed to develop a reliable model to serve for the originally intended purpose. The most needed data for the improvement of the model are that for BOD load particularly for the sub-basin E (between Dubova and Banska Bystrica). In this section of the Hron River, it is considered that a large amount of BOD load is not monitored and identified yet. It can be said that this finding demonstrated the necessity and usefulness of this kind of model analysis, although this study has not achieved the original purpose.

Table E.6 - 3
Detailed Description of Basin B

Basin B

From (km)	To (km)
243.4	223.3

River Data

Flowrate	(m3/day)	
Velocity	(m/s)	0.8
Distance	(m)	20100
Kr	(1/day)	0.2

Landuse Data

	Area (km2)	Unit Load (kg/day/km2)	Non-Point Load (kg/day)
Artificial Surface	1.6	3.83	6.17
Agricutural Area	32.1	2.37	76.00
Forest & Natural	85.2	2.00	170.44
Wetland	0.0	0.0	0.00
Total	118.9		252.61

Previous Basin

Previous Basin	Flowrate (m3/s)	Flowrate (m3/day)	BOD Load (kg/day)	BOD Concentration (mg/l)	Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
A	5.078	438,739.2	1052.97	2.4	20100	0.291	921.0

Diffuse Source

			BOD Load (kg/day)		Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
			252.61		10050	0.145	236.2

Point Source

Hron (km)	GIS No	Effluent (m3/day)	BOD Load (kg/day)	BOD Concentration (mg/l)	Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
243.0	7	178.9	3.95	22.1	19700	0.285	3.5
Total		**178.9**	**3.9**				**3.5**

Simulated BOD at Reach

Previous Basin (kg/day)	Diffuse Source (kg/day)	Point Source (kg/day)	Other Basin (kg/day)	**Total BOD Load (kg/day)**	**BOD Concentration (mg/l)**	**Estimated Un-monitored BOD Load (kg/day)**	
921.0	236.2	3.5	-	**1160.7**	**1.6**	**560.4**	2.4

Observed Data (7015,R025010D)

Flowrate (m3/s)	Flowrate (m3/day)	BOD Concentration (mg/l)
8.3	717,120.0	2.4

Table E.6 - 4
Detailed Description of Basin C

Basin C

From (km)	To (km)
223.3	200.8

River Data

Flowrate	(m3/day)	
Velocity	(m/s)	1
Distance	(m)	22500
Kr	(1/day)	0.2

Landuse Data

	Area (km2)	Unit Load (kg/day/km2)	Non-Point Load (kg/day)
Artificial Surface	15.4	3.83	58.98
Agricutural Area	74.6	2.37	176.80
Forest & Natural	282.5	2.00	565.00
Wetland	0.0	0.0	0.00
Total	372.5		800.78

Inflow from Previous Basin

Previous Basin	Flowrate (m3/s)	Flowrate (m3/day)	BOD Load (kg/day)	BOD Concentration (mg/l)	Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
B	8.3	717,120.0	1721.09	2.4	22500	0.260	1526.6

Diffuse Source

			BOD Load (kg/day)		Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
			800.78		11250	0.130	754.2

Point Source

Hron (km)	Branch (km)	GIS No	Effluent (m3/day)	BOD (kg/day)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
221.8		14	11577.6	229.84	21000	0.243	205.5
216.5	1.4	28	426.1	4.38	17100	0.198	4.0
216.2		19	3456.0	15.56	15400	0.178	14.3
214.4		33	1684.8	92.03	13600	0.157	85.6
203.5		46	3888.0	77.75	2700	0.031	76.6
Total			**21032.5**	**419.56**			**386.0**

Inflow from Basin D

Merge at (km)	Total Flow (m3/s)	Total Flow (m3/day)	BOD Load (kg/day)	BOD (mg/l)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
215.0	3.31	285,984.0	829.35	2.9	14200	0.164	768.9

Simulated BOD at Reach

Previous Basin (kg/day)	Diffuse Source (kg/day)	Point Source (kg/day)	Other Basin (kg/day)	**Total BOD Load (kg/day)**	**BOD Concentration (mg/l)**	**Estimated Un-monitored BOD Load (kg/day)**	
1526.6	754.2	386	768.9	3435.7	2.7	374.5	3.0

Observed Data (7081,D048000D)

Flowrate (m3/s)	Flowrate (m3/day)	BOD (mg/l)
14.7	1,270,080.0	3.0

Table E.6 - 5
Detailed Description of Basin E

Basin E

From (km)	To (km)
200.8	175.2

River Data

Flowrate	(m3/day)	
Velocity	(m/s)	1.2
Distance	(m)	25600
Kr	(1/day)	0.1

Landuse Data	Area (km2)	Unit Load (kg/day/km2)	Non-Point Load (kg/day)
Artificial Surface	16.1	3.83	61.66
Agricutural Area	102.7	2.37	243.40
Forest & Natural	210.0	2.00	420.00
Wetland		0.0	0.00
Total	328.8		725.06

Previous Basin

Previous Basin	Flowrate (m3/s)	Flowrate (m3/day)	BOD Load (kg/day)	BOD Concentration (mg/l)	Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
C	14.7	1,270,080.0	3810.24	3.0	25600	0.247	3599.7

Diffuse Source

			BOD Load (kg/day)		Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
			725.06		12800	0.123	704.7

Point Source

Hron (km)	Branch (km)	GIS No	Effluent (m3/day)	BOD (kg/day)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
192.7	3.0	51	302.4	9.07	20500	0.198	8.7
185.8	0.2	54	1425.6	43.32	10800	0.104	42.3
185.7	1.5	55	432.0	17.29	12000	0.116	16.8
183.8		61	28339.2	654.22	8600	0.083	641.8
181.1	1.2	66	142.6	1.42	7100	0.068	1.4
Total			**30641.8**	**725.32**			**711.0**

Flow from Other Basin

Merge at (km)	Total Flow (m3/s)	Total Flow (m3/day)	BOD Load (kg/day)	BOD (mg/l)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
-	-	-	-	-	-	-	-

Simulated BOD at Reach

Previous Basin (kg/day)	Diffuse Source (kg/day)	Point Source (kg/day)	Other Basin (kg/day)	**Total BOD Load (kg/day)**	**BOD Concentration (mg/l)**	**Estimated Un-monitored BOD Load (kg/day)**	
3599.7	704.7	711	0	5015.4	2.0	9810.8	6.0

Observed Data (7160, D09510D)

Total Flow (m3/s)	Total Flow (m3/day)	BOD (mg/l)
28.6	2,471,040.0	6.0

Table E.6 - 6
Detailed Description of Basin G

Basin G

From (km)	To (km)
175.2	154.1

River Data

Flowrate	(m3/day)	
Velocity	(m/s)	1.3
Distance	(m)	21100
Kr	(1/day)	0.1

Landuse Data

	Area (km2)	Unit Load (kg/day/km2)	Non-Point Load (kg/day)
Artificial Surface	24.7	3.83	94.60
Agricutural Area	107.5	2.37	254.78
Forest & Natural	100.6	2.00	201.20
Wetland		0.0	0.00
Total	232.8		550.58

Previous Basin

Previous Basin	Flowrate (m3/s)	Flowrate (m3/day)	BOD Load (kg/day)	BOD Concentration (mg/l)	Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
F	28.6	2,471,040.0	14826.24	6.0	21100	0.188	14198.6

Diffuse Source

			BOD Load (kg/day)		Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
			550.58		10550	0.094	538.8

Point Source

Hron (km)	Branch (km)	GIS No	Effluent (m3/day)	BOD (kg/day)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
171.5		86	111.5	1.62	17400	0.155	1.6
168.4	3.2	89	51978.2	3094.05	17500	0.156	2985.0
165.6		91	235.6	4.25	11500	0.102	4.1
Total			**52325.4**	**3099.92**			**2990.7**

Flow from Basin F

Merge at (km)	Total Flow (m3/s)	Total Flow (m3/day)	BOD Load (kg/day)	BOD (mg/l)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
175.0	3.356	289,958.4	985.86	3.4	20900	0.186	944.5

Simulated BOD at Reach

Previous Basin (kg/day)	Diffuse Source (kg/day)	Point Source (kg/day)	Other Basin (kg/day)	**Total BOD Load (kg/day)**	**BOD Concentration (mg/l)**	**Estimated Un-monitored BOD Load (kg/day)**	
14198.6	538.8	2990.7	944.5	18672.6	7.1	1420.6	7.6

Observed Data (XXXX, R112000D)

Total Flow (m3/s)	Total Flow (m3/day)	BOD (mg/l)
30.6	2,643,840.0	7.6

Table E.6 - 7
Detailed Description of Basin I

Basin I

From (km)	To (km)
154.1	131.5

River Data

Flowrate	(m3/day)	1.05
Velocity	(m/s)	0.9
Distance	(m)	22600
Kr	(1/day)	0.59

Landuse Data	Area (km2)	Unit Load (kg/day.km2)	Non-Point Load (kg/day)
Artificial Surface	15.3	3.83	58.60
Agricutural Area	168.9	2.37	400.29
Forest & Natural	338.1	2.00	676.20
Wetland		0.0	0.00
Total	522.3		1135.09

Previous Basin

Previous Basin	Flowrate (m3/s)	Flowrate (m3/day)	BOD Load (kg/day)	BOD Concentration (mg/l)	Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
G	30.6	2,643,840.0	20093.18	7.6	22600	0.291	13538.6

Diffuse Source

			BOD Load (kg/day)		Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
			1135.09		11300	0.145	931.7

Point Source

Hron (km)	Branch (km)	GIS No	Effluent (m3/day)	BOD (kg/day)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
154.0	0.0	167	394.5	39.75	22500	0.289	26.8
153.8	1.8	124	4640.4	71.37	24100	0.310	46.8
153.3		138	24239.3	537.75	21800	0.280	367.4
135.0	2.5	118	328.3	8.22	6000	0.077	7.4
135.0	13.5	150	3153.6	179.64	17000	0.219	133.5
Total			**32756.1**	**836.74**			**581.9**

Flow from Basin H

Merge at (km)	Total Flow (m3/s)	Total Flow (m3/day)	BOD Load (kg/day)	BOD (mg/l)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
154.0	7.07	610,848.0	2199.05	3.6	22500	0.289	1484.3

Simulated BOD at Reach

Previous Basin (kg/day)	Diffuse Source (kg/day)	Point Source (kg/day)	Other Basin (kg/day)	**Total BOD Load (kg/day)**	**BOD Concentration (mg/l)**	**Estimated Un-monitored BOD Load (kg/day)**	
13538.6	931.7	581.9	1484.3	16536.5	4.4	76.5	4.4

Observed Data (7260, R185000D)

Total Flow (m3/s)	Total Flow (m3/day)	BOD (mg/l)
43.7	3,775,680.0	4.4

Table E.6 - 8
Detailed Description of Basin J

Basin J

From (km)	To (km)
131.5	74.2

River Data

Flowrate	(m3/day)	
Velocity	(m/s)	0.9
Distance	(m)	57300
Kr	(1/day)	0.1

Landuse Data

	Area (km2)	Unit Load (kg/day/km2)	Non-Point Load (kg/day)
Artificial Surface	28.8	3.83	110.30
Agricutural Area	243.1	2.37	576.15
Forest & Natural	430.4	2.00	860.80
Wetland	0.4	0.0	0.00
Total	702.7		1547.25

Previous Basin

Previous Basin	Flowrate (m3/s)	Flowrate (m3/day)	BOD Load (kg/day)	BOD Concentration (mg/l)	Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
I	43.7	3,775,680.0	16612.99	4.4	57300	0.737	14020.4

Diffuse Source

			BOD Load (kg/day)		Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
			1547.25		28650	0.368	1421.4

Point Source

Hron (km)	Branch (km)	GIS No	Effluent (m3/day)	BOD (kg/day)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
128.9		155	11059.2	142.96	54700	0.703	121.6
126.8		154	5616.0	50.55	52600	0.676	43.3
118.0		158	259.2	12.96	43800	0.563	11.4
115.3	5.1	162	406.1	22.85	46200	0.594	19.9
115.3	2.1	163	639.2	4.47	43200	0.556	3.9
106.3	2.7	173	840.3	3.70	34800	0.448	3.3
106.1		169	259.2	20.74	31900	0.410	18.9
93.2		178	2160.0	19.45	19000	0.244	18.4
Total			**21239.1**	**277.67**			**240.7**

Flow from Other Basin

Merge at (km)	Total Flow (m3/s)	Total Flow (m3/day)	BOD Load (kg/day)	BOD (mg/l)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
-	-	-	-	-	-	-	-

Simulated BOD at Reach

Previous Basin (kg/day)	Diffuse Source (kg/day)	Point Source (kg/day)	Other Basin (kg/day)	**Total BOD Load (kg/day)**	**BOD Concentration (mg/l)**	**Estimated Un-monitored BOD Load (kg/day)**	
14020.4	1421.4	240.7	0	15682.5	3.6	2893.5	4.3

Observed Data (7296, R234000D)

Total Flow (m3/s)	Total Flow (m3/day)	BOD (mg/l)
50	4,320,000.0	4.3

Table E.6 - 9
Detailed Description of Basin K

Basin K

From (km)	To (km)
74.2	10.9

River Data

Flowrate	(m3/day)	
Velocity	(m/s)	0.9
Distance	(m)	63300
Kr	(1/day)	0.1

Landuse Data	Area (km2)	Unit Load (kg/day/km2)	Non-Point Load (kg/day)
Artificial Surface	65.5	3.83	250.87
Agricutural Area	915.3	2.37	2169.26
Forest & Natural	150.2	2.00	300.40
Wetland	2.2	0.0	0.00
Total	1133.2		2720.53

Previous Basin

Previous Basin	Flowrate (m3/s)	Flowrate (m3/day)	BOD Load (kg/day)	BOD Concentration (mg/l)	Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
J	50	4,320,000.0	15552.00	3.6	63300	0.814	12893.8

Diffuse Source

			BOD Load (kg/day)		Flow Distance (m)	Flow Time (day)	BOD Load at reach (kg/day)
			2720.53		31650	0.407	2477.1

Point Source

Hron (km)	Branch (km)	GIS No	Effluent (m3/day)	BOD (kg/day)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
73.4		183	1909.4	79.42	62500	0.804	66.0
62.2		186	302.4	8.47	51300	0.660	7.3
54.2	2.2	188	35424.0	956.44	45500	0.585	835.9
40.9	1.5	196	1356.5	28.77	31500	0.405	26.2
36.8		189	60.8	0.79	25900	0.333	0.7
14.7	12.3	212	13.8	9.81	16100	0.207	9.4
Total			**39066.9**	**1083.7**			**945.5**

Flow from Other Basin

Merge at (km)	Total Flow (m3/s)	Total Flow (m3/day)	BOD Load (kg/day)	BOD (mg/l)	Flow Distance (m)	Flow Time (day)	BOD at reach (kg/day)
-	-	-	-	-	-	-	-

Simulated BOD at Reach

Previous Basin (kg/day)	Diffuse Source (kg/day)	Point Source (kg/day)	Other Basin (kg/day)	**Total BOD Load (kg/day)**	**BOD Concentration (mg/l)**	**Estimated Un-monitored BOD Load (kg/day)**	
12893.8	2477.1	945.5	0	16316.4	3.6	1542.5	3.9

Observed Data (7335, R340000D)

Total Flow (m3/s)	Total Flow (m3/day)	BOD (mg/l)
53	4,579,200.0	3.9

E.7 INVESTMENT PROGRAMMES OF POVODIE HRONA AND STVAK

1. EXPLANATORY TEXT

The Study Team received English translations of the ongoing and proposed investment programmes of Povodie Hrona (Tables E.7 - 1 to E.7 – 3) and StVaK (Table E.7 – 4) only at the very end of the study (after completion of work in Slovakia) – and no comparable information for the lower part of the Basin was obtained from ZsVaK. Therefore there was no time to evaluate and discuss these proposals with the staff of these organisations, nor to compare the proposals with the findings and proposals of the REMP study. Nevertheless these investment programmes are included in the REMP report, at the request of SVP OZ PH and StVaK and to provide an indication of the scale of the investment required in the water sector in the Hron River basin.

Because evaluation (technical, environmental and financial) of these investment programmes was not undertaken, it must be stated that inclusion of these tables in the REMP report does not imply that the Study Team supports all the proposals and cost estimates. Any engineering works on streams and rivers to regulate their flow will require consideration of any negative environmental impacts, including flood risk. Even proposed works to improve ecological conditions in the lower part of the Basin will need to be designed carefully, and to include monitoring programmes, to ensure that they have the desired positive impact. Similarly the Study Team cannot endorse the prioritisation of the wastewater schemes implied by Table E.7 – 4. Nevertheless the results of the REMP Study Team do concur with the message conveyed by Table E.7 – 4, that Banska Bystrica STP and sewerage connections are a priority and that significant investment in wastewater treatment systems is required within the Basin.

Table E.7 – 1 Investment Programme of Povodie Hrona for the year 1999

No.	Name	Date (month.year) Start – finish	Full investment cost (thousand Sk)	Financial need in year 1999 (thousand Sk)
	Construction starting before 1.1.1999			
1.	MVE (Small hydro-power station) Zvolen	11.97 - 12.99	84 254	41 304
2.	Lukavica, regulation of stream, Lukavica	11.97 - 11.99	5 154	3 196
	Construction to start in year 1999			
1.	Belianska Reservoir, reconstruction	10.99 - 10.01	11 000	1 000
2.	Hrinova Reservoir, reconstruction of manipulation(?) equipment	08.99 - 10.99	427	400
	Preparatory work			
1.	Vlkanová – Radvan, antiflood protection			300
2.	Brezno, roof for operations department			15
3.	Ziar nad Hronom, extension of operations department			235
4.	Zvolen, restoration of the Slatina River			150
5.	Hrinova Reservoir, fish management – heating of water			20
	Other investment needs			
1.	Kamenín, Ziar nad Hronom+MVE (Small hydro-power station) channelling of Hron			468
2.	Lukavica – Dolná Micinä, regulation of Lukavica stream			70
3.	Kyncel'ová, regulation of Senického stream			5
4.	Waterworks Dobrá Niva, limnographic station			30
5.	Reservoir Dobrá Niva			50
6.	Reservoirs in the area of Banska Stiavnica			50
	Summary		**100 835**	**47 293**

Source: Povodie Hrona Banská Bystrica, October 1999

Table E.7 – 2 Proposed Investment Programme of Povodie Hrona for the year 2000

No.	Name	Date (month.year) start – finish	Full investment charge (thousand Sk)	Financial need in year 2000 (thousand Sk)
	Construction starting before 1.1.2000			
1.	Belianska Reservoir– reconstruction	10.99 – 10.01	11 943	5 000
	Construction start ing in year 2000			
1.	PH BB – VhR, reconstruction of store rooms	05.00 – 11.00	350	350
2.	Brezno, roof of operations department	05.00 – 10.00	433	420
3.	Psiare, prevention of seepages through OH(?)	06.00 – 10.01	2 500	400
4.	Hrinová Reservoir, fish management – heating of water	07.00 – 10.00	140	120
5.	Waterworks Velké Kozmálovce, fishway for the Hron	08.00 – 09.01	3 100	2 500
6.	Zvolen, pollution control equipment (e.g. ?boom for oil spill containment/arrestment for the Hron)	07.00 – 11.00	1 960	1 960
7.	Tek. Breznica, pollution control equipment (e.g. ?boom for oil spill containment/arrestment for the Hron)	08.00 – 11.00	3 556	3 556
8.	Sokolec, pollution control equipment (e.g. ?boom for oil spill containment/arrestment for the Hron)	08.00 – 11.00	1 927	1 927
	Preparatory Work			
1.	Vlkanová – Radvan, antiflood protection for the Hron			400
2.	Zvolen, Restoration of the Slatina River			200
3.	Ziar nad Hronom, Extenion of operations department, PH			100
4.	Zeliezovce, ecological water management systems for the Hron			300
5.	Hrinová, regulation of River Slatina as far as Reservoir			150
6.	Windšachtská Reservoir – reconstruction			500
7.	Rozgrund Reservoir– reconstruction			300
8.	Dobrá Niva waterworks, operational equipment/department of PH			150
	Summary		**25 909**	**18 333**

Source: Povodie Hrona Banská Bystrica, October 1999

Table E.7 – 3 Investment Proposals of Povodie Hrona until 2005

No.	Name	Year Start – finish	Full investment charge (mil. Sk)
1.	Psiare – reconstruction of stream regulation (engineering works) on the river Hron	1998-2000	20,0
2.	Zvolen –improvement of the flow of the Slatina	1998-2001	60,0
3.	B. Bystrica-Kremnièka – channel regulation of the River Hron (?to be developed by the regional centre for B.Bystrica-Zvolen)	1998-2001	30,0
4.	Waterworks Slatinka on the River Slatina	1998-2001	2 700,0
5.	Protective measures for the regeneration of the branches of the lower River Hron at Kamenín, Bíòa	1999-2002	45,0
6.	Reconstruction and landcaping of Podlu ianky	1999-2002	60,0
7.	B. Bystrica protection of floodplain (town area) Stage I (Srnková - division area)	1999-2002	80,0
8.	B. Bystrica protection of floodplain Stage II (Alternative I - water management with multi-functional tunnel) (Alternative II - water management only	2000-2004	300,0 800,0
9.	Hronèek Waterworks on the Kamenistý potok (brook)	2000-2003	2 900,0
10.	Sliaè – Vlkanová – stream regulation (engineering works) on the river Hron (to be developed by the regional centre for B.Bystrica-Zvolen)	2001-2004	60,0
11.	Brezno - protection of intravilan (town area) and protective measure of water basin of the river Hron	2001-2004	50,0
12.	Bíòa – Pohronský Ruskov, improvement of the flow	2002-2005	100,0
13.	arnovica – Bzenica – protection measures for the river Hron	2002-2005	90,0
14.	Podbrezová – reconstruction of the stream regulation (engineering works) on the river Hron	2003-2005	30,0
15.	Ecological measures in the lower River Hron at Šárovce	2005	30,0
	Summary		**7355,0**

Source: Povodie Hrona Banská Bystrica, October 1999

Table E.7 – 4 StVaK's Financial Proposals for Construction of Wastewater Treatment Plants and Sewers to the year 2005

No.	Name	Year Start – finish	Full investment cost (mil. Sk)
1.	Banská Bystrica, extension of Sewage Treatment Plant (STP)	1988-2000	156,3
2.	Banská Štiavnica, sewerage network and STP	1990-2000	80,1
3.	Banská Bystrica, sewage collectors A	1998-2002	279,2
4.	Zvolen, extension of Sewage Treatment Plant	2000-2003	483,6
5.	Brezno, ?removal of sewerage inlets?	2001-2003	100,0
6.	Vyhne, connection of sewage system ?(to STP)	2000-2001	20,0
7.	Kremnica, sewerage network and STP	2001-2004	40,0
8.	Detva, extension of STP	2002-2004	42,4
9.	Slovenská L'upca, sewerage network and STP	2002-2004	75,9
10.	L'ubietová, sewerage network and STP	2002-2004	115,6
11.	Podbrezová, intensification of STP	2002-2003	17,2
12.	Valaská, sewerage network and STP	2002-2004	35,0
13.	Banská Bystrica, reconstruction and completion of sewerage network	2002-2005	1 099,1
14.	Zvolen, sewerage network system	2002-2004	114,5
15.	Banská Bystrica, sewerage collector AE	2002-2004	130,8
16.	Ziar nad Hronom, reconstruction of sewerage network	2002-2004	63,1
17.	Predajná, sewerage network and STP	2002-2004	50,2
18.	Vyhne, sewerage network	2000-2002	71,2
19.	Nová Bana, completion of sewerage network	2002-2003	11,7
	Total		**2 985,9**

Source: StVaK Banská Bystrica, October 1999