# DANUBE POLLUTION REDUCTION PROGRAMME

# NATIONAL REVIEWS 1998
# CZECH REPUBLIC

## TECHNICAL REPORTS

**Part C: Water Quality**

**Part D: Water Environmental Engineering**

**MINISTRY OF ENVIRONMENT**

*in cooperation with the*

**Programme Coordination Unit**
**UNDP/GEF Assistance**

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# Preface

The National Reviews were designed to produce basic data and information for the elaboration of the Pollution Reduction Programme (PRP), the Transboundary Analysis and the revision of the Strategic Action Plan of the International Commission for the Protection of the Danube River (ICPDR). Particular attention was also given to collect data and information for specific purposes concerning the development of the Danube Water Quality Model, the identification and evaluation of hot spots, the analysis of social and economic factors, the preparation of an investment portfolio and the development of financing mechanisms for the implementation of the ICPDR Action Plan.

For the elaboration of the National Reviews, a team of national experts was recruited in each of the participating countries for a period of one to four months covering the following positions:

- Socio-economist with knowledge in population studies,
- Financial expert (preferably from the Ministry of Finance),
- Water Quality Data expert/information specialist,
- Water Engineering expert with knowledge in project development.

Each of the experts had to organize his or her work under the supervision of the respective Country Programme Coordinator and with the guidance of a team of International Consultants. The tasks were laid out in specific Terms of Reference.

At a Regional Workshop in Budapest from 27 to 29 January 1998, the national teams and the group of international consultants discussed in detail the methodological approach and the content of the National Reviews to assure coherence of results. Practical work at the national level started in March/April 1998 and results where submitted between May and October 1998. After revision by the international expert team, the different reports have been finalized and are now presented in the following volumes:

| | |
|---|---|
| Volume 1: | Summary Report |
| Volume 2: | Project Files |
| Volume 3 and 4: | Technical reports containing: |
| | - Part A : Social and Economic Analysis |
| | - Part B : Financing Mechanisms |
| | - Part C : Water Quality |
| | - Part D : Water Environmental Engineering |

In the frame of national planning activities of the Pollution Reduction Programme, the results of the National Reviews provided adequate documentation for the conducting of National Planning Workshops and actually constitute a base of information for the national planning and decision making process.

Further, the basic data, as collected and analyzed in the frame of the National Reviews, will be compiled and integrated into the ICPDR Information System, which should be operational by the end of 1999. This will improve the ability to further update and access National Review data which is expected to be collected periodically by the participating countries, thereby constituting a consistently updated planning and decision making tool for the ICPDR.

UNDP/GEF provided technical and financial support to elaborate the National Reviews. Governments of participating Countries in the Danube River Basin have actively participated with professional expertise, compiling and analyzing essential data and information, and by providing financial contributions to reach the achieved results.

The National Review Reports were prepared under the guidance of the UNDP/GEF team of experts and consultants of the Danube Programme Coordination Unit (DPCU) in Vienna, Austria. The conceptual preparation and organization of activities was carried out by **Mr. Joachim Bendow**, UNDP/GEF Project Manager, and special tasks were assigned to the following staff members:

- Social and Economic Analysis and Financing Mechanisms: **Reinhard Wanninger**, Consultant
- Water Quality Data: **Donald Graybill**, Consultant
- Water Engineering and Project Files: **Rolf Niemeyer**, Consultant
- Coordination and follow up: **Andy Garner,** UNDP/GEF Environmental Specialist

The **Czech National Review** was prepared under the supervision of the Country Programme Coordinator, **Mr. Milan Bedrich**. The authors of the respective parts of the report are:

- Part A : Social and Economic Analysis: **Mr. Antonin Vaishar**
- Part B : Financing Mechanisms: **Ms. Miroslav Hajek**
- Part C : Water Quality: **Ms. Ilja Bernardova**
- Part D : Water Environmental Engineering: **Mr. Ladislav Pavlovsky**



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Vienna – Austria, November 1998

# Part C

## Water Quality

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# List of Abbreviations on Water Quality

| | |
|---|---|
| **$t.year^{-1}$** | tons per year |
| **$m^3.s^{-1}$** | cubic meters per second |
| **$mg.l^{-1}$** | milligrams per liter |
| **km** | kilometer |
| **$t.km^{-2}$** | tons per kilometer |
| **$t.ha^{-1}$** | tons per hectare |
| **Th** | thousand |
| **$\mu g.l^{-1}$** | micrograms per liter |
| **$ng.l^{-1}$** | nanograms per liter |

## Glossary on Water Quality

| | |
|---|---|
| **ASLAB** | Center for Accreditation of Laboratories |
| **$BOD_5$** | 5-days biological oxygen demand |
| **WWTP** | wastewater treatment plant |
| **CHMI** | Czech Hydrometeorological Institute |
| **CB WWTP** | chemical-biological wastewater treatment plant |
| **$COD_{Cr}$** | chemical oxygen demand |
| **$Cr_t$** | total chromium |
| **CZK** | Czech crowns |
| **$c_{90}$** | concentration value with 90 % probability of not exceedance |
| **DCB** | dichlorbenzene |
| **DBAM** | Danube Basin Alarm Model |
| **EPDB** | Environmental Programme for the Danube River basin |
| **fa** | farm |
| **MBWWTP** | mechanical-biological wastewater treatment plant |
| **NAP** | National Action Plan |
| **$N\text{-}NH_4$** | ammonium nitrogen |
| **$N\text{-}NO_3$** | nitrate-nitrogen |
| **N-pollution** | nitrogen pollution |
| **$N_t$** | total nitrogen |
| **$PCB^+_s$** | polychlorinated biphenyls |
| **PE** | population equivalent |
| **$P_t$** | total phosphorus |
| **$Q_{effl.}$** | effluent discharge from a source of pollution |
| **$Q_{355}$** | 355-days characteristic discharges (overpassed for 355 days in average year assessed from 1931-1980 |
| **SAP** | Strategic Action Plan |
| **TNMN** | Transnational Monitoring Network |
| **WRI** | Water Research Institute |

# 1. Summary

The first list of hot spots in the Morava River basin identifying the largest polluters in the transboundary scale was prepared in 1994 as a part of Strategic Action Plan in the Danube River basin. Updating this list in the National Action Plan in 1995/1997 and Project Morava brought improvement by dividing actual hot spots into five categories of municipal, industrial, agricultural, waste dumps and endangered ground water uptakes.

The first phase of a new hot spots updating presented in this study reflects the current state of water pollution in the Morava River basin. After deleting five municipals, four industrial and five agricultural hot spots and adding two municipals and one industrial hot spots the new lists of hot spots consisting of ten municipals, five agricultural and five industrial localities were elaborated. In order to rank these hot spots an objective simple analysis based on ten criteria was chosen. The result of the evaluation emphasized four municipal hot spots in the high priority rank (Brno, Zlín, Uherské Hradiště and Hodonín), two agricultural ones (Milotice and Dubňany) and two industrial hot spots (Koželužny Otrokovice and FOSFA Poštorná). Three municipal (Břeclav, Olomouc, Přerov), two agricultural (Kunovice and JAVE Velké Němčice) and two industrial (HAME Babice and TANEX Vladislav) hot spots were put into the medium priority rank. Into the low priority group three municipal (Kroměříž, Prostějov and Znojmo), one agricultural (Strachotín) and one industrial hot spot (Snaha Brtnice) have been assessed. The most important reason for this priority ranking was the amount of discharged pollution, the upstream water quality and effect on the receiving water users and on environment in the transboundary area.

Due to the great proportion of land under agricultural cultivation contribution of diffuse sources of pollution in the Morava River basin is important. Although this sector has passed through great changes since 1989 the amount of fertilizers applied has been reduced up to three times but the large area and structure of land endangering waters with erosion has still survived. While the share of non-point sources of pollution is estimated to be about half of the balanced nutrients, the amount of fertilizers used was estimated to be a third of the balanced amount. Actual erosion is high especially in the areas of left-hand tributaries in the lower parts of the Morava River basin in CR. Animal grazing is mostly concentrated in the upper parts of the basin and its contribution to the water quality is not so important.

Since 1963 water quality in the important rivers in CR is regularly monitored in the national water quality-sampling network. Since 1992 this system has been supplemented by results from a special national water quality protection project focused on the Morava River basin - Project Morava - where monitoring of the NAP hot spots is performed. Both laboratories (Morava River Administration and WRI) are externally checked by Accreditation Center in Prague and the first one by the Czech Institute for Accreditation Processes. Quality Control System within the laboratories is fully in accordance with European standard, namely EN 45 001 and covers all aspects of analytical procedures.

Main channel characteristics for reaches downstream the most important hot spots show that streams in the lower parts of their watersheds are not much diversified. There have been identified twelve most important floodplains and estimated their size for more than thirty years occurrence period. Out of eight wetlands of transregional and transboundary importance in this river basin one with greatest transboundary importance is the Lower Dyje Wetlands situated on the Morava and Dyje Rivers confluence.

The river bank erosion of the main rivers is currently low, except of the situation of 1997 flood event, when a great channel and bank erosion occurred. Out of fifteen important dams and reservoirs in the basin the largest one the Dalešice Reservoir influences the lower part of the Jihlava and Dyje Rivers. The greater effect of water impoundment can be seen in the Dyje River basin. The major part of the reservoirs serves for flood protection, power generation, low flow

augmentation and in southern part of the basin also for irrigation uptakes. The lower stretches of the most important rivers have mostly been canalized and have bank protection against flood up to fifty/hundred years period events. There are not any greater transfers of water in the basin only several bifurcations of local importance predominantly on the Morava River and a little transboundary transfer to Austria downstream Znojmo city.

For the purpose of the prepared transboundary diagnostic analysis the data set incorporating results from sampling sites upstream and downstream the high priority hot spots including the TNMN ones has been compiled. The major part of involved sampling sites entered into the national database in CHMI, where the water discharges for these stations are also assessed. Smaller part of results from localities close to the hot spots but with only two years monitoring have been taken from Project Morava data sets. For more than a decade there has been performed sediment monitoring programme by CHMI Brno, where one station is situated in the same locality as the water quality station. The sediment rating curves are under preparation.

In the list of water quality data presented in the Annexes, among the hazardous chemicals were given results of mercury and PCBs concentrations, which in this river basin, according to the national project, created in the last years the most serious problem.

The highest concentrations of inorganic nitrogen found in the period 1994-1997 occurred downstream the Brno and Zlín hot spots and upstream Brno, also values in the Svitava River are notable. About 40 % of monitored stations were assessed as heavily polluted. Long-term trends mostly reflect decline in average concentrations of ammonium nitrogen. For phosphorus the maximal values appeared downstream Brno, Hodonín and Otrokovice municipalities and upstream Brno as well. Large river water quality assessment signalized that app. 60 % of stations is ranked among heavily polluted and also the last decade trend showed strongly increasing trend. As far as the organic pollution concerns, the most serious pollution of river water was identified downstream Kroměříž, Zlín and Otrokovice. Water quality in more than 50 % of sampled sites corresponded in 1996/97 to heavily polluted waters and long-term trends in the last decade were mostly decreasing. Notable high mercury concentrations appeared downstream and upstream Brno and downstream Otrokovice. Any contribution of point source of pollution has not been found. In the last several years with enlarged spectrum of monitored chemicals a problem of notable high concentrations of PCBs in the surface waters in the Morava River basin appeared. The most outstanding values of PCBs were found in the Svitava River, in Lanžhot and downstream Uherské Hradiště.

A survey on the main acts and regulations governing water legislation in the sphere of the water protection is given. The principal legal document governing legal aspects of water protection, water management facilities, water management authorities and transboundary waters is Act No. 138/1973 on Waters. In addition to basic information on the present water management administrative system, the main responsibilities in water and the competent authorities on the Ministries is presented. In the last part the important international agreements in the transboundary water protection are discussed.

# 2. Updating of Hot Spots

The first attempt to create a list of hot spots in the Morava River basin on the Czech Republic territory was made in 1994 as a part of activities within the Strategic Action Plan for the Danube River Basin. As declared in this study one of the goals was to prepare a list of important activities of high priority focused on the most serious health, ecological and economical hazards and declaring also their responsible managers, way of financing and the time schedule of the prepared actions. The first list of hot spots covered 10 actual hot spots (see Tab. C-1) without stating any priorities and without starting background discussion with the involved local players. This operationally elaborated document presented the first attempt of evaluation of the largest polluters from the Danube River basin point of view and reflected the state-of-the-art of the Morava River basin water protection in 1994.

Updating of the first list of hot spots was realized in the framework of the National Action Plan. The basic information on the most important sources of pollution and the actual lists of hot spots have been prepared in 1992-1995 within the national study on water protection - Project Morava. The work on NAP started at the beginning of 1995 and final draft report was finished at the beginning of 1996. As water from CR is drained into three different seas (Black, Baltic and Northern) and this fact brought different international activities to participate in solving the environmental problems, the Ministry of the Environment of the Czech Republic before approval of the National Action Plan for the Morava River basin insisted on harmonizing of all three Action Plans using the same principles and methods of elaboration. The harmonized Action Plan for the Morava River basin in CR was finished at the beginning of 1997. The hot spots were ranked into five lists covering municipal, industrial and agricultural hot spots (see Tab. C-2 – C-4) as well as dangerous waste dump localities and endangered ground water drinking sources. Over that two years period there was a large discussion focused on individual hot spots and their position at the hot spots lists. Due to the current improvements of treatment processes and other changes in emission loads a new updating of hot spots presented in this study based on the same principles for the whole Danube River basin would be of evident use.

## 2.1. General Approach and Methodology

In this phase the methodology discussed during the National Review Workshop in Budapest in January 1998 has been used. In the first phase a list of hot spots from the Morava River basin incorporating all important inland polluters has been compiled. Polluters given in the list were ranked into three categories of municipal, industrial and agricultural polluters. These lists were based on the lists of hot spots elaborated within NAP. To update the information the latest data prepared for the next EP DRB Emission Group meeting and data from the large national water quality study called Project Morava were used. This Project that in the fist stage (1992-95) gave complex survey on water quality and ecosystems protection and identified the main sources of pollution has formed an important background for all national and transboundary activities in the field of water quality protection. Second stage of Project Morava (1996-1999) is focused on improvement of knowledge on point and diffuse sources of pollution as well as water quality downstream hot spots especially as far as the specific pollutants are concerned.

The main objective of this phase of hot spots identification was to find all important polluters not only from organic emissions point of view but including the aspect of nutrient and other toxic emissions (e. g. heavy metals and other specific organics) as well. To be sure that all of the listed municipalities or other problem localities would be included, the lists of hot spots were in the first phase rather long. The list of municipal hot spots covered 10 municipalities, the list of agricultural hot spots 5 hog farms and the list of industrial hot spots 5 industrial localities (see Tab. C-4 – C-7).

To assess the priorities and rank these hot spots, an attempt to create an objective system of universal criteria for use in a simple multicriterial decision analysis was made. According to the methodology given at the National Planning Workshop ten criteria covering all the given ranking aspects were used. Besides of those aspects presented in the workshop paper a new criterion evaluating the state of river canalization downstream the hot spot together with the influence of diffuse pollution from the detached river basin upstream the assessed hot spot was introduced. Using the scale with max. five points assessment for all ten incorporated criteria, a scheme for the decision analysis given in Tab. C-8 has been elaborated. This scheme enabled the author to elaborate the assessment and ranking of hot spot with maximal objectivity respecting all the given aspects.

### 2.1.1. - 2.1.3. Evaluation and Deletion of Existing Hot Spots and Edition of New Hot Spots

Some changes were made in the hot spots lists elaborated within the National Action Plan. Five hot spots given in the previous municipal hot spots list were deleted (Jihlava, Vyškov, Třebíč, Hanušovice, Valašské Meziříčí) with respect to the state-of-the-improvement of their treatment process or/and to their lower transboundary effect. On the other hand, there were incorporated several new polluters which potentially cause greater transboundary effect. Two out of these candidates - Znojmo and Kroměříž - were finally chosen to be included into the new list of hot spots.

Several polluters given in the last list of agricultural hot spots where in the last years any larger problems had not appeared and which had not caused any transboundary implications were deleted (Šebetov, Těšnovice, Dolní Loučka, Paseka and Vícov). As there is generally a certain decline in number of livestock in hog farms in CR, any new localities have not been introduced into the list.

From the list of industrial hot spots several industrial polluters, which had reduced their emissions or/and if their transboundary effect had not been so great (Moravanka Dubňany, MORPA Jindřichov, Nobleslen Hanušovice, Vysočina Hodice) were left out. There was only one new industrial polluter, which was included into the prepared list of hot spots in this phase (TANEX Vladislav). This polluter influences the impounded water of the great reservoirs and protected areas downstream.

### 2.1.4. Ranking of Hot Spots

Ranking of hot spots has been made using the prepared scheme for point assessment presented in Tab. C- 8. In this scheme the first three criteria were used for evaluation of the pollution load from individual polluters in terms of COD, $N\text{-}NH_4$ and $P_t$ discharges. Another important group of criteria used in this process was the upstream water quality which was assessed according to the water quality classes stated in the Czech Standard for Surface Water Quality Classification (ČSN 75 7221). Point assessment of dilution factor given in this table has been made according to the magnitude of quotient of the Czech long-term low discharge (overpassed for 355 days in the average year) and amount of water discharged from the effluent. In the criterion called downstream use of water the high point assessment was used for drinking water uptakes and for the cases where river goes through the protected areas and low point assessment for industrial or agricultural usage with lower water quality demands. The last two criteria cover transboundary effect evaluating the distance from the effluent to the international border. The last criterion reflects the denaturation of the river bottom and banks downstream the hot spot incorporating also the upstream diffuse pollution effect. Each polluter given in the list of hot spots has been assessed using the data from 1996 (emissions) and 1996-97 (river water quality and other background data). The summary of this evaluation for municipalities which is presented in Tab. C-9 made the final score from 26-39 points. Among the high priority hot spots were ranked those where the point assessment score was higher than 32 points and the group of medium priority hot spots achieved more than 28 points. In group of industrial hot spots assessed by 21-31 points, among the high priority hot spots were put those that gained more than 30 points and among the middle priority ones those with more than 24 points.

### 2.1.5. Map of Hot Spots

The compilation of the hot spots lists in the Morava River basin in the period from 1994-1998 consists of three phases. To be able to express this in the form of an illustrative map a differentiation of all three phases of hot spots assessment with respect to the hot spots categories and their ranking was necessary. To give a picture of the last hot spots in Fig. C-1, for those from SAP (1994) black color symbols were used, for those from NAP (1995) red color symbols. For the revised hot spots within the Danube Pollution Reduction Programme described in Fig. C-2 the same symbols were used but the colors had different meaning. For the high priority level red colored symbols were used, for the medium priority level green color was used and for low priority level black symbols were featured. To distinguish the group of the municipal and other categories of hot spots the different symbols for each group were chosen which were identical for all three hot spots time levels (see Fig. C-1 and C-2).

## 2.2. Municipal Hot Spots

### 2.2.1. High Priority

High priority hot spots are formed by four municipalities, which can be declared as the greatest polluters of transboundary rivers in the Morava River basin threatening the downstream users and the aquatic life esp. in protected areas.

Hot Spot +1

The first rank within this assessment belonged to the largest Moravian municipality Brno with more than 400,000 inhabitants (PE = 500,000) including a great contribution of machine and textile industries. Dilution factor of the Svratka River downstream this hot spot is rather low and insufficient capacity of the municipal WWTP together with an old sewerage network system in the city form a persistent water quality problem for the downstream users (infiltration drinking water uptakes, irrigation, recreation) as well as for the nature in the largest wetland and proposed Trilateral National Park (see Tab. C-11). In 1996 this polluter did not fulfil the emission limits given by the Government Order No. 171/92 Coll. in ammonium nitrogen and in total phosphorus.

Hot Spot +2

Second position was given to the municipality of Zlín, where the pollution of 150,000 of equivalent inhabitants with important share of industry is not sufficiently treated and the dilution of the discharged waters in the little Dřevnice River is very low (see Tab. C-12). This pollution endangers the drinking water uptakes from alluvial ground water resources as well as aquatic life in the transboundary area where the Trilateral National Park is proposed. In 1996 this WWTP did not fulfil the emission limits in any of all three given water quality parameters.

Hot Spot +3

Uherské Hradiště in the third position has PE about 83,000. The existing wastewater treatment plant needs to be completed with a unit for the nutrient emissions reduction. Root causes of downstream water quality problems reflect the combination of influence of high nutrient emissions, upstream water quality and periods of low discharges. Nutrient problem of this polluter is fulfillment of emission limits both in $N\text{-}NH_4^+$ and phosphorus. This hot spot is situated inside the protected area of natural water accumulation in the Morava River alluvial plain and rather close to the transboundary river stretch. Further details are given in Tab. C-13.

Hot Spot +4

The last high priority municipal hot spot Hodonín is situated on the border with the Slovak Republic and close to the Austrian border. Therefore as a large polluter its WWTP needs an improvement of organic and nutrient removal in the treatment process. In 1996 the values of this hot spot did not correspond with emission limits in COD and $N\text{-}NH_4^+$. Situated downstream of all other polluters within the Morava River basin in CR this hot spot contributes to pollution of the river in the transboundary area as well as of the adjacent protected area of natural water accumulation and of the proposed Trilateral Park at the Dyje and Morava Rivers confluence /see Tab. C-14/.

### 2.2.2. Medium Priority

Hot Spot +1

In this priority rank we can find municipality of Břeclav, which is situated very close to the border with Austria and represents a great producer of organic and ammonium nitrogen pollution. There was no correspondence with emission limits in COD and N-NH4+ in 1996. Břeclav WWTP with insufficient efficiency of treatment process is not only close to the state border but also to the border of proposed Trilateral National Park and to the protected area of natural water accumulation.

Hot Spot +2

Olomouc is the second largest city in this river basin with PE adequate to 180,000 of inhabitants and it is also one of the greatest producers of organic and nutrient pollution. At present the treatment efficiency of phosphorus removal in the municipal WWTP is still insufficient. As far as the emission limits, only that for phosphorus was exceeded in 1996. The city is situated in the protected area of natural water accumulation.

Hot Spot +3

The City of Přerov with PE of 110 ,000 is known, as a municipality with important chemical industry where N-pollution of treated water is still rather high. The present treatment plant needs improvement especially in this section. In this WWTP the emission limit for ammonium nitrogen was exceeded. The hot spot influences the drinking water uptakes as well as protected areas downstream.

### 2.2.3. Low Priority

Three low priority hot spots (Kroměříž, Prostějov and Znojmo) are situated in the central part of the Morava River basin or in the upper part of the Dyje River basin, therefore their transboundary effect is not as evident as in the case of two previous groups.

Hot Spot +1

Kroměříž is ranked among the greater producers of organic and nutrient pollution with contribution of waters discharged from the adjacent hog farm. Contemporary treatment efficiency of its WWTP is not sufficient with respect to the permissible level of emissions in all three parameters. This hot spot is situated in the protected area of natural water accumulation and it also influences downstream users.

Hot Spot +2

Prostějov can be presented as a larger city with PE of 120,000 including a great load of industrial wastewater. The treatment efficiency of present WWTP is still insufficient especially as far as the nitrogen reduction is concerned. Due to its low dilution effect the Valová River as a smaller tributary of the Morava River is mostly inadequately polluted esp. during the low flow periods.

Hot Spot +3

Znojmo City belongs to the group of the greater organic polluters where the contribution of food processing industry is high and which may cause seasonal pollution variations. This locality did not fulfil any of the three emission limits. The receiving water downstream this hot spot makes border with Austria, water from the Dyje River is used for irrigation and moreover the river enters the Nové Mlýny reservoirs. These reservoirs are known for its recreation capacities and for migratory birds' protection.

## 2.3. Agricultural Hot Spots

Out of former ten agricultural hot spots in NAP, there have been chosen only five within this updating with regard to their transboundary effect (see Tab. C-6). The situation of the presented hog farms has been slightly changing since the beginning of nineties as far as the livestock is concerned. It can be stated that in the last several years the number of stabled hogs has been mostly reduced and the treatment facilities are slightly improving. As it is necessary to give a list of the agricultural priorities for further analysis and there is not any set of objective criteria as in the case of municipal hot spots, their prioritization is rather difficult. There is not enough data to enter to an objective process, so the final ranking has been based only on evaluation of the three aspects, i.e. the present number of stabled livestock, the slurry treatment and the distance of effluent to the international border.

### 2.3.1. High Priority

Hot spot +1

As the first high priority hot spot, the Milotice farm with 22,000 of allocated hogs was appointed which is situated in the Kyjovka River basin. There is a short distance to the border and the centrifuge is stored in lagoons and it is spread over the fields.

Hot spot +2

The Gigant Dubňany with 20,000 hogs is also situated in the Kyjovka River basin rather close to the state border. The slurry treatment covers the centrifuge storing in the pond and irrigation.

### 2.3.2. Medium Priority

Hot Spot +1

The Kunovice farm with 15,000 hogs disposes of a thermal stabilization of slurry, but the slurry spreading over fields still threatens the surface and ground water quality.

Hot Spot +2

The JAVE Velké Němčice belongs with 13,000 hogs among the potential threatens of surface and ground waters though there is anaerobic wastewater treatment plant. The efficiency of this WWTP is not good enough and the Svratka River is bringing its water to the Nové Mlýny reservoirs serving as a natural preservation area for birds at the middle lake and for recreation activities at the upper and the lower lakes.

### 2.3.3. Low Priority

Hot Spot +1

In the locality of Strachotín belonging to Agropodnik Znojmo is stabled 10,000 hogs. Its location close to the Austrian border endangers both surface and ground water when spreading slurry over fields and fertilizing the fish ponds.

## 2.4. Industrial Hot Spots

### 2.4.1. High Priority

Hot Spot +1

As an industrial hot spot of the first rank of priority the industrial complex of Koželužny Otrokovice (Otrokovice Tannery) has been assessed (see Tab. C-7, C-10). This factory is still dominant industrial polluter of the Morava River in its central part. Though the third phase of intensification of treatment plant including biological treatment was finished in 1994, there is still achieved low efficiency of ammonium nitrogen removal (see Tab. C-15). Also organic pollution load characterized by COD is still rather high. There should be realized another phase of WWTP intensification covering nitrification and denitrification processes. As the water quality upstream Otrokovice was evaluated by the IV$^{th}$ class in the last years, the proposed intensification could help to improve the water quality for downstream drinking water uptakes of infiltrated water in the Morava River floodplain. Besides of protected area of natural water accumulation the aquatic life of the lower parts of the Morava River floodplain proposed for the Trilateral National Park at the Morava - Dyje Rivers confluence is also affected by this hot spot.

Hot Spot +2

At the second rank among the high priority hot spots was assessed the phosphate factory FOSFA Poštorná, which discharges wastewater into the Dyje River in a very short distance from the Austrian border. There was problem with fulfilling emission limit for phosphorus. At the end of June 1998 there should be finished the testing period of a new decontamination unit, but further investment into upgrading this WWTP function in phosphorus removal is strongly needed. There are also problems with leacheates from the adjacent dump site. Furthermore, the receiving waters are several kilometers upstream polluted by another hot spot - the Břeclav city, therefore the water quality upstream was in organic pollution and phosphorus described only by the IV$^{th}$ quality class. This river further enters the protected area of natural water accumulation and proposed Trilateral National Park.

### 2.4.2. Medium Priority

Hot Spot +1

The first place takes food factory HAME Babice. After flood in 1997 the production of this factory has been changed and therefore its treatment facilities need some support. Also in this place quality of receiving water is characterized by the IV$^{th}$ quality class and the Morava River downstream enters the protected area of natural water accumulation and also the area of proposed Trilateral National Park.

Hot Spot +2

TANEX Vladislav is another tannery factory among the hot spots, which substantially influences water quality of the Jihlava River upstream the great Dalešice reservoir and further downstream the Nové Mlýny reservoir. Though the total discharged pollution is not so high, the WWTP overcame the permissible emission limit in organic pollution and there is a high danger of toxic pollution.

The Jihlava River upstream pollution is classified by the IV$^{th}$ class of water quality. Downstream the Dalešice reservoir there is a trout zone fishing area and further recreational area on the Nové Mlýny reservoir.

### 2.4.3. Low Priority

Hot Spot +1

Snaha Brtnice was put into the group of industrial hot spots due to the problems with heavy metals (Cr) in the discharged tannery wastewater. It also exceeded the emission limits in organic pollution in 1996. The wastewater influences directly the small Brtnice River and after confluence with the Jihlava River its stretch upstream Vladislav. The impact on the reservoir water quality and trout zone downstream is not neglectable.

# 3. Identification of Diffuse Sources of Agricultural Pollution

Agriculture can be designated as the most important factor responsible for diffuse pollution in the Danube River basin on the Czech Republic territory. Total land under agricultural cultivation in the Morava River basin amounts to app. 1,250,000 ha. The changes in the farm production during the forty years of collective farming when the state supported projects were oriented towards intensification of crop production and concentration of animal husbandry resulted in fact that the whole river basin could be identified as an area of intensive agricultural activities. There were only certain differences in the structure of crops and amounts of industrial fertilizers applied to the agricultural land. Since the beginning of the sixties the use of fertilizers increased from 6.0 - 8.5 $t.km^{-2}$ to the maximum level of 21.6 - 33.2 $t.km^{-2}$ in 1986. Reduction of state subsidies, changes in owner rights, restructuralization and transformation of farm production after political changes in 1989 brought reduction in the application of agrochemicals down to 7.0 -17.0 t $NPK.km^{-2}$. As far as pesticides, their application on the basis of phenoxyacetic acid (MCPA), substituted urea and triazines were most prevailing. In the region with extensive farming the share of pesticides applied on agricultural land reached about 0.2 $t.km^{-2}$.

It is not easy to estimate the contribution of agriculture to the water pollution from application of agrochemicals on cultivated soil. The main areas of agricultural pollution comprise sediment discharges, nutrients and pesticides applied on fields in the last decades as a result of inappropriately used technologies. Though there have been realized great changes in agriculture in 90s´, the excessive area of pieces of land and their inappropriate land use that participate on the erosion danger, is still conserved.

From the results of global water quality project of the Morava River basin BERÁNKOVÁ states that the share of non-point sources of pollution in the Morava River basin reaches 40-60 % of the total balanced amount of nutrients e.g. 490-730 t of N and 180-270 t of P per year. Former intensification trends in agriculture reflected in increase of nitrate concentrations in surface waters from 15 $mg.l^{-1}$ to 30 - 40 $mg.l^{-1}$. The same trend in the last forty years was evident in the sediment discharges. There are not enough data for identification of total agricultural production in the Morava River basin, the only available data are those for the whole Czech Republic. As the gross agricultural production on ha of agricultural land in CR was 18,900 CZK in 1996, the total production from Morava River basin can be estimated as app. 23.6 billion CZK. As far as the total amount of used fertilizers, there are known data for the whole CR, where the average use of fertilizers in tons of active substance is in total 86.3 (58.9 nitrogen and 15.9 of phosphate) referred to the agricultural year 1995/96. For the Morava River basin it can be roughly estimated app. 30 % of the given amount for CR.

Erosion danger in the studied river basin can be divided into 5 categories according to the natural conditions of the characteristic parts. Potential annual soil loss (transport) differs from 1.5 -7.5 $t.ha^{-1}$. Actual erosion transport esp. in flysch belt in the smaller river basins in south eastern part of the Morava River basin (e.g. in the Dřevnice and Olšava River basins) is much higher and comes to 50 $t.ha^{-1}$. There was started a detailed monitoring program carried out by the Czech Hydrometeorological Institute in this region in last years which can soon bring useful information. Using the gained data from 1992-1994 the annual sediment discharge in the Morava River in Strážnice station was evaluated by 380,000 tons.

## 3.1. Grazing Areas

The total land used for grazing in the Morava River basin was estimated as app. 80,000 ha according to available data. The more intensive animal grazing was in the last years mostly concentrated into the upper parts of the river basin. As to the water quality impact concerns it can be stated that the negative impact of grazing activities is relatively low.

# 4. Updating and Validation of Water Quality Data

## 4.1. Index of Water Quality Monitoring Records

In the Morava River basin there are about 110 gauging stations situated on the important rivers where the water discharges are currently measured. The locations of these stations in the Morava River basin are evident from Fig. C-3. In the picture there were also entered water quality sampling stations, where organic pollution parameters, nutrients, suspended solids and heavy metals were measured. The period of water discharges monitoring depends on the locality - some stations are operating even since the last century and several stations downstream new reservoirs are in service only for a few years. As far as the water quality monitoring, since 1963 the major part of water quality sampling stations is involved into the national water quality-sampling network. There is a special monitoring network of water quality in the Project Morava, where the sampling stations were purposefully located downstream the NAP hot spots.

Index of water quality monitoring records for the stations upstream and downstream the high priority hot spots in the reference period (1994-1997) is stated in Tab. C-17. Instead of coordinates the river kilometers of the presented stations are used and given in the table.

## 4.2. Data Quality Control and Quality Assurance

Laboratory of Morava River Administration is externally checked by Accreditation Center ASLAB at Water Research Institute, Prague and by Czech Institute for Accreditation, the highest accreditation body in the Czech Republic. Accreditation Processes and Quality Control system within the laboratories is fully in accordance with European standards, namely EN 45 001 and covers all aspects of analytical procedures.

QA and QC system in WRI Brno laboratory is performed according to ČSN EN 45001 (General criteria for the operation of testing laboratories) and EURACHEM Guidance Document No. 1 (WELAC Guidance Document No. WGD2) - Guidance on the interpretation of the EN 45000. It concerns mainly problems of staff, environment, equipment, reagents, methods and procedures for calibrations and tests, reference materials and chemical standards, procurement and storage of reagents, sampling, sample handling and preparation, maintenance and calibration of instruments, problems of quality control and validation. Sample collection is performed according to Czech Standard ČSN EN 25667-2 (Guidance on sampling techniques; ISO 5667-2; 1991) and ČSN EN ISO 5667-6 (Guidance on sampling of rivers and streams). Preparation of sample containers, custody control and holding times, sample preservation and handling of samples etc. is carried out in accordance with ČSN EN ISO 5667-3 (Guidance on the preservation and handling of samples).

QC for analytical methods is performed mainly by Shewharts control charts (ČSN ISO 8258); blanks, spikes or split samples are used in many methods for controlling and testing of analytical methods. Collecting of analytical results and data handling are performed using Excel 7.0a spreadsheet (on Novell network) protected by system of passwords. Laboratory analyses are performed according to ČSN ISO (ČSN EN) standards or national standards. Laboratory of WRI Brno regularly takes part in interlaboratory comparison of tests organized by the Czech Center for Accreditation of Laboratories (ASLAB) and also in interlaboratory comparison of tests organized through AQUACHECK. Laboratory of WRI Brno is under laboratory audit and review now. In April 1998 WRI laboratory was given the quality audit by ASLAB (Center for Accreditation of Laboratories).

Standards, from which SOPs are derived:

| Water Quality Parameter | Standard used |
|---|---|
| Total N | CSN EN 25663 (ISO 5663:1984) |
| Total P | CSN 830 530 (Part 22) |
| COD | ISO 8467:1993, ISO 6060:1989 |
| $N\text{-}NH_4$ | CSN ISO 7150-1, CSN ISO 5664 |
| $N\text{-}NO_3$ | CSN 830530-25 |
| $PO_4$ | CSN 830 530-22 |
| Hg | CSN 830 530 |
| PCB | EPA Methods 525, 625 |

## 4.3. Data Consistency, Compatibility and Transparency

Data on nutrients and other presented pollutants represent content of those in the whole (unfiltered) sample. Thus, they express total discharge in the water column. For phosphorus both orthophosphates and total phosphorus data are given. Nitrogen in sampled sites represents only total inorganic nitrogen. Only in two sampling sites (Břeclav and Uherské Hradiště) are given data from flood event in the 1st half of July 1997, but the results of water quality parameters do not differ from other results. Synthetic data used in this study are those of water discharges in the cases that gauging station is not located in the same place as the sampling site. In that case for generating of the water discharge values a special interpolation standard method in CHMI was used.

### 4.4.1. Network

The basic part of the Morava River network is formed by two important watercourses - the Morava and Dyje Rivers. The Dyje River has a bit larger river basin (13 426 $km^2$) than the Morava River (10 485 $km^2$), but its average discharge is smaller than in the Morava River (44 $m^3.s^{-1}$/ 65 $m^3.s^{-1}$ resp.) The Morava River increases its discharge by several little and only one larger (the Bečva River) tributaries, the Dyje River is greatly supported by the Jihlava and Svratka Rivers in the lower part of its river course. River network is instructively demonstrated in the map in Fig. C-10, where the chosen scale - 1:1,000,000 - enables good orientation in distances.

### 4.4.2. Channel Cross Sections

The main channel characteristics e.g. widths and depths for the major stretches of the important rivers downstream the high priority hot spots are indicated together with gradients in table in Fig. C-4. As the lower part of the Morava and Dyje Rivers has been included in the DBAM, more detailed data are available there. The cross sections are mostly formed by slopes 1:2 (the Svratka River) and 1:2 - 1:2.5 (all other rivers), except of the stretch of the Dyje River between N. Mlýny and Bulhary, where the slope is 1:4. Also in the lower part of the Dřevnice River downstream Zlín WWTP the slope is 1:2 - 1:3.

### 4.4.3. Gradients

The data needed for the seriously influenced stretches of above mentioned important streams are presented in tables in Fig. C-4 where also localizations of the individual stretches are given. The Morava River in the studied central and lower parts has rather low gradient between 0.14 - 0.3 ‰. Gradient of the Svratka River is a bit higher (0.4 - 0.6 ‰), but the Dyje River has gradient as low as the Morava River itself, e.g. lesser than 0.3 ‰.

### 4.4.4. Floodplains

Upstream the Morava and Dyje Rivers confluence the Morava River floodplain forms biocorridor of European importance, which continues along the Bečva and Odra Rivers floodplains to Poland. Biocorridors of transregional importance are situated along the Dyje, Jihlava and Svratka Rivers. Within this study there have been identified the most important floodplains for higher than 30 years flood events, and given their localization and size. Instead of coordinates kilometers were presented. Their localization together with all other data needed was given in Fig. C-5. Data concerning the size of floodplains for the given high frequency events (5,10 and 30 years period) are not available.

Following an extreme flood event in July 1997 there was prepared a list of all registered floodplains (incl. little brooks). Their total area has been estimated as app. 1946 $km^2$. The average width of floodplains was about 0.1 - 0.7 km, except of those near the Morava and Dyje Rivers, where it came up in average to 2.0 km.

### 4.4.5. Wetlands

From the biodiversity point of view wetlands in the Morava River basin belong to the richest ecosystems in Europe. In the last fifty years these wetlands were unpleasantly influenced, several of them changed their character and some wet meadows and forests have disappeared. Localization and size of eight wetlands of transboundary and transregional importance are given in Fig. C-5. They differ much in size from small ones of 13 ha (Skařiny) to the largest ones of 11,500 ha - the Lower Dyje Wetlands. The last ones can be assigned as the most important wetlands of the Morava River basin. They are located in the area of the proposed Trilateral National Park Danube-Morava-Dyje, which would consist of the Austrian, Slovakian and Czech territories.

### 4.4.6. Erosion and Degradation

As there have been realized some regulations of river banks at the main and also some smaller rivers especially in the lower parts of their watercourses, bank erosion is currently relatively low. Specific situation occurred in July 1997 during more than hundred-year-flood event, when in several stretches (especially in the upper small river basins and in the Bečva River) a great channel and in some places also bank erosion occurred.

## 4.5. Dams and Reservoirs

The total storage capacity of the reservoirs in the river basin of the Morava River itself does not overcome 1.4 % of the average annual discharge, therefore the influence of the hydraulic regime by these reservoirs is not important. In the Dyje River basin is that of greater importance, because the total storage capacity of reservoirs comes up to 20.8 % of average annual discharge. The inventory of dams and reservoirs comprises fifteen important reservoirs in the whole Morava River basin with permanent storage capacity higher than 1 million $m^3$. The largest reservoir in this river basin is the Dalešice Reservoir with total storage capacity of 127 mil.$m^3$, which influences the lower part of the Jihlava and Dyje Rivers. Localization of the individual reservoirs incl. description of their general purpose is given in map in Fig. C-6. It can be stated that major part of the given reservoirs is used for flood protection, power generation and low flow augmentation, and in the southern part of the basin also for irrigation uptakes. The coordinates of each item as well as the efficiency of sediment trapping of these reservoirs are not available.

## 4.6. Other Major Structures and Encroachment

There is not any important dredging realized at the rivers in the Morava River basin. The lower stretches of the main rivers have been mostly canalized and there has been realized bank protection against fifty/hundred-year-flood. Following the historical flood in July 1997 a new system of flood control is under preparation. As far as water structures in the basin are concerned, there are some greater weirs in the lower part of the Morava, Dyje and Svratka Rivers. In the periods of lower flows these can support sediment trapping. Mentioned structures situated in the Morava River have significantly interrupted natural migration of four species of fish (nase, vimb, barbel, ide) upstream from the Danube River. The Morava River traditionally belongs to the most diversified rivers in Europe as far as the structure of fish community concerns. After the interruption some of the most valuable species do not naturally reproduce and this lead to the evident change of community structure favoring the species with ecologically lower demands.

## 4.7. Major Water Transfers

Concerning the Morava River basin there are not any greater transfers of water in the Czech part of the Danube River basin. As the only one international intrabasin transfer bifurcation of the Dyje River downstream the city of Znojmo at Krhovice weir can be mentioned. From this weir discharge of about 2 $m^3.s^{-1}$ is deviated to the Austrian part of the basin and returned back again upstream Nové Mlýny reservoir. Several bifurcations into the races in the central and lower parts of the Morava River are mostly of the local importance.

## 4.8. Preferred Sampling Stations and Data Sets

For the purpose of evaluation of hot spots in the prepared transboundary diagnostic analysis there has been prepared a large set of data measured in the reference period 1994-1997. The data set incorporates all the permanent sampling stations which lie close upstream or downstream the high priority hot spots. Among them there are also the two Czech TNMN stations, both situated in the transboundary stretch of the Morava and Dyje Rivers confluence (Morava - Lanžhot and Dyje - Pohansko). The station characterizing water quality upstream the confluence of the Morava River and Danube River is situated on the Slovak and Austrian border outside the Czech Republic territory.

In the Morava River basin there are only two institutes responsible for the water quality monitoring of large rivers. The permanent monitoring in the state monitoring network as well as monitoring of water quality in TNMN is performed by the laboratory of the Morava River Board (Povodí Moravy). The special monitoring focused on specific organics and heavy metals downstream the hot spots realized in the national water quality study - Project Morava - is performed by the Water Research Institute laboratory. Both laboratories are also appointed as reference laboratories within the EP DRB, where the last one takes the role of the sediment and biological monitoring reference laboratory in CR.

Data from the national monitoring network are centralized and stored in the national database in CHMI Prague, where they are supplemented with water discharge data, balanced and prepared for presentation in the Water Quality Yearbook. The list of three institutions responsible for measuring water discharge, sediment discharge and water quality providing data used in this study is given in Annex C-12.

When trying to choose the most suitable data out of the data in the national database and Project Morava database, the specific guidance recommendations given in the scenario from the Budapest workshop have been respected. In the process of making the choice priority was given to the stations with better geographical position to the priority hot spots, to the station where water quality parameters are longer time simultaneously measured and to the stations with data which entered the national database. As frequency of sampling is in both data sets equal (once a month), the main decisive factor for using these data sets was the length of the realized measurements. Respecting the given recommendation, the set of eleven sampling stations where data for the whole representative period together with the nearest gauging stations were mostly available has been chosen as the most suitable basis for the transboundary analysis (see Tab.C-17).

## 4.9. Water Discharges

Water discharges in all gauging stations are regularly evaluated in the CHMI and the adequate values for each water quality sampling station are assessed. The actual flow rates for each representative sampling station are given in Annexes C-1 - C-11. Monthly average, maximum and minimum discharges for 1995-97 are presented in Tab. C-18, C-19 and C-20. The last Tab. C-21 is devoted to the flow duration curves evaluated from fifty years period measurements (1931-1980). The hydrographs giving the continuous graphic records of the flow regime are not available.

## 4.10. Sediment Discharges

A special sediment monitoring in several stations in the lower part of the Morava River has been performed by the hydrological department of CHMI since 1985. In the last years there are four gauging stations where sediment sampling is realized. The data obtained from daily vertical samplings are being reassessed now and the more precise sediment rating curves will be finished by the end of 1998.

For estimation of approximate sediment loads in the water quality sampling stations the suspended solids data instead of sediment data were stated in tables in Annexes. There is only one sampling station identical to the sediment one, where parallel data of sediments and suspended solids can be presented (in Annex C-9 they are given in brackets). Generally in about 25 % of measurements these data do not differ more than max. 20 % of actual suspended solids values. The rest of sediments concentration data show evidently (3 -16times) different values. Preliminary evaluation of results gained from the daily average concentrations covering the whole measured period showed about 3 times higher sediment load to compare it with suspended solids load.

## 4.11. Water Quality Data

In this section the available water quality data from the four years period 1994-1997 are presented and reported. The presented water quality parameters include total nitrogen, but the routine measurement in CR gives only inorganic nitrogen as a sum of $N\text{-}NH_4^+$, $N\text{-}NO_2^-$ and $N\text{-}NO_3^-$. For the case of necessary precision available nitrogen fractions are also presented in the Annexes. As to other water quality parameters from group of heavy metals and other hazardous chemicals mercury and PCBs concentrations are given in Annexes C-1 - C-11. In the first half of nineties, before the seeds treatment with mercury based on herbicides has been prohibited, mercury belonged to the problematic water quality parameters in the Morava River basin. From time to time there still appear higher concentrations of mercury exceeding the imission limit in surface waters in CR (1 $\mu g.l^{-1}$). The second water quality parameter presented in Annex is PCBs.

Generally the most used method of surface water quality evaluation is classification according to the Czech Standard ČSN 75 7221 where 5 classes on water quality are used and for ranking into classes the characteristic value $c_{90}$ is applied. More detailed assessment is based on imission values given in the Government Order No.171/92 Coll., trend analysis of concentrations or of pollution loads.

### 4.11.1. Nitrogen

In the last four years the concentrations of total inorganic nitrogen fluctuated in the chosen 11 sampling sites between 1.4 - 12.2 $mg.l^{-1}$. The maxima of inorganic nitrogen was found in the Svratka River downstream the Brno hot spot (12.2 $mg.l^{-1}$), in the Svitava River upstream Brno (10.5 $mg.l^{-1}$), in the Svratka River in Brno-Pisárky (11.0 $mg.l^{-1}$) and in the Dřevnice River downstream the Zlín hot spot (10.5 $mg.l^{-1}$). Little lower maximum concentrations assessed in the Morava River itself (above 7 $mg.l^{-1}$) reflect certain improvement in this water quality parameter in this stretch of the Morava River. In ammonium nitrogen 39 % out of 73 sampled sites were assessed by the IV. and V. quality class e.g. heavily and very heavily polluted water (see Fig. C-7). Results gained when monitoring little rivers showed that about 16 % out of 816 sampled sites were ranked into this water quality category. The long term trends (1966-91) mostly reflect a decline of average concentrations of $NH_4^+$. Also the last decade (1986-95) trend signalized declining in ammonium nitrogen and mostly no trend in nitrate nitrogen.

### 4.11.2. Phosphorus

In 1994-97 concentrations of total phosphorus were within the range of 0.06-1.52 $mg.l^{-1}$. From the survey of total phosphorus data it can be seen that the maxima in this parameter (>1$mg.l^{-1}$) were found in 1994-97 downstream Brno hot spot (1.55 $mg.l^{-1}$) and downstream Hodonín (1.43 $mg.l^{-1}$), also in the Svitava River above Brno (1.52 $mg.l^{-1}$) and in the Morava River downstream Otrokovice (1.52 $mg.l^{-1}$) and in the last station of the Morava River monitoring in CR - in Lanžhot (1.25 $mg.l^{-1}$). Assessment of the large rivers signalized that in the last four years 58% of monitored stations was evaluated by the IV. - V. class (see Fig. C-8), in the category of small rivers only 20 % of their number. The long-term trends available only for phosphate phosphorus showed in 1966-91 strongly increasing trend. In the last decade increasing trend of concentration has been found in major part of sites in the Svratka River basin, in other parts of the Morava River basin this trend was either declining or not statistically significant. In major part of stations the average value came up 0.3-0.5 $mg.l^{-1}$, while the permissible imission value in surface waters acc. to the Government Order is 0.4 $mg.l^{-1}$.

### 4.11.3. COD

Values of $COD_{Cr}$ fluctuated in 1994-97 from 5.3 - 75 $mg.l^{-1}$. The presented data show the most serious problem in the Morava River downstream Otrokovice, Zlín and Kroměříž. We can say that cumulative effect of hot spot Zlín and Otrokovice is evidently seen predominately in organic pollution, in the results of the Kroměříž sampling station there can be seen cumulative effect of Přerov and Prostějov pollution discharges. The maximum value of about 75 $mg.l^{-1}$ occurred down Zlín, another high value coming up to 59 $mg.l^{-1}$ was found in the Morava River down Otrokovice. When assessing all 73 sampling sites situated at important rivers it has been found that in 51 % of these sites water quality corresponds to the IV. -V. class (see Fig. C-9). As to the small rivers 16 % were classified by the IV. - V. quality class. Long-term trends of this water quality parameter were mostly decreasing reflecting improvements in organic pollution loads. Though the most significant sources of pollution have their treatment plants built up, an increasing trend can be still seen in 1/3 of evaluated stations in the Dyje River basin in the last decade.

### 4.11.4. Heavy Metals

As the most dangerous for human and aquatic life out of group of heavy metals high mercury concentrations have been assessed in the Project Morava in 1992-1995. This was the reason why the mercury was presented as notable parameter in the survey in group of specific matters and heavy metals. Except of four stations, in all other measured sites presented in this study maximum concentrations of Hg higher than permissible value for this parameter in the Government Order (1.0 μg.l$^{-1}$) were found. The maximal concentrations were highest in sampling station at the Svratka River downstream Brno (2.8 μg.l$^{-1}$), in the Morava River downstream Otrokovice (Spytihněv 2.6 μg.l$^{-1}$) and at the Svitava River upstream Brno (Obřany 2.0 μg.l$^{-1}$). It is not possible to assess the long-term trends in this parameter because the monitoring of heavy metals started at the beginning of 90s.

The comparison of results from 1992-93 with the results from the last years shows the evident improvement and decrease of former higher concentrations. Any contribution of point source of pollution has not been found yet.

### 4.11.5. Oil and Other Hazardous Chemicals

In the last several years with enlarged spectrum of monitored chemicals a problem of notable high concentrations of PCBs in the surface waters in the Morava River basin appeared. PCBs originate in the old loads of the environment from products with their content. Even now after their prohibition their leaching into water cannot be excluded. That is the reason why this parameter is presented in this study. In the period 1994-97 the highest value of PCBs was found in the Svitava River (3,345 ng.l$^{-1}$). Also the PCBs concentrations in Lanžhot and Uherské Hradiště (221 and 105 ng.l$^{-1}$ resp.) are notably high. According to the Government Order No. 171/92 Coll. the permissible imission value is 25 ng.l$^{-1}$. As the PCBs are measured only since 1991, any trends of concentrations can not be given.

### 4.11.6. Special Linkages

The effect of atmospheric depositions of nutrients on agricultural land has been tested using the results of monitoring carried out by the Central Supervising and Testing Institute of Agriculture in Brno. Measurement in 1990-1993 showed the minimum values of about 8 kg N.ha$^{-1}$ and 0.3 kg P.ha$^{-1}$, while the maximum values could be even ten times higher.

Statistical analysis of concentration data and following calculations of mass flow of mineral nitrogen and phosphorus based on the data from monitoring in 12 river sampling sites in 1992-93 demonstrated that the minimal load belonging rather to the point sources of pollution is about fifteen times lower than the load during high water level associated with maximum loads from non-point sources of pollution.

The evident drop in nitrogen fertilizers application in CR after 1990 down to 60 % of former amount (from 99 kg N per ha of agricultural land to 40 kg.ha$^{-1}$ in 1993 and later to 61 in 1996) followed by other changes has not reflected in reduction of the nutrient load of waters. The same situation was in phosphates, where portions applied have been cut down from 65 to 12 kg $P_2O_5$ per ha in 1989/1996. Long-term trend of both nitrate concentration ($c_{90}$) in the final sampling site on the Czech territory (Lanžhot) and the amount of yearly applied mineral nitrogen fertilizers in the detached district showed parallel increasing trend up to 1980-1982 followed in last years by decreasing trend in fertilizers and only very slight decline in nitrate concentrations.

# 5. Brief Overview of Legal and Institutional Framework for Water Quality Control

## 5.1. Water Legislation

Protection of water and water rights in general is regulated by Act No.138/1973 Coll. on Waters, Act No.130/1974 Coll. on State Administration and Water Management, amending Government Order No.35/1979 Coll., on Payments in the Field of Water Economy and related regulations, especially Government Order No.171/1992 Coll., regulating the indicators for permissible degree of water pollution as amended by Government Order No.185/1996 Coll.

The Act No.138/1973 on Waters is the principal legal document with respect to water issues governing legal aspects of water protection, water management facilities, and defining the domain of water management authorities and municipalities. This Act regulates also international water and transboundary water.

The Water Act determines the basic requirements for any activities, which could affect the amount and quality of water. Among others, the discharge of wastewater into ground or surface waters is a subject of permitting process. The water management authority will issue the permit based upon the Government Order No.171/1992, which sets up the admissible limits of the water pollution. According to this Order, the water management authority will take into account the emission limits with making allowance of the ambient water quality limits.

## 5.2. Mandates through the Government Hierarchy

The present water management administrative system in the Czech Republic is represented by institutions of the state administration which have responsibility in permitting all the activities of water use generally including licensed abstractions, discharges, permitting water constructions and deciding about water use in situations of water lack or during flood flow emergency and deciding about conditions of water protection and basic supervising compliance with license condition.

System of these institutions has three competent authority levels. Decision process is made in the first level where negotiations about licensed abstractions or discharges or about permitting constructions are exercised. This first competent authority is represented by district offices and chosen municipal offices (e.g. larger cities). These offices are organized as complex authorities with departments for separate special professional matters. Water management belongs to the department of environment; district offices belong to the sphere of competence of the Ministry of Interior.

Authorities of the higher competence authority resolve only appeals of the parties from unsuccessful negotiations at the lower level and they are domiciled to competent sphere of the Ministry of the Environment. These are regional departments of this Ministry and as the third level the highest organ of water management administration is the Ministry itself.

The River Basin Administrations (Companies) are responsible for organization of technical custody in the individual basins and except coordination of all water activities including basic care over groundwater.

The River Basin Administrations appertain to the competent sphere of Ministry of the Agriculture. The watercourses with local importance in agriculture or forest landscape are in technical custody by two state organizations belonging also to competent sphere of the Ministry of Agriculture. They are the State Melioration Administration and the Forests of the Czech Republic.

## 5.3. Relevant International Agreements

As the most important international agreement in the sphere of water management and environmental protection can be stated the following:

*Europe Association Agreements*, which have been concluded between the EU and Central and East European Countries to prepare their eventual accession to the European Union. The agreements provide increased cooperation in a number of areas including environment.

The UN/ECE *Convention on Protection and Use of Transboundary Watercourses and International Lakes* (Helsinki Convention), which was signed by 25 countries and European Community in 1992 and came into effect in October 1996. The Convention is under process of adoption in the Czech Republic.

*The Convention on Wetlands of International Importance, Especially as Wildlife Habitat* (Ramsar, 1991) and *Convention on Biological Diversity* (Rio de Janeiro, 1992) were ratified by the Czech Republic.

Finally the important activities realized in the Danube River basin have been since 1991 under the umbrella of the *Environmental Programme for the Danube River Basin* (the Danube Environmental Programme) which the Danube River countries drawn up in 1991 in order to emphasize an initiative to support and reinforce national actions for the restoration and protection of the environment of both this basin and the Black Sea. The linked activities to the Programme were given by the *Convention on Cooperation for the Protection and Sustainable Use of the River Danube* (the Danube River Protection Convention) which was signed in 1994 in Sofia.

# Tables

Tab. C-1

## Hot spots in the Strategic Action Plan for the Danube River basin - 1994 (Environmental programme for the Danube River basin)

| Name / Site | Location (river basin) | Type | Problems / Issues | Cost |
|---|---|---|---|---|
| **BRNO** | Morava/Svratka | Municipal WWTP modernization, sewerage network system reconstruction | Efficient drainage and treatment of municipal and industrial (engineering, textile and chemical industries) waste waters. Disposal of municipal WWTP sludge | USD 39.75 mil. |
| **DOLNI ROZINKA** | Morava/Svratka | Possible risks of surface drinking water sources contamination - heavy metals and hazardous substances | need of modern monitoring and warning system | USD 0.7 mil. |
| **LEDNICE (FRUTA)** | Morava/Dyje | Food processing | Vegatable and fruit processing, organic chemical pollution | USD 0.9 mil. |
| **OLOMOUC** | Morava | Municipal WWTP | BOD; pathogens; micro pollutants from industry | |
| **POSTORNA (FOSFA)** | Morava/Dyje | Fertilizer factory | Production of phosphoric acid, sulphuric acid, leakages of phosphates to groundwater | USD 1.2 mil. |
| **PREROV** | Morava/Becva | Sewerage network system reconstruction, MWWTP reconstruction. Sanitation of chemical industry structures - "Precheza" | Threatening of ground water sources - drinking water for Troubky - Tovačov. Acids, oils and hazardous wastes | Prerov MWWTP - USD 11.22 mil. Prerov sewerage network system - USD 2.20 mil. Precheza USD 2.42 mil. Total - USD 15.87 mil. |
| **STARE MESTO u UHERSKEHO HRADISTE** | Morava | Dye factory producing and storing products containing PCBs | Changing to new technologies, sanitation to prevent groudwater contamination(PCBs). Threatening of ground water sources - drinking water for Uherské Hradiště region | USD 2.46 mil. |
| **SUMPERK - OLSANY** | Morava | Pulp and paper mill | Discharges impact protected area | |
| ***Various*** | Morava | Agriculture - large hog farms (between 10 000 - 30 000 of livestock) | Organic pollution and spreading of slurry from hog farms in Milotice and Dubnany (district Hodonin), Tesnovice (district Kromeriz), Dlouha Loucka and Paseka (district Olomouc), Sebetov (Blansko), Krizanov - Jakubovicky Dvur (d. Zdar nad Sazavou), Vicov (d. Prostejov), Jave Velke Nemcice (district Breclav) | USD 4 mil. |
| **ZLIN - OTROKOVICE** | Morava | Municipal sewerage network system reconstruction, finishing the WWTP construction, sanitation of industrial waste waters "Toma" tannery | High loads of stream during lower flows, oxygenless states, eutrophication | Toma tannery - USD 0.31 mil. Otrokovice WWTP - USD 4.58 mil. Sewerage network system reconstruction - USD 0.39 mil. total - USD 5.28 mil. |

Tab. C-2

# Municipal hot spots according to NAP 1995 (actualized 1997)

| No. | Municipality | Receiving water | PE of waste water entering WWTP | $BOD_5$ load entering the river ($t.year^{-1}$) | | Main parameters of water pollution | Proposed arrangement |
|---|---|---|---|---|---|---|---|
| | | | | present state | after realization of suggested measures | | |
| 1 | **BRNO** | Svratka | 450,0 | 515 | 507 | $BOD_5$, COD, N-$NH_4$, $P_t$ | WWTP intensification and completion |
| 2 | **PROSTEJOV** | Valova | 120,0 | 95 | 90 | $BOD_5$, N-$NH_4$, $P_t$ | WWTP intensification and completion |
| 3 | **JIHLAVA** | Jihlava | 100,0 | 238 | 87 | $BOD_5$, COD, N-$NH_4$, $P_t$ | WWTP reconstruction (N uptake) |
| 4 | **VYSKOV** | Hana | 35,0 | 35 | 35 | $BOD_5$, COD, N-$NH_4$, $P_t$ | WWTP reconstruction and intensification |
| 5 | **ZLIN** | Drevnice | 130,0 | 307 | 147 | $BOD_5$, COD, N-$NH_4$, $P_t$ | WWTP intensification and sewarage network system reconstruction |
| 6 | **HODONiN** | Morava | 75,6 | 32 | 42 | $BOD_5$, COD, N-$NH_4$ | WWTP global reconstruction |
| 7 | **BRECLAV** | Dyje | 30,0 | 62 | 58 | $BOD_5$, COD, N-$NH_4$, $P_t$ | WWTP reconstruction and intensification |
| 8 | **TREBIC** | Jihlava | 64,0 | 79 | 43 | $BOD_5$, COD, N-$NH_4$, $P_t$ | WWTP reconstruction and intensification |
| 9 | **UHERSKE HRADISTE** | Morava | 83,0 | 74 | 43 | $BOD_5$, COD, N-$NH_4$, $P_t$ | WWTP reconstruction and intensification |
| 10 | **PREROV** | Becva | 94,5 | 248 | 110 | $BOD_5$, COD, N-$NH_4$ | WWTP reconstruction and intensification |
| 11 | **HANUSOVICE** | Morava | 43,0 | 123 | 4 | $BOD_5$, COD, N-$NH_4$, $P_t$ | Sewarage system construction |
| 12 | **VALASSKE MEZIRICI** | Becva | 63,9 | 83 | 51 | $BOD_5$, COD, N-$NH_4$, $P_t$ | WWTP reconstruction (N, P uptake) |

**Tab. C-3**

**Agricultural hot spots according to NAP 1995 (actualized 1997)(The large hog farms with more than 10 000 of live stock)**

| No. | Name of Locality | Farm | Present state of livestock (thousand) | Endangered water resource (river) | Slurry treatment |
|---|---|---|---|---|---|
| 1 | **MILOTICE** | Agropodnik Hodonín, fa Milotice | 28 | Kyjovka | Storing of centrifugate in lagoons spreading over fields |
| 2 | **SEBETOV** | Agropodnik Skalice, fa Sebetov | 20 | Svitava | Anaerobic fermentation, spreading over fields |
| 3 | **STRACHOTICE** | Agropodnik Znojmo, fa Strachotice | 10 | Dyje | Spreading over fields, fertilization of fish ponds |
| 4 | **VEL.NEMCICE** | JAVE Vel.Nemcice | 13 | Svratka | 6 stage aerobic wastewater treatment plant |
| 5 | **DUBNANY** | Gigant Dubnany | 28 | Kyjovka | Storing of centrifugate in pond, slurry irrigation |
| 6 | **TESNOVICE** | Slouceny zemed. podnik Tesnovice | 21 | Morava | Centrifugate discharge to WWTP Kromeriz |
| 7 | **D.LOUCKA** | Vepaspol Olomouc, fa D.Loucka | 17 | Oskava | Mechanical-biological WWTP, spreading over fields |
| 8 | **PASEKA** | Vepaspol Olomouc, fa Paseka | 10 | Oskava | Mechanical-biological WWTP, spreading over fields |
| 9 | **VICOV** | ZD Vicov, fa Vicov | 13 | Valova | Mechanical-biological WWTP, spreading over fields |
| 10 | **KUNOVICE** | Zevos, fa Kunovice | 15 | Morava | Thermal stabilization, spreading over fields |

Tab. C-4

**Industrial hot spots according to NAP 1995 (actualized 1997)**

| No. | Industrial property | Receiving water | $BOD_5$ load entering the river ($t.year^{-1}$) | | Main parameters of water pollution | Suggested Arrangements |
|---|---|---|---|---|---|---|
| | | | present state | after realization of suggested measures | | |
| 1 | **SNAHA BRTNICE** | Jihlava | 22,5 | 4,0 | $BOD_5$, COD, $Cr_t$ | Reconstruction of CB WWTP |
| 2 | **KOZELUZNY OTROKOVICE** | Drevnice | 144,7 | 144,7 | $BOD_5$, COD, N | Reconstruction of sewarage system, construction unit for N uptake |
| 3 | **MORAVANKA DUBNANY** | Rumzovsky jarek | 62,5 | 4,5 | $BOD_5$, COD | Construction of MB WWTP |
| 4 | **MORPA JINDRICHOV** | Branna | 70,3 | 24,0 | $BOD_5$ | Construction of MB WWTP |
| 5 | **NOBLESLEN HANUSOVICE** | Morava | 31,8 | 22,0 | $BOD_5$, COD, oil | Construction of pretreatment and sewarage |
| 6 | **TANEX VLADISLAV** | Jihlava | 17,6 | 11,5 | $BOD_5$, COD | Intensification and reconstruction of WWTP |
| 7 | **VYSOCINA HODICE** | Trestsky potok | 4.1 ( 216.9 ) | 4.1 ( 140.0 ) | $BOD_5$, COD | Construction of MB WWTP |

**Tab. C-5**

**Revised list of municipal hot spots prepared within the Danube Pollution Reduction Programme**

| No. | Municipality | Receiving water | PE of waste water entering WWTP | Main parameters of water pollution which do not fulfil the demands of Governmental Regulation No. 171/92 Coll. | Priority Order |
|---|---|---|---|---|---|
| 1 | **Brno** | Svratka | 500,0 | $N\text{-}NH_4$, $P_t$ | High |
| 2 | **Zlin** | Drevnice | 150,0 | $BOD_5$, COD, $N\text{-}NH_4$, $P_t$ | High |
| 3 | **Uherske Hradiste** | Morava | 83,0 | $BOD_5$, $N\text{-}NH_4$, $P_t$ | High |
| 4 | **Hodonin** | Morava | 75,6 | $BOD_5$, COD, $N\text{-}NH_4$ | High |
| 5 | **Breclav** | Dyje | 30,0 | $BOD_5$, $N\text{-}NH_4$ | Medium |
| 6 | **Olomouc** | Morava | 180,0 | $P_t$ | Medium |
| 7 | **Prerov** | Becva | 110,0 | $N\text{-}NH_4$ | Medium |
| 8 | **Kromeriz** | Morava | 35,0 | $BOD_5$, COD, $N\text{-}NH_4$, $P_t$ | Low |
| 9 | **Prostejov** | Valova | 120,0 | $N\text{-}NH_4$ | Low |
| 10 | **Znojmo** | Dyje | 50,0 | $BOD_5$, COD, $N\text{-}NH_4$, $P_t$ | Low |

Tab. C-6

**Revised list of agricultural hot spots prepared within the Danube Pollution Reduction Programme**

| No. | Name of locality | Hog farm | Present state of livestock (in thousands) | Endangered water resource (river) | Priority Order |
|---|---|---|---|---|---|
| 1 | **MILOTICE** | Agropodnik Hodonin, fa Milotice | 22 | Kyjovka | High |
| 2 | **DUBNANY** | Gigant Dubnany | 20 | Kyjovka | High |
| 3 | **KUNOVICE** | Zevos, fa Kunovice | 15 | Morava | Medium |
| 4 | **VEL.NEMCICE** | JAVE Vel.Nemcice | 13 | Svratka | Medium |
| 5 | **STRACHOTICE** | Agropodnik Znojmo, fa Strachotice | 10 | Dyje | Low |

**Tab. C-7**

**Revised list of industrial hot spots prepared within the Danube Pollution Reduction Programme**

| No. | Industrial property | Receiving water | Main parameters of water pollution | Priority Order |
|---|---|---|---|---|
| 1 | **KOZELUZNY OTROKOVICE** | Drevnice | $N\text{-}NH_4$ | High |
| 2 | **FOSFA POSTORNA** | Dyje | $P_t$ | High |
| 3 | **HAME BABICE** | Morava | $BOD_5$, COD | Medium |
| 4 | **TANEX VLADISLAV** | Jihlava | $BOD_5$, COD, $C_r$ | Medium |
| 5 | **SNAHA BRTNICE** | Brtnice | $BOD_5$, COD | Low |

Tab. C-8

**Criteria for simple decision analysis of hot spots priority order**

| No. | Criterion Identification | Point Assessment of Individual Criteria | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| 1 | **Pollution load** **COD** ( t.year$^{-1}$ ) | > 1000 | > 500 | > 300 | > 200 | < 200 |
| 2 | **Pollution load** **N-NH$_4$** ( t.year$^{-1}$) | > 500 | > 300 | > 100 | > 50 | < 50 |
| 3 | **Pollution load** **Pt** ( t.year$^{-1}$) | > 100 | > 50 | > 30 | > 20 | < 20 |
| 4 | **Dillution factor** **$Q_{355}$ : $Q_{effl.}$** | < 1 | < 5 | < 20 | < 100 | > 100 |
| 5 | **Ambient water quality** water quality class **COD** ( mg.l$^{-1}$) | V. > 55 | IV. < 55 | III. < 35 | II. < 25 | I. < 15 |
| 6 | **Ambient water quality** water quality class **N-NH$_4$** ( mg.l$^{-1}$) | V. > 5 | IV. < 5 | III. < 1.5 | II. < 0.5 | I. < 0.3 |
| 7 | **Ambient water quality** water quality class **$P_t$** ( mg.l$^{-1}$) | V. > 1 | IV. < 1 | III. < 0.4 | II. < 0.15 | I. < 0.03 |
| 8 | **Downstream use of water** | * drinking water uptakes<br>* PANWA<br>* National Parks | * bathing<br>* trout zones (fishing)<br>* river entering reservoirs | * agricultural irrigations<br>* industrial usage - higher demands<br>* carp zones | * industrial usage - lower demands<br>* agricultural usage - lower demands<br>* canoeing and other water sports | * other usage |
| 9 | **Transboundary effect** - distance to the border (km) | < 10 | < 30 | < 50 | < 100 | > 100 |
| 10 | **Canalization of river** - diffuse pollution effect | fully canalized<br>industrial area | mostly artificial banks/bottom<br>high intensive farming | partly artificial banks/bottom<br>middle intesive farming | only few parts of river banks/bottom artificial<br>low intensive farming | near to natural state<br>natural vegetation cover |

? Protected Area of Natural Water Accumulation

**Tab. C-9**

**Simple decision analysis of municipal hot spots priority order based on the state-of-the-art in 1996**

| Hot Spot Priority Order | Hot Spot | River | River km | Detailed Assessment of Individual Priority Criterion 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total Sum of Points | Priority Order |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Brno** | **- Svratka** | 39,1 | 1913 **5** | 678 **5** | 355 **5** | 2.3 **4** | III./III. **3** | II./III. **2.5** | III./IV. **3.5** | DW **5** | (80) **2** | **4** | **39** | **High** |
| 2 | **Zlin** | **- Drevnice** | 6,5 | 1147 **5** | 302 **4** | 46 **3** | 0.7 **5** | III. **3** | III. **3** | III. **3** | PANWA **5** | (70) **2** | **4** | **37** | **High** |
| 3 | **Uherske Hradiste** | **- Morava** | 157,1 | 246 **2** | 110 **3** | 4 **1** | 95.8 **2** | IV. **4** | IV. **4** | IV. **4** | PANWA **5** | (51) **4** | **4** | **33** | **High** |
| 4 | **Hodonin** | **- Morava** | 99,0 | 228 **2** | 31 **1** | 30 **1** | 115.6 **1** | IV. **4** | IV. **4** | IV. **4** | PANWA **5** | 0.5 **5** | **5** | **32** | **High** |
| 5 | **Breclav** | **- Dyje** | 24,5 | 601 **4** | 94 **2** | 8 **1** | 54.7 **2** | III. **3** | III. **3** | IV. **4** | PANWA **5** | 7 **5** | **3** | **32** | **Medium** |
| 6 | **Olomouc** | **- Morava** | 232,0 | 1422 **5** | 44 **1** | 102 **5** | 9.1 **3** | II. **3** | III. **3** | III. **3** | PANWA **5** | 125 **1** | **3** | **32** | **Medium** |
| 7 | **Prerov** | **- Becva** | 8,1 | 346 **3** | 110 **3** | 4 **1** | 8.4 **4** | III. **3** | III. **3** | III. **3** | PANWA **5** | 108 **1** | **3** | **29** | **Medium** |
| 8 | **Kromeriz** | **- Morava** | 200,0 | 332 **3** | 131 **3** | 23 **2** | 71.2 **2** | II. **2** | III. **3** | IV. **4** | PANWA **5** | 101 **1** | **3** | **28** | **Low** |
| 9 | **Prostejov** | **- Valova** | 15,4 | 435 **3** | 197 **3** | 5 **1** | 0.71 **5** | III. **3** | II. **2** | III. **3** | WI **3** | 110 **1** | **3** | **27** | **Low** |
| 10 | **Znojmo** | **- Dyje** | 126,5 | 511 **4** | 141 **3** | 11 **1** | 10.9 **3** | III. **3** | I. **1** | III. **3** | RER **4** | **1** | **2** | **25** | **Low** |

**Tab. C-10**

**Simple decision analysis of industrial hot spots priority order based on the state of state-of-the-art in 1996**

| Hot Spot Priority Order | Hot Spot | River | River km | Detailed Assessment of Individual Priority Criterion | | | | | | | | | | Total Sum of Points | Priority Order |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| 1 | **Kozeluzny Otrokovice** | **- Morava** | 177,2 | 791.9 **4** | 229.6 **3** | 3.7 **1** | 47.0 **2** | III. **3** | IV. **4** | III. **4** | PANWA **5** | 107 **1** | **4** | **31** | **High** |
| 2 | **FOSFA Postorna** | **- Dyje** | 22,1 | 15.1 **1** | 0.96 **1** | 102.6 **5** | 1064 **1** | IV. **4** | IV. **4** | IV. **4** | PANWA **5** | 3 **5** | **3** | **31** | **High** |
| 3 | **HAME Babice** | **- Morava** | 166,8 | 211.6 **2** | 15.7 **1** | 1.5 **1** | 690 **1** | IV. **4** | IV. **4** | IV. **4** | PANWA **5** | 96 **2** | **4** | **28** | **Medium** |
| 4 | **TANEX Vladislav** | **- Jihlava** | 87,0 | 92.3 **1** | 26.4 **1** | 0.2 **1** | 88 **2** | IV. **4** | IV. **4** | IV. **4** | TZ,RER **4** | 113 **1** | **3** | **25** | **Medium** |
| 5 | **SNAHA Brtnice** | **- Brtnice** | 10,6 | 77.8 **1** | 3.1 **1** | 0.2 **1** | 17 **3** | II. **2** | III. **3** | III. **3** | TZ,RER **4** | 169 **1** | **2** | **21** | **Low** |

**Tab. C-11**

**Summary of information for the high priority hot spots**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of the Hot Spot: | BRNO | | | | | | | | | | | |
| Name of the receiving water: | Svratka | | | | | | | | | | | |
| River km of the effluent: | 39,1 | | | | | | | | | | | |
| Critical Emissions | Discharge ($10^3 m^3.year^{-1}$) | | | COD ($t.year^{-1}$) | | | $N\text{-}NH_4^+$ ($t.year^{-1}$) | | | $P_t$ ($t.year^{-1}$) | | |
| | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 |
| | 47000 | 39027 | 44897 | 3525 | 1592 | 1913 | 992 | 355 | 552 | 99 | 101 | 139 |
| Seasonal Variations | Downstream the hot spot there is rather critical dillution factor ($Q_{355}$:$Q_{effl.}$= 2), which in the period of summer low flows causes unpleasant states of water quality. This may affect principal users or the state of aquatic life. | | | | | | | | | | | |
| Immediate Causes of Emissions | Old sewerage system in the city as well as insufficient capacity of the WWTP esp. in P and N uptakes - intensification of this WWTP is strongly needed. | | | | | | | | | | | |
| Root Causes of Water Quality Problems | Relatively large city lying on the river with relative small discharge in combination with the insufficient treatment (esp. in nutrients) create problem to downstream users and aguatic life as well. | | | | | | | | | | | |
| Receiving Waters | Receiving waters are formed by two rivers: The Svratka River and the Svitava River. The first one has water quality in referring parameters (COD, P, N) responding to III$^{rd}$ water quality class. The Svitava River which is comparable in discharge with the Svratka River is mostly ranked to the IV$^{th}$ quality class (COD, Pt, Hg). | | | | | | | | | | | |
| Nearby Downstream Uses | Small irrigation and other uptakes several kilometres downstream the effluent of WWTP. Vulnerability of the drinking water underground accumulation area lying downstream is high, vulnerability of the recreation area of low N.Mlyny reservoir as well as the natural area for birds in central N.Mlyny reservoir is not neglectable. | | | | | | | | | | | |
| Transboundary Implications | The Dyje River near its confluence with the Svratka River forms border with Austria. In this part the Dyje River is rich in fishery attractive fish. Due to the unique nature parts and very natural state of this area there is prepared a concept of Trilateral National Park. | | | | | | | | | | | |
| Rank | High | | | | | | | | | | | |

Tab. C-12

**Summary of information for the high priority hot spots**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of the Hot Spot: | ZLIN | | | | | | | | | | | |
| Name of the receiving water: | Drevnice | | | | | | | | | | | |
| River km of the effluent: | 6,5 | | | | | | | | | | | |
| Critical Emissions | Discharge ($10^3 m^3.year^{-1}$) | | | COD ($t.year^{-1}$) | | | $N\text{-}NH_4^+$ ($t.year^{-1}$) | | | $P_t$ ($t.year^{-1}$) | | |
| | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 |
| | 11220 | 11316 | 11242 | 994 | 990 | 1147 | 278 | 238 | 302 | 30 | 37 | 46 |
| Seasonal Variations | Capacity of the Drevnice River is rather small to dilute the emission esp. in storm flows and in the summer low flow periods. In combination with higher temperature it influences the water quality in the Morava River and subsequently the downstream users. | | | | | | | | | | | |
| Immediate Causes of Emissions | To improve insufficient treatment a reconstruction of Zlin WWTP has been started. Lack of money caused a delay of the reconstruction. It is necessary to involve the removal of nutrients into the treatment process. | | | | | | | | | | | |
| Root Causes of Water Quality Problems | Combination of insufficient treatment and low dilution factor, which is caused by drinking water uptakes from the dam upstream the hot spot. | | | | | | | | | | | |
| Receiving Waters | Water quality of the Drevnice River was in the last period classified by III$^{rd}$ class, the Morava River water was also in the III$^{rd}$ class of water quality. | | | | | | | | | | | |
| Nearby Downstream Uses | The Drevnice and Morava Rivers downstream Zlin flow through the Protected area of Natural Water Accumulation. Drinking water uptakes from the accumulation (alluvial ground water resources and qravel pits area) are influenced by the emitted pollution as well as the aquatic life esp. fish in transboundary area. | | | | | | | | | | | |
| Transboundary Implications | There is some effect on water uptakes in transboundary Morava River stretch, further impact on aquatic life in suggested Trilateral Natural Park is also evident. | | | | | | | | | | | |
| Rank | High | | | | | | | | | | | |

**Tab. C-13**

**Summary of information for the high priority hot spots**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of the Hot Spot: | UHERSKE HRADISTE | | | | | | | | | | | |
| Name of the receiving water: | Morava | | | | | | | | | | | |
| River km of the effluent: | 157,1 | | | | | | | | | | | |
| Critical Emissions | Discharge ($10^3 m^3.year^{-1}$) | | | COD ($t.year^{-1}$) | | | $N\text{-}NH_4^+$ ($t.year^{-1}$) | | | $P_t$ ($t.year^{-1}$) | | |
| | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 |
| | 3783 | 2896 | 3108 | 265 | 188 | 246 | 78 | 87 | 73 | 13 | 41 | 11 |
| Seasonal Variations | Due to the reduction of food processing industry connected to the WWTP the seasonal variations are at present nearly neglectable. More serious problems arise in connection with the low flow periods in combination with high water temperatures. | | | | | | | | | | | |
| Immediate Causes of Emissions | Present waste water treatment plant should be strenghtened by unit enabling reduction of N and P emissions to receiving water. | | | | | | | | | | | |
| Root Causes of Water Quality Problems | Root cause reffers to combination of high nutrient emissions and water quality uptakes in the Morava River. | | | | | | | | | | | |
| Receiving Waters | The receiving Morava River is influenced by several sources of pollution so that its water quality is classified by $IV^{th}$ class of water pollution (excluding parameter $P_t$ in $V^{th}$ class). | | | | | | | | | | | |
| Nearby Downstream Uses | The Morava River is an important water source from which water is infiltering into the Protected Area of Natural Water Accumulation in the adjacent Morava River alluvial plain. Downstream Uherske Hradiste is the largest user of water in the Morava River Basin - thermic power plant Hodonin. | | | | | | | | | | | |
| Transboundary Implications | In the Morava River transboundary stretch aquatic life and water uptakes are adequately influenced by this hot spot as well as the nature of the prepared Trilateral National Park at the confluence of the Dyje and Morava Rivers. | | | | | | | | | | | |
| Rank | High | | | | | | | | | | | |

Tab. C-14

**Summary of information for the high priority hot spots**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of the Hot Spot: | HODONIN | | | | | | | | | | | |
| Name of the receiving water: | Morava | | | | | | | | | | | |
| River km of the effluent: | 99,0 | | | | | | | | | | | |
| Critical Emissions | Discharge ($10^3 m^3.year^{-1}$) | | | COD ($t.year^{-1}$) | | | $N\text{-}NH_4^+$ ($t.year^{-1}$) | | | $P_t$ ($t.year^{-1}$) | | |
| | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 |
| | 2816 | 2801 | 2585 | 386 | 305 | 228 | 24 | 27 | 31 | 5 | 5 | 3 |
| Seasonal Variations | Connected food processing industry does not cause any evident seasonal variation of discharge or water quality. | | | | | | | | | | | |
| Immediate Causes of Emissions | Situated so close to border of the Slovak Republic and Austria this Hot Spot urgently heeds a further treatment unit enabling adeguate reduction of nutrients in discharged waters. | | | | | | | | | | | |
| Root Causes of Water Quality Problems | Combination of nutrient emissions with polluted receiving water. | | | | | | | | | | | |
| Receiving Waters | The Hodonin Hot Spot is situated downstream several sources of pollution including two hot spots so that the water quality of the Morava River is adequate to $IV^{th}$ - $V^{th}$ class. | | | | | | | | | | | |
| Nearby Downstream Uses | Except of drinking water uptakes from Protected Area of Natural Water Acumulation there is an urgent need to preserve aquatic and terrestrial life of this very natural part of alluvial plane at the confluence of two major Moravian rivers in this transboundary section. | | | | | | | | | | | |
| Transboundary Implications | There is an urgent need of improvement of conditions not only for water uptakes but predominantly for the nature preservation at the transboundary region suggested for the Trilateral National Park. | | | | | | | | | | | |
| Rank | High | | | | | | | | | | | |

**Tab. C-15**

**Summary of information for the high priority hot spots**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of the Hot Spot: | KOZELUZNY OTROKOVICE | | | | | | | | | | | |
| Name of the receiving water: | Morava | | | | | | | | | | | |
| River km of the effluent: | 177,3 | | | | | | | | | | | |
| Critical Emissions | Discharge ($m^3.year^{-1}$) | | | COD ($t.year^{-1}$) | | | $N\text{-}NH_4^+$ ($t.year^{-1}$) | | | $P_t$ ($t.year^{-1}$) | | |
| | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 |
| | 6111 | 5787 | 5314,4 | 1533,9 | 1365,83 | 791,85 | 208,39 | 255,22 | 229,58 | 7,76 | 5,79 | 3,72 |
| Seasonal Variations | This industrial hot spot causes the largest problems during low discharge period when unpleasant effect of dilution of effluent from Zlin WWTP and higher water temperature enlarge eutrophication process in staqnant water in weirs on the Morava River. | | | | | | | | | | | |
| Immediate Causes of Emissions | Insufficient capacity of the present WWTP, where also municipal waste water are treated esp. in N-pollution stays as the immediate cause of the unacceptable high emissions (treatment effect of this WWTP in $N\text{-}NH_4^+$ in 1996 was only 34%). | | | | | | | | | | | |
| Root Causes of Water Quality Problems | High level of $N\text{-}NH_4^+$ emissions in combination with low quality of receiving water. | | | | | | | | | | | |
| Receiving Waters | Water quality of the Morava River upstream Otrokovice hot spot can be characterized mostly by $III^{rd}$ water quality class. Only one parameter ($N\text{-}NH_4^+$) was in the last period ranked to $IV^{th}$ quality class (PCB, DCB concentrations are higher than those acceptable for streams). | | | | | | | | | | | |
| Nearby Downstream Uses | The Morava River is the main water source supplying the protected area of natural water accumulation where several water uptakes are realized. The discharged pollution also influences the aguatic life of the dowstream stretch of the Morava River. | | | | | | | | | | | |
| Transboundary Implications | Beside of effect on water uptakes, pollution from this hot spot influences the aquatic life of downstream stretch supposed to be involved into the Trilateral National Park. | | | | | | | | | | | |
| Rank | High | | | | | | | | | | | |

Tab. C-16

**Summary of information for the high priority hot spots**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of the Hot Spot: | FOSFA POSTORNA | | | | | | | | | | | |
| Name of the receiving water: | Dyje | | | | | | | | | | | |
| River km of the effluent: | 22,2 | | | | | | | | | | | |
| Critical Emissions | Discharge ($m^3.year^{-1}$) | | | COD ($t.year^{-1}$) | | | N-$NH_4^+$ ($t.year^{-1}$) | | | $P_t$ ($t.year^{-1}$) | | |
| | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 |
| | 277.9 | 279.7 | 283.2 | 5.54 | - | 15.12 | 3.8 | - | 0.968 | 49.733 | 54.697 | 102.779 |
| Seasonal Variations | There are high emissions of phosphorus in relation to the discharge and location of the factory so close to the transboundary area. | | | | | | | | | | | |
| Immediate Causes of Emissions | Not sufficient treatment of waste water with high level of phosporus content. | | | | | | | | | | | |
| Root Causes of Water Quality Problems | Combination of emission discharge together with leaches from dump site and downstream transboundary demands. | | | | | | | | | | | |
| Receiving Waters | The receiving water is polluted by the emissions from the Břeclav city situated several kilometres upstream - water quality of the Dyje River refers to the IV$^{th}$ class. | | | | | | | | | | | |
| Nearby Downstream Uses | Protected Area of natural water accumulation, fishing, preservation of aguatic life in the prepared Trilateral National Park. | | | | | | | | | | | |
| Transboundary Implications | This hot spot is very close to the Austrian and Slovakian border, where is an urgent need for improvement of aquatic life in the area of the prepared Trilateral National Park. | | | | | | | | | | | |
| Rank | High | | | | | | | | | | | |

Tab. C-17

## Index of water quality discharge records 1994 - 1997

| No. | Sampling Stations Characterstics | | | | | Number of Years of Records and the Last Year of Available Complete Record | | | | | | | Other Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HOT SPOT | **Sampling** / Gauging Station Name | River Name | River Bank | River km | Water Discharge | Sediment Discharge | Nt | Pt | BOD/COD | Heavy Metals | Other Toxicants | |
| 1 | **BRNO** | **Pisarky** upstr. | **Svratka** | C | 49,7 | | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | |
| | | Porici | Svratka | R | 49,5 | 4/97 | | | | | | | |
| | | **Obrany** upstr. | **Svitava** | C | 11,0 | | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | |
| | | Bilovice | Svitava | L | 18,0 | 4/97 | | | | | | | |
| | | **pod Brnem** dstr. | **Svratka** | C | 35,0 | | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | |
| | | Zidlochovice | Svratka | R | 28,4 | 4/97 | | | | | | | |
| 2 | **ZLIN** | **Otrokovice** dstr. | **Drevnice** | C | 1,5 | | 4/97 | 4/97 | 4/97 | 4/97 | 1/97 | - | |
| | | Zlin | Drevnice | R | 14,4 | 4/97 | | | | | | | |
| 3 | **UH.HRADISTE** | **Spytihnev** upstr. | **Morava** | C | 170,0 | | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | data from |
| | | **Uh.Hradiste** dstr. | **Morava** | L | 156,9 | | 2/97 | 2/97 | 2/97 | 2/97 | 2/97 | 2/97 | Projekt Morava |
| | | Spytihnev | Morava | R | 169,7 | 4/97 | | | | | | | |
| 4 | **HODONIN** | **Hodonin** upstr. | **Morava** | C | 108,0 | | 4/97 | 4/97 | 4/97 | 4/97 | - | - | |
| | | **Lanzhot** dstr. | **Morava** | C | 79,0 | | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | |
| | | Straznice | Morava | L | 133,3 | 4/97 | | | | | | | |
| 5 | **KOZELUZNY OTROKOVICE** | **Kromeriz** upstr. | **Morava** | C | 193,0 | 4/94 | 4/97 | 4/97 | 4/97 | 4/97 | 1/97 | - | |
| | | **Spytihnev** dstr. | **Morava** | C | 170,0 | | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | 4/97 | |
| | | Spytihnev | Morava | P | 169,7 | 4/97 | | | | | | | |
| 6 | **FOSFA POSTORNA** | **Breclav** upstr. | **Dyje** | L | 23,7 | | 2/97 | 2/97 | 2/97 | 2/97 | 2/97 | 2/97 | Projekt Morava |
| | | **Pohansko** dstr. | **Dyje** | L | 17,0 | | 3/97 | 3/97 | 3/97 | 3/97 | 3/97 | 3/97 | EP DRB |
| | | Breclav-Ladna | Dyje | P | 26,4 | 4/97 | | | | | | | |

Tab. C-18

**Water discharge characteristics. Monthly average, maximum and minimum discharges Hydrological Year 1995**

| Gauging Station Name | | Month Discharges in $m^3.s^{-1}$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | XI | XII | I | II | III | IV | V | VI | VII | VIII | IX | X |
| **Kromeriz** | **Aver.** | 28,503 | 54,955 | 80,600 | 116,000 | 84,600 | 96,353 | 82,755 | 92,957 | 48,823 | 17,338 | 52,267 | 25,000 |
| **Morava** | **Max.** | 69,500 | 175,000 | 263,000 | 248,000 | 150,000 | 248,000 | 240,000 | 242,000 | 161,000 | 79,900 | 182,000 | 58,200 |
| 193.0 km | **Min.** | 16,700 | 23,500 | 29,100 | 87,200 | 61,800 | 58,500 | 40,500 | 42,300 | 15,700 | 7,780 | 24,500 | 17,200 |
| **Zlin** | **Aver.** | 0,783 | 2,445 | 2,920 | 3,405 | 3,254 | 3,608 | 4,065 | 3,697 | 1,133 | 0,786 | 2,285 | 0,736 |
| **Drevnice** | **Max.** | 2,200 | 25,700 | 23,300 | 6,850 | 11,900 | 26,400 | 30,800 | 42,400 | 9,150 | 7,800 | 26,600 | 1,500 |
| 14.4 km | **Min.** | 0,581 | 0,598 | 0,626 | 2,140 | 2,000 | 1,910 | 1,660 | 1,510 | 0,404 | 0,365 | 0,776 | 0,615 |
| **Spytihnev** | **Aver.** | 30,000 | 58,287 | 84,600 | 121,900 | 91,100 | 102,053 | 89,958 | 99,433 | 51,665 | 18,415 | 56,773 | 27,174 |
| **Morava** | **Max.** | 99,500 | 176,000 | 266,000 | 265,000 | 158,000 | 272,000 | 241,000 | 251,000 | 164,000 | 68,000 | 210,000 | 69,700 |
| 169.2 km | **Min.** | 10,800 | 24,000 | 30,400 | 90,400 | 70,200 | 69,700 | 54,200 | 49,500 | 16,300 | 5,040 | 25,500 | 18,400 |
| **Straznice** | **Aver.** | 31,010 | 60,758 | 87,052 | 127,300 | 98,500 | 104,837 | 97,439 | 104,680 | 54,216 | 18,670 | 58,890 | 28,606 |
| **Morava** | **Max.** | 74,800 | 179,000 | 262,000 | 263,000 | 174,000 | 306,000 | 255,000 | 248,000 | 164,000 | 67,000 | 211,000 | 92,100 |
| 133.3 km | **Min.** | 16,100 | 26,300 | 30,700 | 96,100 | 75,800 | 68,000 | 57,000 | 54,600 | 16,900 | 2,460 | 26,100 | 12,100 |
| **Breclav-Ladna** | **Aver.** | 15,927 | 18,698 | 22,032 | 39,007 | 33,777 | 42,033 | 38,848 | 43,313 | 22,652 | 11,140 | 33,783 | 23,471 |
| **Dyje** | **Max.** | 38,000 | 33,200 | 34,200 | 58,000 | 58,000 | 125,000 | 69,500 | 98,900 | 50,100 | 21,400 | 91,200 | 33,900 |
| 32.3 km | **Min.** | 10,200 | 8,950 | 13,400 | 29,100 | 26,300 | 26,600 | 28,200 | 26,300 | 9,800 | 9,300 | 11,000 | 18,400 |
| **Brno** | **Aver.** | 3,782 | 7,787 | 9,091 | 18,384 | 12,868 | 14,152 | 13,047 | 11,152 | 4,921 | 2,688 | 7,867 | 4,649 |
| **Svratka** | **Max.** | 20,000 | 20,800 | 20,900 | 32,400 | 34,800 | 22,500 | 22,000 | 35,900 | 20,500 | 18,200 | 24,100 | 22,500 |
| 47.2 km | **Min.** | 3,210 | 3,010 | 5,130 | 9,090 | 4,610 | 9,100 | 5,550 | 5,370 | 2,530 | 2,260 | 2,880 | 2,880 |
| **Zidlochovice** | **Aver.** | 6,924 | 12,302 | 15,403 | 31,836 | 23,723 | 23,433 | 22,652 | 22,803 | 11,516 | 6,421 | 16,437 | 9,728 |
| **Svratka** | **Max.** | 13,000 | 26,000 | 30,250 | 41,000 | 45,100 | 29,400 | 37,000 | 48,300 | 29,800 | 23,500 | 43,200 | 14,500 |
| 28.4 km | **Min.** | 6,190 | 7,590 | 10,900 | 23,100 | 18,200 | 18,800 | 14,700 | 14,900 | 7,790 | 5,540 | 8,970 | 7,190 |
| **Bilovice** | **Aver.** | 1,396 | 2,903 | 3,202 | 6,974 | 6,464 | 4,943 | 5,343 | 6,832 | 3,375 | 1,730 | 4,130 | 3,298 |
| **Svitava** | **Max.** | 2,670 | 7,980 | 11,300 | 10,200 | 8,120 | 7,750 | 16,700 | 23,400 | 20,800 | 3,980 | 16,700 | 4,930 |
| 15.4 km | **Min.** | 1,110 | 1,130 | 2,100 | 4,910 | 4,420 | 3,500 | 2,700 | 3,380 | 1,790 | 1,450 | 1,900 | 2,490 |

**Water discharge characteristics. Monthly average, maximum and minimum discharges Hydrological Year 1996** **Tab. C-19**

| Gauging Station Name | | Average Month Discharges in $m^3.s^{-1}$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | XI | XII | I | II | III | IV | V | VI | VII | VIII | IX | X |
| **Kromeriz** | **Aver.** | 36,910 | 42,074 | 43,355 | 21,514 | 70,387 | 160,317 | 120,103 | 45,597 | 37,074 | 23,997 | 76,567 | 42,206 |
| **Morava** | **Max.** | 72,600 | 143,000 | 99,600 | 31,500 | 249,000 | 309,000 | 235,000 | 120,000 | 114,000 | 87,400 | 386,000 | 76,000 |
| 193.0 km | **Min.** | 18,100 | 22,500 | 23,000 | 18,000 | 15,000 | 77,900 | 69,800 | 28,400 | 19,300 | 12,000 | 23,700 | 27,500 |
| **Zlin** | **Aver.** | 1,171 | 1,626 | 1,542 | 0,744 | 3,860 | 5,211 | 3,016 | 1,939 | 1,761 | 0,812 | 3,300 | 1,918 |
| **Drevnice** | **Max.** | 8,500 | 8,550 | 4,000 | 1,700 | 13,700 | 18,000 | 8,400 | 13,500 | 11,700 | 4,250 | 33,600 | 7,000 |
| 14.4 km | **Min.** | 0,688 | 0,780 | 0,715 | 0,595 | 0,707 | 1,710 | 1,380 | 0,784 | 0,686 | 0,420 | 0,656 | 1,240 |
| **Spytihnev** | **Aver.** | 38,803 | 44,800 | 46,823 | 24,021 | 79,235 | 171,480 | 127,832 | 50,087 | 41,439 | 25,284 | 80,977 | 46,248 |
| **Morava** | **Max.** | 76,700 | 170,000 | 101,000 | 33,600 | 267,000 | 313,500 | 250,000 | 135,000 | 142,000 | 77,200 | 389,000 | 82,000 |
| 169.2 km | **Min.** | 19,100 | 23,000 | 21,700 | 16,800 | 17,100 | 94,600 | 81,000 | 30,200 | 20,800 | 10,200 | 19,200 | 32,900 |
| **Straznice** | **Aver.** | 40,547 | 47,277 | 51,303 | 26,617 | 90,226 | 185,733 | 135,761 | 57,423 | 44,784 | 26,495 | 84,060 | 49,858 |
| **Morava** | **Max.** | 93,300 | 168,000 | 102,000 | 43,400 | 294,000 | 321,000 | 245,000 | 160,000 | 147,000 | 85,200 | 364,000 | 81,000 |
| 133.3 km | **Min.** | 13,500 | 28,100 | 28,500 | 22,300 | 19,200 | 111,000 | 91,500 | 35,600 | 24,700 | 6,650 | 22,900 | 33,600 |
| **Breclav-Ladna** | **Aver.** | 29,267 | 35,219 | 48,010 | 30,331 | 75,303 | 188,933 | 125,506 | 44,880 | 23,032 | 21,458 | 21,357 | 32,832 |
| **Dyje** | **Max.** | 43,700 | 69,000 | 99,200 | 45,100 | 217,000 | 311,500 | 273,000 | 83,800 | 50,900 | 47,000 | 31,500 | 60,000 |
| 32.3 km | **Min.** | 17,400 | 16,300 | 23,300 | 21,700 | 20,100 | 93,000 | 75,200 | 22,800 | 11,900 | 12,000 | 15,200 | 25,600 |
| **Brno** | **Aver.** | 9,308 | 7,244 | 10,110 | 5,740 | 8,077 | 27,917 | 23,101 | 7,389 | 5,158 | 4,790 | 4,647 | 8,012 |
| **Svratka** | **Max.** | 22,000 | 21,000 | 22,000 | 22,000 | 29,200 | 68,800 | 81,800 | 22,500 | 20,500 | 21,500 | 21,000 | 22,000 |
| 47.2 km | **Min.** | 5,680 | 4,470 | 5,240 | 4,110 | 2,680 | 12,900 | 4,080 | 3,590 | 3,360 | 3,560 | 3,480 | 3,610 |
| **Zidlochovice** | **Aver.** | 14,007 | 12,111 | 18,613 | 10,636 | 23,565 | 50,793 | 41,452 | 14,490 | 9,592 | 9,647 | 8,968 | 13,631 |
| **Svratka** | **Max.** | 72,700 | 28,800 | 30,600 | 18,500 | 57,700 | 123,000 | 155,000 | 40,000 | 29,000 | 50,000 | 22,800 | 35,000 |
| 28.4 km | **Min.** | 10,500 | 8,960 | 14,400 | 9,260 | 9,280 | 24,900 | 19,500 | 10,300 | 6,970 | 7,570 | 7,160 | 7,930 |
| **Bilovice** | **Aver.** | 2,383 | 2,883 | 3,312 | 2,346 | 7,922 | 15,179 | 11,970 | 4,694 | 3,244 | 2,836 | 2,803 | 3,822 |
| **Svitava** | **Max.** | 4,200 | 9,750 | 9,650 | 2,900 | 27,400 | 33,900 | 43,500 | 9,450 | 6,680 | 7,620 | 4,850 | 9,500 |
| 15.4 km | **Min.** | 1,800 | 1,980 | 2,350 | 2,250 | 2,250 | 6,590 | 5,830 | 3,510 | 2,470 | 1,990 | 2,200 | 2,350 |

**Water discharge characteristics. Monthly average, maximum and minimum discharges Hydrological Year 1997** **Tab. C-20**

| Gauging Station Name | | Average Month Discharges in $m^3.s^{-1}$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | XI | XII | I | II | III | IV | V | VI | VII | VIII | IX | X |
| **Kromeriz** | **Aver.** | 63,490 | 28,513 | 16,181 | 76,154 | 74,929 | 60,150 | 60,803 | 40,043 | 348,432 | 51,729 | 33,380 | 23,226 |
| **Morava** | **Max.** | 162,000 | 42,800 | 34,700 | 379,000 | 246,000 | 102,000 | 138,000 | 118,000 | 1034,000 | 153,000 | 97,200 | 37,800 |
| 193.0 km | **Min.** | 35,900 | 18,000 | 14,200 | 14,800 | 39,500 | 47,000 | 38,100 | 22,900 | 20,900 | 24,500 | 18,400 | 18,900 |
| **Zlin** | **Aver.** | 2,823 | 1,166 | 0,897 | 4,068 | 2,203 | 2,155 | 3,163 | 2,512 | 23,546 | 2,272 | 1,626 | 1,269 |
| **Drevnice** | **Max.** | 10,700 | 1,800 | 1,250 | 24,700 | 6,000 | 4,000 | 45,100 | 20,800 | 284,000 | 9,700 | 5,050 | 3,150 |
| 14.4 km | **Min.** | 1,350 | 0,870 | 0,703 | 0,663 | 1,450 | 1,400 | 1,120 | 0,862 | 1,510 | 1,070 | 1,070 | 0,916 |
| **Spytihnev** | **Aver.** | 68,743 | 31,558 | 17,997 | 81,429 | 80,774 | 64,197 | 65,519 | 45,857 | 383,000 | 67,258 | 42,283 | 26,755 |
| **Morava** | **Max.** | 181,000 | 47,500 | 31,700 | 404,000 | 255,000 | 110,000 | 168,000 | 144,000 | 920,000 | 156,000 | 132,000 | 68,200 |
| 169.2 km | **Min.** | 40,600 | 12,800 | 14,400 | 15,400 | 49,000 | 54,400 | 43,400 | 24,400 | 32,400 | 31,800 | 23,500 | 16,500 |
| **Straznice** | **Aver.** | 72,217 | 34,577 | 19,910 | 85,071 | 87,355 | 68,717 | 69,768 | 50,380 | 434,139 | 82,794 | 48,280 | 31,410 |
| **Morava** | **Max.** | 185,000 | 69,700 | 28,100 | 391,000 | 261,000 | 109,000 | 174,000 | 146,000 | 901,000 | 208,000 | 121,000 | 62,900 |
| 133.3 km | **Min.** | 44,600 | 17,100 | 16,500 | 17,100 | 53,700 | 57,100 | 44,900 | 26,300 | 38,700 | 44,800 | 28,300 | 25,700 |
| **Breclav-Ladna** | **Aver.** | 38,070 | 26,626 | 22,748 | 47,689 | 79,642 | 79,027 | 39,842 | 21,703 | 141,445 | 50,165 | 26,750 | 28,271 |
| **Dyje** | **Max.** | 51,600 | 51,100 | 32,800 | 104,000 | 112,000 | 142,000 | 84,700 | 51,300 | 326,000 | 123,000 | 34,700 | 35,200 |
| 32.3 km | **Min.** | 25,000 | 15,400 | 15,500 | 18,700 | 25,500 | 31,000 | 25,100 | 14,200 | 17,000 | 22,000 | 20,100 | 19,500 |
| **Brno** | **Aver.** | 7,767 | 5,232 | 4,865 | 14,609 | 18,512 | 14,383 | 6,845 | 4,448 | 48,153 | 10,756 | 5,082 | 5,491 |
| **Svratka** | **Max.** | 21,200 | 16,600 | 22,300 | 58,900 | 51,000 | 21,500 | 17,400 | 18,700 | 111,000 | 42,000 | 19,100 | 20,500 |
| 47.2 km | **Min.** | 5,000 | 3,950 | 3,590 | 4,060 | 9,560 | 6,650 | 3,750 | 3,240 | 4,020 | 4,630 | 3,630 | 3,660 |
| **Zidlochovice** | **Aver.** | 13,050 | 8,927 | 8,199 | 25,545 | 28,290 | 22,107 | 13,554 | 8,806 | 88,497 | 19,077 | 11,087 | 10,912 |
| **Svratka** | **Max.** | 23,200 | 16,700 | 11,700 | 109,000 | 76,700 | 31,400 | 25,400 | 21,400 | 223,000 | 61,600 | 28,800 | 22,300 |
| 28.4 km | **Min.** | 10,700 | 7,160 | 7,080 | 9,050 | 18,000 | 13,700 | 8,890 | 7,530 | 9,160 | 11,400 | 9,360 | 8,780 |
| **Bilovice** | **Aver.** | 3,473 | 2,482 | 1,980 | 7,660 | 7,301 | 5,928 | 4,291 | 2,743 | 29,825 | 5,912 | 3,760 | 3,627 |
| **Svitava** | **Max.** | 5,900 | 3,600 | 2,430 | 30,100 | 20,500 | 9,830 | 8,600 | 5,700 | 125,000 | 12,600 | 5,700 | 4,800 |
| 15.4 km | **Min.** | 2,300 | 2,150 | 1,900 | 2,200 | 4,930 | 4,490 | 3,180 | 2,050 | 2,520 | 4,150 | 3,400 | 3,370 |

Tab. C-21

**Long-term water discharge characteristics. Processed data from period 1930 - 1980**

| Gauging Station Name | River | m - days water discharges in $m^3.s^{-1}$ | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **30** | **90** | **180** | **270** | **330** | **355** | **364** |
| **Olomouc** | **Morava** | 61,030 | 32,360 | 18,470 | 11,300 | 7,121 | 5,292 | 3,096 |
| **Dluhonice** | **Becva** | 46,060 | 19,090 | 8,748 | 4,549 | 2,679 | 1,739 | 1,101 |
| **Polkovice** | **Valova** | 3,170 | 1,350 | 0,759 | 0,500 | 0,354 | 0,254 | 0,163 |
| **Kromeriz** | **Morava** | 119,000 | 61,100 | 34,000 | 20,000 | 12,100 | 8,260 | 5,090 |
| **Zlin** | **Drevnice** | 5,580 | 2,200 | 1,140 | 0,580 | 0,320 | 0,200 | 0,073 |
| **Spytihnev** | **Morava** | 129,000 | 65,000 | 36,300 | 21,400 | 13,100 | 8,950 | 5,640 |
| **Straznice** | **Morava** | 141,000 | 71,000 | 39,500 | 22,900 | 14,000 | 9,480 | 5,630 |
| **Znojmo** | **Dyje** | 23,400 | 10,800 | 6,310 | 4,790 | 3,870 | 1,870 | 0,886 |
| **Breclav-Ladna** | **Dyje** | 92,160 | 45,180 | 27,630 | 18,950 | 13,560 | 9,580 | 4,590 |
| **Brno-Porici** | **Svratka** | 18,100 | 8,550 | 4,460 | 2,850 | 1,840 | 1,260 | 0,820 |
| **Zidlochovice** | **Svratka** | 33,700 | 17,000 | 10,000 | 6,680 | 4,620 | 3,390 | 2,420 |
| **Bilovice** | **Svitava** | 11,000 | 5,640 | 3,600 | 2,500 | 1,900 | 1,520 | 1,180 |

# Figures

# A Survey of Existing Hot Spots in the Strategic Action Plan for the Danube River Basin (SAP) and in the National Action Plan for the Morava River Basin (NAP), 1994 - 1997

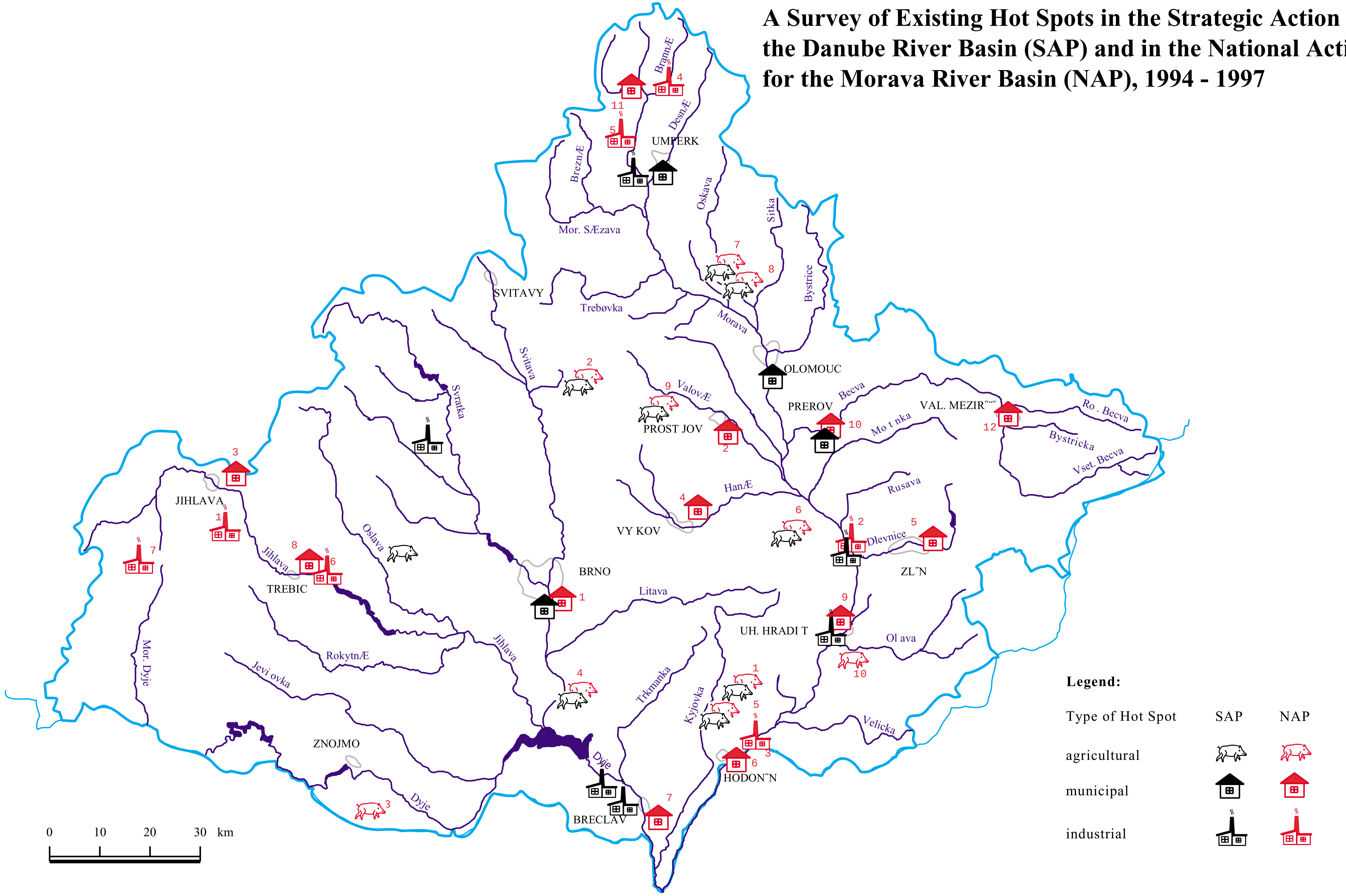


Fig. C-2

# Priority Hot Spots within the Danube Pollution Reduction Programme, 1998

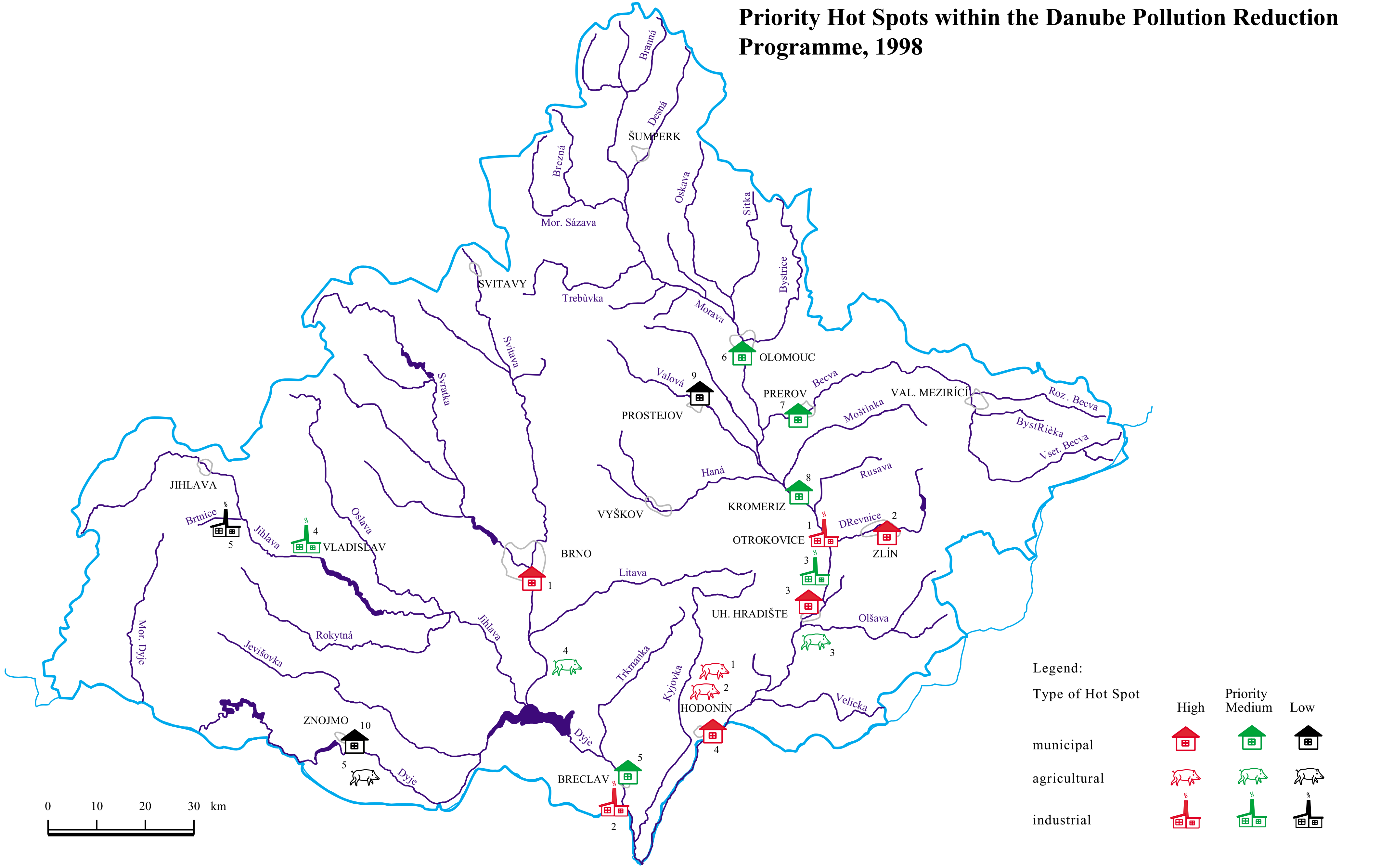


Fig. C-3

# Gauging and Sampling Stations in the Morava River Basin

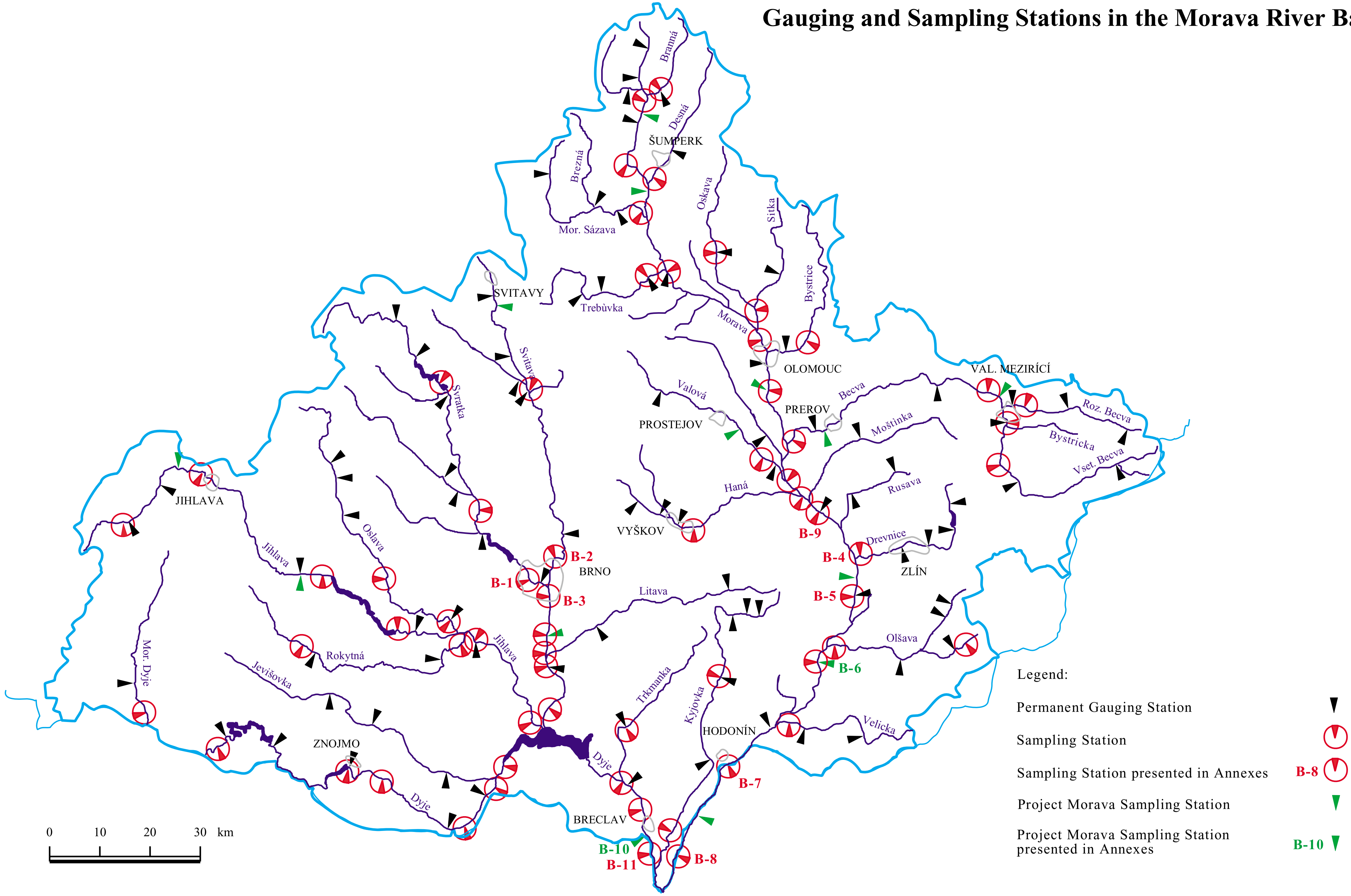
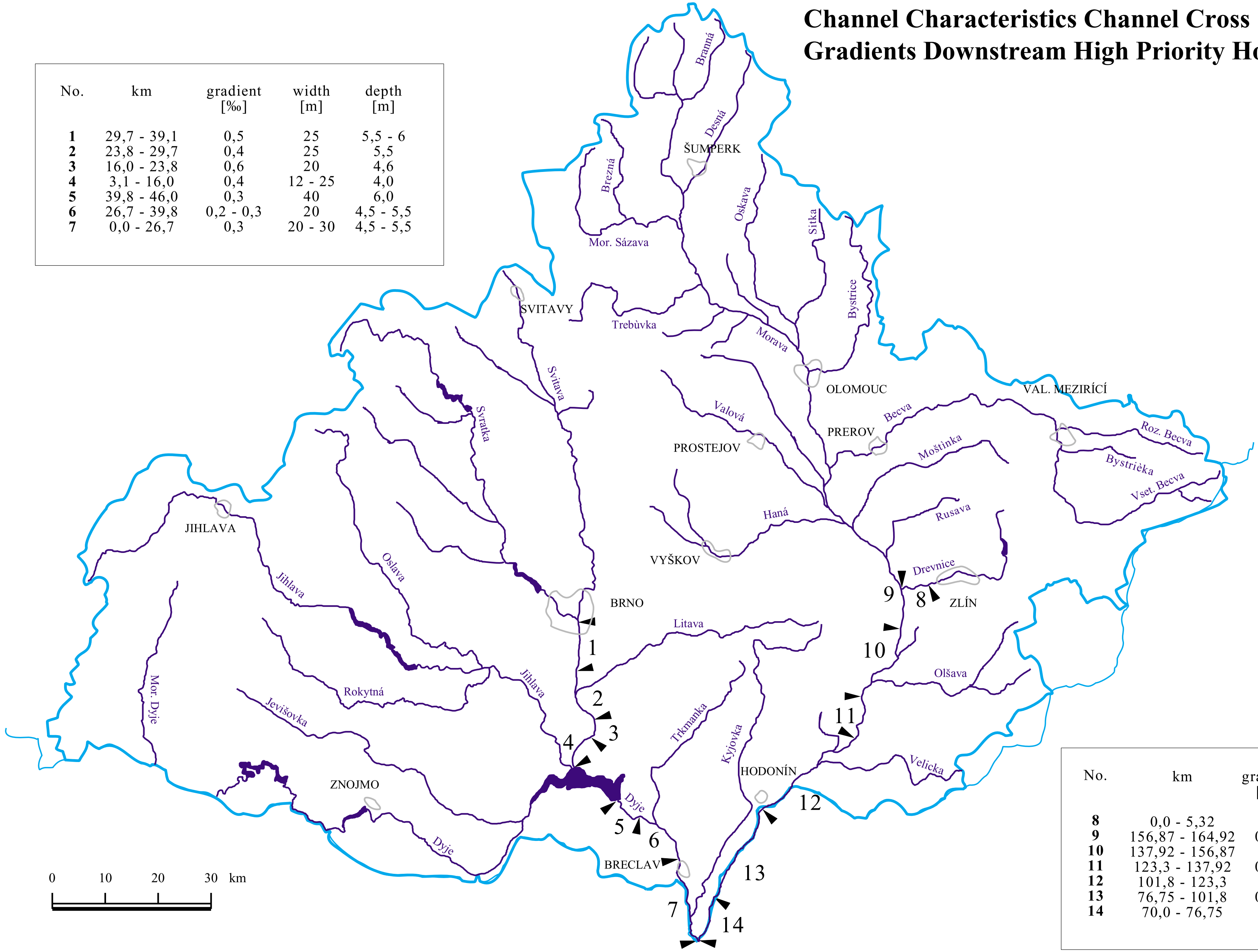


Fig. C-4

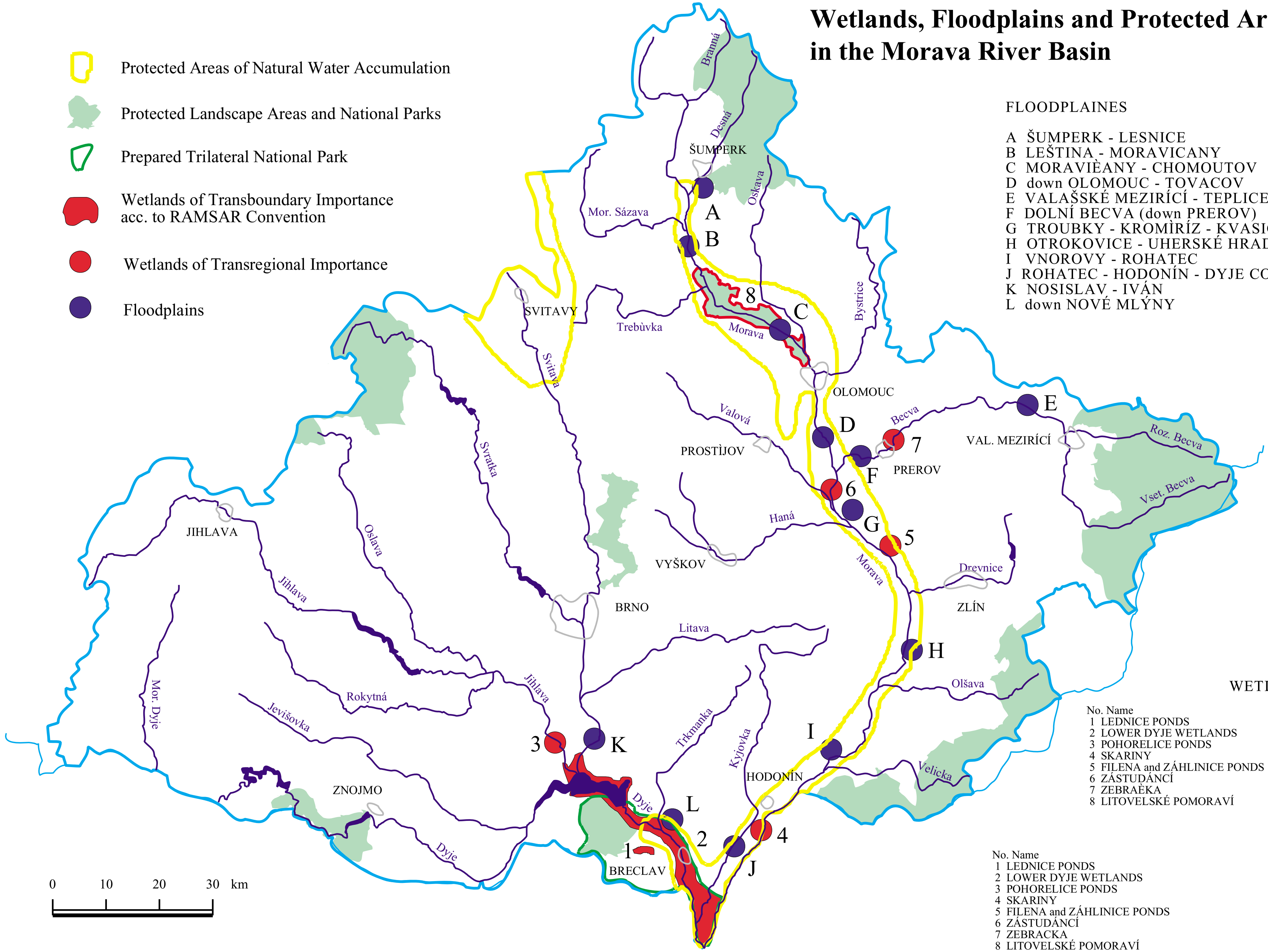
# Channel Characteristics Channel Cross Sections and River Gradients Downstream High Priority Hot Spots

| No. | km | gradient [‰] | width [m] | depth [m] |
|---|---|---|---|---|
| **1** | 29,7 - 39,1 | 0,5 | 25 | 5,5 - 6 |
| **2** | 23,8 - 29,7 | 0,4 | 25 | 5,5 |
| **3** | 16,0 - 23,8 | 0,6 | 20 | 4,6 |
| **4** | 3,1 - 16,0 | 0,4 | 12 - 25 | 4,0 |
| **5** | 39,8 - 46,0 | 0,3 | 40 | 6,0 |
| **6** | 26,7 - 39,8 | 0,2 - 0,3 | 20 | 4,5 - 5,5 |
| **7** | 0,0 - 26,7 | 0,3 | 20 - 30 | 4,5 - 5,5 |




| No. | km | gradient [‰] | width [m] | depth [m] |
|---|---|---|---|---|
| **8** | 0,0 - 5,32 | 1,3 | 15 | 4 - 4,5 |
| **9** | 156,87 - 164,92 | 0,14 | 51 | 5 - 6 |
| **10** | 137,92 - 156,87 | 0,2 | 56 | 5 - 6 |
| **11** | 123,3 - 137,92 | 0,23 | 56 | 5,5 - 6 |
| **12** | 101,8 - 123,3 | 0,3 | 30 - 50 | 4,5 - 6 |
| **13** | 76,75 - 101,8 | 0,32 | 56 - 63 | 5,6 - 6 |
| **14** | 70,0 - 76,75 | 0,2 | 36 | 4,5 - 5,5 |

# Wetlands, Floodplains and Protected Areas in the Morava River Basin




| FLOODPLAINES | km | ha |
|---|---|---|
| A ŠUMPERK - LESNICE | 0,0 - 9,5 | 5,0 |
| B LEŠTINA - MORAVICANY | 274,0 - 295,0 | 21,0 |
| C MORAVIÈANY - CHOMOUTOV | 238,0 - 271,5 | 53,0 |
| D down OLOMOUC - TOVACOV | 212,0 - 230,0 | 12,0 |
| E VALAŠSKÉ MEZIRÍCÍ - TEPLICE | 43,5 - 57,5 | 25,6 |
| F DOLNÍ BECVA (down PREROV) | 0,0 - 10,0 | |
| G TROUBKY - KROMÌRÍZ - KVASICE | 169,5 - 210,0 | 33,0 |
| H OTROKOVICE - UHERSKÉ HRADIŠTE | 149,0 - 159,5 | 6,9 |
| I VNOROVY - ROHATEC | 111,0 - 122,0 | 11,7 |
| J ROHATEC - HODONÍN - DYJE CONFL. | 104,3 - 111,0 | 58,9 |
| K NOSISLAV - IVÁN | 3,1 - 23,0 | 30,0 |
| L down NOVÉ MLÝNY | 0,0 - 46,0 | 150,0 |

WETLANDS

| No. Name | Coordinates |
|---|---|
| 1 LEDNICE PONDS | 48°43'-48°48' N 16°42'-16°48' E |
| 2 LOWER DYJE WETLANDS | 48°37'-48°51' N 16°35'-16°58' E |
| 3 POHORELICE PONDS | not available |
| 4 SKARINY | not available |
| 5 FILENA and ZÁHLINICE PONDS | not available |
| 6 ZÁSTUDÁNCÍ | not available |
| 7 ZEBRAÈKA | not available |
| 8 LITOVELSKÉ POMORAVÍ | 49°48'-49°36' N 16°55'-17°14' E |

| No. Name | Size (ha) | Type |
|---|---|---|
| 1 LEDNICE PONDS | 650 | fish ponds, sedge, marshes |
| 2 LOWER DYJE WETLANDS | 11500 | floodplain forests,meadows and ponds |
| 3 POHORELICE PONDS | 470 | fauna of fish ponds and forests - birds |
| 4 SKARINY | 13,2 | floodplain forest - fauna |
| 5 FILENA and ZÁHLINICE PONDS | 500 | fish ponds, wetlands biotopes - birds |
| 6 ZÁSTUDÁNCÍ | 100,6 | floodplain forest - fauna |
| 7 ZEBRACKA | 234,1 | floodplain forest - typical fauna |
| 8 LITOVELSKÉ POMORAVÍ | 5122 | floodplain biotopes and forest oxbows |

Fig. C-6

# Dams and Reservoirs in the Morava River Basin on the Territory of the Czech Republic

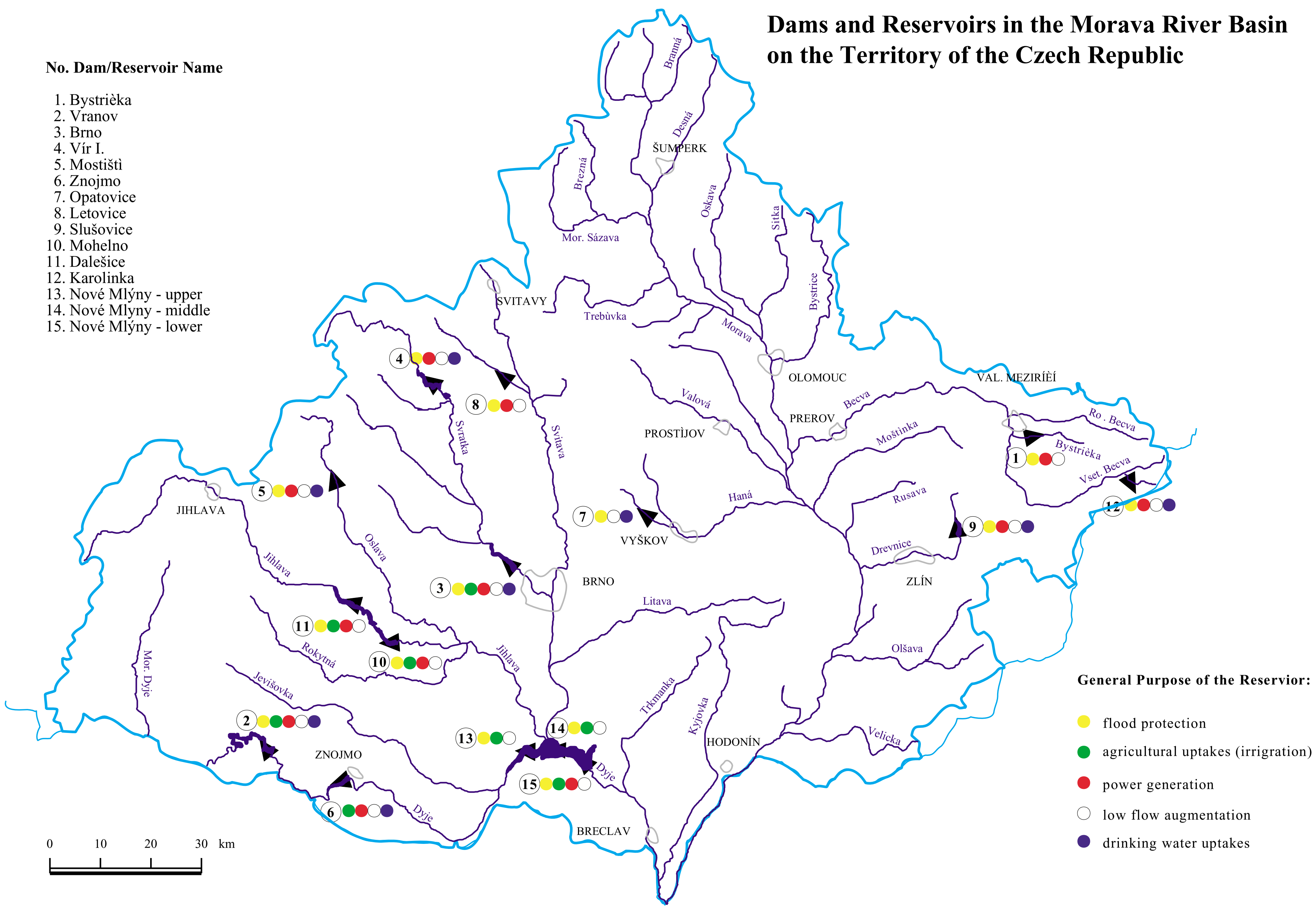
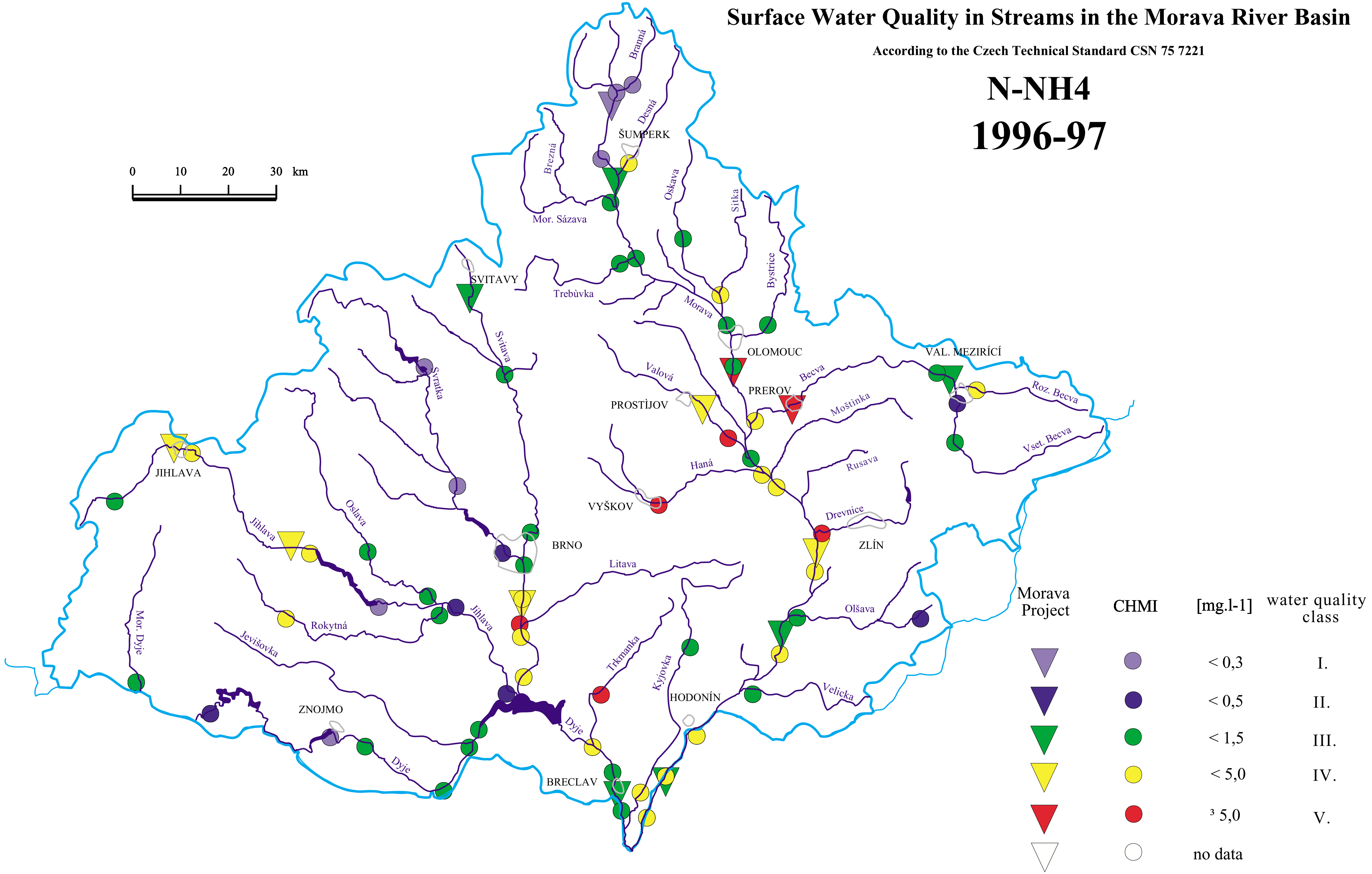


Fig. C-7

# Surface Water Quality in Streams in the Morava River Basin

**According to the Czech Technical Standard CSN 75 7221**

# N-NH4
# 1996-97

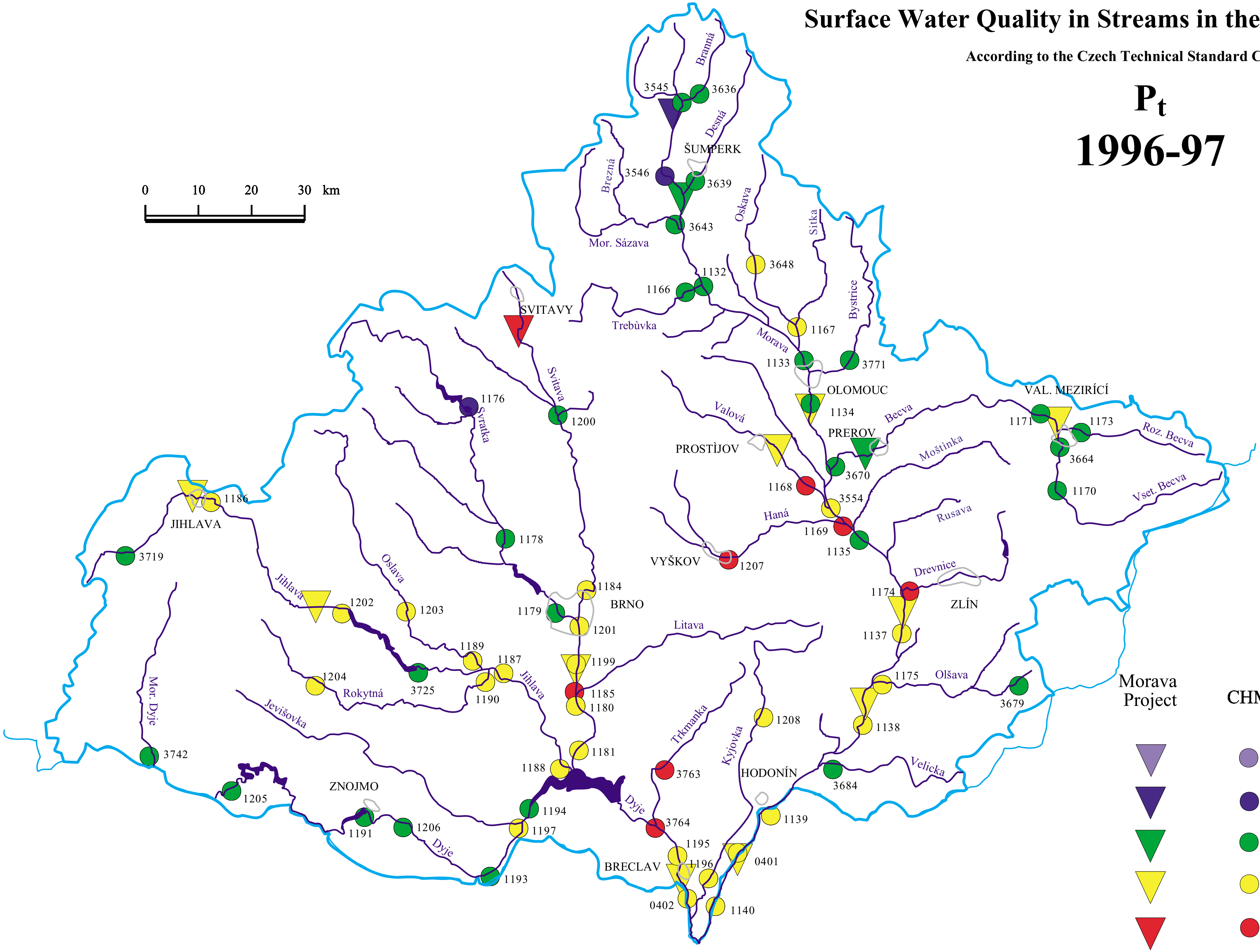


# Surface Water Quality in Streams in the Morava River Basin

According to the Czech Technical Standard CSN 75 7221

## $P_t$

## 1996-97




| Morava Project | CHMI | [mg.l-1] | water quality class |
|---|---|---|---|
| ▽ | ○ | < 0,03 | I. |
| ▽ | ○ | < 0,15 | II. |
| ▽ | ○ | < 0,4 | III. |
| ▽ | ○ | < 1,0 | IV. |
| ▽ | ○ | ³ 1,0 | V. |
| ▽ | ○ | no data | |

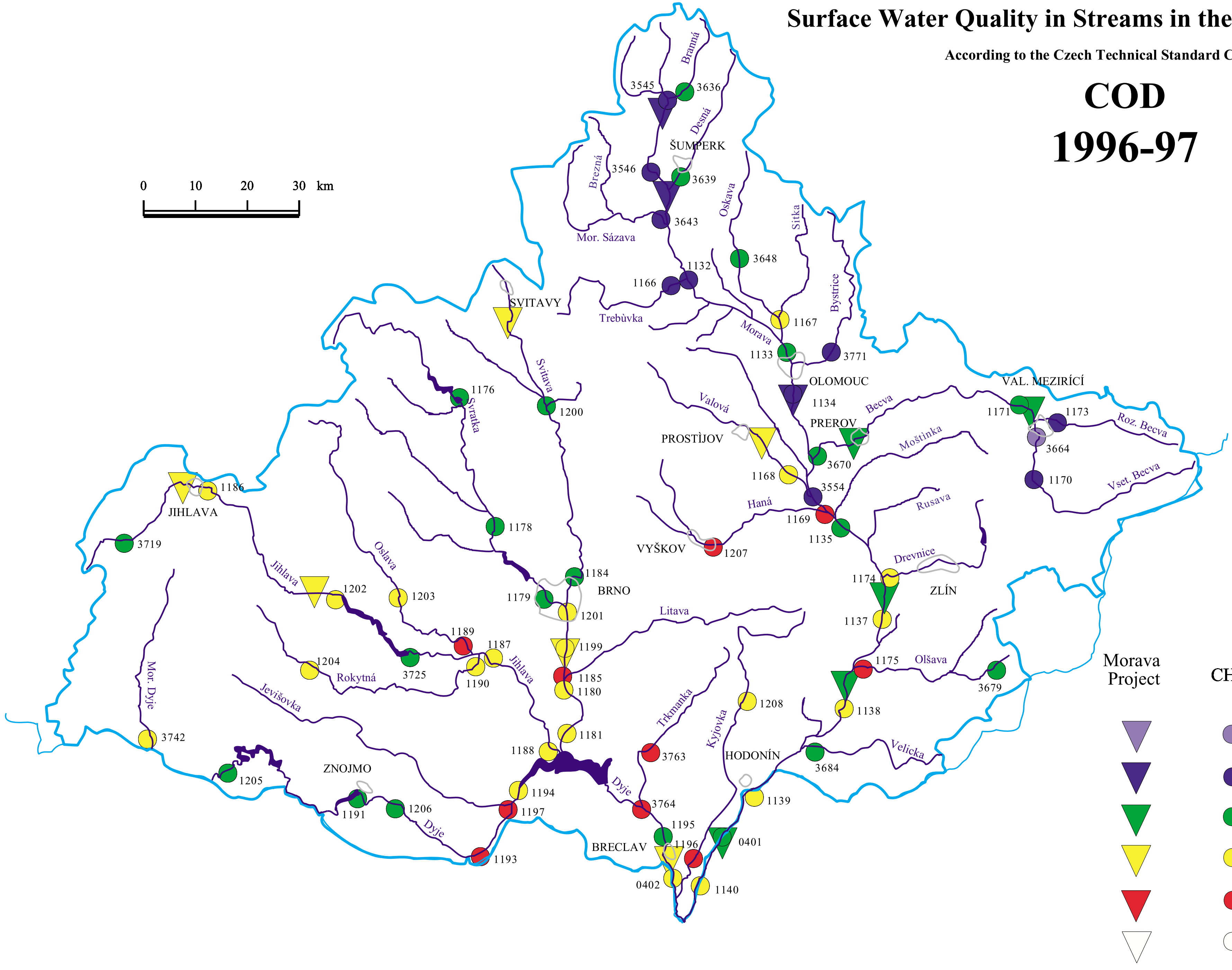
**Fig. C-9**

# Surface Water Quality in Streams in the Morava River Basin

According to the Czech Technical Standard CSN 75 7221

## COD

## 1996-97




| Morava Project | CHMI | [mg.l-1] | water quality class |
| --- | --- | --- | --- |
| ▽ (light purple) | ● (light purple) | < 15 | I. |
| ▽ (dark purple) | ● (dark purple) | < 25 | II. |
| ▽ (green) | ● (green) | < 35 | III. |
| ▽ (yellow) | ● (yellow) | < 55 | IV. |
| ▽ (red) | ● (red) | ³ 55 | V. |
| ▽ (white) | ○ (white) | no data | |

# Annexes

Annex C-1

## Summary of simultaneous data on water and sediment discharge and water quality at the Brno-Pisarky sampling station

| Water Discharge [$m^3.s^{-1}$] | Sediment Discharge [$mg.l^{-1}$] | Total N [$mg.l^{-1}$] | Total P [$mg.l^{-1}$] | COD [$mg.l^{-1}$] | $N\text{-}NH_4^+$ [$mg.l^{-1}$] | $N\text{-}NO_3^-$ [$mg.l^{-1}$] | $PO_4^-$ [$mg.l^{-1}$] | Hg [$mg.l^{-1}$] | PCB [$mg.l^{-1}$] | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 7,800 | 9 | 10,950 | 0,14 | 13,6 | 0,400 | 10,5 | 0,260 | 0,0004 | < 0,000005 | 20.01.1994 |
| 4,700 | 4 | 9,740 | 0,14 | 16,8 | 0,500 | 9,2 | 0,250 | 0,0002 | - | 22.02.1994 |
| 3,770 | 7 | 6,230 | 0,38 | 43,5 | 0,500 | 5,7 | 0,160 | < 0,0001 | < 0,000005 | 22.03.1994 |
| 19,350 | 12 | 9,740 | 0,09 | 21,2 | 0,300 | 9,4 | 0,190 | < 0,0001 | - | 20.04.1994 |
| 4,400 | 8 | 7,390 | 0,13 | 18,6 | 0,500 | 6,8 | 0,280 | 0,0003 | 0,000009 | 25.05.1994 |
| 1,970 | 16 | 6,570 | 0,07 | 29,7 | 0,400 | 6,1 | 0,180 | 0,0003 | - | 22.06.1994 |
| 2,190 | 14 | 3,650 | 0,20 | 28,8 | 0,200 | 3,3 | 0,260 | < 0,0001 | 0,000009 | 26.07.1994 |
| 2,880 | 14 | 3,700 | 0,24 | 22,2 | 0,600 | 2,9 | 0,440 | 0,0002 | - | 23.08.1994 |
| 2,150 | 7 | 3,480 | 0,17 | 18,4 | 0,300 | 3,1 | 0,350 | 0,0003 | - | 21.09.1994 |
| 2,190 | 4 | 3,870 | 0,12 | 22,7 | 0,300 | 3,5 | 0,220 | < 0,0001 | 0,000018 | 25.10.1994 |
| 4,270 | 5 | 3,950 | 0,13 | 22,2 | 0,500 | 3,4 | 0,250 | < 0,0001 | - | 22.11.1994 |
| 6,950 | 3 | 5,140 | 0,13 | 22,2 | 0,500 | 4,6 | 0,310 | < 0,0001 | < 0,000001 | 21.12.1994 |
| 11,776 | 5 | 5,850 | 0,12 | 24,3 | 0,500 | 5,3 | 0,250 | 0,0002 | 0,000007 | 24.01.1995 |
| 20,659 | 14 | 8,740 | 0,10 | 26,7 | 0,300 | 8,4 | 0,190 | < 0,0001 | - | 21.02.1995 |
| 8,114 | 6 | 8,840 | 0,10 | 20,1 | 0,200 | 8,6 | 0,140 | < 0,0001 | - | 22.03.1995 |
| 16,667 | 7 | 6,840 | 0,09 | 22,1 | 0,100 | 6,7 | 0,120 | 0,0001 | 0,000022 | 25.04.1995 |
| 11,876 | 6 | 6,030 | 0,09 | 20,6 | 0,200 | 5,8 | 0,110 | < 0,0001 | 0,000013 | 24.05.1995 |
| 9,391 | 8 | 5,980 | 0,10 | 23,3 | 0,200 | 5,7 | 0,120 | < 0,0001 | - | 21.06.1995 |
| 3,174 | 6 | 4,230 | 0,10 | 24,5 | 0,200 | 3,9 | 0,090 | 0,0005 | - | 25.07.1995 |
| 4,571 | 4 | 3,820 | 0,15 | 22,9 | 0,600 | 3,1 | 0,400 | 0,0001 | 0,000011 | 29.08.1995 |
| 14,172 | 7 | 4,580 | 0,15 | 22,1 | 0,300 | 4,2 | 0,340 | < 0,0001 | 0,000022 | 26.09.1995 |
| 4,441 | 5 | 3,970 | 0,14 | 17,1 | 0,200 | 3,7 | 0,280 | 0,0001 | - | 24.10.1995 |
| 13,174 | 8 | 4,360 | 0,14 | 33,5 | 0,200 | 4,1 | 0,270 | < 0,0001 | < 0,000005 | 21.11.1995 |
| 9,241 | 3 | 4,950 | 0,11 | 23,6 | 0,200 | 4,7 | 0,120 | < 0,0001 | - | 13.12.1995 |
| 8,333 | 3 | 7,030 | 0,12 | 23,3 | 0,300 | 6,7 | 0,250 | < 0,0001 | 0,000013 | 23.01.1996 |
| 4,950 | 4 | 5,930 | 0,14 | 21,8 | 0,700 | 5,2 | 0,290 | < 0,0001 | - | 21.02.1996 |
| 3,573 | 11 | 5,920 | 0,15 | 23,2 | 0,400 | 5,5 | 0,310 | < 0,0001 | 0,000022 | 20.03.1996 |
| 18,263 | 9 | 9,040 | 0,10 | 19,4 | 0,100 | 8,9 | 0,130 | 0,0001 | - | 24.04.1996 |
| 18,064 | 13 | 7,470 | 0,15 | 24,4 | 0,200 | 7,2 | 0,190 | 0,0001 | < 0,000002 | 22.05.1996 |
| 13,473 | 8 | 5,380 | 0,12 | 20,9 | 0,100 | 5,1 | 0,130 | 0,0001 | - | 24.06.1996 |
| 4,511 | 6 | 4,550 | 0,12 | 20,8 | 0,120 | 4,3 | 0,070 | 0,0001 | 0,000006 | 23.07.1996 |
| 3,872 | 36 | 3,620 | 0,20 | 32,2 | 0,200 | 3,3 | 0,180 | < 0,0001 | - | 20.08.1996 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3,623 | 4 | 3,350 | 0,16 | 24,0 | 0,090 | 3,2 | 0,250 | < 0,0001 | - | 25.09.1996 |
| 9,411 | 7 | 3,860 | 0,15 | 23,9 | 0,120 | 3,7 | 0,190 | 0,0001 | 0,000094 | 24.10.1996 |
| 8,782 | 6 | 4,440 | 0,13 | 21,4 | 0,110 | 4,3 | 0,260 | 0,0001 | - | 21.11.1996 |
| 6,387 | 5 | 4,600 | 0,12 | 18,7 | 0,070 | 4,5 | 0,210 | < 0,0001 | 0,000022 | 05.12.1996 |
| 4,870 | 2 | 5,817 | 0,15 | 18,5 | 0,290 | 5,5 | 0,337 | 0,0002 | - | 29.01.1997 |
| 13,473 | 18 | 7,475 | 0,19 | 23,7 | 0,540 | 6,9 | 0,307 | 0,0003 | - | 19.02.1997 |
| 11,277 | 4 | 5,034 | 0,09 | 14,7 | 0,100 | 4,9 | 0,153 | < 0,0001 | - | 26.03.1997 |
| 9,671 | 6 | 6,264 | 0,09 | 15,3 | 0,024 | 6,2 | - | < 0,0001 | - | 23.04.1997 |
| 6,198 | 19 | 4,101 | 0,12 | 24,2 | 0,040 | 4,0 | - | < 0,0001 | 0,000023 | 22.05.1997 |
| 3,453 | 5 | 4,574 | 0,11 | 23,5 | 0,190 | 4,2 | 0,184 | < 0,0001 | - | 26.06.1997 |
| 62,874 | 27 | 3,867 | 0,22 | 32,5 | 0,120 | 3,7 | 0,215 | 0,0001 | - | 23.07.1997 |
| 8,982 | 7 | 4,469 | 0,09 | 28,7 | 0,024 | 4,4 | 0,092 | 0,0003 | - | 20.08.1997 |
| 3,683 | 4 | 3,981 | 0,10 | 24,2 | 0,210 | 3,7 | 0,184 | 0,0002 | - | 30.09.1997 |
| 5,709 | 5 | 3,700 | 0,11 | 21,6 | 0,140 | 3,5 | 0,245 | < 0,0001 | 0,000012 | 21.10.1997 |
| 7,026 | 5 | 4,217 | 0,12 | 19,6 | 0,170 | 4,0 | 0,245 | 0,0001 | - | 26.11.1997 |
| 6,277 | 7 | 4,652 | 0,14 | 23,1 | 0,200 | 4,4 | 0,307 | 0,0001 | - | 09.12.1997 |

## Summary of simultaneous data on water and sediment discharge and water quality at the Obrany sampling station

| Water Discharge [$m^3.s^{-1}$] | Sediment Discharge [$mg.l^{-1}$] | Total N [$mg.l^{-1}$] | Total P [$mg.l^{-1}$] | COD [$mg.l^{-1}$] | $N\text{-}NH_4^+$ [$mg.l^{-1}$] | $N\text{-}NO_3^-$ [$mg.l^{-1}$] | $PO_4^-$ [$mg.l^{-1}$] | Hg [$mg.l^{-1}$] | PCB [$mg.l^{-1}$] | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 3,320 | 11 | 11,150 | 0,23 | 23,7 | 1,300 | 9,8 | 0,560 | 0,0066 | < 0,000005 | 04.01.1994 |
| 2,770 | 6 | 9,850 | 0,36 | 27,9 | 1,200 | 8,6 | 1,830 | 0,0002 | 0,000008 | 02.02.1994 |
| 2,270 | 3 | 9,450 | 0,36 | 19,8 | 1,500 | 7,9 | 1,040 | < 0,0020 | 0,000019 | 02.03.1994 |
| 3,660 | 5 | 8,870 | 0,38 | 23,8 | 0,900 | 7,9 | 0,950 | 0,0001 | - | 29.03.1994 |
| 4,980 | 6 | 8,980 | 0,26 | 18,6 | 0,500 | 8,4 | 0,520 | 0,0002 | - | 27.04.1994 |
| 2,320 | 10 | 7,370 | 0,51 | 24,4 | 0,600 | 6,6 | 1,280 | 0,0008 | 0,000010 | 31.05.1994 |
| 1,230 | 24 | 5,720 | 0,53 | 30,6 | 0,600 | 5,0 | 1,230 | < 0,0001 | - | 20.07.1994 |
| 1,270 | 12 | 4,960 | 0,53 | 25,5 | 0,300 | 4,6 | 1,560 | < 0,0001 | 0,000012 | 02.08.1994 |
| 1,180 | 18 | 6,050 | 0,58 | 24,2 | 0,200 | 5,8 | 1,590 | < 0,0001 | 0,000024 | 31.08.1994 |
| 2,780 | 127 | 5,920 | 0,55 | 39,0 | 1,000 | 4,8 | 0,770 | < 0,0001 | 0,000013 | 29.09.1994 |
| 1,580 | 10 | 5,290 | 0,39 | 25,2 | 0,600 | 4,6 | 0,670 | < 0,0001 | 0,000012 | 01.11.1994 |
| 1,410 | 5 | 6,960 | 0,55 | 23,7 | 0,800 | 6,1 | 1,550 | < 0,0001 | - | 29.11.1994 |
| 3,518 | 9 | 8,340 | 0,31 | 23,2 | 1,000 | 7,3 | 0,820 | < 0,0001 | 0,000011 | 03.01.1995 |
| 9,497 | 271 | 8,860 | 0,76 | 45,9 | 0,600 | 8,2 | 0,470 | < 0,0001 | - | 31.01.1995 |
| 5,337 | 20 | 8,450 | 0,28 | 23,4 | 0,800 | 7,6 | 0,580 | < 0,0001 | - | 28.02.1995 |
| 6,342 | 14 | 7,650 | 0,22 | 26,0 | 0,300 | 7,3 | 0,410 | 0,0002 | - | 04.04.1995 |
| 5,337 | 19 | 7,380 | 0,33 | 19,5 | 0,400 | 6,9 | 0,640 | < 0,0001 | - | 02.05.1995 |
| 2,724 | 16 | 7,200 | 0,48 | 24,6 | 0,400 | 6,6 | 1,020 | < 0,0001 | - | 30.05.1995 |
| 5,809 | 53 | 6,330 | 0,52 | 28,8 | 0,200 | 6,0 | 0,770 | 0,0002 | - | 27.06.1995 |
| 1,608 | 11 | 5,600 | 0,50 | 26,5 | 0,100 | 5,4 | 1,170 | < 0,0001 | 0,000012 | 10.08.1995 |
| 2,010 | 20 | 6,090 | 0,54 | 25,2 | 0,500 | 5,4 | 1,450 | 0,0005 | 0,000023 | 29.08.1995 |
| 3,497 | 8 | 5,940 | 0,33 | 26,3 | 0,300 | 5,5 | 0,760 | 0,0001 | 0,000033 | 03.10.1995 |
| 2,050 | 5 | 5,900 | 0,41 | 25,8 | 0,300 | 5,5 | 1,030 | < 0,0001 | < 0,000005 | 01.11.1995 |
| 2,563 | 5 | 6,550 | 0,41 | 21,0 | 0,900 | 5,6 | 1,140 | 0,0002 | - | 29.11.1995 |
| 2,513 | 8 | 7,540 | 0,38 | 22,1 | 1,200 | 6,3 | 0,850 | 0,0003 | - | 09.01.1996 |
| 2,362 | 4 | 7,260 | 0,34 | 22,4 | 1,100 | 6,1 | 0,950 | < 0,0001 | < 0,000002 | 01.02.1996 |
| 2,312 | 13 | 7,420 | 0,56 | 34,2 | 1,500 | 5,9 | 1,070 | 0,0001 | - | 05.03.1996 |
| 8,553 | 23 | 9,050 | 0,28 | 30,7 | 0,500 | 8,5 | 0,460 | < 0,0001 | 0,000006 | 02.04.1996 |
| 9,035 | 24 | 6,450 | 0,21 | 29,9 | 0,400 | 6,0 | 0,340 | 0,0001 | - | 25.04.1996 |
| 6,633 | 22 | 7,340 | 0,29 | 21,5 | 0,500 | 6,7 | 0,580 | < 0,0001 | 0,000010 | 30.05.1996 |
| 3,849 | 20 | 6,530 | 0,38 | 24,5 | 0,310 | 5,9 | 0,820 | 0,0002 | - | 02.07.1996 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2,523 | 15 | 6,220 | 0,41 | 21,0 | 0,100 | 6,0 | 0,980 | 0,0008 | - | 01.08.1996 |
| 2,724 | 33 | 6,230 | 0,54 | 24,8 | 0,310 | 5,7 | 1,170 | 0,0004 | 0,000026 | 05.09.1996 |
| 5,628 | 18 | 4,680 | 0,31 | 26,9 | 0,210 | 4,4 | 0,660 | 0,0002 | 0,000023 | 09.10.1996 |
| 2,492 | 5 | 5,810 | 0,41 | 25,1 | 0,410 | 5,3 | 1,120 | 0,0002 | 0,000005 | 06.11.1996 |
| 2,613 | 6 | 6,600 | 0,34 | 21,3 | 0,650 | 5,9 | 0,890 | < 0,0001 | - | 04.12.1996 |
| 1,910 | 4 | 6,619 | 0,46 | 28,0 | 0,900 | 5,7 | 1,104 | 0,0002 | 0,000023 | 14.01.1997 |
| 2,261 | 4 | 6,829 | 0,41 | 25,9 | 1,310 | 5,5 | 1,073 | 0,0001 | - | 05.02.1997 |
| 12,563 | 34 | 7,433 | 0,24 | 24,8 | 0,300 | 7,1 | - | 0,0001 | - | 04.03.1997 |
| 5,638 | 4 | 6,375 | 0,21 | 20,2 | 0,270 | 6,1 | 0,368 | < 0,0001 | - | 03.04.1997 |
| 5,286 | 4 | 6,160 | 0,18 | 22,9 | 0,210 | 5,9 | - | 0,0002 | 0,000013 | 24.04.1997 |
| 3,799 | 9 | 6,550 | 0,45 | 25,7 | 0,640 | 5,7 | 1,134 | 0,0002 | - | 28.05.1997 |
| 3,648 | 34 | 4,904 | 1,52 | 30,9 | 0,110 | 4,6 | 1,318 | < 0,0001 | 0,003345 | 01.07.1997 |
| 13,367 | 54 | 5,596 | 0,28 | 30,9 | 0,130 | 5,4 | - | 0,0002 | - | 30.07.1997 |
| 3,769 | 18 | 6,644 | 0,30 | 19,8 | 0,110 | 6,4 | 0,705 | < 0,0001 | - | 10.09.1997 |
| 4,020 | 19 | 5,828 | 0,37 | 25,4 | 0,200 | 5,5 | 0,797 | < 0,0001 | 0,000006 | 02.10.1997 |
| 3,417 | 4 | 6,498 | 0,30 | 12,2 | 0,520 | 5,9 | 0,828 | 0,0001 | - | 29.10.1997 |
| 3,618 | 8 | 6,414 | 0,32 | 23,4 | 0,650 | 5,7 | 0,828 | < 0,0001 | - | 25.11.1997 |

## Summary of simultaneous data on water and sediment discharge and water quality at the Brno-pod sampling station

| Water Discharge $[m^3.s^{-1}]$ | Sediment Discharge $[mg.l^{-1}]$ | Total N $[mg.l^{-1}]$ | Total P $[mg.l^{-1}]$ | COD $[mg.l^{-1}]$ | $N\text{-}NH_4^+$ $[mg.l^{-1}]$ | $N\text{-}NO_3^-$ $[mg.l^{-1}]$ | $PO_4^-$ $[mg.l^{-1}]$ | Hg $[mg.l^{-1}]$ | PCB $[mg.l^{-1}]$ | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 15,480 | 18 | 11,650 | 0,48 | 25,8 | 3,200 | 8,4 | 0,790 | 0,0001 | - | 20.01.1994 |
| 10,160 | 13 | 11,430 | 0,50 | 35,5 | 5,000 | 6,4 | 1,050 | < 0,0001 | - | 22.02.1994 |
| 11,200 | 18 | 6,940 | 0,62 | 30,8 | 0,700 | 6,2 | 1,090 | 0,0001 | - | 22.03.1994 |
| 32,450 | 29 | 9,050 | 0,19 | 26,4 | 1,100 | 7,9 | 0,450 | - | - | 20.04.1994 |
| 9,710 | 6 | 10,640 | 0,92 | 33,3 | 6,100 | 4,4 | 1,760 | 0,0011 | - | 25.05.1994 |
| 6,760 | 6 | 8,560 | 1,45 | 43,0 | 6,400 | 1,9 | 2,150 | 0,0028 | - | 22.06.1994 |
| 5,090 | 23 | 9,930 | 1,51 | 30,2 | 8,100 | 1,7 | 1,610 | - | - | 26.07.1994 |
| 4,270 | 17 | 12,050 | 1,55 | 38,2 | 10,800 | 1,1 | 2,120 | 0,0001 | - | 23.08.1994 |
| 5,180 | 5 | 12,190 | 1,10 | 32,1 | 10,000 | 2,1 | 2,620 | < 0,0001 | - | 21.09.1994 |
| 7,070 | 10 | 7,730 | 0,83 | 36,0 | 5,500 | 2,1 | 2,430 | 0,0001 | - | 25.10.1994 |
| 7,210 | 14 | 6,760 | 0,55 | 44,0 | 3,900 | 2,8 | 1,510 | < 0,0001 | - | 22.11.1994 |
| 12,400 | 27 | 7,550 | 0,49 | 30,7 | 3,300 | 4,2 | 0,840 | < 0,0001 | - | 21.12.1994 |
| 16,900 | 22 | 8,230 | 0,62 | 49,1 | 4,200 | 3,9 | 1,370 | 0,0001 | - | 24.01.1995 |
| 31,900 | 26 | 9,540 | 0,33 | 23,7 | 1,200 | 8,3 | 0,590 | < 0,0001 | - | 21.02.1995 |
| 21,000 | 19 | 8,870 | 0,24 | 28,0 | 2,200 | 6,6 | 0,520 | < 0,0001 | - | 22.03.1995 |
| 24,400 | 11 | 8,090 | 0,27 | 20,1 | 0,600 | 7,4 | 0,590 | 0,0001 | - | 25.04.1995 |
| 20,200 | 8 | 6,890 | 0,51 | 16,4 | 1,300 | 5,4 | 1,220 | < 0,0001 | - | 24.05.1995 |
| 19,800 | 15 | 7,170 | 0,40 | 29,7 | 2,000 | 5,0 | 0,590 | < 0,0001 | - | 21.06.1995 |
| 9,020 | 9 | 5,820 | 0,70 | 28,9 | 0,600 | 4,9 | 1,950 | 0,0001 | - | 25.07.1995 |
| 8,440 | 16 | 4,610 | 0,63 | 30,7 | 0,900 | 3,4 | 1,590 | 0,0003 | - | 29.08.1995 |
| 18,600 | 14 | 5,750 | 0,44 | 23,3 | 1,100 | 4,5 | 0,960 | < 0,0001 | - | 26.09.1995 |
| 8,440 | 6 | 6,460 | 0,67 | 25,1 | 2,700 | 3,6 | 1,960 | 0,0001 | - | 24.10.1995 |
| 19,400 | 11 | 6,870 | 0,54 | 25,0 | 2,300 | 4,3 | 1,320 | < 0,0001 | - | 21.11.1995 |
| 14,900 | 18 | 8,200 | 0,59 | 38,5 | 2,900 | 5,2 | 1,540 | 0,0004 | - | 13.12.1995 |
| 16,600 | 18 | 9,260 | 0,59 | 30,0 | 3,300 | 5,9 | 1,270 | < 0,0001 | - | 23.01.1996 |
| 11,900 | 7 | 6,790 | 0,39 | 39,6 | 2,200 | 4,5 | 1,050 | < 0,0001 | - | 21.02.1996 |
| 27,000 | 68 | 8,290 | 0,61 | 42,1 | 2,900 | 5,3 | 1,120 | 0,0001 | - | 20.03.1996 |
| 32,700 | 18 | 7,690 | 0,26 | 25,3 | 0,500 | 7,1 | 0,500 | 0,0001 | - | 24.04.1996 |
| 33,400 | 32 | 7,410 | 0,29 | 24,2 | 0,300 | 7,0 | 0,490 | < 0,0001 | - | 22.05.1996 |
| 22,600 | 35 | 7,310 | 0,56 | 20,9 | 0,700 | 6,4 | 0,970 | 0,0001 | - | 24.06.1996 |
| 8,220 | 9 | 9,040 | 0,81 | 24,3 | 1,980 | 6,6 | 1,740 | 0,0001 | - | 23.07.1996 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 7,960 | 16 | 8,130 | 0,91 | 37,4 | 2,340 | 5,3 | 2,260 | < 0,0001 | - | 20.08.1996 |
| 8,810 | 12 | 7,440 | 0,69 | 31,3 | 3,400 | 3,7 | 1,900 | 0,0001 | - | 25.09.1996 |
| 14,600 | 8 | 6,390 | 0,53 | 27,8 | 2,480 | 3,8 | 1,260 | 0,0001 | - | 24.10.1996 |
| 15,300 | 11 | 7,040 | 0,57 | 27,6 | 2,390 | 4,5 | 1,500 | < 0,0001 | - | 21.11.1996 |
| 12,300 | 9 | 6,690 | 0,50 | 24,9 | 1,460 | 5,1 | 1,240 | < 0,0001 | - | 05.12.1996 |
| 8,450 | 7 | 12,061 | 0,48 | 33,2 | 7,520 | 4,4 | 1,134 | 0,0002 | - | 29.01.1997 |
| 22,600 | 26 | 8,638 | 0,31 | 26,5 | 2,180 | 6,4 | 0,521 | 0,0022 | - | 19.02.1997 |
| 18,500 | 7 | 8,659 | 0,40 | 25,7 | 3,300 | 5,3 | 1,012 | < 0,0001 | - | 26.03.1997 |
| 19,400 | 6 | 8,038 | 0,41 | 21,0 | 2,050 | 5,9 | 0,981 | < 0,0001 | - | 23.04.1997 |
| 13,100 | 11 | 6,240 | 0,44 | 27,8 | 1,280 | 4,7 | 0,920 | < 0,0001 | - | 22.05.1997 |
| 8,880 | 8 | 7,052 | 0,31 | 30,0 | 3,520 | 3,1 | 0,705 | 0,0001 | - | 26.06.1997 |
| 116,000 | 71 | 4,980 | 0,33 | 34,5 | 0,120 | 4,8 | - | 0,0001 | - | 23.07.1997 |
| 15,400 | 12 | 6,595 | 0,27 | 30,6 | 0,430 | 6,0 | 0,552 | 0,0003 | - | 20.08.1997 |
| 9,910 | 8 | 7,416 | 0,34 | 31,1 | 3,610 | 3,7 | 0,767 | 0,0005 | - | 30.09.1997 |
| 10,600 | 6 | 6,888 | 0,32 | 24,3 | 3,000 | 3,8 | 0,797 | 0,0001 | - | 21.10.1997 |
| 11,800 | 18 | 7,495 | 0,26 | 28,2 | 3,300 | 4,1 | 0,583 | < 0,0001 | - | 26.11.1997 |
| 13,800 | 6 | 8,858 | 0,28 | 26,2 | 2,730 | 6,0 | 0,705 | 0,0001 | - | 09.12.1997 |

## Summary of simultaneous data on water and sediment discharge and water quality at the Otrokovice sampling station

| Water Discharge [$m^3.s^{-1}$] | Sediment Discharge [$mg.l^{-1}$] | Total N [$mg.l^{-1}$] | Total P [$mg.l^{-1}$] | COD [$mg.l^{-1}$] | $N\text{-}NH_4^+$ [$mg.l^{-1}$] | $N\text{-}NO_3^-$ [$mg.l^{-1}$] | $PO_4^-$ [$mg.l^{-1}$] | Hg [$mg.l^{-1}$] | PCB [$mg.l^{-1}$] | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 3,840 | 23 | 6,130 | 0,28 | 22,2 | 1,400 | 4,7 | 0,200 | - | - | 11.01.1994 |
| 2,930 | 14 | 6,550 | 0,30 | 32,3 | 1,800 | 4,7 | 0,700 | - | - | 07.02.1994 |
| 1,150 | 4 | 7,050 | 0,70 | 34,6 | 3,900 | 3,1 | 1,300 | - | - | 02.03.1994 |
| 12,720 | 267 | 5,560 | 0,28 | 60,0 | 0,600 | 4,9 | 0,500 | - | - | 14.04.1994 |
| 1,960 | 17 | 5,740 | 0,40 | 20,0 | 2,700 | 2,9 | 1,100 | - | - | 03.05.1994 |
| 2,510 | 85 | 4,900 | 0,13 | 65,2 | 2,200 | 2,4 | 0,300 | - | - | 10.06.1994 |
| 0,520 | 33 | 6,800 | 0,42 | 28,6 | 5,500 | 0,8 | 1,000 | - | - | 01.07.1994 |
| 0,280 | 30 | 4,700 | 0,02 | 58,6 | 0,040 | 4,5 | 0,010 | - | - | 01.08.1994 |
| 0,530 | 76 | 5,500 | 0,50 | 36,0 | 2,100 | 3,0 | 1,200 | - | - | 05.09.1994 |
| 0,420 | 17 | 10,450 | 1,00 | 35,4 | 8,800 | 1,5 | 2,500 | - | - | 03.10.1994 |
| 1,840 | 28 | 6,100 | 0,49 | 26,0 | 2,700 | 3,3 | 1,030 | - | - | 01.11.1994 |
| 0,670 | 6 | 9,060 | 0,98 | 18,5 | 7,100 | 1,9 | 2,670 | - | - | 30.11.1994 |
| 1,573 | 35 | 6,620 | 0,42 | 21,9 | 2,800 | 3,8 | 0,520 | - | - | 04.01.1995 |
| 6,911 | 17 | 5,250 | 0,16 | 13,3 | 0,600 | 4,6 | 0,100 | - | - | 01.02.1995 |
| 3,260 | 17 | 6,130 | 0,23 | 14,1 | 1,700 | 4,4 | 0,640 | - | - | 01.03.1995 |
| 3,754 | 16 | 5,250 | 0,23 | 18,5 | 1,700 | 3,5 | 0,500 | - | - | 03.04.1995 |
| 2,813 | 28 | 5,860 | 0,33 | 13,3 | 1,900 | 3,9 | 0,900 | - | - | 03.05.1995 |
| 4,454 | 315 | 4,830 | 0,27 | 35,3 | 0,800 | 3,9 | 0,670 | - | - | 08.06.1995 |
| 2,870 | 37 | 6,390 | 0,77 | 18,2 | 2,000 | 4,2 | 0,630 | - | - | 26.06.1995 |
| 0,563 | 41 | 7,880 | 1,16 | 16,3 | 5,700 | 2,0 | 2,990 | - | - | 21.07.1995 |
| 3,042 | 100 | 6,290 | 0,30 | 18,2 | 0,900 | 5,3 | 0,830 | - | - | 05.09.1995 |
| 0,908 | 8 | 5,260 | 0,59 | 12,1 | 1,700 | 3,4 | 1,650 | - | - | 02.10.1995 |
| 1,779 | 115 | 6,870 | 0,39 | 18,6 | 2,100 | 4,7 | 1,000 | - | - | 08.11.1995 |
| 0,986 | 6 | 6,660 | 0,78 | 10,8 | 3,900 | 2,7 | 2,420 | - | - | 27.11.1995 |
| 2,020 | 22 | 6,730 | 0,39 | 17,0 | 3,100 | 3,6 | 1,130 | - | - | 16.01.1996 |
| 0,758 | 9 | 7,530 | 0,63 | 16,2 | 4,400 | 3,1 | 1,700 | - | - | 26.02.1996 |
| 0,875 | 20 | 8,730 | 1,15 | 27,0 | 5,700 | 3,0 | 0,620 | - | - | 11.03.1996 |
| 4,156 | 22 | 6,750 | 0,50 | 17,3 | 2,600 | 4,1 | 0,610 | - | - | 17.04.1996 |
| 1,722 | 49 | 5,990 | 0,67 | 25,5 | 2,800 | 2,9 | 1,710 | - | - | 20.05.1996 |
| 1,412 | 50 | 6,030 | 0,76 | 43,6 | 3,300 | 2,4 | 1,580 | - | - | 19.06.1996 |
| 2,480 | 40 | 4,560 | 0,59 | 25,0 | 1,950 | 2,4 | 1,430 | - | - | 15.07.1996 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0,751 | 20 | 7,830 | 0,97 | 28,7 | 4,980 | 2,6 | 2,600 | - | - | 06.08.1996 |
| 3,777 | 94 | 4,320 | 0,68 | 29,3 | 1,390 | 2,8 | 1,000 | - | - | 16.09.1996 |
| 4,339 | 506 | 3,920 | 1,29 | 75,3 | 1,070 | 2,7 | 0,830 | - | - | 18.10.1996 |
| 5,109 | 93 | 4,700 | 1,03 | 28,9 | 1,350 | 3,3 | 0,720 | - | - | 21.11.1996 |
| 1,412 | 7 | 4,670 | 0,67 | 24,0 | 1,420 | 3,2 | 1,590 | - | - | 05.12.1996 |
| 0,754 | 15 | 9,320 | 1,52 | 26,6 | 6,600 | 2,7 | - | 0,0001 | - | 20.01.1997 |
| 3,191 | 21 | 7,028 | 0,40 | 25,5 | 1,900 | 5,0 | 1,012 | 0,0013 | - | 17.02.1997 |
| 1,871 | 20 | 6,979 | 0,58 | 32,4 | 4,030 | 2,9 | 1,410 | 0,0006 | - | 27.03.1997 |
| 1,917 | 13 | 5,152 | 0,37 | 19,9 | 2,400 | 2,7 | 1,073 | 0,0001 | - | 14.04.1997 |
| 4,041 | 59 | 4,706 | 0,77 | 41,1 | 1,890 | 2,6 | 1,748 | < 0,0001 | - | 19.05.1997 |
| 1,424 | 3 | 7,328 | 1,20 | 19,6 | 3,830 | 3,2 | 2,576 | < 0,0001 | - | 09.06.1997 |
| 1,711 | 6 | 7,248 | 0,89 | 29,5 | 4,550 | 2,4 | 2,085 | < 0,0001 | - | 03.07.1997 |
| 3,318 | 16 | 4,299 | 0,35 | 23,0 | 1,480 | 2,6 | 0,920 | 0,0001 | - | 06.08.1997 |
| 2,503 | 73 | 4,499 | 0,62 | 25,3 | 0,940 | 3,3 | 1,012 | 0,0001 | - | 08.09.1997 |
| 1,745 | 1 | 4,236 | 0,48 | 23,0 | 1,050 | 3,0 | 1,043 | 0,0001 | - | 13.10.1997 |
| 1,014 | 9 | 9,240 | 0,65 | 26,9 | 5,330 | 3,8 | 1,962 | 0,0001 | - | 05.11.1997 |
| 5,602 | 52 | 5,885 | 0,42 | 29,2 | 1,060 | 4,7 | 0,828 | 0,0002 | - | 01.12.1997 |

## Summary of simultaneous data on water and sediment discharge and water quality at the Spytihnev sampling station

| Water Discharge [$m^3.s^{-1}$] | Sediment Discharge [$mg.l^{-1}$] | Total N [$mg.l^{-1}$] | Total P [$mg.l^{-1}$] | COD [$mg.l^{-1}$] | $N-NH_4^+$ [$mg.l^{-1}$] | $N-NO_3^-$ [$mg.l^{-1}$] | $PO_4^-$ [$mg.l^{-1}$] | Hg [$mg.l^{-1}$] | PCB [$mg.l^{-1}$] | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 67,800 | 5 | 5,560 | 0,30 | 18,9 | 1,600 | 3,9 | 0,550 | 0,0003 | - | 25.01.1994 |
| 46,700 | 15 | 6,480 | 0,25 | 18,5 | 1,800 | 4,5 | 0,450 | 0,0001 | 0,000007 | 15.02.1994 |
| 80,200 | 16 | 5,640 | 0,21 | 18,0 | 1,500 | 4,1 | 0,400 | 0,0001 | - | 14.03.1994 |
| 118,000 | 22 | 4,940 | 0,19 | 31,5 | 0,700 | 4,2 | 0,400 | 0,0002 | 0,000008 | 11.04.1994 |
| 44,500 | 19 | 4,190 | 0,20 | 18,5 | 1,100 | 3,0 | 0,450 | 0,0011 | 0,000009 | 10.05.1994 |
| 21,000 | 39 | 3,510 | 0,29 | 21,1 | 1,200 | 2,1 | 0,500 | 0,0026 | - | 21.06.1994 |
| 17,100 | 42 | 4,160 | 0,45 | 30,3 | 2,600 | 1,3 | 0,950 | < 0,0001 | < 0,000005 | 11.07.1994 |
| 3,000 | 30 | 3,150 | 0,17 | 27,0 | 1,200 | 1,8 | 0,300 | < 0,0001 | - | 22.08.1994 |
| 19,200 | 51 | 4,810 | 0,37 | 30,1 | 1,300 | 3,4 | 0,850 | < 0,0001 | < 0,000005 | 20.09.1994 |
| 26,300 | 16 | 5,200 | 0,22 | 21,0 | 2,000 | 3,1 | 0,900 | < 0,0001 | - | 11.10.1994 |
| 39,200 | 7 | 3,950 | 0,23 | 23,2 | 1,300 | 2,6 | 0,450 | < 0,0001 | < 0,000005 | 21.11.1994 |
| 29,300 | 15 | 5,430 | 1,05 | 25,0 | 2,600 | 2,8 | 0,700 | 0,0004 | - | 06.12.1994 |
| 44,900 | 3 | 4,440 | 0,32 | 14,0 | 0,300 | 4,1 | 0,940 | 0,0003 | - | 23.01.1995 |
| 95,000 | 16 | 5,930 | 0,17 | 9,7 | 0,800 | 5,1 | 0,400 | < 0,0001 | 0,000036 | 22.02.1995 |
| 96,000 | 5 | 5,150 | 0,16 | 15,1 | 0,700 | 4,4 | 0,360 | < 0,0001 | - | 20.03.1995 |
| 109,000 | 24 | 3,630 | 0,30 | 10,5 | 0,800 | 2,8 | 0,370 | < 0,0001 | < 0,000005 | 19.04.1995 |
| 97,300 | 30 | 4,460 | 0,18 | 15,3 | 0,600 | 3,8 | 0,360 | < 0,0001 | 0,000018 | 23.05.1995 |
| 85,600 | 55 | 3,000 | 0,18 | 18,7 | 0,400 | 2,5 | 0,420 | < 0,0001 | 0,000018 | 19.06.1995 |
| 41,700 | 71 | 3,020 | 0,17 | 13,5 | 0,200 | 2,7 | 0,500 | < 0,0001 | - | 12.07.1995 |
| 12,700 | 30 | 3,040 | 0,30 | 20,1 | 0,200 | 2,7 | 0,610 | 0,0004 | 0,000009 | 15.08.1995 |
| 55,300 | 71 | 6,110 | 0,23 | 27,4 | 0,300 | 5,7 | 0,480 | < 0,0001 | - | 19.09.1995 |
| 28,400 | 21 | 4,210 | 0,32 | 32,0 | 1,000 | 3,1 | 0,780 | < 0,0001 | 0,000005 | 09.10.1995 |
| 41,700 | 8 | 3,960 | 0,21 | 12,2 | 0,800 | 3,1 | 0,410 | < 0,0001 | < 0,000005 | 16.11.1995 |
| 42,200 | 8 | 4,650 | 0,19 | 10,9 | 1,000 | 3,6 | 0,520 | < 0,0001 | < 0,000005 | 05.12.1995 |
| 45,900 | 9 | 5,830 | 0,26 | 16,7 | 1,800 | 4,0 | 0,720 | < 0,0001 | - | 10.01.1996 |
| 29,600 | 15 | 6,220 | 0,27 | 13,2 | 2,000 | 4,2 | 0,780 | < 0,0001 | < 0,000002 | 05.02.1996 |
| 20,000 | 9 | 6,030 | 0,63 | 20,6 | 2,700 | 3,3 | 1,090 | < 0,0001 | - | 04.03.1996 |
| 94,600 | 26 | 7,460 | 0,23 | 16,5 | 0,500 | 6,9 | 0,370 | 0,0001 | 0,000012 | 03.04.1996 |
| 143,000 | 452 | 4,870 | 0,24 | 61,6 | 1,400 | 3,4 | 0,360 | 0,0001 | - | 30.04.1996 |
| 114,000 | 175 | 5,620 | 0,28 | 26,5 | 0,600 | 4,9 | 0,360 | 0,0001 | 0,000021 | 27.05.1996 |
| 88,100 | 87 | 3,540 | 0,16 | 19,6 | 0,320 | 3,1 | 0,440 | < 0,0001 | - | 25.06.1996 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20,800 | 30 | 2,810 | 0,44 | 24,2 | 0,120 | 2,6 | 0,770 | < 0,0001 | 0,000003 | 30.07.1996 |
| 17,800 | 5 | 2,820 | 0,34 | 18,6 | 0,030 | 2,7 | 0,690 | < 0,0001 | - | 27.08.1996 |
| 60,600 | 18 | 2,780 | 1,98 | 14,5 | 0,120 | 2,6 | 0,480 | < 0,0001 | 0,000020 | 30.09.1996 |
| 43,900 | 8 | 3,050 | 0,21 | 20,6 | 0,500 | 2,5 | 0,480 | < 0,0001 | - | 04.11.1996 |
| 63,300 | 5 | 4,370 | 0,12 | 14,3 | 0,740 | 3,6 | 0,350 | < 0,0001 | 0,000023 | 26.11.1996 |
| 15,800 | 17 | 6,444 | 0,57 | 21,9 | 3,120 | 3,3 | - | < 0,0001 | 0,000016 | 27.01.1997 |
| 104,000 | 94 | 5,829 | 0,21 | 28,2 | 1,080 | 4,7 | 0,429 | 0,0002 | - | 24.02.1997 |
| 80,600 | 10 | 5,052 | 0,15 | 17,2 | 0,800 | 4,2 | - | 0,0001 | - | 10.03.1997 |
| 55,900 | 8 | 4,332 | 0,14 | 19,1 | 0,880 | 3,4 | 0,368 | 0,0001 | 0,000023 | 03.04.1997 |
| 47,700 | 9 | 3,034 | 0,21 | 14,1 | 0,470 | 2,5 | 0,429 | < 0,0001 | - | 05.05.1997 |
| 80,600 | 45 | 3,021 | 0,24 | 22,2 | 0,360 | 2,6 | 0,337 | < 0,0001 | 0,000020 | 02.06.1997 |
| 39,900 | 20 | 2,820 | 0,29 | 19,2 | 0,410 | 2,3 | 0,613 | < 0,0001 | - | 30.06.1997 |
| 168,000 | 59 | 3,203 | 0,27 | 26,9 | 0,230 | 2,9 | - | < 0,0001 | 0,000105 | 30.07.1997 |
| 39,300 | 59 | 3,211 | 0,18 | 21,1 | 0,120 | 3,0 | - | 0,0003 | - | 25.08.1997 |
| 25,200 | 10 | 3,252 | 0,24 | 24,1 | 0,430 | 2,7 | 0,460 | 0,0001 | 0,000019 | 30.09.1997 |
| 22,900 | 2 | 3,857 | 0,20 | 19,9 | 0,890 | 2,9 | 0,460 | 0,0003 | - | 29.10.1997 |
| 48,000 | 11 | 5,399 | 0,22 | 36,5 | 2,250 | 3,1 | 0,491 | < 0,0001 | 0,000003 | 26.11.1997 |

## Summary of simultaneous data on water and sediment discharge and water quality at the Uherske Hradiste sampling station

| Water Discharge $[m^3.s^{-1}]$ | Sediment Discharge $[mg.l^{-1}]$ | Total N $[mg.l^{-1}]$ | Total P $[mg.l^{-1}]$ | COD $[mg.l^{-1}]$ | $N\text{-}NH_4^+$ $[mg.l^{-1}]$ | $N\text{-}NO_3^-$ $[mg.l^{-1}]$ | $PO_4^-$ $[mg.l^{-1}]$ | Hg $[mg.l^{-1}]$ | PCB $[mg.l^{-1}]$ | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 183,000 | - | 0,000 | 0,32 | 14,0 | | | | 0,00023 | 0,000001 | 23.04.1996 |
| 109,000 | - | 5,636 | 0,16 | 19,5 | 0,489 | 5,0 | 0,650 | < 0,00010 | 0,000006 | 20.05.1996 |
| 40,400 | - | 4,503 | 0,47 | 25,4 | 0,745 | 3,6 | 1,260 | 0,00018 | - | 10.06.1996 |
| 51,000 | - | 4,460 | 0,22 | 19,2 | 0,761 | 3,5 | 0,960 | 0,00018 | 0,000003 | 02.07.1996 |
| 29,600 | - | 4,203 | 0,32 | 25,9 | 0,885 | 3,2 | 0,960 | 0,00022 | 0,000002 | 25.07.1996 |
| 19,600 | - | 3,738 | 0,38 | 23,4 | 0,621 | 3,0 | 0,970 | < 0,00010 | 0,000001 | 13.08.1996 |
| 29,200 | - | 3,664 | 0,33 | 22,4 | 0,559 | 3,0 | 0,900 | 0,00069 | 0,000003 | 03.09.1996 |
| 43,000 | - | 8,167 | 0,31 | 17,1 | 4,977 | 3,1 | 0,460 | 0,00013 | 0,000005 | 24.09.1996 |
| 38,000 | - | 4,980 | 0,28 | 24,7 | 1,965 | 2,9 | 0,370 | 0,00023 | 0,000004 | 15.10.1996 |
| 47,200 | - | 6,904 | 0,33 | 21,7 | 4,162 | 2,7 | 0,520 | 0,00011 | 0,000002 | 05.11.1996 |
| 81,000 | - | 4,554 | 0,20 | 16,5 | 0,559 | 3,9 | 0,620 | < 0,00010 | - | 20.11.1996 |
| 221,000 | - | 6,683 | 0,52 | 18,2 | 1,219 | 5,4 | 1,040 | 0,00010 | - | 26.02.1997 |
| 82,800 | - | 5,789 | 0,18 | 11,6 | 1,173 | 4,5 | 0,550 | 0,00017 | - | 11.03.1997 |
| 55,800 | - | 4,992 | 0,22 | 17,9 | 1,242 | 3,7 | 0,650 | 0,00015 | 0,000015 | 02.04.1997 |
| 72,100 | - | 4,048 | 0,14 | 13,6 | 0,831 | 3,2 | 0,390 | 0,00014 | - | 22.04.1997 |
| 55,400 | - | 4,310 | 0,31 | 17,1 | 1,374 | 2,8 | 0,970 | < 0,00010 | 0,000016 | 20.05.1997 |
| 25,500 | - | 3,884 | 0,25 | 20,6 | 0,761 | 3,0 | 1,170 | 0,00015 | - | 10.06.1997 |
| 620,000 | - | 3,122 | 0,31 | 30,4 | 0,210 | 2,9 | 2,790 | 0,00018 | 0,000048 | 09.07.1997 |
| (480) | - | 2,762 | 0,22 | 34,3 | 1,087 | 1,5 | 1,950 | 0,00011 | - | 15.07.1997 |
| 65,800 | - | 3,883 | 0,16 | 19,3 | 0,443 | 3,3 | 2,040 | 0,00023 | 0,000026 | 13.08.1997 |
| 61,900 | - | 3,659 | 0,20 | 20,4 | 0,745 | 2,8 | 0,660 | 0,00012 | - | 02.09.1997 |
| 33,700 | - | 4,088 | 0,18 | 20,8 | 0,777 | 3,2 | 0,680 | 0,00010 | - | 17.09.1997 |
| 21,500 | - | 3,724 | 0,25 | 25,7 | 0,497 | 3,1 | 0,660 | 0,00012 | 0,000015 | 08.10.1997 |

## Summary of simultaneous data on water and sediment discharge and water quality at the Hodonin sampling station

| Water Discharge [$m^3.s^{-1}$] | Sediment Discharge [$mg.l^{-1}$] | Total N [$mg.l^{-1}$] | Total P [$mg.l^{-1}$] | COD [$mg.l^{-1}$] | $N\text{-}NH_4^+$ [$mg.l^{-1}$] | $N\text{-}NO_3^-$ [$mg.l^{-1}$] | $PO_4^-$ [$mg.l^{-1}$] | Hg [$mg.l^{-1}$] | PCB [$mg.l^{-1}$] | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 73,600 | 11 | 5,650 | 0,20 | 17,0 | 1,500 | 4,1 | 0,450 | - | - | 25.01.1994 |
| 47,970 | 15 | 5,150 | 0,24 | 18,5 | 0,900 | 4,2 | 0,400 | - | - | 15.02.1994 |
| 84,560 | 26 | 5,450 | 0,16 | 15,8 | 1,100 | 4,3 | 0,400 | - | - | 14.03.1994 |
| 121,980 | 31 | 5,250 | 0,09 | 9,30 | 0,900 | 4,3 | 0,200 | - | - | 11.04.1994 |
| 52,990 | 25 | 3,700 | 0,20 | 21,5 | 0,200 | 3,4 | 0,350 | - | - | 10.05.1994 |
| 23,270 | 50 | 2,910 | 0,20 | 31,3 | 0,100 | 2,6 | 0,300 | - | - | 21.06.1994 |
| 15,580 | 34 | 2,180 | 1,27 | 26,0 | 0,500 | 1,4 | 0,900 | - | - | 11.07.1994 |
| 5,330 | 25 | 1,680 | 0,13 | 22,0 | 0,100 | 1,5 | 0,350 | - | - | 22.08.1994 |
| 20,090 | 37 | 4,720 | 0,33 | 33,2 | 0,600 | 4,0 | 0,750 | - | - | 20.09.1994 |
| 27,910 | 21 | 4,910 | 0,31 | 22,8 | 1,400 | 3,4 | 0,770 | - | - | 11.10.1994 |
| 41,620 | 13 | 4,550 | 0,29 | 23,1 | 1,700 | 2,8 | 0,700 | - | - | 21.11.1994 |
| 29,930 | 13 | 5,140 | 1,43 | 11,2 | 2,000 | 3,1 | 1,050 | - | - | 06.12.1994 |
| 46,125 | 3 | 4,630 | 0,33 | 31,0 | 0,400 | 4,2 | 0,800 | - | - | 23.01.1995 |
| 103,525 | 33 | 5,660 | 0,19 | 11,8 | 0,800 | 4,8 | 0,380 | - | - | 22.02.1995 |
| 102,193 | 15 | 5,650 | 0,17 | 13,5 | 0,800 | 4,8 | 0,330 | - | - | 20.03.1995 |
| 101,475 | 27 | 3,330 | 0,20 | 10,2 | 0,400 | 2,9 | 0,340 | - | - | 19.04.1995 |
| 112,750 | 46 | 4,280 | 0,20 | 15,4 | 0,400 | 3,8 | 0,330 | - | - | 23.05.1995 |
| 91,635 | 74 | 3,010 | 0,14 | 17,9 | 0,200 | 2,7 | 0,380 | - | - | 19.06.1995 |
| 51,763 | 70 | 3,020 | 0,10 | 14,8 | - | 2,9 | 0,300 | - | - | 12.07.1995 |
| 10,763 | 24 | 2,110 | 0,22 | 17,9 | 0,200 | 1,8 | 0,420 | - | - | 15.08.1995 |
| 56,683 | 65 | 5,800 | 0,10 | 18,0 | 0,100 | 5,6 | 0,580 | - | - | 19.09.1995 |
| 32,595 | 16 | 4,010 | 0,29 | 11,9 | 0,300 | 3,6 | 0,650 | - | - | 09.10.1995 |
| 43,768 | 4 | 4,660 | 0,29 | 10,1 | 1,200 | 3,4 | 0,700 | - | - | 16.11.1995 |
| 44,690 | 15 | 4,830 | 0,22 | 12,9 | 0,900 | 3,9 | 0,680 | - | - | 05.12.1995 |
| 57,708 | 8 | 5,230 | 0,24 | 18,8 | 0,900 | 4,3 | 0,660 | - | - | 10.01.1996 |
| 25,625 | 15 | 6,120 | 0,26 | 15,3 | 1,800 | 4,3 | 0,780 | - | - | 05.02.1996 |
| 22,243 | 9 | 6,530 | 0,35 | 20,6 | 2,700 | 3,8 | 1,030 | - | - | 04.03.1996 |
| 113,775 | 49 | 7,350 | 0,26 | 22,3 | 0,400 | 6,9 | 0,370 | - | - | 03.04.1996 |
| 144,525 | 155 | 3,870 | 0,27 | 47,5 | 0,200 | 3,6 | 0,300 | - | - | 30.04.1996 |
| 141,450 | 485 | 5,450 | 0,53 | 42,8 | 0,200 | 5,1 | 0,400 | - | - | 27.05.1996 |
| 96,863 | 147 | 4,050 | 0,26 | 35,7 | 0,480 | 3,4 | 0,150 | - | - | 25.06.1996 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 25,318 | 25 | 1,740 | 0,42 | 22,2 | 0,080 | 1,6 | 0,760 | - | - | 30.07.1996 |
| 18,963 | 4 | 3,280 | 0,43 | 23,7 | 0,030 | 3,2 | 0,870 | - | - | 27.08.1996 |
| 72,878 | 43 | 3,210 | 1,33 | 21,2 | 0,010 | 3,0 | 0,580 | - | - | 30.09.1996 |
| 48,483 | 8 | 3,250 | 0,40 | 19,6 | 0,410 | 2,8 | 0,400 | - | - | 04.11.1996 |
| 66,215 | 8 | 4,030 | 0,27 | 15,3 | 0,500 | 3,5 | 0,350 | - | - | 26.11.1996 |
| 17,425 | 19 | 7,231 | 0,35 | 19,0 | 3,910 | 3,3 | 0,981 | - | - | 27.01.1997 |
| 108,650 | 46 | 5,773 | 0,16 | 13,6 | 1,030 | 4,7 | 0,399 | - | - | 24.02.1997 |
| 85,280 | 20 | 5,000 | 0,16 | 15,1 | 0,660 | 4,3 | - | - | - | 10.03.1997 |
| 60,168 | 15 | 3,793 | 0,14 | 17,2 | 0,450 | 3,3 | 0,307 | - | - | 03.04.1997 |
| 58,528 | 10 | 2,770 | 0,22 | 15,2 | 0,200 | 2,5 | 0,337 | - | - | 07.05.1997 |
| 87,638 | 125 | 2,935 | 0,31 | 26,3 | 0,280 | 2,6 | 0,399 | - | - | 02.06.1997 |
| 39,873 | 25 | 3,029 | 0,35 | 19,2 | 0,080 | 2,9 | 0,705 | - | - | 30.06.1997 |
| 218,325 | 95 | 2,608 | 0,39 | 32,7 | 0,150 | 2,4 | 0,307 | - | - | 30.07.1997 |
| 55,453 | 30 | 2,603 | 0,13 | 29,5 | 0,024 | 2,5 | 0,184 | - | - | 25.08.1997 |
| 29,930 | 19 | 3,694 | 0,22 | 26,2 | 0,190 | 3,4 | 0,276 | - | - | 30.09.1997 |
| 26,343 | 2 | 3,751 | 0,17 | 19,9 | 0,490 | 3,2 | 0,307 | - | - | 29.10.1997 |
| 50,430 | 2 | 4,390 | 0,19 | 24,0 | 0,950 | 3,4 | 0,521 | - | - | 26.11.1997 |

## Summary of simultaneous data on water and sediment discharge and water quality at the Lanzhot sampling station

| Water Discharge $[m^3.s^{-1}]$ | Sediment Discharge $[mg.l^{-1}]$ | Total N $[mg.l^{-1}]$ | Total P $[mg.l^{-1}]$ | COD $[mg.l^{-1}]$ | $N\text{-}NH_4^+$ $[mg.l^{-1}]$ | $N\text{-}NO_3^-$ $[mg.l^{-1}]$ | $PO_4^-$ $[mg.l^{-1}]$ | Hg $[mg.l^{-1}]$ | PCB $[mg.l^{-1}]$ | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 74,670 | 95 | 5,560 | 0,28 | 44,6 | 2,800 | 2,7 | 0,750 | 0,0002 | - | 25.01.1994 |
| 48,670 | 55 | 5,350 | 0,26 | 42,6 | 1,000 | 4,3 | 0,300 | 0,0001 | 0,000006 | 15.02.1994 |
| 85,800 | 31 | 5,250 | 0,14 | 19,8 | 0,900 | 4,3 | 0,300 | < 0,0001 | - | 14.03.1994 |
| 123,760 | 34 | 4,850 | 0,13 | 16,7 | 0,600 | 4,2 | 0,300 | 0,0008 | 0,000008 | 11.04.1994 |
| 53,770 | 32 | 3,490 | 0,18 | 38,2 | 0,200 | 3,2 | 0,250 | 0,0014 | 0,000013 | 10.05.1994 |
| 23,610 | 50 | 2,770 | 0,13 | 33,6 | 0,100 | 2,5 | 0,250 | 0,0006 | - | 21.06.1994 |
| 15,810 | 23 | 2,480 | 0,89 | 30,6 | 0,300 | 2,0 | 0,890 | < 0,0001 | < 0,000005 | 11.07.1994 |
| 5,410 | 25 | 1,360 | 0,23 | 24,5 | 0,040 | 1,3 | 0,400 | < 0,0001 | - | 22.08.1994 |
| 20,380 | 40 | 5,190 | 0,37 | 21,4 | 0,200 | 4,9 | 0,750 | 0,0002 | < 0,000005 | 20.09.1994 |
| 28,320 | 12 | 4,790 | 0,33 | 20,7 | 0,700 | 4,0 | 0,800 | 0,0001 | - | 11.10.1994 |
| 42,220 | 18 | 5,450 | 0,33 | 25,5 | 2,100 | 3,3 | 0,700 | < 0,0001 | < 0,000005 | 21.11.1994 |
| 30,370 | 15 | 5,230 | 1,25 | 16,3 | 2,200 | 3,0 | 1,030 | < 0,0001 | - | 06.12.1994 |
| 46,800 | 9 | 4,630 | 0,34 | 13,9 | 0,300 | 4,3 | 0,880 | < 0,0001 | - | 23.01.1995 |
| 105,040 | 39 | 5,450 | 0,23 | 11,4 | 0,800 | 4,6 | 0,460 | < 0,0001 | 0,000005 | 22.02.1995 |
| 103,688 | 21 | 4,950 | 0,20 | 18,3 | 0,800 | 4,1 | 0,350 | < 0,0001 | - | 20.03.1995 |
| 102,960 | 24 | 4,030 | 0,27 | 13,5 | 0,400 | 3,6 | 0,410 | < 0,0001 | < 0,000005 | 19.04.1995 |
| 114,400 | 68 | 4,790 | 0,28 | 18,1 | 0,700 | 4,0 | 0,100 | < 0,0001 | 0,000018 | 23.05.1995 |
| 92,976 | 84 | 2,910 | 0,16 | 17,9 | 0,300 | 2,5 | 0,390 | < 0,0001 | 0,000018 | 19.06.1995 |
| 52,520 | 79 | 3,500 | 0,10 | 13,5 | 0,200 | 3,2 | 0,260 | 0,0002 | - | 12.07.1995 |
| 10,920 | 39 | 1,440 | 0,22 | 28,2 | 0,200 | 1,2 | 0,170 | 0,0002 | 0,000012 | 15.08.1995 |
| 57,512 | 76 | 5,400 | 0,29 | 13,0 | 0,100 | 5,2 | 0,570 | < 0,0001 | - | 19.09.1995 |
| 33,072 | 17 | 3,890 | 0,20 | 13,6 | 0,200 | 3,6 | 0,480 | < 0,0001 | 0,000004 | 09.10.1995 |
| 44,408 | 7 | 4,460 | 0,30 | 12,4 | 1,200 | 3,2 | 0,750 | < 0,0001 | < 0,000005 | 16.11.1995 |
| 45,344 | 11 | 4,340 | 0,20 | 15,3 | 0,400 | 3,9 | 0,600 | < 0,0001 | < 0,000005 | 05.12.1995 |
| 58,552 | 33 | 6,430 | 0,26 | 37,5 | 1,800 | 4,6 | 0,580 | 0,0001 | 0,000005 | 10.01.1996 |
| 26,000 | 8 | 6,520 | 0,26 | 39,8 | 1,900 | 4,6 | 0,810 | < 0,0001 | 0,000024 | 05.02.1996 |
| 22,568 | 10 | 6,730 | 0,32 | 27,8 | 2,800 | 3,9 | 0,920 | < 0,0001 | 0,000008 | 04.03.1996 |
| 115,440 | 72 | 7,250 | 0,38 | 29,1 | 0,400 | 6,8 | 0,350 | 0,0014 | 0,000002 | 03.04.1996 |
| 146,640 | 48 | 4,070 | 0,16 | 33,3 | 0,200 | 3,8 | 0,280 | 0,0001 | 0,000025 | 30.04.1996 |
| 143,520 | 619 | 5,440 | 0,39 | 48,9 | 0,200 | 5,1 | 0,550 | < 0,0001 | 0,000010 | 27.05.1996 |
| 98,280 | 164 | 4,100 | 0,25 | 33,7 | 0,230 | 3,7 | 0,630 | < 0,0001 | 0,000009 | 25.06.1996 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 25,688 | 13 | 3,200 | 0,32 | 17,2 | 0,040 | 3,1 | 0,610 | < 0,0001 | 0,000005 | 30.07.1996 |
| 19,240 | 4 | 2,860 | 0,45 | 22,7 | 0,030 | 2,8 | 0,850 | < 0,0001 | 0,000004 | 27.08.1996 |
| 73,944 | 44 | 3,130 | 0,53 | 17,9 | 0,080 | 3,0 | 0,680 | < 0,0001 | 0,000015 | 30.09.1996 |
| 49,192 | 15 | 3,020 | 0,18 | 20,6 | 0,180 | 2,8 | 0,120 | 0,0003 | 0,000004 | 04.11.1996 |
| 67,184 | 11 | 4,030 | 0,21 | 18,4 | 0,400 | 3,6 | 0,410 | 0,0001 | 0,000020 | 26.11.1996 |
| 23,000 | 19 | 6,371 | 0,43 | 21,9 | 3,250 | 3,1 | 0,981 | < 0,0001 | 0,000018 | 27.01.1997 |
| 103,000 | 62 | 6,037 | 0,19 | 21,4 | 1,200 | 4,8 | 0,491 | 0,0002 | 0,000014 | 24.02.1997 |
| 86,000 | 20 | 5,050 | 0,17 | 18,8 | 0,610 | 4,4 | 0,276 | 0,0002 | 0,000006 | 10.03.1997 |
| 60,000 | 18 | 4,076 | 0,16 | 16,2 | 0,430 | 3,6 | 0,307 | 0,0002 | 0,000023 | 03.04.1997 |
| 68,500 | 13 | 3,097 | 0,21 | 16,2 | 0,430 | 2,6 | 0,368 | < 0,0001 | 0,000003 | 07.05.1997 |
| 91,500 | 126 | 2,955 | 0,26 | 26,3 | 0,200 | 2,7 | 0,521 | < 0,0001 | 0,000003 | 02.06.1997 |
| 39,800 | 20 | 2,972 | 0,29 | 22,6 | 0,090 | 2,8 | 0,552 | < 0,0001 | 0,000221 | 30.06.1997 |
| 265,000 | 89 | 2,592 | 0,41 | 36,5 | 0,140 | 2,4 | 0,307 | < 0,0001 | 0,000113 | 30.07.1997 |
| 76,600 | 39 | 2,594 | 0,27 | 31,6 | 0,024 | 2,5 | 0,184 | < 0,0001 | 0,000043 | 25.08.1997 |
| 42,500 | 18 | 3,724 | 0,22 | 27,2 | 0,120 | 3,5 | 0,276 | 0,0002 | 0,000012 | 30.09.1997 |
| 37,800 | 5 | 3,961 | 0,17 | 22,9 | 0,600 | 3,3 | 0,368 | 0,0002 | 0,000003 | 29.10.1997 |
| 43,300 | 8 | 4,370 | 0,22 | 26,4 | 0,840 | 3,5 | 0,460 | < 0,0001 | 0,000016 | 26.11.1997 |

# Summary of simultaneous data on water and sediment discharge and water quality at the Kromeriz sampling station

| Water Discharge $[m^3.s^{-1}]$ | Sediment Discharge $[mg.l^{-1}]$ | Total N $[mg.l^{-1}]$ | Total P $[mg.l^{-1}]$ | COD $[mg.l^{-1}]$ | $N\text{-}NH_4^+$ $[mg.l^{-1}]$ | $N\text{-}NO_3^-$ $[mg.l^{-1}]$ | $PO_4^-$ $[mg.l^{-1}]$ | Hg $[mg.l^{-1}]$ | PCB $[mg.l^{-1}]$ | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 56,900 | 18 (12.6) | 5,450 | 0,23 | 21,6 | 1,100 | 4,3 | 0,450 | - | - | 24.01.1994 |
| 48,300 | 20 (15.5) | 6,050 | 0,26 | 20,4 | 1,200 | 4,8 | 0,500 | - | - | 16.02.1994 |
| 98,000 | 63 (44.9) | 4,560 | 0,28 | 25,0 | 0,800 | 3,7 | 0,350 | - | - | 15.03.1994 |
| 136,000 | 48 (69.7) | 2,450 | 0,18 | 34,2 | 0,500 | 1,9 | 0,300 | - | - | 12.04.1994 |
| 42,800 | 22 (25.6) | 3,590 | 0,20 | 15,1 | 0,600 | 2,9 | 0,400 | - | - | 09.05.1994 |
| 21,500 | 19 (15.7) | 2,810 | 0,22 | 18,1 | 0,100 | 2,6 | 0,400 | - | - | 20.06.1994 |
| 16,200 | 49 (29.5) | 2,600 | 0,31 | 24,0 | 0,100 | 2,3 | 0,350 | - | - | 12.07.1994 |
| 13,100 | 43 (14.6) | 2,040 | 0,21 | 27,0 | 0,200 | 1,7 | 0,400 | - | - | 23.08.1994 |
| 18,100 | 41 (30.4) | 3,980 | 0,36 | 21,0 | 0,500 | 3,4 | 0,650 | - | - | 19.09.1994 |
| 25,900 | 33 (12.6) | 4,520 | 0,34 | 23,2 | 1,000 | 3,4 | 0,750 | - | - | 10.10.1994 |
| 34,200 | 6 (3.9) | 3,240 | 0,27 | 9,8 | 0,600 | 2,6 | 0,400 | - | - | 22.11.1994 |
| 26,500 | 9 (1.2) | 4,330 | 0,33 | 16,2 | 1,500 | 2,8 | 0,800 | - | - | 05.12.1994 |
| 111,000 | 224 (14.7) | 5,230 | 0,91 | 59,0 | 1,000 | 4,2 | 0,480 | - | - | 24.01.1995 |
| 88,200 | 26 (30.8) | 5,410 | 0,02 | 7,5 | 0,500 | 4,9 | 0,340 | - | - | 23.02.1995 |
| 76,800 | 17 (13.7) | 4,250 | 0,12 | 12,5 | 0,700 | 3,5 | 0,310 | - | - | 21.03.1995 |
| 76,800 | 7 (6.7) | 3,430 | 0,13 | 49,1 | 0,400 | 3,0 | 0,280 | - | - | 18.04.1995 |
| 111,000 | 30 (39.4) | 3,960 | 0,06 | 22,7 | 0,400 | 3,5 | 0,350 | - | - | 22.05.1995 |
| 64,700 | 110 (54.5) | 5,280 | 0,12 | 18,9 | 0,100 | 5,1 | 0,330 | - | - | 20.06.1995 |
| 39,800 | 45 (28.9) | 3,980 | 0,17 | 20,3 | 0,400 | 3,5 | 0,420 | - | - | 13.07.1995 |
| 10,400 | 41 (34.9) | 3,090 | 0,17 | 19,8 | 0,200 | 2,8 | 0,400 | - | - | 14.08.1995 |
| 56,000 | 20 (104.8) | 4,990 | 0,25 | 18,3 | 0,200 | 4,7 | 0,480 | - | - | 18.09.1995 |
| 28,200 | 16 (8.6) | 3,500 | 0,17 | 14,1 | 0,300 | 3,1 | 0,470 | - | - | 10.10.1995 |
| 36,600 | 20 (4.1) | 3,660 | 0,06 | 13,2 | 0,500 | 3,1 | 0,300 | - | - | 15.11.1995 |
| 41,200 | 5 (8.7) | 4,450 | 0,17 | 7,0 | 0,600 | 3,8 | 0,420 | - | - | 04.12.1995 |
| 36,000 | 12 (10.5) | 6,430 | 0,17 | 14,6 | 1,700 | 4,7 | 0,420 | - | - | 08.01.1996 |
| 24,000 | 16 (9.4) | 5,210 | 0,29 | 10,2 | 1,100 | 4,1 | 0,860 | - | - | 06.02.1996 |
| 15,000 | 13 (6.5) | 4,910 | 0,41 | 21,6 | 1,600 | 3,3 | 0,910 | - | - | 05.03.1996 |
| 87,200 | 23 (45.3) | 7,450 | 0,24 | 22,2 | 0,300 | 7,1 | 0,320 | - | - | 02.04.1996 |
| 98,400 | 19 (149.8) | 3,560 | 0,15 | 14,0 | 0,300 | 3,2 | 0,260 | - | - | 29.04.1996 |
| 89,700 | 69 (83.8) | 4,700 | 0,23 | 24,5 | 0,200 | 4,4 | 0,340 | - | - | 28.05.1996 |
| 41,300 | 23 (38.3) | 3,440 | 0,17 | 23,8 | 0,030 | 3,3 | 0,460 | - | - | 01.07.1996 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 19,300 | 45 (22.1) | 2,750 | 0,33 | 19,2 | 0,100 | 2,6 | 0,570 | - | - | 29.07.1996 |
| 16,600 | 14 (16.4) | 2,330 | 0,36 | 24,0 | 0,070 | 2,2 | 0,830 | - | - | 26.08.1996 |
| 43,900 | 10 (10.7) | 2,840 | 0,15 | 14,5 | 0,090 | 2,7 | 0,370 | - | - | 01.10.1996 |
| 40,000 | 11 (8.8) | 2,980 | 0,20 | 11,8 | 0,330 | 2,6 | 0,600 | - | - | 05.11.1996 |
| 57,000 | 9 (28.6) | 3,820 | 0,09 | 13,0 | 0,290 | 3,5 | 0,170 | - | - | 25.11.1996 |
| 19,000 | 13 (9.0) | 6,187 | 0,41 | 19,8 | 2,960 | 3,2 | - | 0,0001 | - | 29.01.1997 |
| 233,000 | 55 (900.0) | 4,970 | 0,27 | 32,2 | 0,430 | 4,5 | 0,337 | 0,0011 | - | 26.02.1997 |
| 64,200 | 1 (12.0) | 4,693 | 0,11 | 5,3 | 0,650 | 4,0 | 0,337 | 0,0001 | - | 12.03.1997 |
| 50,500 | 8 (33.1) | 3,909 | 0,14 | 16,3 | 0,360 | 3,5 | 0,337 | < 0,0001 | - | 02.04.1997 |
| 52,600 | 7 (20.5) | 2,761 | 0,17 | 10,6 | 0,200 | 2,5 | 0,399 | < 0,0001 | - | 05.05.1997 |
| 45,200 | 16 (155.0) | 2,973 | 0,16 | 12,3 | 0,300 | 2,6 | 0,399 | < 0,0001 | - | 04.06.1997 |
| 37,600 | 23 (65.6) | 2,982 | 0,24 | 8,7 | 0,300 | 2,6 | 0,491 | 0,0001 | - | 26.06.1997 |
| 141,000 | 34 (68.0) | 3,020 | 0,22 | 31,7 | 0,150 | 2,8 | 0,399 | 0,0001 | - | 29.07.1997 |
| 28,800 | 15 (15.1) | 2,900 | 0,17 | 12,0 | 0,030 | 2,8 | 0,368 | 0,0001 | - | 26.08.1997 |
| 19,200 | 2 (29.4) | 3,160 | 0,18 | 36,4 | 0,190 | 2,9 | 0,215 | 0,0001 | - | 29.09.1997 |
| 19,300 | 8 (18.6) | 3,659 | 0,19 | 16,3 | 0,610 | 3,0 | 0,368 | 0,0001 | - | 30.10.1997 |
| 33,900 | 7 (8.3) | 4,070 | 0,21 | 18,8 | 0,730 | 3,3 | 0,399 | 0,0005 | - | 25.11.1997 |

## Summary of simultaneous data on water and sediment discharge and water quality at the Breclav sampling station

| Water Discharge [$m^3.s^{-1}$] | Sediment Discharge [$mg.l^{-1}$] | Total N [$mg.l^{-1}$] | Total P [$mg.l^{-1}$] | COD [$mg.l^{-1}$] | $N\text{-}NH_4^+$ [$mg.l^{-1}$] | $N\text{-}NO_3^-$ [$mg.l^{-1}$] | $PO_4^-$ [$mg.l^{-1}$] | Hg [$mg.l^{-1}$] | PCB [$mg.l^{-1}$] | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 123,000 | - | 0,000 | 0,18 | 26,5 | | | | 0,00014 | 0,000013 | 23.04.1996 |
| 192,000 | - | 8,113 | 0,21 | 26,9 | 0,085 | 8,0 | 0,680 | 0,00042 | 0,000004 | 20.05.1996 |
| 38,100 | - | 6,763 | 0,22 | 43,7 | 0,039 | 6,6 | 0,660 | 0,00021 | - | 10.06.1996 |
| 34,600 | - | 4,336 | 0,43 | 34,5 | 0,427 | 3,8 | 0,940 | 0,00041 | - | 02.07.1996 |
| 17,300 | - | 3,887 | 0,37 | 31,9 | 0,668 | 3,0 | 0,720 | 0,00013 | 0,000003 | 25.07.1996 |
| 21,300 | - | 3,016 | 0,47 | 31,9 | 0,520 | 2,3 | 1,160 | < 0,00010 | 0,000001 | 13.08.1996 |
| 18,700 | - | 2,875 | 0,47 | 32,5 | 0,777 | 2,0 | 0,440 | 0,00029 | 0,000005 | 03.09.1996 |
| 27,200 | - | 7,079 | 0,32 | 32,0 | 4,015 | 3,0 | 0,630 | 0,00027 | 0,000006 | 24.09.1996 |
| 30,600 | - | 4,523 | 0,30 | 41,6 | 0,357 | 4,1 | 0,680 | 0,00028 | - | 15.10.1996 |
| 33,100 | - | 6,606 | 0,36 | 39,6 | 2,702 | 3,8 | 0,660 | < 0,00010 | 0,000001 | 05.11.1996 |
| 35,600 | - | 4,855 | 0,30 | 34,4 | 0,334 | 4,5 | 0,630 | < 0,00010 | - | 20.11.1996 |
| 43,400 | - | 8,316 | 0,70 | 37,9 | 1,817 | 6,4 | 1,120 | < 0,00010 | - | 26.02.1997 |
| 60,700 | - | 8,869 | 0,18 | 29,7 | 0,893 | 7,9 | 0,510 | 0,00016 | - | 11.03.1997 |
| 107,000 | - | 7,246 | 0,22 | 35,2 | 0,202 | 7,0 | 0,680 | 0,00019 | 0,000036 | 02.04.1997 |
| 46,000 | - | 6,959 | 0,21 | 37,0 | 0,217 | 6,7 | 0,610 | < 0,00010 | - | 22.04.1997 |
| 28,900 | - | 5,032 | 0,28 | 32,0 | 0,373 | 4,6 | 0,700 | < 0,00010 | - | 20.05.1997 |
| 19,200 | - | 5,385 | 0,28 | 26,8 | 0,885 | 4,4 | 1,190 | 0,00012 | 0,000044 | 10.06.1997 |
| 158,000 | - | 3,809 | 0,31 | 36,6 | 0,808 | 2,9 | 1,010 | 0,00013 | - | 09.07.1997 |
| 34,600 | - | 5,105 | 0,26 | 28,8 | 0,365 | 4,7 | 1,190 | 0,00015 | 0,000036 | 13.08.1997 |
| 28,900 | - | 4,371 | 0,35 | 33,4 | 1,033 | 3,2 | 0,640 | 0,00020 | - | 02.09.1997 |
| 20,500 | - | 3,839 | 0,25 | 35,4 | 0,916 | 2,8 | 0,780 | < 0,00010 | 0,000011 | 17.09.1997 |
| 27,400 | - | 3,624 | 0,30 | 35,1 | 0,590 | 2,9 | 0,770 | 0,00010 | 0,000049 | 08.10.1997 |

## Summary of simultaneous data on water and sediment discharge and water quality at the Pohansko sampling station

| Water Discharge [$m^3.s^{-1}$] | Sediment Discharge [$mg.l^{-1}$] | Total N [$mg.l^{-1}$] | Total P [$mg.l^{-1}$] | COD [$mg.l^{-1}$] | $N\text{-}NH_4^+$ [$mg.l^{-1}$] | $N\text{-}NO_3^-$ [$mg.l^{-1}$] | $PO_4^-$ [$mg.l^{-1}$] | Hg [$mg.l^{-1}$] | PCB [$mg.l^{-1}$] | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| 16,900 | 8 | 5,300 | 0,21 | - | 1,580 | 3,7 | - | - | - | 11.01.95 |
| 33,100 | 7 | 6,700 | 0,19 | - | 0,790 | 5,8 | - | - | - | 23.02.95 |
| 27,600 | 17 | 6,300 | 0,18 | - | 0,130 | 6,1 | - | - | - | 21.03.95 |
| 33,050 | 18 | 6,400 | 0,21 | - | 0,250 | 6,1 | - | - | - | 26.04.95 |
| 26,000 | 16 | 4,800 | 0,23 | - | 0,260 | 4,5 | - | - | - | 23.05.95 |
| 35,700 | 16 | 3,400 | 0,27 | - | 0,110 | 3,2 | - | - | - | 20.06.95 |
| 10,700 | 22 | 2,100 | 0,77 | - | 0,100 | 1,9 | - | - | - | 26.07.95 |
| 9,800 | 26 | 1,000 | 0,62 | - | 0,210 | 0,7 | - | - | - | 21.08.95 |
| 27,300 | 13 | 2,300 | 0,62 | - | 0,380 | 1,8 | - | - | - | 20.09.95 |
| 19,900 | 28 | 3,500 | 0,45 | - | 0,290 | 3,1 | - | - | - | 23.10.95 |
| 28,550 | 4 | 4,100 | 0,25 | - | 0,510 | 3,5 | - | - | - | 23.11.95 |
| 15,250 | 7 | 4,900 | 0,28 | - | 0,750 | 4,1 | - | - | - | 13.12.95 |
| 25,600 | 7 | 7,400 | 0,30 | - | 0,860 | 6,5 | - | - | - | 22.01.96 |
| 39,500 | 2 | 9,500 | 0,59 | - | 1,470 | 8,0 | - | - | - | 22.02.96 |
| 112,800 | 83 | 8,800 | 0,51 | - | 1,220 | 7,5 | - | - | - | 21.03.96 |
| 124,300 | 17 | 7,800 | 0,14 | - | 0,180 | 7,5 | - | - | - | 23.04.96 |
| 155,000 | 14 | 7,300 | 0,19 | - | 0,170 | 7,1 | - | - | - | 21.05.96 |
| 43,200 | 31 | 5,400 | 0,45 | - | 0,050 | 5,2 | - | - | - | 18.06.96 |
| 17,200 | 14 | 3,800 | 0,70 | - | 0,430 | 3,1 | - | - | - | 24.07.96 |
| 15,500 | 10 | 2,600 | 0,71 | - | 0,190 | 2,3 | - | - | - | 27.08.96 |
| 27,750 | 17 | 3,400 | 0,55 | - | 0,350 | 3,0 | - | - | - | 24.09.96 |
| 29,500 | 23 | 3,900 | 0,47 | - | 0,100 | 3,8 | - | - | - | 23.10.96 |
| 35,900 | 18 | 4,700 | 0,39 | - | 0,150 | 4,5 | - | - | - | 20.11.96 |
| 25,700 | 9 | 6,100 | 0,38 | - | 0,470 | 5,6 | - | - | - | 09.12.96 |
| 24,300 | 20 | 7,721 | 0,47 | 40,0 | 1,570 | 6,1 | 1,134 | 0,0002 | 0,000021 | 21.01.1997 |
| 77,500 | 21 | 7,739 | 0,26 | 36,3 | 1,070 | 6,6 | 0,552 | 0,0005 | 0,000000 | 25.02.1997 |
| 108,000 | 22 | 7,638 | 0,22 | 33,0 | 0,210 | 7,4 | 0,245 | 0,0001 | 0,000000 | 20.03.1997 |
| 46,600 | 39 | 6,265 | 0,35 | 41,1 | 0,030 | 6,2 | 0,368 | 0,0001 | 0,000009 | 22.04.1997 |
| 25,900 | 11 | 4,868 | 0,44 | 29,5 | 0,440 | 4,3 | 1,165 | 0,0001 | 0,000002 | 27.05.1997 |
| 17,500 | 17 | 3,487 | 0,54 | 33,7 | 0,180 | 3,2 | 1,318 | < 0,0001 | 0,000007 | 25.06.1997 |
| 30,800 | 16 | 3,976 | 0,41 | 33,2 | 0,280 | 3,6 | 0,859 | 0,0001 | 0,000060 | 26.08.1997 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 15,280 | 13 | 3,015 | 0,34 | 42,0 | 0,310 | 2,6 | 0,705 | < 0,0001 | 0,000005 | 23.09.1997 |
| 31,700 | 18 | 3,035 | 0,59 | 30,8 | 0,240 | 2,7 | 1,226 | 0,0001 | 0,000010 | 07.10.1997 |
| 25,500 | 15 | 3,123 | 0,32 | 34,1 | 0,350 | 2,7 | 0,767 | < 0,0001 | 0,000002 | 23.10.1997 |
| 34,200 | 17 | 3,348 | 0,34 | 32,0 | 0,210 | 3,1 | 0,644 | < 0,0001 | 0,000003 | 18.11.1997 |
| 40,400 | 13 | 5,664 | 0,28 | 35,1 | 0,810 | 4,8 | 0,705 | 0,0002 | 0,000004 | 10.12.1997 |

**Annex C-12**

## Institutions responsible for measuring water discharge, sediment discharge or water quality

| Name of Institution | Address of Institution | Responsibility |
|---|---|---|
| Morava River Administration<br>(Povodí Moravy) | Dřevařská 11<br>601 75 Brno<br>Czech Republic | ➢ water quality measuring in the state sampling network<br>➢ water quality measuring in TNMN |
| Water Research Institute T. G. M.<br>(VÚV) | Dřevařská 12<br>657 57 Brno<br>Czech Republic | ➢ water quality measuring in the Project Morava sampling network<br>➢ sediment quality measuring in the Project Morava and TNMN sampling networks |
| Czech Hydrometeorological Institute<br>(ČHMÚ) | Kroftova 43<br>616 67 Brno<br>Czech Republic | ➢ discharge measuring and assessment<br>➢ sediment discharge measuring in the CHMI network |

# Annex C-13

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# Part D

## Water Environmental Engineering

# Table of Contents

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# List of Abbreviations

**(Units in Water Environmental Engineering)**

| | |
|---|---|
| **°C** | temperature degree (Celsius) |
| **kg/d** | kilogram per day |
| **$km^2$** | square kilometer |
| **$m^3/s$ or $m^3.s^{-1}$** | cubic metros per second |
| **mg/l or $mg.l^{-1}$** | milligrams per litter |
| **μg.l or $\mu g.l^{-1}$** | micrograms per litter |
| **ng.l or $ng.l^{-1}$** | nanograms per litter |
| **t/y or t/year** | tons per year |

# Glossary on Water Environmental Engineering

## Abbreviations:

| | |
|---|---|
| Al, Fe, Hg, $SO_4$ ... | respective metals, compounds etc. according to chemical symbols |
| AOX | absorbable organic halogens |
| appr. | approximately |
| $BOD_5$ | biochemical oxygen demand (for 5-days) |
| CCU | colony counts in the unit (for microbiological parameters) |
| $COD_{Cr}$ | chemical oxygen demand (with the aid of acid potassium dichromate) |
| CZK | Czech Crown (unit of the Czech currency) |
| DDT | dichlorodiphenyltrichloroethane (pesticide) |
| DS | dissolved solids |
| HCH | hexachlorrocyclohexane (pesticide) |
| inh. | inhabitants |
| NAP | National Action Plan of the Czech Republic |
| $N\text{-}NH_4$ or $NH_4$ | ammonium nitrogen |
| $N\text{-}NO_2$ or $NO_2$ | nitrite-nitrogen |
| $N\text{-}NO_3$ or $NO_3$ | nitrate-nitrogen |
| $N_{Tot}$ | total nitrogen |
| PAH | polycyclic aromatic hydrocarbons |
| PCB | polychlorinated biphenyls |
| PE | population equivalent |
| $P_{Tot}$ | total phosphorus |
| Q | discharge, flow |
| R. | River |
| SS or TSS or UDS | suspended solids or total suspended solids or undissolved solids |
| WQ | water quality |
| WWTP | wastewater treatment plant |
| WWTPs | wastewater treatment plants |

## Often used terms:

| | | |
|---|---|---|
| agriculture | agricultural pollution | |
| dump site | | |
| hazardous substances | | |
| heavy metals | metals | |
| industry | industrial pollution | |
| municipalities | municipal pollution | |
| pesticides | | |
| pollutant | priority pollutant | polluter |
| remedial measures | remedying measures | remedying works |
| sanitation | | |
| sewage | sewage treatment plant | |
| sewer | sewer system | sewerage |
| sources of pollution | non-point sources | point sources |
| watercourse | profiles on watercourses | |
| wastes | waste management | |
| waste water | waste water treatment | waste water treatment plant |
| water pollution | water contamination | water pollution reduction |
| water protection | water management | water resources |
| water quality | water quality parameter | |

# 1. Summary

## 1.1. National Targets and Instruments for Water Pollution Reduction

Major problems in the Morava River basin and in the Czech part of the Vah River basin have been connected with nutrients (phosphorus, nitrogen), some heavy metals and other hazardous substances. Water pollution must be reduced mainly in municipalities and in industry, but some water quality issues spring also from agriculture and transport. Municipal and industrial polluters represent in particular point sources; the agriculture has been marked by combined pollution from point sources and non-point sources. Special part play challenges borne upon a handling old wastes and dump sites near municipalities, industrial establishments; these sites have been laid out in many places of landscape.

National targets and instruments for water pollution reduction are entirely drawn up in the text of “State Environmental Policy”, forwarded in the year 1995 by Ministry of Environment and approved by Czech Government. The targets of environmental policy and the instruments for their attainment were formulated to maximize the potential for creating an optimal system. This process proceeds from finding a socially acceptable level of environmental and health risks. The state targets concerning water issues have been reflected to these priorities towards water in the short-term context (1995 - 1998):

- improving water quality by limiting pollution discharges,
- reducing the production of wastes, namely hazardous wastes,
- eliminating the impacts of harmful physical and chemical factors,
- remedying previous environmental damages.

Improving air quality through the reduction of harmful emissions amounts to very important priorities. These emissions connected with mentioned period have considerably affected almost all water resources and systems in the Morava River catchment. For the period 1999 - 2005 there are two medium-term objectives and tasks aiming at special problems of water:

- creating land use provisions which will safeguard the efficient protection of water and fulfil international commitments through regional planning,
- increasing the water retention capacity of land by improving the revitalizing measures.

In the short-term context were adopted some political, social, institutional, legal, normative, economic and informational tools dealing with water pollution reduction. Probably the most significant instrument is the political and social tool resulting in the transition pressure leading up to changes of ownership from state to private sectors, leading up to reprivatization of most personal or real estate. These changes have been principal for other procedures in Czech Republic and have impacted favorably almost all implemented, proposed or prepared tools and measures of water pollution reduction. However, some economic instruments were applied before 1989, but many of them had to be upgraded after mentioned year. Among these tools belong charges for wastewater discharges and for waste disposal, some fines, taxes and other economic measures. The previous enforcement of Governmental Decree No. 171/1992 aiming at limits of wastewater discharges and following implementation in practice represent turning-points of former unfavorable tendency. The adoption of principle “The polluter pays” is the result of new political, social, economical, environmental and water management steps. However, there are some other tools related to water quality issues with increasing incentive function: emphasizing on water quality monitoring and evaluation in upgraded laboratories, better water quality supervision by district, inspection and hygiene authorities, growth of information and knowledge concerning the water - as consequence of new survey, studies and projects dealing with water and environment state in basins and other areas. But it is sure that other important instruments will have to be applied: more effective law, institutional and regional arrangements, completing of system of stimulating environmental charges and taxes, support of environmentally oriented policy approaches in agriculture, forestry, industry, mining, energetic and transport. The new acceding of Czech government to principles of sustainable development is very important and it could be probably resulted in the enforcing of other important tools and expected measures.

## 1.2. Measures for Reduction of Water Pollution

Main implemented measures for reduction of water pollution in Czech Republic - including the Czech part of the Morava River basin - have been particularly leant on Governmental Decree No. 171/1992 aiming at limits of wastewater discharges and on requests of binding international conventions and agreements. In the given case it refers above all to the "Convention on the Cooperation for Protection and Sustainable Use of the Danube"; this convention was ratified by Czech Republic in the year 1995. In addition to political, social, normative, legal and economic measures there have been mainly some technical measures by means of sanitation i.e. of constructions, reconstructions, extensions and intensifications of municipal and industrial wastewater treatment plants, of sewer systems reconstruction and with the aid of remedying previous environmental damages in old dump sites and landfills. Likewise, there have been also prepared some measures in agriculture, but the transition in this sector branch has been passed very slowly according to slow and difficult ownership processes. That is why there are no well prepared important projects of landscape or wetland rehabilitation and of pig farm sanitation. A lot of difficulties have been connected with insufficient knowledge applying mainly to non-managed dump sites and landfills in many parts of the Morava River basin, too; after all the same challenges have affected all area of Czech Republic.

The chief effort aimed at looking up the key hot spots in the catchment area of the Morava River. The base information in this branch descended from the water quality analysis. There were chosen main hot spots in the Morava River basin: municipalities Brno, Zlin, Uherske Hradiste and Hodonin, industrial polluters Kozeluzny a.s. Otrokovice, Fosfa Postorna a.s. and agricultural polluter Gigant Dubnany, s.r.o. The first five are represented by wastewater treatment plants, the 6th hot spot Fosfa Postorna a.s. is combination of wastewater treatment and remedying of old dumpsite containing different substances - including phosphates. The last polluter is represented by the large-capacity pig farm near the border with Slovakia. In the more detailed report are mentioned some other significant hot spots in the Morava River basin; they are following in the order. All systems of sanitation must be modernized, especially with respect to requirements on water pollution reduction in the field of nutrients, heavy metals and other harmful physical, chemical and microbiological factors. Likewise, all is considered with respect to transboundary effects downstream the Morava River and the Dyje River. The neighboring states in this sense are Slovakia and Austria.

Most measures must be divided in two or more stages. It depends on the extent of issues and challenges, on calculated or assumed costs, on timing of implementation, on local, national and international funds and capacities. The largest investment is the extension and intensification of the wastewater treatment plant in Modrice (WWTP for the city of Brno), then follow reconstruction and extension of WWTP Zlin, remedying measures for removal of previous environmental damages in area of company Fosfa Postorna a.s., reconstruction of technology systems in WWTP Uherske Hradiste, remedial measures and reduction of slurry production in the pig farm Gigant Dubnany, then reconstruction, intensification and extension of WWTP Hodonin, intensification of WWTP Kozeluzny Otrokovice (the owner is "Cistirna odpadnich vod Kozeluzny, a.s."; in English "Wastewater treatment plant of Tannery"). From other problems juts out the municipal WWTP Olomouc with finished reconstruction but with not effective reduction of phosphorus, notwithstanding the investments materials have not been prepared at this time. We set out other municipal hot spots here, with incidental stating of the given impact on the river and of investment preparedness:

- reconstruction of WWTP Znojmo (Dyje River, starting two years ago),
- extension of WWTP Breclav (Dyje River, 1st stage started two years ago, 2nd is prepared),
- intensification and extension of WWTP Prostejov (Valova River and then Morava River, recently started),
- reconstruction and extension of WWTP Prerov (Becva River and then Morava River, recently started),
- reconstruction of WWTP Kromeriz (Morava River, in the stage of preparedness; wastewater treatment concerns municipal, industrial and agricultural waters).

Among industrial hot spots have been further included:

- HAME Babice (Morava R., food-stuff industry, 1st stage of WWTP reconstruction finished not long ago, other projects are not prepared),
- Snaha Brtnice (Brtnice R., then Jihlava R. and then Dyje R., tannery, WWTP project partly prepared),
- Tanex Vladislav (Jihlava R., then Dyje R., tannery, at the beginning of preparedness).

There also some agricultural hot spots representing by five high-capacity pig farms: Milotice (near Kyjovka River, then Dyje River and Morava River), Dubnany (near Kyjovka River, then Dyje River and Morava River), Kunovice (Morava River), Velke Nemcice (Svratka River, then Dyje River) and Strachotice (Dyje River). Special problem is connected with the large-capacity pig farm Tesnovice near Kromeriz (wastewater are treated together in the municipal WWWTP in Kromeriz). The investment preparedness of agricultural projects is different and many difficulties have been connected with vague ownership relations and with very slow transition procedures in agriculture.

At this time-evaluated investment costs as regards six chosen hot spots are as follows:

| | |
|---|---|
| WWTP Brno | 39.7 million US $ |
| WWTP Zlin | 10.8 million US $ |
| WWTP Uherske Hradiste | 5.0 million US $ |
| WWTP Hodonin | 2.3 million US $ |
| WWTP Kozeluzny Otrokovice | 2.4 million US $ |
| Remedial measures in area of company Fosfa Postorna | 3.4 million US $ |
| Remedial measures and reduction of slurry production in the pigs farm Gigant Dubnany | 4.6 million US $ |
| **Total needed amount** | **68.2 million US $** |

There are some national and local financial sources and funds available, but the support from foreign funds is very needed as a consequence of domestic financial lack. All hot spots are also characterized by significant transboundary effect. However, after the termination of mentioned investment works the activities will have to continue, mainly with regard to WWTPs Zlin, Uherske Hradiste, Hodonin, to remedial measures of Fosfa Postorna and of Gigant Dubnany. These needful future activities are connected with nutrient challenges and with urgency of water pollution reduction in this sense.

## 1.3. Expected Regional and Transboundary Effects of Actual and Planned Measures

Environmental objectives of all project proposals are to meet the conditions given by international water quality standards for wastewater imission to watercourses and by the Czech Republic Decree No. 171/1992 concerning the admissible water discharges. The parameters by the design of measures will mostly comply with the EC regulations and with transboundary requirements to Slovakia and Austria.

The main benefits of projects implementation are the resulting decreasing of pollution in watercourses on the boundary reach of the Morava River between Czech Republic and Slovakia, of the Dyje River between Czech Republic and Austria, and of the Morava River downstream the confluence with the Dyje River - between Austria and Slovakia. Very important for most river reach is reduction of poorly degradable forms of *organic pollution, reduction of nutrients and reduction of heavy metals load*. Some WWTP projects were finished not long ago, other ones have been under construction. From the point of view of nutrient reduction is the role of WWTP modernization in Brno and of remedial measures of Fosfa Postorna the most essential, by other hot spots could be awaited the following improvement after implementation of submitted projects. Comparable importance is given by positive effects of water quality improvement for regional demands and for groundwater resources near mentioned rivers and for aquatic ecosystems. It concerns all planned projects:

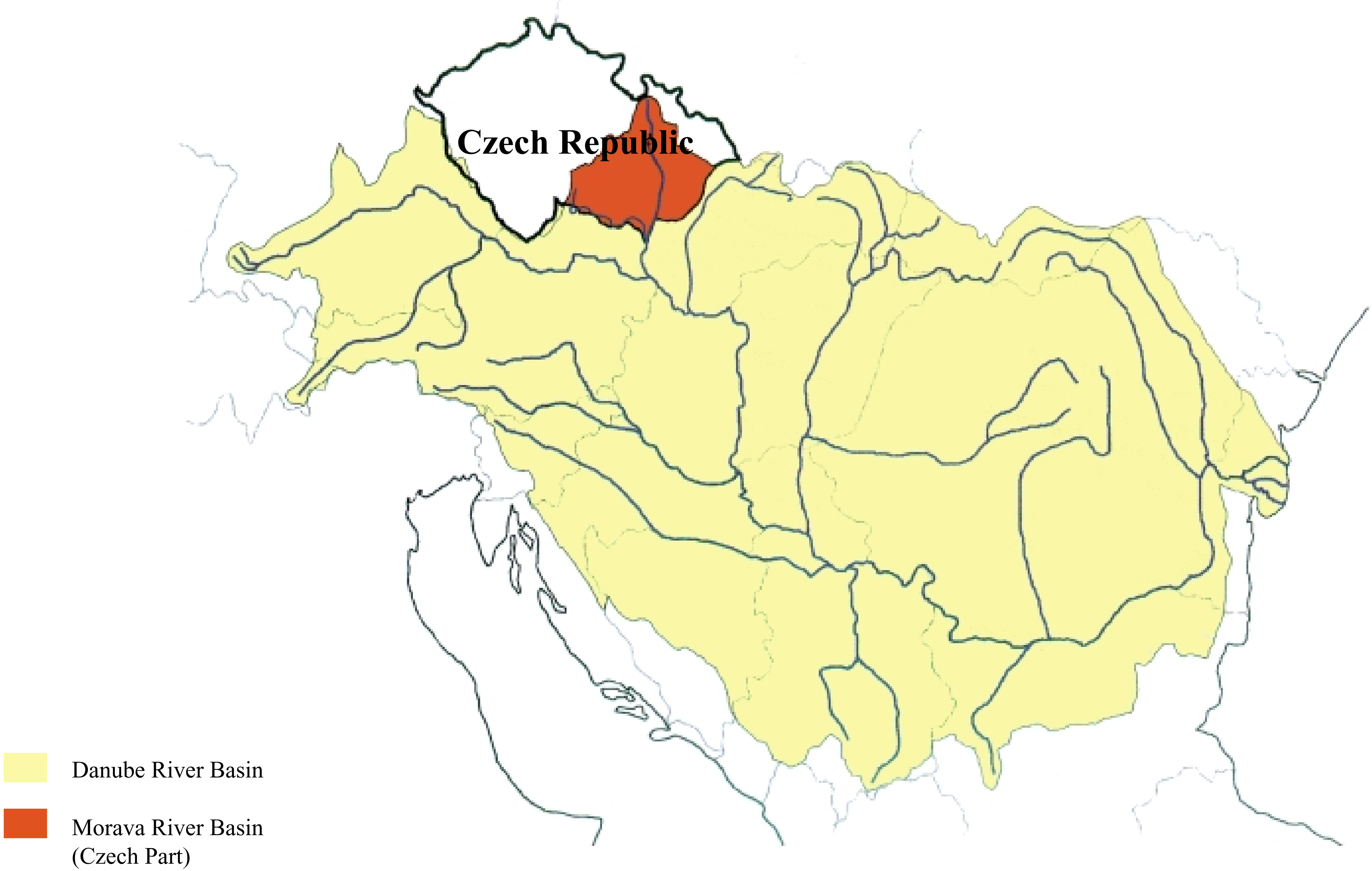
- modernization of municipal wastewater treatment plants for Brno - the largest city in the Morava River Catchment with almost 400,000 inhabitants, further for Zlin, Uherske Hradiste, Hodonin
- modernization of combined industrial and municipal wastewater treatment plant in Otrokovice (owner is industrial company Kozeluzny a.s. Otrokovice),
- remedying of previous environmental damages caused by Fosfa Postorna a.s. (decontamination of waters and remedying of dump sites)
- rehabilitation, reconstruction and upgrade of the pig farm Gigant Dubnany, s.r.o., jointly with neighboring areas and outfit.

Very significant role have also some social and economic benefits of project results, mainly higher degree of landscape quality downstream the WWTP discharges or dump sites more safeguarded sludge application for agriculture or forestry, higher quality of agricultural products in relevant surroundings, recreation benefits etc.

Planned projects involving necessary modernization and remedying of existing structures or equipment belonging to important municipalities, industrial and agricultural companies would solve the most essential problems in area and in harmony with transboundary and international requirements. However, the hot spot projects submitted at this time must be step by step completed by other projects in detail and awaited following measures. They must be implemented not only at same places or at other essential hot spot localities and not only through technical means, but also in all area of Czech part of the Morava River basin and with help of all needed instruments on social, economic, legal, normative and institutional level, with support and by aid of adult education, of participatory approach and capacity building. The elaborated National Action Plan of the Morava River basin must be soon approved by Czech Government and Parliament in terms of realizing by practice steps. All mentioned measures would contribute to sustainable urban and industrial development, to improvement of water quality downstream the hot spots and towards neighboring states, to gradual improvement of sustainability conditions in the rural landscape and in the agriculture, to adoption of all principles of integrated water management. But some transition processes will continue slowly - according to complex problems (above all in agriculture and with connection to previous environmental damages) and to funds at hand and from different sources.

Fig. 1

Danube River Basin



# 2. National Targets and Instruments for Reduction of Water Pollution

## 2.1. Actual State of and Foreseeable Trends in Water Management with Respect to Water Pollution Control

Water management in Czech Republic has been in the transition phase and main changes could be awaited in connection with necessary upgrading of principal water act. It is sure that many important instruments will have to be applied: updating of the act No. 138/1973 on water (the new act referring to water protection and management is step by step prepared further to mentioned amendment), creation of more effective institutional and regional arrangements, completing of system of stimulating environmental charges and taxes, support of environmentally oriented policy approaches in agriculture, forestry, industry, mining, energetic and transport. The new acceding of Czech government to principles of sustainable development is very important and it could be probably resulted in the enforcing of important tools and expected measures with regard to environment, to water protection and water management.

Parallel to legal measures there must be implemented mainly economic and institutional changes according to holistic, sustainable and participatory approaches of integrated water resources development and management - due to natural catchment areas and in relation to needed capacity building and awareness growth. It concerns the stabilization of authorities on national, regional and local level, too. These issues are very closely connected with requirements of European Union and with effort of Czech Republic to associate with this supranational organization.

The Morava River is one of the most important tributaries of the Danube River. The confluence of these two rivers is not in Czech Republic; it is on the boundary between Austria and Slovakia, not far from their capitals Vienna and Bratislava.

The region of the Morava River basin in Czech Republic makes up 26.2 per cent of all Czech Republic, the number of inhabitants forms similar part - 26.0 per cent. This part of the Morava River catchment consists of 59 % of agricultural land, 31 % of forests, 1.5 % of surface water bodies, 1.5 % of urbanized areas. The rate of average annual precipitation in the Morava River basin accounts for 635 mm and the value of mean annual runoff from the same catchment was appraised at 3,430 million $m^3$. The density of hydrological network in the Morava River basin is current as in similar regions in the middle Europe. The length of most significant rivers accounts for 3,747 km and the length of remaining watercourses was estimated at 30,000 km. In this basin there are 34 important storage reservoirs, all reservoirs including several thousands of ponds run to the total volume of 659 million $m^3$.

The whole basin is highly exploited both economically and agriculturally, but its water resources are limited, particularly in the Morava River basin upstream the confluence with the Dyje River. Natural conditions relating to possible water retention in the landscape have not been favorable here as far as slopes or occurrence of upland plateaus and upstream extensive floodplains is concerned. That is why there is a lack of natural retention areas in this region in particularly by headwaters where the rainfall amount has been essentially higher than in downstream parts of the basin. On the other hand in the same catchment area (of the Morava River upstream the mouth into the Dyje River) there is no storage reservoir for multipurpose uses, for satisfaction of needful water management demands. The water management situation in the Dyje River basin is better. However, not only the annual runoff is low, the unfavorable water balance is emphasized by low capacities of groundwaters due to the geological structure of all area - excluding one resource: water-withdrawal area Brezova in headwaters of the Svitava River, in the Cretaceous System. It is one of main sources performing the service of drinking water supply for the largest municipality in all Morava River basin - for Brno.

Water quality state on many reaches of watercourses in the Morava River basin is unfavorable, especially the rivers downstream larger **municipalities and industrial centers** are very polluted: Svratka River downstream above mentioned ***Brno*** (389,000 inhabitants), then Morava River downstream ***Olomouc*** (106,000 inh.), Drevnice River and following Morava River downstream ***Zlin*** (83,000 inh.), Jihlava River downstream ***Jihlava*** (53,000 inh.), Becva River and following Morava River downstream ***Prerov*** (50,500 inh.), Valova River and following Morava River downstream ***Prostejov*** (50,000 inh.). Main point sources of pollution are connected with industrial activities in said towns and in other municipalities. Water pollution issues were very serious here already twenty - thirty years ago and were partially solved by construction of municipal, industrial and combined wastewater treatment plants. In most of larger municipalities and important factories the wastewater treatment plants have been operated, but some of these structures, equipment and connected sewerage systems must be reconstructed or upgraded, also with regard to small efficiency. It must be also mentioned that many sewerage systems are obsolete and permeable. These challenges have been and would be solved step by step.

The predominant problem for surface waters in the Morava River basin is the presence of ***nutrients*** (e.g. of nitrogen and phosphorus compounds) that are transportable over long distances and they cause the eutrophication. Very abundant is also the occurrence of ***organic pollutants*** - both biodegradable and chemically degradable ones. Some stream reaches are also polluted by priority pollutants including ***heavy metals***; recently had very significant position mercury here, but origin of it was not exactly explained. On the other hand the existing mercury concentration is mostly lower than previously. Very important is also the pollution by zinc in some watercourses, especially downstream larger municipalities.

***Industrial sectors*** which are the greatest polluters in the Morava River basin are formed by food-stuff, paper, pulp, clothing, boot-and-shoe, tanning, power, machine, metal-working, building and chemical industries. The most significant industrial pollutants are textile, tannery, chemical, papermaking, wood-making, machine-tool, metallurgical, electrical and food-stuff industry, pulp mills and sugar factories. Contamination by heavy metals comes from smaller metallurgical plants and tanneries. Very significant position among the polluters in the area has *nutrients* (nitrogen, phosphorus) and some *heavy metals* - above all mercury. Significant problems are caused by agricultural non-point sources of pollution and by large-capacity pig farms with more then 5,000 - 10,000 pcs. of livestock (farms Milotice, Dubnany, Tesnovice, etc.). There exist some other potential hazards in the Morava River basin, particularly specific organic substances (oil products, PCB, PAH, AOX etc.). In this region there is a dense network of roads and railways, dense network of oil pipelines. Water quality is also threatened by recent operation of uranium industry, by oil and lignite mining and by operation in the nuclear power plant Dukovany. This all contributes to requirement of updated monitoring, information and warning systems and forecasting means for water quality management.

Some anthropogenic activities in an agricultural and forest landscape or in urban and industrial environment have influenced more or less changes of hydrological cycle and water regime. All these activities resulted in water pollution, in losses of soil, humus, natural wetlands and floodplain biotops. Remedying measures should be focused on locally important problems that have transboundary impacts.

Occurrence of eutrophication and of water bloom in rivers and storage reservoirs has been depending on the presence of nutrients in waters. This phenomenon is usual at the time of dry atmosphere and of lower discharges in watercourses. Low flows have been occurring mainly during summer and autumn time. On the contrary some sub-catchments are affected by floods and flooding, by water erosion, nutrients leaching and soil loss as a consequence of old-time deforestation, of recent large-capacity farming and of adverse ground slopes in landscape. These facts are very distinctive for agricultural landscape on hillsides and in foot-sides in the southern and middle part of the defined region. The risk of flooding in the neighborhood of watercourses is higher than awaited - after experiences with huge floods in July 1997.

It seems that very significant problems have been connected with long-term and not finished transition of ***agriculture*** and ***forestry***, of agricultural and forest management, of urgent retrograde ***changes in agricultural and forested landscap***e. Especially the former cultural landscape was very changed at the time of collectivization and ownership restriction in the "socialist" period of years 1948 - 1989. Many of these anthropogenic activities have resulted in water erosion situations, in oversaturation of soil by fertilizers, manure, and pesticides, sometimes also by heavy metals and other toxic substances. Manure was often changed into waste product owing to oversized livestock breeding and to dumping of manure overplus on agricultural soils. On the other hand the fertilizers were formerly dosed according to state directives, the application has increased considerably till 1989.

In the past there were many specific changes in Czech landscape:

- changes of slope (higher inclination than in previous fifty - hundred years) and with it related water and wind erosion, washing out and sedimentation processes,
- extensive drainages of wetlands, of soil, plots and pieces of land,
- changes caused by acid precipitation and following acidification of soil - mainly in mountain regions and forests (deforestation, degradation of woods etc.),
- removal of balks, terraces, forests, groves, meadows and wetlands, ploughing of them,
- directive modification of crop rotations, of crop plants applications and of silviculture (choice of timber species etc.),
- modification and mechanization of ploughing and soil cultivation,
- preference of hillside ploughing in relation to reducing of contour ploughing,
- extensive mechanization of other works in agricultural and forested land for the purpose of maximizing outputs at the cost of high inputs,
- many rivers and brooks were trained and straightened,
- growth of number of large-capacity animal houses, of large-scale breading and rearing (mainly pig and cattle farms),
- growth of number and capacities of different dump sites in agricultural land.

Agriculture is the biggest source of nutrient emission into waters in our country. The contribution of total nitrogen-emission into surface waters is more than 50 %, the similar rate originated in the total phosphorus-emission. However the transition procedures in agriculture have been very slow. The restructuring of land-ownership has been solved in 10 - 15 % of cases, other land has managed by new agricultural cooperatives of "owners", but their influence, knowledge and ownership awareness is not adequate to need. It would be very long time till all necessary steps in the agriculture will be finished. But some important tasks have been hitherto implemented: rehabilitation of some watercourses, increased protection of existing wetlands and waters, finishing of fertilizers overdosing and of other unfavorable "socialist" activities.

Corridors of polluted streams are imminently affected by deteriorated water quality in surface waters and it has been resulting in detrimental impacts on fish and other aquatic life, in the contamination of adjacent banks, rock environment and alluvial sediments, sometimes even of alluvial groundwaters and soils. Other groundwaters are adversely influenced by human activities in communities and agriculture for the most part.

All water resources in the region are also threatened with many old municipal, industrial and agricultural ***dump sites*** (containing dangerous and toxic solid or liquid substances), with dense network of ***roads***, railways and ***oil pipelines***, with possible breakdowns and accidents. The next two tables present recent water quality state of important places on streams in the Morava River basin:

**Table 1 Water quality state of important river profiles in the Morava River basin 1992 - 1993**

| Place | watercourse | monitoring of water quality parameters (interval) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | $BOD_5$ | $COD_{Cr}$ | $N\text{-}NH_4$ | $N\text{-}NO_2$ | $N\text{-}NO_3$ | $P_{Tot}$ | Hg |
| | | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | µµg/l |
| Blatec | Morava | 2.1-21.5 | 22.2-68.5 | 0.08-2.57 | 0.02-0.46 | 0.1-7.6 | 0.15-0.80 | .... |
| Lanzhot | Morava | 3.1-14.2 | 23.8-56.7 | 0.00-2.84 | 0.04-0.24 | 0.6-8.6 | 0.11-0.50 | 0.2-12.0 |
| Troubky | Becva | 1.5-14.4 | 16.7-48.9 | 0.02-2.03 | 0.03-0.54 | 0-5.2 | 0.12-0.77 | 0.1-0.7 |
| Brno (downstream) | Svratka | 5.3-20.4 | 19.5-58.9 | 1.79-15.2 | 0.04-1.63 | 0.6-9.5 | 0.13-2.59 | 0.1-3.3 |
| Ivan | Jihlava | 1.6-12.4 | 18.5-69.9 | 0.25-2.33 | 0.03-0.55 | 0.6-9.8 | 0.19-0.48 | 0.1-1.4 |
| Breclav | Dyje | 2.3-15.0 | 14.7-47.0 | 0.24-2.30 | 0.01-0.14 | 0.1-7.9 | 0.14-1.80 | < 0.5 |

** according to monitoring of Povodi Moravy, a.s., 1992 - 1993*

**Table 2 Water quality state of important river profiles in the Morava River basin 1996 - 1997**

| Place | watercourse | monitoring of water quality parameters (interval) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | $BOD_5$ | $COD_{Cr}$ | $N\text{-}NH_4$ | $N\text{-}NO_2$ | $N\text{-}NO_3$ | $P_{Tot}$ | Hg |
| | | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | µµg/l |
| Blatec | Morava | 1.6-5.5 | 5.7-30.7 | 0.05-3.09 | 0.015-0.09 | 2.6-6.5 | 0.07-0.57 | <0.1-0.7 |
| Lanzhot | Morava | 2.3-9.8 | 16.2-48.9 | <0.024-3.25 | 0.02-0.17 | 2.42-6.80 | 0.16-0.53 | <0.1-1.4 |
| Troubky | Becva | 1.8-10.5 | 5.2-185.2 | <0.01-2.34 | 0.024-0.11 | 1.10-4.40 | 0.08-0.52 | <0.1-0.4 |
| Brno (downstream) | Svratka | 3.2-21.4 | 20.9-42.1 | 0.12-7.52 | 0.058-0.489 | 3.13-7.07 | 0.26-0.91 | <0.1-2.20 |
| Ivan | Jihlava | 1.7-13.0 | 27.5-78.3 | 0.02-0.98 | 0.019-0.144 | 3.98-11.0 | 0.21-0.75 | <0.1-0.40 |
| Breclav | Dyje | 2.3-12.5 | 29.2-45.8 | 0.03-1.57 | 0.028-0.181 | 2.27-8.00 | 0.14-0.71 | <0.1-0.5 |

** according to monitoring of Povodi Moravy, a.s., 1996 - 1997*

Note: Blatec is downstream Olomouc, in the center of the region; Lanzhot is near the confluence of two rivers, the Morava River with the Dyje River (near the border of three states - Czech Republic with Austria and Slovakia); Troubky is upstream the mouth of the Becva River into the Morava

River, downstream Prerov; profile Brno is not far from reservoirs Nove Mlyny (upstream), near these reservoirs is Ivan (also upstream); the place in Breclav is downstream the Nove Mlyny reservoirs and upstream the borders with Austria and Slovakia and of the confluence of the Dyje River with the Morava River.

The comparison of values in both tables shows that some parameters of water quality in period 1992 - 1997 have been improved, some other ones have varied in size including nutrients. But in addition to it must be said that almost all existent wastewater treatment plants are not abundantly effective for the purpose of nutrients i.e. nitrogen and phosphorus removing processes. It has resulted mainly in the state of almost no phosphorus reduction or even of phosphorus load increase in some reaches of watercourses. It has been connected with more circumstances - with utilization of washing products, of fertilizers, with high consumption of albumen and with connected large-capacity breeding farm animals in all Czech Republic.

Likewise groundwaters in the question - in particular the shallow ones - are highly contaminated. Some more abundant aquifers extend only in the Morava River floodplains and partly in the Dyje River floodplains. Among very threatened regions are following especially all protected areas in alluvial plains with groundwater resources:

- protected area of groundwater resources Mohelnice (threatened by industry; between Zabreh and Mohelnice, northward of Litovel),
- protected area of groundwater resources Tlumacov - Troubky - Zarici (threatened by industry and agriculture; between Prerov and Kojetin)
- protected area of groundwater resources Kvasice - Tlumacov (threatened by industry and agriculture; between Kromeriz and Otrokovice)
- protected area of groundwater resources Knezpole (threatened by industry; approximately 35 km to border with Slovakia, 70 km to boundary with Austria)
- protected area of groundwater resources Ostrozska Nova Ves (threatened by industry and landfills; approximately 25 km to border with Slovakia, 60 km to boundary with Austria),
- protected area of groundwater resources Bzenec (threatened by industry and landfills; approximately 15 km to border with Slovakia, 50 km to boundary with Austria)
- protected area of groundwater resources Moravska Nova Ves (threatened by mining; approximately 0 - 2 km to border with Slovakia, 30 km to boundary with Austria).

All these areas were severely inundated and contaminated in the course of floods in July 1997.

Very great transboundary attention must be paid also to protection of some specific areas with Ramsar wetlands:

- region of Ramsar wetland "Lower Reach of the Dyje River and the Confluence with the Morava River" - with oxbows, oxbow lakes, floodplain forests and three reservoirs Nove Mlyny (approximately 0 - 40 km to border with Austria, 0 - 60 km to boundary with Slovakia),
- region of Ramsar wetland "Lednice Pounds" - with brooks, pounds, bank wetlands and floodplain forests (approximately 10 - 20 km to border with Austria, 30 - 40 km to boundary with Slovakia).

It is sure that the new integrated water management strategy would be very positive in all fields of human activities. It is sure that all agriculture will be changed by favorable ecological, environmental, holistic and economical methods to rehabilitated system, with minimizing of nutrient outputs to the environment. However it is also sure that all integrating and rehabilitating processes in our country, in agriculture and in water management will take a very long time.

## 2.2. National Targets for Water Pollution Reduction

National targets and instruments for water pollution reduction in Czech Republic are entirely drawn up in the text of "State Environmental Policy", forwarded in the year 1995 by Ministry of Environment and approved by Czech Government. The targets of environmental policy and the instruments for their attainment were formulated to maximize the potential for creating an optimal system. This process proceeds from finding a socially acceptable level of environmental and health risks. The state targets concerning water issues have been reflected to these priorities towards water in the short-term context (1995 - 1998):

- improving water quality by limiting pollution discharges,
- reducing the production of wastes, namely hazardous wastes,
- eliminating the impacts of harmful physical and chemical factors,
- remedying previous environmental damages.

Improving air quality through the reduction of harmful emissions amounts to very important priorities. These emissions connected with mentioned period have considerably affected almost all water resources and systems in the Morava River Catchment. For the period 1999 - 2005 there are two medium-term objectives and tasks aiming at special problems of water:

- creating land use provisions which will safeguard the efficient protection of water and fulfil international commitments through regional planning,
- increasing the water retention capacity of land by improving the revitalizing measures.

In the short-term context were adopted some political, social, institutional, legal, normative, economic and informational tools dealing with water pollution reduction. Probably the most significant instrument is the political and social tool resulting in the transition pressure leading up to changes of ownerships from state to private sectors, leading up to reprivatization of most personal or real estate. These changes have been principal for other procedures in Czech Republic and have impacted favorably almost all implemented, proposed or prepared tools and measures of water pollution reduction. However, some economic instruments were applied before 1989, but many of them had to be upgraded after mentioned year. Among these tools belong charges for wastewater discharges and for waste disposal, some fines, taxes and other economic measures. The previous enforcement of Governmental Decree No. 171/1992 aiming at limits of wastewater discharges and following implementation in practice represent turning-points of former unfavorable tendency. The adoption of principle "The polluter pays" is the result of new political, social, economical, environmental and water management steps. However, there are some other tools related to water quality issues with increasing incentive function: emphasizing on water quality monitoring and evaluation in upgraded laboratories, better water quality supervision by district, inspection and hygiene authorities, growth of information and knowledge concerning the water - as consequence of new surveys, studies and projects dealing with water and environment state in basins and other areas.

Other targets which are not mentioned in official documents of Czech policy must be also accomplished. They are specified in the end of the chapter 2.2.

## 2.3. Technical Regulations and Guidelines

There are different technical ways aiming at water quality improvement. The option depends on many factors - on monitored or evaluated parameters, on the pollution rate, on runoff conditions, on watercourse reaches, on the reason of water contamination, on environs of profiles, on available financial sources etc. Very important is the classification of surface water quality. Parameters for this classification in terms of Czech standard CSN 757221 are divided into six groups:

- oxygen regime parameters (dissolved oxygen, $BOD_5$, COD),
- basic chemical and physical parameters (e.g. $N\text{-}NO_3$, $N\text{-}NH_4$, total P, suspended solids),
- additional chemical parameters (e.g. Ca, Mg, $SO_4$, non-polar extractable substances, some organic substances, etc.),
- heavy metals (Fe, Mn, Cu, Hg, Cd, Pb + also As),
- biological and bacteriological parameters (saprobity, total coliforms, total fecal coliforms),
- radiological parameters.

The categorization of individual parameters within each water quality group is done by comparing of the characteristic value with required value for adequate category. Surface waters are in Czech Republic divided into five categories characterized in the next simple characterization and following list of classification with chosen water quality parameters in surface waters - due to the Czech standards:

**Table 3 Quality categories of surface waters according to Czech standard CSN 75 7221**

| Quality Category<br>(according to Czech standard - CSN 75 7221) | Characterization of Water |
|---|---|
| I | very clean |
| II | clean |
| III | polluted |
| IV | heavily polluted |
| V | very heavily polluted |

**Table 4 List of classification and some water quality parameters in surface waters according to Czech standard CSN 75 7221**

| Parameters | Class | | |
|---|---|---|---|
| | III (polluted water) | IV (heavily polluted w.) | V (very heavily polluted w.) |
| *Principal parameters* | ($mg \cdot l^{-1}$) | | |
| $BOD_5$ | (5 - 10⟩ | (10 - 15⟩ | ≥15 |
| $COD_{Cr}$ | (25 - 35⟩ | (35 - 55⟩ | ≥55 |
| TSS (susp. solids) | (40 - 60⟩ | (60 - 100⟩ | ≥100 |
| $N\text{-}NH_4$ | (0.5 - 1.5⟩ | (1.5 - 5.0⟩ | ≥5.0 |
| $P_{tot}$ | (0.15 - 0.4⟩ | (0.4 - 1.0⟩ | ≥1.0 |
| $O_2$ dissolved | ⟨ 5.0 - 6.0) | ⟨ 3.0 - 5.0) | ≤3.0 |
| $N\text{-}NO_2$ | (0.005 - 0.02⟩ | (0.02 - 0.05⟩ | ≥0.05 |
| $N\text{-}NO_3$ | (3.4 - 7.0⟩ | (7.0 - 11.0⟩ | ≥11.0 |
| N-org | (1.0 - 2.5⟩ | (2.5 - 3.5⟩ | ≥3.5 |
| $Fe_{Tot}$ | (1.0 - 2.0⟩ | (2.0 - 3.0⟩ | ≥3.0 |
| *Heavy metals* | ($\mu g.l^{-1}$) | | |
| Hg | (0.2 - 0.5⟩ | (0,5 - 1,0⟩ | ≥1,0 |
| Zn | (50 - 100⟩ | (100 - 500⟩ | ≥500 |

Water by the category I can be used for all purposes, mainly for drinking water supply, food industry, bathing and is suitable for salmonid fishes. The water with category II can be used for most purposes, for drinking water supply, water sports, industry and agriculture water supply, fisheries and is suitable most fishes excluding salmonids. The water of category III can be conditionally used for some purposes in industry and agriculture; for drinking water supply is suitable only with application of extensive treatment technologies. In this water live only some species of carp fishes. The usage of water IV is limited and classified as V is unsuitable for any purposes.

Above characterized categories are comparable with international classification. Czech category I is almost comparable with international category I, Czech II is near the international I-II and II, Czech III is similar the international II-III, Czech IV is parallel to international III and III-IV, and Czech V is near the international IV. However, it is sure that the classification must be step by step adjusted to European standards.

The above mentioned classification has formed the base for all technical regulations and guidelines in Czech Republic with regard to water quality concerns. The standards of the Czech Republic include more than 50 parameters and the practice has leant against the mentioned Czech Governmental Decree No. 171/1992. The main authority, which designate the water quality limits for water users, is the District Office and its Department of Environment Protection. Very important authority is also the Czech Inspection of Environment. This authority has monitored and controlled at random the water quality of discharges and is authorized to fine all overstepping of licensed limits. Finances from licenses, charges and penalties form bases for the State Environmental Fund, which is accumulated in Praha - in the capitol of the Czech Republic. Further to these procedures follows the useful utilization of finances for different environmental purposes including the support of constructions of wastewater treatment plants and sewer systems. However, the rate of return of finances to regions or localities near places of origin has not been adequate every time.

## 2.4. Expected Impacts of EU - Directives to Water Pollution Control

The following table presents pollution standards by the Czech Government Decree No. 171/1992 compared with emission limits by European Union (EU) which are laid down in the Council Directive 91/271/EEC.

**Table 5 Czech and European water quality standards for surface waters - principal parameters**

| *Document (decree/standard)* | *No.* | *unit* | *parameter* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *$BOD_5$* | *$COD_{Cr}$* | *Coli** | *FaeColi** | *N org.* | *$N\text{-}NH_4$* | *$N\text{-}NO_3$* | *$P_{tot}$* |
| *CGD 171/92 - dw* | *1* | *mg/l* | *4* | *20* | *2000* | *400* | *1.5* | *0.5* | *3.4* | *0.15* |
| *CGD 171/92 – ndw* | *2* | *mg/l* | *8* | *50* | *20000* | *4000* | *3.0* | *2.5* | *11.0* | *0.4* |
| *EU - salmon G* | *3* | | *3* | | | | | *0.031* | | |
| *EU - salmon I* | *4* | | | | | | | *0.776* | | |
| *EU - carp G* | *5* | | *6* | | | | | *0.155* | | |
| *EU - carp I* | *6* | | | | | | | *0.776* | | |
| *EU - $A_1$* | *7* | *mg/l* | *5* | | *5000* | *2000* | *1.22* | *0.766* | *5.65* | *0.48*** |
| *EU - $A_2$* | *8* | *mg/l* | *5* | | *5000* | *2000* | | *1.0* | *50.0* | |
| *EU - $A_3$* | *9* | *mg/l* | | | | | | *2.0* | *50.0* | |
| *CSN 75 7214 - A* | *10* | *mg/l* | *3.0* | *3.0**** | *50* | | | *0.5* | *50.0* | |
| *CSN 75 7214 - B* | *11* | *mg/l* | *5.0* | *7.0**** | *5000* | | | *1.0* | *50.0* | |
| *CSN 75 7214 - C* | *12* | *mg/l* | *7.0* | *10.0**** | *50000* | | | *3.0* | *100.0* | |
| *CSN 75 7221 - 1* | *13* | *mg/l* | *2.0* | *15.0* | *100* | *20* | *0.5* | *0.3* | *1.0* | *0.03* |
| *CSN 75 7221 - 2* | *14* | *mg/l* | *5.0* | *25.0* | *1000* | *200* | *1.0* | *0.5* | *3.4* | *0.15* |
| *CSN 75 7221 - 3* | *15* | *mg/l* | *10.0* | *35.0* | *10000* | *2000* | *2.5* | *1.5* | *7.0* | *0.4* |
| *CSN 75 7221 - 4* | *16* | *mg/l* | *15.0* | *55.0* | *100000* | *20000* | *3.5* | *5.0* | *11.0* | *1.0* |
| *CSN 75 7143 - s.* | *17* | *mg/l* | | | *10000* | *1000* | | | | |
| *CSN 75 7143- cs.* | *18* | *mg/l* | | | *100000* | *10000* | | | | |

*Notes:*

***a)***

*CGD 171/92 - dw* — *limits according to Czech Governmental Decree No. 171/1992 Sb.; values related to watercourses with existing or planned withdrawal for drinking water supply*

*CGD 171/92 - ndw* — *limits according to Czech Governmental Decree No. 171/1992 Sb.; values related to watercourses with no withdrawal for drinking water supply*

*EU* — *concerning the limits for surface waters according directives of European Union; EU - salmon G = limits for watercourses with salmonids (by alternative G), EU - salmon I = limits for watercourses with salmonids (by alternative I), EU - carp G = limits for watercourses with carp fishes (by alternative G), EU - carp I = limits for watercourses with carp fishes (by alternative I); other parameters for alternative I: EU A1 = limits for surface waters, group A1, EU A2 = limits for surface waters, group A2 , EU A3 = limits for surface waters, group A3 (groups A1 , A2 , A3 are defined according to classification of surface waters due to criteria of European Union with respect to the quality required of surface water intended for the water treatment and following drinking water supply - see point b)*

*CSN 75 7221* — *from 4. 8.1989; limited values according to Czech standard for classification of surface waters due to four categories of water quality 1, 2, 3, 4 (category 5 - as very polluted water is not mentioned)*

| | |
|---|---|
| *CSN 75 7214* | *from February 1994; limits according to Czech standard for raw water abstracted from surface waters for drinking water supply purposes or for assumed drinking water supply in the future (i.e. for existing or planned drinking water treatment; indexes A, B, C - see point b)* |
| *CSN 75 7143 - s.* | *from 10.5.1991; limits according to Czech standard for water suitable for irrigation* |
| *CSN 75 7143 - cs.* | *from 10.5.1991; limits according to Czech standard for water conditionally suitable for irrigation* |

***b)***

*There are two directives of European Union (EU): limited value binding for all members of EU (value imperative ... I) and value recommended, more strict (G). The first group proceeds from ecological conditions of fishes (salmonids, carp fishes). Some limits are determined also for bathing. On the other hand there are three types of limits relating to water treatibility i.e. the quality required of surface water intended for water treatment and following drinking water supply:*

*A1 ... simple physical treatment and elimination of germs*

*A2 ... current physical and chemical treatment and elimination of germs*

*A3 ... physical and refined chemical treatment, oxidation, adsorption and elimination of germs*

*The raw water due to the Czech standard CSN 75 7214 is divided on four categories due to the quality required of surface water according to water treatibility for drinking water supply:*

*A ... above all disinfection, further if it is need - sand filtration, chemical and mechanical neutralization or elimination of gaseous components through aeration*

*B ... the treatment of raw water is simple, e.g. filtration with coagulation or removal of iron and manganese or artificial infiltration and disinfection*

*C ... the raw water must be treated with aid of two or more degrees: clarification, sorption, oxidation,*
*removal of iron and manganese, decarbonization or some combinations of physical, chemical, microbiological and biological procedures*

*D ... the raw water not suitable for drinking water treatment*

***c)***

*Other standards are not mentioned here: Czech standard for drinking water (CSN 75 7111) and for drinking water suitable for suckling (CSN 56 7858). The limits of these standards are near world and European ones.*

***d)***

| | |
|---|---|
| * | *it is the colony counts in the unit (CCU)/100 ml* |
| ** | *due to P2O5* |
| *** | *for CODMn* |

The limits due to the concentration of heavy metals in surface waters according to different standards and decrees are as follows (No. relating to previous table, all values are in mg/l):

**Table 6 Czech and European water quality standards for surface waters - heavy metals**

| No. | Mercury Hg | zinc Zn | cadmium Cd | lead Pb | arsenic As | copper Cu | iron Fe | manganese Mn | nickel Ni | chromium total - Cr |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | max. 0.0005 | max. 0.05 | max. 0.005 | max. 0.005 | max. 0.005 | max 0.05 | max 0.5 | max 0.2 | max 0.05 | max. 0.1 |
| 2 | max. 0.001 | max. 0.2 | max. 0.015 | max. 0.1 | max. 0.1 | max 0.1 | max 2.0 | max 0.5 | max 0.15 | max. 0.3 |
| 3 | | | | | | | | | | |
| 4 | | ≤0.3 | | | | ≤0.04 | | | | |
| 5 | | ≤0.1 | | | | ≤0.04 | | | | |
| 6 | | | | | | | | | | |
| 7 | ≤0.001 | ≤3.0 | ≤0.005 | ≤0.05 | ≤0.05 | ≤0.02 | ≤0.1 | ≤0.05 | ... | ≤0.05 |
| 8 | ≤0.001 | ≤5.0 | ≤0.005 | ≤0.05 | ≤0.05 | ≤0.05 | ≤1.0 | ≤0.1 | ... | ≤0.05 |
| 9 | ≤0.001 | ≤5.0 | ≤0.005 | ≤0.05 | ≤0.1 | ≤1.0 | ≤1.0 | ≤0.1 | ... | ≤0.05 |
| 10 | m 0.001 | m 5.0 | m 0.005 | m 0.1 | m 0.05 | m 0.1 | m 0.3 | m 0.1 | ... | ... |
| 11 | m 0.001 | m 5.0 | m 0.005 | m 0.1 | m 0.05 | m 0.1 | m 5.0 | m 3.0 | ... | ... |
| 12 | m 0.001 | m 5.0 | m 0.005 | m 1.0 | m 0.1 | m 1.0 | m 20.0 | m 5.0 | ... | ... |
| 13 | 〈 0.0001 | 〈 0.02 | 〈 0.003 | 〈 0.01 | 〈 0.01 | 〈 0.02 | 〈 0.5 | 〈 0.05 | 〈 0.02 | 〈 0.02 |
| 14 | 〈 0.0002 | 〈 0.05 | 〈 0.005 | 〈 0.02 | 〈 0.02 | 〈 0.05 | 〈 1.0 | 〈 0.1 | 〈 0.05 | 〈 0.1 |
| 15 | 〈 0.0005 | 〈 0.1 | 〈 0.01 | 〈 0.05 | 〈 0.05 | 〈 0.1 | 〈 2.0 | 〈 0.3 | 〈 0.1 | 〈 0.2 |
| 16 | 〈 0.001 | 〈 0.5 | 〈 0.02 | 〈 0.1 | 〈 0.1 | 〈 0.2 | 〈 3.0 | 〈 0.8 | 〈 0.2 | 〈 0.5 |
| 17 | ≤0.005 | ≤1.0 | ≤0.01 | ≤0.05 | ≤0.05 | ≤0.5 | ≤10.0 | ≤3.0 | ≤0.1 | ≤0.2 |
| 18 | ≤0.01 | ≤2.0 | ≤0.02 | ≤0.1 | ≤0.1 | ≤2.0 | ≤100.0 | ≤5.0 | ≤0.2 | ≤0.5 |

*Notes:*
*m= limited value*
*Limits for chromium VI are five - six times stricter than by chromium total*

The comparison of many values is resulting in the conclusion that it would be no problem to modify Czech system of standards to European Union values. Many Czech limits have been even more severe than European. However, some criteria must be modified especially with regard to ecological conditions (mainly life of fishes and fisheries), to sensibility of hydrological systems (according to available water quantity, to municipalities, industry, agriculture, forestry), to landscape, biodiversity and recreational conditions. All mentioned aspects must be involved.

## 2.5. Law and Practice on Water Pollution Control

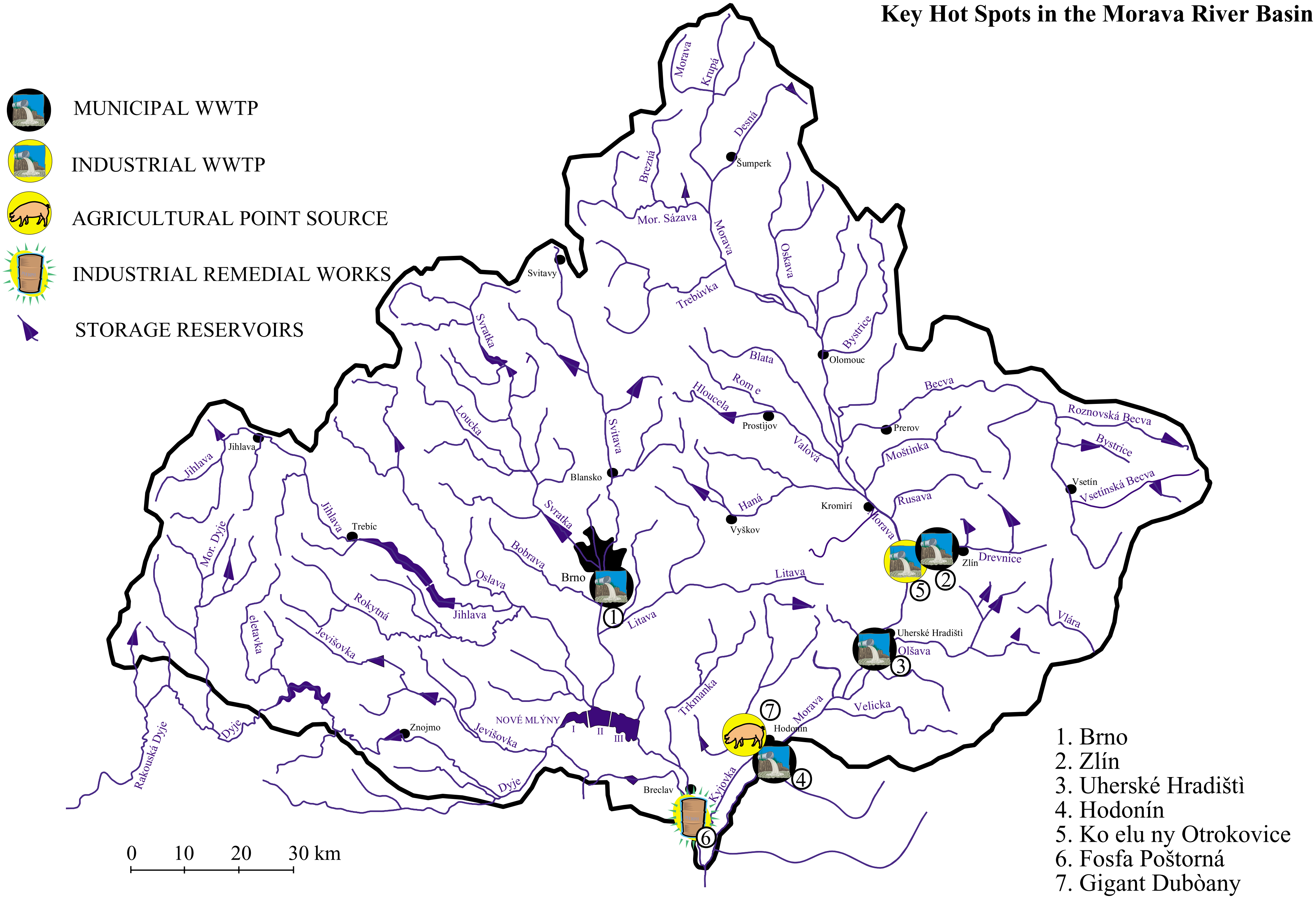
After political changes in the year 1989 were performed necessary legal adjustments by the means of other tools coherent with the water act. In such way many new environmental laws sprung out including the act No. 17/1992 on environmental protection, the act No. 244/1992 regarding environmental impact assessment, the act No. 388/1991 on the State Environmental Fund. Important changes run also directly in the section of water protection and water management and they resulted in new act No. 458/1992 on public service in water management (it deals mostly with modifications of competencies), in some updated decrees, regulations and standards, especially with relation to demand of water quality improvement. Above all the Governmental Decree No. 171/1992 aiming at limits of wastewater discharges has been of vital importance for all society and people living in Czech Republic. At the beginning of year 1998 was the old act No. 138/1973 on water (from the year 1973) in some statutes amended by means of the new act No. 14/1998. The final new act on water is very needed at this time, but there are some obstacles relating to uncompleted transition processes involving also ownership changes, to unclear final arrangement of water authorities in basins and to unclear division of competencies among three or more ministries. Some complications have been also partially connected with general underestimating of water importance in economic, social and environmental systems, with underestimating of requirement of fast solution concerning institutional and capacity building issues, with delay of final regional arrangement by Civil Service. Ministry of Environment manages issues of water protection, Ministry of Agriculture manages water management and administration of river basins, Ministry of Interior manages water authorities by districts and cities, partially also ministries of industry and of transport have been participating in the process. Also the fact that very small part of water management officers is familiar with international documents relevant to water problems represent very significant circumstance. Almost nobody knows what is the meaning of main provisions of Agenda 21, of conferences in Delhi, Dobris, Dublin, Rio de Janeiro, Luzern, Helsinki, Noordwijk, Sofia, Aarhuis, Paris, of important international conventions, agreements and declarations. Only some international documents were officially translated into Czech. Also the awareness of public with respect to issues of water has been symptomatically and proportionately low.

There have been also some other laws which are connected with water issues: act No. 282/1992 regarding responsibilities of the Czech Environmental Inspection, act No. 334/1992 on protection of the agricultural soil fund, act No. 114/1992 on nature and landscape protection, act No. 238/1991 on waste management, act No. 289/1995 on forests, act No. 125/1997 on wastes, act No. 218/1997 on land arrangements and land registry, act No. 252/1997 on agriculture. Likewise new laws dealing with protection of the air from pollutants, with health of people, with management in building, mining, traffic or other systems etc. arose recently.

Practical use of valid Czech laws, acts, decrees, directives and regulations is not so complicated as the knowledge of international documents. The function of water pollution control was well prepared twenty - twenty-five years ago and within the control system have been involved: Ministry of Environment (the key authority - after 1989), five administrations of River Basins (control of wastewater discharges and monitoring of water quality), Czech Environmental Inspections (with departments of water quality and water pollution control), authorities of districts and cities (determination and control of water quality limits, control of activities connected with water; before 1990 functioned also regional authorities), Czech Hydrometeorological Institute (monitoring of water quality in watercourses, sources and aquifers), T.G.M. Water Research Institute (water research and development) or other organizations (for groundwaters, for project proposals, supervision and constructions), schools, etc. The compatibility of individual elements of water pollution control system is relatively good, the missing part is represented only by the regional link of the Civil Service (also due to natural borders of hydrological catchments) and Autonomy responsible for Water Management Fund Control.

Fig. 2

Key Hot Spots in the Morava River Basin



# 3. Actual and Planned Projects and Policy Measures for Reduction of Water Pollution

It has been indicated in accordance with the State Environmental Policy of the Czech Republic (from August 1995) and due to analysis of the environment after 1989 that certain environmental problems warrant immediate attention and as such represent the priority challenges. The order of priorities in the short-term context has been - with respect to the necessity of health hazards and have transmit pollution reduction among different components of the environment - as follows:

1. Improving air quality through the reduction of harmful emissions
2. Improving water quality by limiting pollution discharges
3. Reducing the production of waste - namely hazardous waste
4. Eliminating the impacts of harmful physical and chemical factors
5. Remedying previous environmental damages

All priority points have coherence with the state of water quality in rivers, brooks, storage reservoirs, pools, ponds, pits, springs, wells and aquifers. Unfavorable state that some reaches of water bodies in Czech part of the Morava River basin have been very polluted owing to many-sided past anthropogenic activities in watershed - especially in municipalities, industry and agriculture - has been connected with very relevant reasons. It was closely related to a long-term insufficient water quality prevention and protection and accordingly to frequent utilization of bad techniques and practices out-of-date, to ineffective or no wastewater treatment, to obsolete leaky sewerage systems hitherto.

***Cities, towns, and villages*** are significant sources of pollution. Almost all-larger towns are equipped with ***wastewater treatment plants*** (WWTP), but their efficiency is not quite satisfactory. In all cases many of direct and indirect industrial discharges are connected to WWTP and these plants are accordingly highly overloaded. Municipality sewer systems represent also a considerable problem, as they are out of date and/or poorly built and they contaminate both ground and surface waters. Due to a lot of leaking connections groundwater drains into sewerages and it comes into the treatment plants thus decreasing their efficiency. Some smaller municipalities are equipped by reed-bed plants i.e. by small constructed wetlands.

Main ***industrial areas*** are concentrated in particular above-mentioned cities Brno, Olomouc, Zlin and larger towns Jihlava, Prerov and Prostejov. Other industrial centers are mostly identical with following other municipalities in the Morava River basin: Hanusovice, Olsany, Lanskroun, Zabreh, Sumperk, Unicov, Sternberk, Vsetin, Roznov pod Radhostem, Valasske Mezirici, Hranice, Vyskov, Kromeriz, Otrokovice, Uhersky Brod, Uherske Hradiste, Hodonin, Znojmo, Kurim, Svitavy, Blansko, Adamov, Trebic, Velke Mezirici, Breclav and Kyjov. There are about 800 industrial point sources of water pollution in the Czech sub-catchment of the Morava River. From this amount approximately 360 factories discharge their sewage directly into receiving river without treatment, remaining industrial enterprises have been step by step provided with more or less efficient sewage treatment plants. A lot of industrial entities in larger towns are connected to municipal sewage network and wastewater treatment plants.

***Agricultural pollution*** has been originating in part from livestock operations - especially in large-capacity pig farms - and in part from retarded non-point effects due to the recent oversize application rates of manure, fertilizers and pesticides. The agricultural point sources have been almost regularly laid out in the Morava River basin in the north of Olomouc, in the middle and southern part of the catchment area, in the Bohemian-Moravian Uplands. The topical five agricultural hot spots (according to part B Water Quality) are situated in southern Moravia i.e. in lower part the Morava River basin upstream the mouth of the Dyje River (pig farm Kunovice), in lower part of the Dyje River (pig farm Strachotice near Znojmo), in lower part of the Svratka River (pig farm Velke Nemcice near and upstream the Nove Mlyny Hydraulic Structure), in the Kyjovka River Catchment (pig farms Dubnany and Milotice between towns Hodonin and Kyjov; Kyjovka River is the left-hand tributary of the Dyje River, the mouth is downstream the Nove Mlyny Hydraulic Structure). Rather more distant from state borders are other important pig farms; very significant is the farm Tesnovice near Kromeriz. The biggest farms are Dubnany, Milotice and Tesnovice with more than 15,000 livestock. However, there are some other point sources of agricultural pollution - large capacity cowsheds, dunghills, disposal sites of silage etc. Principal outputs consist in ammonia and microbiological contamination.

Agricultural non-point sources have been laid out nearly equally through all region of the Morava River basin, in particular in agricultural landscape. Main outcomes of it are represented by nutrients, ammonia and pesticides.

Main problems in the Morava River basin have been connected with unfavorable internal and transboundary impacts are concentrated particularly in the middle and lower reaches of larger rivers - as the ***Morava River, Becva River, Dyje River, Svratka River and Drevnice River***. The greatest part of pollution comes from economically and agriculturally intensively exploited regions in the Morava River basin.

Some projects of water pollution reduction with respect to all Morava River basin were recently implemented; some have been going on. The most important project is the "Morava River basin Project" (in Czech "Projekt Morava") which was realized in many stages. The preparing phase was in 1991 and resulted work was focused - as a pilot project - for the Svratka River basin upstream the city of Brno. Very important part of it was the base of future methodology of the "Morava River Basin Project". From 1992 - 1996 was worked up the principal "Morava River Basin Project" which was oriented on these main tasks: hydrology in the basin, changes of runoff conditions (including water erosion influences, low flow and flood regime), water quality monitoring, point pollution of water, non-point pollution of water, threat of drinking water resources (mainly in aquifers), evaluation from view of drinking water supply, water balance in the basin, water use and water management in the basin, modeling of water quality, natural valences and disturbance degree referring to watercourses morphology in the basin, conclusions and recommendations. Further "Morava River Basin Project" stage - with beginning in 1997 - has dealing in detail with some special challenges concerning the water quality and water management, partially with respect to smaller regions, to sub-basins etc. Mentioned tasks were set by Czech Ministry of Environment to T.G.M. Water Research Institute Praha, Branch Brno. However, there have been many other institutes and companies which have participated in tasks in question. Among other significant project and studies referring to the Morava River basin or its parts belong:

- Chemical Time Bombs. Long-term Environmental Risks for Soils, Sediments and Groundwater in the Danube Catchment Area (focused on the Morava River basin, cooperation of T.G.M. Water Research Institute Brno with institutes from Bratislava, 1992),
- Water Quality Study for the Dyje River Basin. Cooperation with Allplan Vienna (towards the Danube Programme, T.G.M. Water Research Institute Brno, 1993 - 1994),
- Project of Bohemian-Moravian Uplands Region (focused on water quality issues in three districts, Aquatis Brno, 1993).

In the course of the year 1992 started works as far as the Environmental Programme for the Danube River basin is concerned (cooperation of Povodi Moravy, a.s. and T.G.M. Water Research Institute Brno with companies BCEOM, Lahmeyer, Haskoning, Schüffl & Forsthuber and so forth).

Some projects in detail focused on water quality problems in smaller geographical units started earlier, twenty - thirty years ago. Thus arose municipal wastewater treatment plants (WWTPs) in larger towns and some factories, with technology corresponding to knowledge, technical level and financial possibilities of that time: in Modrice (for city of Brno), Olomouc, Zlin-Malenovice, Jihlava, Prerov, Trebic, Znojmo, Sumperk, Vsetin etc, in some factories (DEZA Valasske Mezirici, Precheza Prerov etc.). But on the other hand many water quality problems were neglected for a long time: maintenance of WWTPs and sewer system (often very old), waste management and waste disposal on dump sites - including the dangerous and toxic substances.

All these problems have to be solved after 1989 and many new remedial activities started in particular with regard to problems caused by important smaller towns and villages. In some of villages there were built reed-bed plants, the works on other classical wastewater treatment plants - recently in construction - were mostly finished not long ago. The construction of some plants recently has started. Some WWTPs were reconstructed, the most important municipal WWTP recently reconstructed is the second large city in the Morava River basin - in Olomouc. With respect to many environmental damages, to privatization activities, to changes of ownership conditions and to law changes there were a lot of ***environmental expertise*** (related to financial requirements to the State Environmental Fund), of ***environmental audit***s (referring to new owners, to old damages and to National Property Fund - as to the survival of former socialist economic system) and of ***environmental impact assessment***s *E.I.A.* there were constructions, equipment, devices or other anthropogenic systems. Those were after 1989 by means of mentioned tools monitored and evaluated - including WWTPs, reed-bed plants (or other macrophyte-based wastewater treatment systems), sewer systems, small hydropower stations, water resources or water supply system, hydraulic structures and remedial measures (in factories, power plants, mining systems, relevant to dump sites or landfills, to waste management etc.).

All 33 municipalities with more than 10,000 inhabitants have their own wastewater treatment plants. From 33 municipalities in the Morava River basin between 5,000 and 10,000 inhabitants are to WWTP connected 27 towns and villages. In the Czech part of the Vah River basin (which belongs to the Danube River basin, too) are three other towns between 5,000 and 10,000 inhabitants: Slavicin, Valasske Klobouky and Brumov-Bylnice. These towns have been equipped by WWTPs. There are also some other plants in smaller towns and villages. It amounts to almost of 1.4 million inhabitants bound to wastewater treatment plants or exceptionally to reed-bed plants or other macrophyte-based wastewater treatment plants. It has a bearing upon these municipalities (in sequence regarding to number of inhabitants):

| | |
|---|---|
| more than 100,000 inh. | Brno, Olomouc |
| between 50,000 and 100,000 inh. | Zlin, Jihlava, Prerov, Prostejov |
| between 20, 000 and 50,000 inh. | Trebic, Znojmo, Vsetin, Sumperk, Kromeriz, Hodonin, Valasske Mezirici, Uherske Hradiste, Breclav, Vyskov, Blansko, Hranice, Otrokovice |
| between 10,000 and 20,000 inh. | Roznov pod Radhostem, Uhersky Brod, Svitavy, Zabreh, Sternberk, Kyjov, Holesov, Veseli nad Moravou, Unicov, Velke Mezirici, Moravska Trebova, Boskovice, Nove Mesto na Morave, Litovel |

In the Morava River Watershed are 41 municipalities with more than 10,000 population equivalent (PE). Most of following values corresponding to some important towns in the Morava River basin originates from the part C - Water Quality. The data used here are mostly updated with respect to the national Action Plan of the Czech Republic (NAP), but some numbers sprung from this NAP. The values of PE are as follows: Brno 500,000 ; Olomouc 180,000 ; Zlin 150,000 ; Prostejov

120,000 ; Prerov 110,000 ; Jihlava 84,300 (NAP) ; Uherske Hradiste 83,000 ; Hodonin 75,600 ; Trebic 64,000 (NAP); Znojmo 50,000 ; Valasske Mezirici 45,200 (NAP) ; Kromeriz 35,000 ; Svitavy 32,700 (NAP); Breclav 30,000.

In the Morava River basin were in the course of years 1991 - 1997 built some wastewater treatment plants including ones in 19 municipalities with more than 5,000 inhabitants as follows: Holesov (12.7 thousand inh.), Hulin, Bzenec, Policka, Kojetin, Hustopece, Uhersky Brod (18.0 th. inh.), Litovel (10.1 th. inh.), Ivancice, Moravske Budejovice, Velke Mezirici, Nove Mesto na Morave, Lanskroun, Kyjov, Moravska Trebova, Bystrice pod Hostynem, Bucovice, Dacice, Napajedla. Very important reconstruction was recently implemented in Olomouc (105 th. inh.) and many industrial WWTPs were completed or reconstructed. It is true that some problems are going on. ***As a matter of fact almost no municipal WWTP has been equipped by effective system able to remove phosphorus***, on the other hand the nitrification and denitrification devices have formed the important sub-system of most WWTPs. Still the water quality efficiency to reduce the nitrogen is very different and often considerably low and will have to be increased step by step.

However, the vital measures for improvement of the situation following from the Strategic Action Plan and specified in the national Action Plan of the Czech Republic - and taking up with Slovakia and Austria - would be realized shortly in the course of next 5 - 10 year and to a decisive degree from resources that are available within countries. The main question is to find economical, effective and environmentally very sustainable solution for the most significant municipalities and other hot spots. It is also the matter of more effective reduction of nutrients and priority pollutants through all basin.

Nevertheless, because of the extent of essential measures, which mostly should remedy deficiencies incurred during the previous regime or some new problems originating from the process of transition, there have not been enough financial sources for some urgent measures.

The prepared projects focus on solving different partial problems by different means, but the goals are similar:

- **progressive and consecutive improving the surface and groundwater quality from the point of view of main parameters and step by step of nutrients and priority pollutants - with the aid of proceedings by stages,**
- **contributing to the restoration of river ecosystems,**
- **decreasing the transport of nutrients, hazardous substances and poorly degradable organic compounds to the Danube and into the Black Sea.**

More important pollution point sources are called "***hot spots***" according to the Strategic Action Plan (SAP) and to the national Project of the Morava River, from draft of the national Action Plan of the Czech Republic (NAP) and at this time from multi-criteria evaluation in the part C of submitted document - Water Quality. In the first priority group (described in detail in the annex) there are these hot spots:

1. **Brno** (the largest city + industry - ***municipal hot spot***)
2. **Zlin** (city + industry - ***municipal hot spot***)
3. **Uherske Hradiste** (town + industry - ***municipal hot spot***)
4. **Hodonin** (town + industry - ***municipal hot spot***)
5. **Kozeluzny Otrokovice** (industry + town - ***industrial hot spot***)
6. **Fosfa Breclav-Postorna** (industry, dump site - ***industrial hot spot***)
7. **Gigant Dubnany** (agriculture - large-capacity pig farm - ***agricultural hot spot***)

Special group represents other important municipal hot spots with recently started projects (mostly town + industry): ***Prostejov***, ***Prerov***, ***Znojmo***, ***Breclav***, ***Svitavy*** and other municipalities between 5,000 and 10,000 inhabitants. The projects for larger municipalities will have to be prepared or they are in the stage of studies: Jihlava, Trebic, Kromeriz, Valasske Mezirici and further significant towns. The recently reconstructed municipal WWTP in the city of **Olomouc** must be further completed. This city is the second largest in the Morava River Catchment and main issues consist of existing presence of phosphorus downstream Olomouc. All these more or less prepared projects or studies are not mentioned here in detail.

There were also chosen other three important industrial and five agricultural hot spots, but the project preparedness of them is mostly at the beginning (or before beginning):

- industrial hot spots: **HAME Babice, Snaha Brtnice and Tanex Vladislav,**
- agricultural hot spots: **large-capacity pig farms Milotice, Tesnovice, Kunovice, Velke Nemcice, Strachotice.**

Special problems of water systems have been caused by waste management, by dump sites and landfills. Above all the fifth priority - mentioned at the beginning of this chapter - has coherence with challenges of waste disposals. The primary objective of this priority task is the remediation of previous damage, which poses acute hazards for human health and the environment. A considerable part of the remediation costs for privatization costs has been provided by the commitments of the ***National Property Fund***, however, in many cases the responsibility has been very problematic. In addition to it there have been many hidden or latent places and regions comprising these dangerous substances - in solid, liquid and gaseous phase. A lot of dump sites has not been more precisely identified hitherto; these sites have been often covered by earthy material or by land. Special problems have been connected with former military activities in areas Libava (near Olomouc in basin of the Becva River and the Bystrice River), Vyskov and Prostejov (in the Drahany Uplands - in basins of the Valova River, Brodecka Brook and Hana River) and Sumperk (in the Desna River basin).

Problems of dump sites have been solved in different ways. Among priority hot spots was chosen only one locality - above mentioned Fosfa Postorna. However, there are many other old dump sites, e.g. of Colorlak Stare Mesto, Precheza Prerov (both are mentioned in the Strategic Action Plan - they are in the phase of remedial works step by step) and minimum 17 localities mentioned in the draft of national Action Plan of the Czech Republic - at present mostly without projects a proposals of solution.

Comprehensive result of all mentioned water quality factors has lead into intensive ***transboundary impacts***. All three key states (Czech Republic, Austria, Slovakia) have cooperated on all water management problems including water quality issues, water quantity information, floods, flooding and accident, emergency warning system.

The water quality state referring to mentioned key hot spots and transboundary impacts is expressed by values in next table. The data are borrowed from the evaluation of water quality monitoring in the Morava River basin in the course of two years 1996 - 1997 (Povodi Moravy, a.s., 1998; values are mostly in mg/l, other units are mentioned in enclosed notes):

## Table 7 Water quality monitoring in important river profiles of the Morava River basin from 1996 to 1997 - principal parameters

| Parameter | Value | profile | | | | | |
|---|---|---|---|---|---|---|---|
| | | downstream Brno - Svratka | downstream Zlin - Drevnice | downstream Uh.. Hradiste - Morava | **downstream Hodonin - Morava TI** | downstream Otrokovice - Morava | **downstream Breclav - Dyje TI** |
| Dissolved $O_2$ | AMV | 9.5 | 10.1 | 10.5 | **11.1** | 9.8 | **10.8** |
| | ChV | 6.0 | 7.5 | 7.3 | **8.8** | 6.5 | **7.5** |
| | WQ-C | 3 | 1 | 1 | **1** | 2 | **1** |
| $BOD_5$ | AMV | 7.1 | 10.5 | 4.8 | **5.2** | 4.4 | **5.6** |
| | ChV | 11.5 | 16.9 | 7.1 | **7.8** | 6.4 | **9.6** |
| | WQ-C | 4 | 5 | 3 | **3** | 3 | **3** |
| $COD_{Mn}$ | AMV | 6.9 | 7.8 | 5.8 | **5.6** | 5.2 | **8.7** |
| | ChV | 8.1 | 10.8 | 8.1 | **8.8** | 8.1 | **10.5** |
| | WQ-C | 2 | 3 | 2 | **2** | 2 | **3** |
| $COD_{Cr}$ | AMV | 28.9 | 28.3 | 27.2 | **26.5** | 22.4 | **36.1** |
| | ChV | 38.0 | 41.8 | 53.1 | **38.1** | 30.4 | **41.9** |
| | WQ-C | 4 | 4 | 4 | **4** | 3 | **4** |
| PH | AMV | 7.9 | 7.9 | 7.8 | **7.9** | 7.6 | **8.3** |
| | ChV | 8.0 | 8.2 | 8.1 | **8.3** | 7.9 | **8.9** |
| | WQ-C | 1 | 1 | 1 | **1** | 1 | **4** |
| Temperature | AMV | 9.3 | 11.1 | 10.5 | **11.2** | 10.2 | **11.0** |
| | ChV | 16.5 | 19.9 | 21.4 | **21.7** | 20.9 | **20.7** |
| | WQ-C | 1 | 1 | 1 | **1** | 1 | **1** |
| dis. Solids | AMV | 373 | 488 | 387 | **421** | 357 | **451** |
| | ChV | 420 | 592 | 4.99 | **582** | 432 | **521** |
| | WQ-C | 2 | 3 | 2 | **3** | 2 | **3** |
| Conductivity | AMV | 52 | 60.8 | 47.4 | **47.1** | 43.6 | **58.9** |
| | ChV | 59.0 | 78.9 | 60.5 | **61.7** | 55.9 | **67.5** |
| | WQ-C | 2 | 3 | 2 | **2** | 2 | **2** |
| susp. Solids | AMV | 18 | 51 | 56 | **62** | 49 | **19** |
| | ChV | 43 | 93 | 125 | **136** | 115 | **33** |
| | WQ-C | 3 | 4 | 5 | **5** | 5 | **2** |
| Fe | AMV | 0.29 | 0.85 | 0.91 | **0.97** | 0.74 | **0.27** |
| | ChV | 0.49 | 1.67 | 2.07 | **1.70** | 1.51 | **0.38** |
| | WQ-C | 1 | 3 | 4 | **3** | 3 | **1** |
| Mn | AMV | 0.09 | 0.21 | 0.16 | **0.15** | 0.14 | **0.11** |
| | ChV | 0.14 | 0.26 | 0.30 | **0.24** | 0.21 | **0.17** |
| | WQ-C | 3 | 3 | 4 | **3** | 3 | **3** |
| $N\text{-}NH_4$ | AMV | 2.37 | 2.87 | 0.75 | **0.70** | 0.91 | **0.47** |
| | ChV | 3.54 | 5.41 | 2.24 | **2.16** | 2.36 | **1.29** |
| | WQ-C | 4 | 5 | 4 | **4** | 4 | **3** |
| $N\text{-}NO_2$ | AMV | 0.168 | 0.148 | 0.067 | **0.058** | 0.066 | **0.075** |
| | ChV | 0.440 | 0.298 | 0.119 | **0.113** | 0.120 | **0.114** |
| | WQ-C | 5 | 5 | 5 | **5** | 5 | **5** |
| $N\text{-}NO_3$ | AMV | 5.16 | 3.12 | 3.50 | **3.62** | 3.38 | **4.89** |
| | ChV | 6.74 | 4.24 | 4.74 | **4.87** | 4.72 | **7.50** |
| | WQ-C | 3 | 3 | 3 | **3** | 3 | **4** |
| $P_{tot}$ | AMV | 0.45 | 0.73 | 0.31 | **0.28** | 0.34 | **0.41** |
| | ChV | 0.72 | 1.22 | 0.52 | **0.44** | 0.59 | **0.62** |
| | WQ-C | 4 | 5 | 4 | **4** | 4 | **4** |

## Table 8 Water quality monitoring in important river profiles of the Morava River basin from 1996 to 1997 - other parameters

| Parameter | value | profile | | | | | |
|---|---|---|---|---|---|---|---|
| | | downstream Brno | downstream Zlin | downstream Uh.. Hradiste | **downstream Hodonin - TI** | downstream Otrokovice | **downstream Breclav - TI** |
| $Cl^-$ | AMV | 34.9 | 34.5 | 26.8 | **27.7** | 25.4 | **38.9** |
| | ChV | 42.0 | 59.3 | 39.0 | **42.4** | 35.9 | **46.2** |
| | WQ-C | 1 | 2 | 1 | **1** | 1 | **1** |
| $SO_4^-$ | AMV | 74.7 | 80.8 | 74.1 | **80.3** | 68.8 | **112.5** |
| | ChV | 81.9 | 93.9 | 94.0 | **101.0** | 88.2 | **132.6** |
| | WQ-C | 2 | 2 | 2 | **2** | 2 | **2** |
| Ca | AMV | 61.6 | 89.1 | 66.6 | **67.7** | 62.3 | **64.3** |
| | ChV | 79.1 | 104.3 | 86.9 | **91.9** | 83.2 | **75.0** |
| | WQ-C | 2 | 2 | 2 | **2** | 2 | **1** |
| Mg | AMV | 11.9 | 13.8 | 11.7 | **11.9** | 10.5 | **21.6** |
| | ChV | 14.0 | 17.0 | 17.2 | **18.0** | 14.1 | **25.4** |
| | WQ-C | 1 | 1 | 1 | **1** | 1 | **2** |
| surface active agent | AMV | ? | ? | ? | **0.18** | 0.02 | **0.04** |
| | ChV | ? | ? | ? | **0.04** | ? | **0.09** |
| | WQ-C | ? | ? | ? | **1** | ? | **2** |
| non-polarized ext. substances | AMV | <0.05 | 0.08 | <0.05 | **<0.05** | <0.05 | **<0.05** |
| | ChV | 0.13 | 0.14 | ? | **0.08** | ? | **0.08** |
| | WQ-C | 4 | 4 | ? | **3** | ? | **3** |
| Hg | AMV | 0.22 | 0.25 | <0.1 | **<0.1** | 0.1 | **0.14** |
| | ChV | 0.35 | 0.70 | 0.30 | **0.23** | 0.23 | **0.20** |
| | WQ-C | 3 | 4 | 3 | **3** | 3 | **3** |
| Cd | AMV | <0.1 | ? | ? | **<0.1** | <0.1 | **<0.1** |
| | ChV | 0.1 | ? | ? | **0.2** | 0.2 | **0.3** |
| | WQ-C | 1 | ? | ? | **1** | 1 | **1** |
| Pb | AMV | 1.8 | ? | ? | **2.8** | 3.4 | **1.8** |
| | ChV | 2.9 | ? | ? | **6.3** | 9.0 | **2.5** |
| | WQ-C | 1 | ? | ? | **1** | 1 | **1** |
| Cu | AMV | 3.3 | ? | ? | **3.3** | 3.1 | **3.9** |
| | ChV | 5.0 | ? | ? | **7.0** | 7.0 | **5.1** |
| | WQ-C | 1 | ? | ? | **1** | 1 | **1** |
| $Cr_{Tot}$ | AMV | <1 | ? | ? | **2.6** | 2.0 | **1.6** |
| | ChV | 2.9 | ? | ? | **4.0** | 3.6 | **2.0** |
| | WQ-C | 1 | ? | ? | **1** | 1 | **1** |
| Ni | AMV | 3.0 | ? | ? | **3.3** | 3.5 | **3.3** |
| | ChV | 4.5 | ? | ? | **7.6** | 5.9 | **5.0** |
| | WQ-C | 1 | ? | ? | **1** | 1 | **1** |
| Zn | AMV | 29.8 | ? | ? | **12.3** | 11.0 | **29.3** |
| | ChV | 60.6 | ? | ? | **22.5** | 22.3 | **54.7** |
| | WQ-C | 3 | ? | ? | **2** | 2 | **3** |
| saprobic index | AMV | 2.0 | 2.0 | 2.0 | **2.2** | 2.0 | **21** |
| | ChV | 2.0 | 2.1 | 2.1 | **2.6** | 2.1 | **2.4** |
| | WQ-C | 2 | 2 | 2 | **3** | 2 | **3** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Coliforms | AMV | 120 | 91 | 70 | **34** | 62 | **82** |
| | ChV | 183 | 180 | 128 | **58** | 160 | **161** |
| | WQ-C | 4 | 4 | 4 | **3** | 4 | **4** |
| PCB | AMV | ? | ? | ? | 27 (2-221mg/l) | ? (<2-105mg/l) | 14 (3-60mg/l) |
| PAH | AMV | ? | ? | ? | 369(10-2157mg/l) | ?(<10-1700mg/l) | 684(<10-1000mg/l) |

*Notes:*

*1) Profiles in the fourth and sixth column are on the state border or very near borders with Slovakia or Austria; these columns are mare marked in bold type - as profiles with considerable transboundary effect (characterized in the point 2).*

*2) Profiles of stable water quality monitoring (performed in Povodi Moravy, a.s.)*

| | |
|---|---|
| *downstream Brno* | *downstream the WWTP Brno in the profile Rajhrad on the Svratka River* |
| *downstream Zlin* | *downstream the WWTP Zlin-Malenovice in the profile Otrokovice on the Drevnice River (upstream the confluence with the Morava River)* |
| *downstream Uherske Hradiste* | *downstream the WWTP Uherske Hradiste in the profile Nedakonice on the Morava River* |
| *downstream Hodonin TI* | *downstream the WWTP Hodonin and Gigant Dubnany in the profile Lanzhot on the Morava River; outcome profile TI - with evident transboundary impact (on the border with Slovakia, 5 km to the border with Austria)* |
| *downstream Otrokovice* | *downstream the industrial WWTP Kozeluzny Otrokovice in the profile Spytihnev on the Morava River* |
| *downstream Breclav TI* | *downstream the Remedial Measures of Area Fosfa Postorna in the profile Pohansko; outcome profile TI - with evident transboundary impact (1 km to the border with Austria, 19 km to the border with Slovakia)* |

*3) numbers as 0,3 (underlined)* — *datum does not represent the annual mean value, the annual mean median is the matter*

*4) abbreviations*

| | |
|---|---|
| *AMV* | *two years mean value (1.1.1996 - 31.12.1997)* |
| *ChV* | *characteristic value (1.1.1996 - 31.12.1997)* |
| *WQ-C* | *category of surface waters according to water quality (Czech standard CSN 7221)* |
| *TI* | *transboundary impact* |

*5) units*

| | |
|---|---|
| *Hg, Cd, Pb, Cu, CrTOT, Ni, Zn* | *µg/l* |
| *saprobic index* | *numerically expressed due to a formula* |
| *coliforms* | *colony counts in the unit (CCU) in 1 ml of water* |

To this text is attached a sketch map of the Morava River basin with marking out of key hot spots where the ongoing or planned projects of environmental remedying are available (see page …).

## 3.1. Reduction of Water Pollution from Municipalities

All 33 municipalities with more than 10,000 inhabitants have their own wastewater treatment plants. From 33 municipalities in the Morava River basin between 5,000 and 10,000 inhabitants 27 towns and villages are connected to WWTP. In the Czech part of the Vah River basin (which belongs to the Danube River basin, too) are three other towns between 5,000 and 10,000 inhabitants: Slavicin, Valasske Klobouky and Brumov-Bylnice. These towns have been equipped by WWTPs. There are also some other plants in smaller towns and villages. It amounts to almost of 1.4 million inhabitants bound to wastewater treatment plants or exceptionally to reed-bed plants or other macrophyte-based wastewater treatment plants. All significant municipalities were mentioned and characterized before.

In the Morava River Watershed there are 40 - 50 municipalities with more than 10,000 population equivalent (PE). The largest values of PE are as follows: Brno 500,000 ; Olomouc 180,000 ; Zlin 150,000 ; Prostejov 120,000 ; Prerov 110,000 ; Jihlava 84,000 ; Uherske Hradiste 83,000 ; Hodonin 75,600 ; Trebic 64,000; Znojmo 50,000.

In the Morava River basin were in the course of years 1991 - 1997 built some wastewater treatment plants including ones in 19 municipalities with more than 5,000 inhabitants: Holesov, Hulin, Bzenec, Policka, Kojetin, Hustopece, Uhersky Brod, Litovel, Ivancice, Moravske Budejovice, Velke Mezirici, Nove Mesto na Morave, Lanskroun, Kyjov, Moravska Trebova, Bystrice pod Hostynem, Bucovice, Dacice, Napajedla. Very important reconstruction was recently implemented in Olomouc (with 105 thousand inhabitants) and many industrial WWTPs were completed or reconstructed. It is true that some problems are going on. However, almost no municipal WWTP has been equipped by effective system able to remove phosphorus, on the other hand the nitrification and denitrification devices have formed the important part of most WWTPs. Still the water quality efficiency to reduce the nitrogen is very different and often considerably low and will have to be increased step by step.

Above all the implementation of the WWTP in Olomouc has caused very important step to reduction of pollution. The total load in recipients of the Morava River basin decreased from 1995 to 1996 as follows (in thousand tons/year):

| | | | | |
|---|---|---|---|---|
| $BOD_5$ | from 29.7 (1991) | to 24.3 (1993) | to 16.2 (1995) | to 6.6 (1996) |
| $COD_{Cr}$ | from 72.0 (1991) | to 70.0 (1993) | to 45.5 (1995) | to 23.9 (1996) |
| TSS | from 30.0 (1991) | to 17.2 (1993) | to 20.0 (1995) | to 10.8 (1996) |

The reconstructed WWTP has had the main impact (about 35% - 40%). On the other hand the nutrient reduction was not so significant and the load development was in the Morava River basin as follows (approximately):

| | | | | |
|---|---|---|---|---|
| $NH_4$ | from 6.2 (1991) | to 4.0 (1993) | to 2.7 (1995) | to 2.8 (1996) |
| $P_{Tot}$ | from 1.2 (1991) | to 0.9 (1993) | to 0.8 (1995) | to 0.8 (1996) |

The main decrease by nutrients has been connected with changes in agriculture. The tendency in municipalities has been - on the contrary - almost opposite due to nutrition customs and utilization of phosphate washing powders.

Recent evaluation of urgency priorities in NAP has been resulted in this implementation sequence of municipal wastewater treatment plants: Brno, Prostejov, Jihlava, Svitavy, Zlin, Hodonin, Breclav, Trebic, Uherske Hradiste, Prerov, Hanusovice, Valasske Mezirici. According to this choice and to transboundary impacts was submitted in January 1996 "Project Identification List of Municipal Wastewater Treatment Plants in the Morava River Basin - Czech Republic" - characterizing following six projects:

- Reconstruction of the Sewer System and Wastewater Treatment Plant Modernization in Brno (Brno-Modrice),
- Extension and Intensification of the Wastewater Treatment Plant in Zlin (Town District Malenovice),
- Intensification and Extension of the Municipal Wastewater Treatment Plant in Prostejov,
- Reconstruction and Extension of the Wastewater Treatment Plant in Prerov,
- Sewerage and Wastewater Treatment Plant Extension in Breclav,
- Sewerage and municipal wastewater treatment plant in Hodonin.

The municipal hot spots projects were updated at this time - in correspondence with new conditions and with evaluation and option according to criteria of part C Water Quality:

- **Extension and intensification of the wastewater treatment plant Brno** (WWTP for the city of Brno, but situated in Modrice) ... (approximately 70 km to border with Austria, 85 km to boundary with Slovakia),
- **Reconstruction and extension of WWTP Zlin** ... (approximately 55 km to border with Slovakia, 90 km to boundary with Austria),
- **Reconstruction of technology systems in WWTP Uherske Hradiste** ... (approximately 30 km to border with Slovakia, 65 km to boundary with Austria),
- **Reconstruction, intensification and extension of WWTP Hodonin** .... (approximately 1 km to border with Slovakia, 36 km to boundary with Austria),

Principal problems of municipal wastewater treatment plants consist of

a. dating of constructions and mainly equipment; WWTPs are 20 - 30 years old, many devices and machines are obsolete and affected by corrosion, there are frequent faults etc.,
b. lower effectiveness of some treatment procedures (mainly with regard to further degrees concerning nutrients etc.) ,
c. insufficient financial coverage,
d. long-term underestimating of issue caused by water pollution from municipalities.

The principal criteria for the option of mentioned key hot spots are as follows:

- nutrients pollution reduction,
- significant transboundary effect,
- reduction of heavy metals concentration and other priority dangerous and toxic substances in downstream reaches of rivers.

From the point of view of sewage treatment efficiency to remedy and of transboundary effect would be awaited the key role of the WWTP Brno, then Zlin, Hodonin and Uherske Hradiste.

The assumed reduction of nutrient discharges - regarding to four key municipal hot spots - will be as follows (in mg/l):

**Table 9 Assumed reduction of nutrient discharges related to key municipal hot spots**

| hot spot | till 31.12. 2004 | | after 1.1. 2005 | |
|---|---|---|---|---|
| | $N\text{-}NH_4$ | $P_{tot}$ | $N\text{-}NH_4$ | $P_{Tot}$ |
| Brno | 10.0 (limit) | 3.0 (limit) | 5.0 (limit) | 1.5 (limit) |
| Zlin | 10.0 (limit) | 3.0 (limit) | 5.0 (limit) | 1.5 (limit) |
| Uherske Hradiste | 15.0 (limit) | 5.0 (limit) | 10.0 (limit) | 3.0 (limit) |
| Hodonin | 15.0 (limit) | 5.0 (limit) | 10.0 (limit) | 3.0 (limit) |

For WWTP Brno are determined these final average values according the project proposal: $N_{Tot}$ = 10 mg/l and $P_{Tot}$ = 1.0 mg/l. The values in the table have followed from the Governmental Decree No. 171/1992. However, it must be said that for meeting above mentioned limits all WWTPs - excluding Brno - will have to be completed by final stages of reconstructions, with stages of more effective removal of phosphorus. The values between the present (1997) and future state after the 1st January 2005 must be decreased as follows (in mg/l):

Brno: $N\text{-}NH_4$ ..... from 17.5 (maximum 35.7) to 5.0; $N\text{-}NO_3$ ..... from 54.4 (maximum 94.3) to < 5.0, $P_{Tot}$ ..... from 1.4 (maximum 3.7) to 1.0

Zlin: $N\text{-}NH_4$ ..... from 19.5 (maximum 33.9) to 5.0; $N\text{-}NO_3$ ..... from 6.4 (maximum 94.3) to < 11.0, $P_{Tot}$ ..... from 3.6 (maximum 6.5) to 1.5

Uherske Hradiste $N\text{-}NH_4$ ..... from 23.4 (maximum 79.0) to 10.0; $N\text{-}NO_3$ ..... mean value of 4.4 complies apparently (but the maximum value 72.0 is not good with respect to future demands); $P_{Tot}$ ..... from 3.2 (maximum 17.0) to 3.0

Hodonin $N\text{-}NH_4$ ..... from 13.4 (mean value) to 10.0; $N\text{-}NO_3$ ..... mean value of 32.4 complies apparently with future requirements; $P_{Tot}$ ..... mean value 1.1 is apparently also good related to future limits 3.0

The load reduction with respect to nutrients is represented by these approximate values (between these days 1994 - 1996 and future 2004/2005 (in t/year):

| municipality | $N\text{-}NH_4$ | | $P_{tot}$ | |
|---|---|---|---|---|
| | from | to | from | to |
| Brno | 400 - 1,000 | 250 - 300 | 100 - 140 | 50 - 70 |
| Zlin | 250 - 300 | 45 - 60 | 30 - 45 | 10 - 20 |
| Uherske Hradiste | 70 - 90 | 25 - 30 | 10 - 40 | 5 - 10 |
| Hodonin | 90 - 110 | 35 - 45 | 5 - 25 | 3 - 7 |
| and other towns: | | | | |
| Olomouc | 40 - 50 (1994: 440) | 40 - 45 | 100 - 130 | 30 - 45 |
| Prostejov | 150 - 200 | 60 - 80 | 10 - 30 | 15 - 22 |
| Prerov | 100 - 170 | 25 - 40 | 5 - 15 | 4 - 7 |
| Kromeriz | 130 - 190 | 20 - 30 | 20 - 30 | 10 - 18 |
| Jihlava | 150 - 200 | 40 - 55 | 5 - 10 | 4 - 10 |
| Trebic | 70 - 100 | 35 - 45 | 15 - 20 | 8 - 12 |
| Znojmo | 140 - 170 | 35 - 45 | 15 - 25 | 5 - 10 |
| Breclav | 90 - 100 | 30 - 45 | 5 - 20 | 3 - 8 |
| altogether | 1,680 - 2,680 | 640 - 820 | 320 - 530 | 147 - 239 |
| % reduction | | 30 - 40 | | 40 - 50 |

After Chapter 3.2. the list with municipal hot spots (table 10.) is enclosed.

# 3.2. Reduction of Water Pollution from Agriculture

## 3.2.1. Prevention of Pollution from Agricultural Point Sources

Main issues have been connected with large-capacity pig farms. In the past there also were some problems with large-capacity cowsheds, poultry houses, breeding of ducks, with discharges from dunghills, from disposal sites of slurry or silage.

For the past stage of National Action Plan of the Czech Republic (1996) were chosen ten large-capacity pig farms as hot spots: Milotice, Dubnany, Tesnovice, Dlouha Loucka, Paseka, Sebetov, Krizanov - Jakubovicky Dvur, Vicov, Velke Nemcice, Kunovice. After this step there have been reflecting localities with significant transboundary impacts:

- pig farm Dubnany,
- pig farm Milotice,
- pig farm Kunovice,
- pig farm JAVE Velke Nemcice,

The chosen topical five agricultural hot spots (five pig farms according to part B Water Quality) are situated in southern Moravia i.e. in lower part the Morava River basin upstream the mouth of the Dyje River (Kunovice), in lower part of the Dyje River (Strachotice near Znojmo), in lower part of the Svratka River (Velke Nemcice near and upstream the Nove Mlyny Hydraulic Structure), in the Kyjovka River Catchment (farms Dubnany and Milotice between towns Hodonin and Kyjov). The biggest farms are Dubnany and Milotice, with more than 15,000 livestock. However, there are some other point sources of agricultural pollution - large capacity cowsheds, dunghills, disposal sites of silage etc. Principal outputs consist of ammonia, microbiological pollution, sometimes also heavy metals.

There are these agricultural hot spots in the Morava River basin:

- pig farm Dubnany (approximately 8 km to border with Slovakia, 31 km to boundary with Austria),
- pig farm Milotice (approximately 17 km to border with Slovakia, 40 km to boundary with Austria),
- pig farm Kunovice (approximately 30 km to border with Slovakia, 65 km to boundary with Austria),
- pig farm Velke Nemcice (approximately 50 km to border with Austria, 70 km to boundary with Slovakia),
- pig farm Strachotice (approximately 12 km to border with Austria, 65 km to boundary with Slovakia),

As the first-rate agricultural hot spot was chosen the pig farm near Dubnany. The name of Project is **Remedial Measures and Reduction of Slurry Production in the Pig Farm Gigant Dubnany**.

Solution of this Project is oriented on the improvement of present unfavorable state of water quality related to outflow from the large-capacity pig farm, to old environmental damages (contaminated sediments in the lagoon, etc.) and to water quality requirements in surface and ground waters.

The present water quality indicators 1993 - 1998 in the Kyjovka River and brooks Mlynarka B. and Rumzovsky Jarek B. downstream Dubnany are as follows:

| | | |
|---|---|---|
| $BOD_5$ | class 4 - 5 | values between ... 3.0 - 200 mg/l |
| $COD_{Cr}$ | class 4 - 5 | values between ... 10.0 - 360.0 mg/l |
| TSS | class 3 - 5 | values between ... 60 - 110 mg/l |
| TDS | class 3 - 5 | values between ... 800 - 1320 mg/l |
| $N\text{-}NH_4$ | class 3 - 4 | values between ... 3.0 - 4.60 mg/l |
| $P_{Tot}$ | class 3 - 4 | values between ... 0.10 - 0.80 mg/l |

There are also problems with heavy metals occurring in particular in slurry residua and sediments: zinc - up to 5,000 mg/kg of sediments, copper - up to 15,000 mg/kg of sediments. Likewise, the microbiological contamination of surface waters is significant, above all coliforms, fecal coliforms and enterococci.

Expected limits due quality in surface water bodies downstream the pig farm Gigant Dubnany are: $BOD_5$... 8 mg/l, N - $NH_4$... 3 mg/l, $P_{Tot}$ ... 0.4 mg/l

The rehabilitation design of the pig farm "Gigant Dubnany" and proposal of measures needful for the reduction of slurry production are the most important agricultural "hot spot" project in the Morava River basin. There are two steps of the project: a) measures to reduce the slurry production and application, b) reconstruction of pig farm, removal of contaminated sediments, soil etc.

Some other projects of remedial measures in pig farms were worked up, but the transition process and ownership changes in agriculture have not been cleared up and finished hitherto. That is why no agricultural project is involved to chosen "hot spot" projects in this document. These changes pertain to principal conditions of necessary improvement of water quality, of possible pollution prevention connected with point sources in agriculture. It is sure that all problems mentioned here will have to be solved as soon as possible, by means of WWTPs, impermeable storage constructions, capacity changes, changes in the manure, dung-water and slurry management. Very important circumstance will be also represented by contingent modification of nourishment manners in the Czech Republic.

All transition circumstances - mentioned here or in next chapters 3.2.2., 3.2.3.. - have pertained to reasons of very complicated way to real sustainable agriculture in our country and in the Morava River basin, too. Many cooperative storage tanks for liquid manure - for slurry or dung-water - have not been water-tight and well maintained. The correct uses of manure and other suitable agro-technical measures (including improved live-stock practices, collection of effluents from storage of silage) according to capability of vegetation and cultivated land have started in some localities, above all in the private sector in agriculture. There have been also regional differences due to improvement of agro-technical measures relating to point sources. Better results are in parts of the Morava River basin with long-term Czech settlement: in the "Hana" region, in regions of "Moravian Slovakia", "Valachia", "Bohemian-Moravian Uplands" or "Drahany Uplands". However other regions and places with former prevailing German settlement have been in this sense more or less backward. It applies mainly to mountain parts of districts Sumperk and Bruntal, to border parts of districts Znojmo and Jindrichuv Hradec. There have been also main problems with ownership transition here.

Between pages is interposed the list with agricultural hot spots (table 11.)

### 3.2.2. Prevention of Pollution from Agricultural Non-Point Sources

However, the solution of non-point contamination issues has been more complicated. Severe non-point pollution was caused by past ineffective agriculture, by using of pesticides, of imported feed-stuffs, of phosphates, or also by ways of inconvenient nourishment of people. It altogether results in water contamination by nitrogen, phosphorus, heavy metals (mainly mercury and zinc), PCB, PAH, oils, other organic substances, pesticides etc.

It seems that very significant problems have been connected with the long-term and not finished transition of agriculture, of agricultural management and agricultural landscape. Especially the former cultural landscape was very changed at the time of collectivization and ownership restriction in the "socialist" period of years 1948 - 1989. Many of these anthropogenic activities have resulted in water erosion situations, in oversaturation of agricultural soil by fertilizers, manure, and pesticides, sometimes also by heavy metals and other toxic substances. Manure was often changed into waste product owing to oversized livestock breeding and to dumping of manure overplus on agricultural soils. On the other hand the fertilizers were formerly dosed according to state directives, the application has increased considerably till 1989.

In the past there were many specific changes in Czech landscape, which were mentioned in the chapter No. 2.1.: reallocation of land on large areas, changes of slopes, extensive drainages of wetlands and of soil, removal of balks, terraces and meadows, extensive ploughing and mechanization, directive modification of crop rotations and of crop plants applications, maximizing outputs at the cost of high inputs, training and straightening of watercourses, increase of number of large-capacity animal houses, of large-scale breeding and rearing (mainly pig and cattle farms), inefficient storage of manure, dung-water, slurry, silage, haylage and straw - often outside villages in open agricultural landscape.

It is almost unambiguous that the agriculture is the biggest source of nutrient emission into waters in our country. The contribution of total nitrogen-emission into surface waters is more than 50 %, the similar rate originated in the total phosphorus-emission. The year Morava River basin contribution in nitrogen fertilizers and manure was about 100,000 tons/year, by phosphates it was about 85,000 tons/year (fifteen years ago).

It is sure that the new integrated water management strategy would be very positive in all fields of human activities. It is sure that all agriculture will be changed by favorable ecological, environmental and economical methods to rehabilitated system, with minimizing of nutrient outputs to the environment. However it is also sure that all integrating and rehabilitating processes in our country, in landscape, in all agriculture and its water management will take a very long time. The prevention of pollution from agricultural non-point sources depends on urgent demand of “come-back” to ecological and perceptive ways of agricultural management in all spheres including the necessary “come-back” to ownership and fans relations to landscape, land, soil, water, farm animals, crop plants, manure and to all values of rural wealth and life.

On the other hand some needful measures with regard to non-point issues have been implemented: reduction of artificial fertilizers use and reduction of pesticides use with the aim to eliminate those active agents which pose threat to the drinking water and ecosystems (lindanee, DDT, persistent pesticides). The agricultural rate of water pollution originated in fertilizers has been essentially decreased, but some problems connected with pesticides use go on. Some measures to improve organic farming have been uniquely implemented by private agricultural sector, by progressive peasants in the “Hana” region, in the “Moravian Slovakia” (under “Bile Karpaty Mountains”) and in the “Bohemian-Moravian Uplands”. At universities have been established departments for low-input sustainable and organic agriculture and some training centers have been arose as well.

Other measures will be depended on ownership clearings up and on needful legislation changes providing suitable framework and pressure towards environmental rehabilitation of agricultural landscape. It refers to changing regulations towards sustainable agriculture and to supporting activities oriented at specific agro-ecological zones, forest shelter belts on river banks along the watercourses with the aim to reduce nutrient runoff, to vital measures to reduce erosion from arable land, to suitable ploughing and other agro-technical activities in the landscape.

Among future measures will belong the strengthening of necessary agricultural institutions or agencies or agricultural extension services, specialized in development of sustainable approaches in agricultural management.

### 3.2.3. Reduction of Water Pollution through Improved Land Management

Reduction of water pollution originating from the agriculture could be also connected with improved land management. That is why it is necessary to search ways towards the above mentioned "come-back" of ecological agricultural management in all spheres including the ownership relations to landscape, land, soil, water, farm animals, crop plants, manure and including the governmental support to restore all values of rural wealth and life.

However, this task is very complicated with respect to interrupted continuity of ownership relations in the agricultural or peasant management, to violent transformation of former private sector to state-cooperative form (till fifties of this century) and to "employee's" mode of recent agricultural management (after performed collectivization till 1990) with typical appearances:

- directives from the part of communist-party and state authorities (including the move and other insensitive encroachments upon peasant property and freedom, in particular between 1948 - 1960),
- farming on collectivized big pieces of land (after combining of them and ploughing away the balks),
- large intensification and emphasis on crop yield to the detriment of environment,
- extent applying fertilizers, slurry and pesticides,
- changes and shortening of traditional crop rotation,
- oversized drainage of lands,
- extent mechanization,
- removal of groves and meadows (the fields arose instead of them),
- growing of "lucrative" plants (maize, turnip or sugar-beet, oil rape etc.) instead of corn (in part), clover, pulses, flax, grass growth,
- increase of slopes on lands and of farming up-and-down slopes (it resulted in the increase the amount and speed of surface runoff water, in increase the rate of sloping land and in removal of fertile vegetative topsoil cover),
- parallel to it decrease of farming on "contour lines", terraces or on lands with very moderate slope and hydraulic gradient,
- long-term support of large-capacity farming including large-capacity breeding of pigs, beef cattle, poultry an ducks, including large-capacity animal farms and large-capacity storage of manure, slurry, dung-water, silage, haylage and straw.

However, all transition procedures in agriculture have been run very slowly. The restructuring of land-ownership has been solved in 10 - 15 %, exceptionally 20% of cases, other land has managed by new agricultural cooperatives of "owners", but their influence, knowledge and ownership awareness is not adequate to need. The transferring of state-cooperative management to combined cooperative-owner way has represented and will represent a very complex process and it will take a very long time till all necessary steps in the agriculture will be finished. All procedures of the agriculture transition are not simple, referring to past extent changes and to excessive costs to cover without fail all vital activities - as minimum variant. Thanks to moral or social behavior and to management tendencies of inertia, the consequent results of running transition processes have not been mostly satisfying for rural environment.

The principal agricultural “come-back” in the Morava River basin (but not only here) consists in ***retrograde step towards private ownership***. This task represents the ***main project*** ***of the agriculture of this time***; there are about 20% of private owners in agriculture in Morava River basin at a guess. Very important was the finishing of fertilizers and pesticides overdosing (but not everywhere) and of other unfavorable “socialist” activities. On the other hand there are some “small” projects with the aid of governmental support, subsidies and grants. Thus some dispersed tasks have been implemented here hitherto: small projects aimed at landscape rehabilitation, rehabilitation of chosen small watercourses, increased protection of some existing wetlands and waters, small activities resulting from requirements of integrated agriculture. The state directives and encroachment were dismissed and some large-capacity animals farms reduced their capacities, production and requirements. Other needful transition processes in agriculture have been going on very slowly, particularly those which are coherent with runoff regime, water erosion and water quality issues. Solution of them could be awaited in a long-term context. However for the time being, these projects are not of great importance as far as the demand of water quality pollution reduction in the Morava River basin is concerned.

Improved management in agriculture including use of all “classical” environmental methods and ways will contribute to better self-purification of watercourses, to all actions needful towards this improvement, to vital rehabilitation, reconstruction and extension of floodplains and wetlands in agricultural landscape. However, it is sure that all vital remedial activities will be very complicated, laborious and expensive (about 1,000,000 million CZK = 30,000 million US$ or more altogether - according to past estimation). Only some agricultural remedial, restoration or rehabilitation projects have been prepared. The main present task in Czech agriculture is concentrated on the stabilization of rural inhabitants and workers, on the solution of ownership relations.

## Table 10 Summary of recommended projects for municipal hot spots

| Hot Spot Name<br>River - *Location* | Parameters which Define the Problem | Ranking of the Problem | Name - Type of Project (Structural or Non-structural) | Project Strategy - Targets | Parameters - Values which Define Project Benefits | Project Beneficiaries |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **WWTP Brno**<br>Svratka R. - *Modrice* | BOD, COD, $NH_4$, $P_{Tot}$, 1961 | 1/ $NH_4$, $P_{Tot}$ | Structural | 1 stage 2004 | WQ all 2005 | WM, EC, A, FO, FI, TI |
| **WWTP Zlin**<br>Drevnice R. - *Zlin-Malenovice* | BOD, COD, $NH_4$, $P_{Tot}$, 1963 | 2/$NH_4$, $P_{Tot}$ | Structural | 2 stages 2004 | WQ all 2005 | WM (WR), EC, A, FI, IN, R, TI |
| **WWTP Hodonin**<br>Morava R. - *Hodonin* | BOD, COD, $NH_4$, (1982) | 3/$NH_c$, COD | Structural | 2 stages 2004 | WQ all 2005 | WM (WR), EC, TI, A, FI, FO, IN |
| **WWTP Uherske Hradiste**<br>Morava R. - *Uherske Hradiste* | BOD, COD, $NH_4$, $P_{Tot}$, 1974 | 4/$NH_4$, $P_{Tot}$ | Structural | 2 stages 2004 | WQ all 2005 | TI, EC, WM (WR), R, FO, FI, A |
| WWTP Olomouc<br>Morava R. - *Olomouc* | $P_{tot}$, (1996) | 5/$P_{Tot}$ | Structural | 1 stage 2004 | WQ all 2005 | WM (WR), EC, A, FI, FO, IN |
| WWTP Prostejov<br>Valova R. - *Prostejov* | BOD, $NH_4$, $P_{Tot}$, 1977 | 6/$NH_4$, $P_{Tot}$ | Structural | completing before 2004 | WQ all 2005 | WM, EC, A, FI, FO |
| WWTP Prerov<br>Becva R. - *Prerov* | BOD, COD, $NH_4$, 1969 | 7/$NH_4$, COD | Structural | completing before 2004 | WQ all 2005 | WM (WR), EC, A, FI, FO |
| WWTP Breclav<br>Dyje R. - *Breclav* | BOD, COD, $NH_4$, 1974 | 8/$NH_4$, BOD | Structural | 2 stages 2004 | WQ all 2005 | TI, EC, WM, FO, FI |
| WWTP Znojmo<br>Dyje R. - *Znojmo* | BOD, COD, $NH_4$, $P_{Tot}$, 1976 | 9/$NH_4$, $P_{Tot}$ | Structural | 1 - 2 stages 2004 | WQ all 2005 | WM, EC, TI, A, FI, R, IN |
| WWTP Kromeriz<br>Morava R. - *Kromeriz* | BOD, COD, $NH_4$, $P_{Tot}$, 1972 | 10/$NH_4$, $P_{Tot}$ | Structural | 1 - 2 stages 2004 | WQ all 2005 | WM (WR), EC, A, FI, R, FO, IN |

*Notes:*
- *ranking ... number conforming with significance of pollution, then the order according to pollutants*
- *year in the 2nd column ... beginning of WWTP operation; year in parenthesis ... the fact is not important in terms of needful modernization of WWTP*
- *WQ all 2005 ... all parameters according Czech Governmental Decree No. 171/1992 after 1.1.2005*
- *WM ... water management and water protection, WR ... near downstream water resources, IN ... industry (abstractions for industry downstream the profile), A ... agriculture, FO ... forestry (improvement of conditions in forested areas), FI ... fishery, EC ... improvement of environmental and ecological conditions, R ... water recreation, TI ... transboundary impacts; order conforming with the meaning*
- *column of Project Strategy - Targets: 1 stage 2004 or 2 stages 2004 or ..... 2004 ... number of project stages towards 31.12.2004*

**Table 11 Summary of recommended projects for agricultural hot spots**

| Hot Spot Name River - *Location* | Parameters - Values which Define the Problem | Ranking of the Problem | Name - Type of Project (Structural or Non-structural) | Project Strategy - Targets | Parameters - Values which Define Project Benefits | Project Beneficiaries |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Pig farm Dubnany** - Kyjovka R. - *Dubnany* | BOD, $NH_4$, μ ; >15 | 1/$NH_4$, μ, BOD | mostly structural, two stages | it must be solved as soon as possible | WQ all 2005 | WM (WR), EC, TI, A, FI, FO |
| Pig farm Milotice – Kyjovka R. - *Milotice* | BOD, $NH_4$, μ ; >15 | 2/$NH_4$, μ, BOD | Perhaps structural | it must be solved as soon as possible | WQ all 2005 | WM (WR), EC, TI, A, FI, FO |
| Pig farm Tesnovice - Morava R. - *Tesnovice* | BOD, $NH_4$, μ ; >15 | 3/$NH_4$, μ, BOD | perhaps structural | it must be solved as soon as possible | WQ all 2005 | WM (WR), EC, R, A, FI, FO, IN, TI (far) |
| Pig farm Kunovice – Morava R. - *Kunovice* | BOD, $NH_4$, μ ; >10 | 4/$NH_4$, μ, BOD | perhaps structural | it must be solved as soon as possible | WQ all 2005 | WM (WR), EC, A, FI, R, TI, FO, IN |
| Pig farm Velke Nemcice - Svratka R. - *Velke Nemcice* | BOD, $NH_4$, μ ; 10 | 5/$NH_4$, μ, BOD | perhaps structural | it must be solved as soon as possible | WQ all 2005 | WM, EC, TI, A, FI, FO, R |
| Pig farm Strachotice – Dyje R. - *Strachotice* | BOD, $NH_4$, μ ; max. 10 | 6/$NH_4$, μ, BOD | perhaps structural | it must be solved as soon as possible | WQ all 2005 | WM, EC, TI, A, FI, R |

*Notes:*

- *numbers in the 2nd column ... capacity of pig farm in thousands*
- *μ (in the 2nd and 3rd column) ... microbiological contamination*
- *ranking ... number conforming with significance of pollution, then the order according to pollutants*
- *WQ all 2005 ... all parameters according Czech Governmental Decree No. 171/1992 after 1.1.2005*
- *WM ... water management and water protection, WR ... near downstream water resources, IN ... industry (abstractions for industry downstream the profile), A ... agriculture, FO ... forestry (improvement of conditions in forested areas), FI ... fishery, EC ... improvement of environmental and ecological conditions, R ... water recreation, TI ... transboundary impacts; order conforming with the meaning*

## 3. 3. Reduction of Water Pollution from Industries

Industrial sectors are the greatest polluters in the Czech Republic. That is also true relating to the Morava River basin. There have been many industrial polluters here. However, with respect to sum concentration, almost the same impact have achieved special municipal services demanding and using the water: some workshops and local places of business, cleaning shops, petrol pumps, store-houses, tips, photographic, printing and copying services etc.

Main point sources of pollution are connected with industrial activities in above mentioned towns and municipalities, in Brno, Olomouc, Zlin, Jihlava, Prerov, Prostejov etc. Serious water pollution issues started here already twenty - thirty years ago and were partially solved by construction of industrial and combined wastewater treatment plants; combined plants have treated together municipal and industrial wastewater and in the Morava River basin it is the question of frequent way. Wastewater treatment plants have been operated in most of larger municipalities and important factories, but some of needful structures, equipment and linking-up sewerage systems must be reconstructed or upgraded, often with regard to small efficiencies. Likewise, some sewerage systems are obsolete and permeable, but not in such extent as in municipalities. Problems in industrial systems have been and would be also solved step by step.

Industrial sectors are in the Morava River basin formed by foodstuff, paper, pulp, clothing, boot-and-shoe, tanning, power, machine, metalworking, building and chemical industries. ***The most significant industrial pollutants are textile, tannery, chemical, papermaking, wood-making, machine-tool, metallurgical, electrical and food-stuff industry, pulp mills and sugar factories***. Contamination by heavy metals comes from smaller metallurgical plants and tanneries. Very significant position among the polluters in the area has *nutrients* (nitrogen, phosphorus) and some *heavy metals* - above all mercury. There exist some potential hazards in the Morava River basin, particularly specific organic substances (oil products, PCB, PAH, AOX etc.). In this region there is a dense network of roads and railways, dense network of oil pipelines. Water quality is also threatened by recent operation of uranium industry, by oil and lignite mining and by operation in the nuclear power plant Dukovany. This all contributes to requirement of updated monitoring, information and warning systems and forecasting means for water quality management.

In two next tables are demonstrated main industrial problems in the Morava River basin (and mostly in other basins in the Czech Republic) as far as the water pollution issues is concerned - by means of simple schematic expressions:

**Table 12 Main pollution impacts referring to industries and some other activities**

| Industry or activities | main pollution impacts |
|---|---|
| Food-stuff industry | COD, BOD |
| Ore-working industry (mining and ore preparation) | COD, HM |
| Iron industry | SS, COD, HM (Fe) |
| Metallurgical industry | SS, HM |
| Machine industry, surface treatment of metals | SS, COD, $F^-$, $NO_2$, $SO_4$, HM |
| Coal mining | COD, SS, phenols, $NH_4$, HM |
| Chemical industry | SS, COD, BOD, DS, HM |
| Dyes and paint industry (paints, varnishes, pigments) | SS, BOD, COD, HM |
| Paper and pulp industry | BOD, SS,, COD, HM |
| Tanning industry | BOD, COD, HM (Cr), $SO_4$ |
| Timber and wood-working industry | SS, BOD, HM |
| Ceramic industry | SS, HM |
| Boot-and-shoe industry | SS |

| | |
|---|---|
| Textile industry | SS, , COD, BOD |
| Clothing industry | SS |
| Printing industry | SS, DS, HM |
| Electrical industry | HM |
| Combustion of coal | Thermal pollution, HM |
| Combustion of fuel oil | Thermal pollution, HM |
| Nuclear power plants | Thermal pollution, HM (U) |
| Production and application of pesticides | SS, DS, HM |
| Production and application of synthetic fertilizers | SS, DS, $NO_3$, $P_{Tot}$, HM |
| Metal structure corrosion (including conduits) | HM |
| Transport (mainly road transport) | HM |

*Notes:*

| | |
|---|---|
| *BOD* | *biochemical oxygen demand* |
| *COD* | *chemical oxygen demand (chromium)* |
| *SS* | *suspended solids, undissolved substances* |
| *DS* | *dissolved solids, dissolved substances* |
| *HM* | *heavy metals* |
| | *other marks .... according to chemical formula* |

Occurrence of metals and their compounds in waters of the Morava River basin depends on many circumstances and it is currently characterized by the diagram as follows:

### Table 13 Occurrence of heavy metals (originating from industry) in surface waters

| Industry or activities | occurrence of metals and their compounds |
|---|---|
| Food-stuff industry | Al, Sn |
| Ore-working industry (mining and ore preparation) | Fe, Zn, Hg, As, Se, Mn, Cu, Sb, U |
| Iron industry | Fe, Ni, Cr, Mn |
| Metallurgical industry | Al, Cr, Mo, Ni, Pb, V, Cu, Sn, Sb, Hg |
| Coal mining | Fe, Al, Mn, Ni, Cu, Zn |
| Machine industry, surface treatment of metals | Cr, Cu, Ni, Zn, Cd, Fe, Al, Sn |
| Chemical industry | Fe, Al, W, Mo, Zn, Pb, Cu, Hg |
| Dyes and paint industry (paints, varnishes, pigments) | Hg, Cr, Pb, Zn, Ti, Al, Ba, Sr, Mn, As, Se |
| Paper and pulp industry | Ti, Zn, Al, Ba, Sr, Cr, Se, Cu, Hg |
| Tanning industry | Cr, Al , Fe |
| Timber and wood-working industry | Hg, |
| Ceramic industry | Hg, Cd |
| Boot-and-shoe industry | |
| Textile industry | Cu, Zn, Cr, Pb, Fe, Sn |
| Clothing industry | |
| Printing industry | Zn, Cr, Ni, Cd, Cu, Pb |
| Electrical industry | Ag, Se, Ge, Mn, Ni, Pb, Cu, Hg |
| Combustion of coal | As, Ti, Al, Ge, Se, Hg, Be, Zn, Mo, Ni, Pb, Sb |
| Combustion of fuel oil | V, Ni, Zn, Cu |
| Nuclear power plants | U |
| Production and application of pesticides | Hg, As, Cu, Zn, Ba, Tl |
| Production and application of synthetic fertilizers | Cd, Mn, As, Cr |
| Metal structure corrosion (including conduits) | Fe, Pb, Cu, Ni, Zn, Cr |
| Transport (mainly road transport) | Pb, V, Ni. Fe |

There are two key industrial hot spots at the time mostly connecting with existing two industrial enterprises:

- **Intensification of WWTP Kozeluzny Otrokovice** (the owner is "Cistirna odpadnich vod kozeluzny, a.s."; in English "Wastewater treatment plant of tannery") ... (approximately 50 km to border with Slovakia, 85 km to boundary with Austria),
- **Remedying measures for removal of previous environmental damages in area of company Fosfa Postorna a.s.** ... (approximately 5 km to border with Austria, 20 km to boundary with Slovakia)

The present water quality indicators 1996 - 1997 in the Morava River downstream **Otrokovice** and **WWTP Kozeluzny Otrokovice** are as follows:

| | | | |
|---|---|---|---|
| $BOD_5$ | class 3 | AMV ... 4.4 mg/l | ChV ... 6.4 mg/l |
| $COD_{Cr}$ | class 3 | AMV ... 22.4 mg/l | ChV ... 30.4 mg/l |
| TSS | class 5 | AMV ... 49 mg/l | ChV ... 115 mg/l |
| $N\text{-}NH_4$ | class 4 | AMV ... 0.91 mg/l | ChV ... 2.36 mg/l |
| $P_{Tot}$ | class 4 | AMV ... 0.34 mg/l | ChV ... 0.59 mg/l |

(Note: AMV ... two years mean value 01.01.1996 - 31.12.1997, ChV ... characteristic value in the same time)

Expected outflow concentration from WWTP Kozeluzny Otrokovice (for the final phase):

| | |
|---|---|
| $BOD_5$ | 15 mg/l |
| $COD_{Cr}$ | 75 mg/l |
| TSS | 20 mg/l |
| $N_{Tot}$ | 5 mg/l |
| $P_{Tot}$ | 1 mg/l |

The present water quality indicators 1996 - 1997 in the Dyje River downstream **Breclav and Fosfa Postorna** are as follows:

| | | | |
|---|---|---|---|
| $BOD_5$ | class 3 | AMV ... 5.6 mg/l | ChV ... 9.6 mg/l |
| $COD_{Cr}$ | class 4 | AMV ... 36.1 mg/l | ChV ... 41.9 mg/l |
| TSS | class 2 | AMV ... 19 mg/l | ChV ... 33 mg/l |
| $N\text{-}NH_4$ | class 3 | AMV ... 0.47 mg/l | ChV ... 1.29 mg/l |
| $P_{Tot}$ | class 4 | AMV ... 0.41 mg/l | ChV ... 0.62 mg/l |

(Note: AMV ... two years mean value 01.01.1996 - 31.12.1997, ChV ... characteristic value in the same time)

Expected WWTP (industrial plant for Fosfa Postorna) outflow concentration (for the final phase):

| | |
|---|---|
| $BOD_5$ | 15 mg/l |
| $COD_{Cr}$ | 75 mg/l |
| TSS | 20 mg/l |
| $N_{Tot}$ | 5 mg/l |
| $P_{Tot}$ | 1 mg/l |

Among industrial hot spots have been further included:

- HAME Babice (Morava River, food-stuff industry, 1st stage of WWTP reconstruction finished not long ago, other projects are not prepared),
- Snaha Brtnice (Brtnice R., then Jihlava R. and then Dyje R., tannery, WWTP project partly prepared),
- Tanex Vladislav (Jihlava R., then Dyje R., tannery, at the beginning of preparedness).

The predominant problem for surface waters in the Morava River basin is the presence of ***nutrients*** (e.g. of nitrogen and phosphorus compounds) that are transportable over long distances and they cause the eutrophication. Very abundant is also the occurrence of ***organic pollutants*** - both biodegradable and chemically degradable ones. Some stream reaches are also polluted by priority pollutants including ***heavy metals***; recently had very significant position mercury here, but origin of it was not exactly explained. On the other hand the existing mercury concentration is mostly lower than previously. Very important is also the pollution by zinc in some watercourses, especially downstream larger municipalities.

Reduction of point sources of hazardous discharges is the main task of district authorities and of all stakeholders including industrial polluters, including special industry where the sewages have severe impact on water quality. A lot of these problems have been already solved with the aid of adequately arranged wastewater treatment plants, but there are some industrial hot spots, which remain to immediate tasks. The most important hot spots were involved in the submitted text.

Pollution by oil and grease is not connected in the Morava River basin with spills from shipping (bilge oil), with existence of harbor facilities for treatment of bilge oil. There is only small navigation in the region in question: on backwaters of the Brno Storage Reservoir, on the "Bata Canal" (near the Morava River) and recreation activities on two smaller reservoirs (motor boats). However, the navigation operation on mentioned water bodies is well controlled as far as the water quality is concerned. Essentially greater problems have been coherent with oil and grease transport - by means of road traffic (lorries etc.) or through oil pipelines. Some critical situation or crashes are relevant to leakages and leaches of oil or grease. Very important is the main oil-pipeline among Bratislava (Slovakia) - crossing over the Morava River (between the confluence with the Dyje River and Hodonin) - upstream Brno (crossing over the Svratka River) - near Velka Bites (crossing over the Bityska River) - near Velke Mezirici (crossing the Oslava River) - in the north of Jihlava. Some "small" leakages have originate from old and many new petrol pumps along roads, but all stations must be equipped by grease traps of suitable quality.

Reducing hydrocarbon pollution of the water in the Morava River basin is mostly the part of sewage treatment technologies systems, mainly in industrial and service complexes. All these activities have been controlled by Czech Environment Inspection, by district, municipal and hygienic authorities.

Between pages is interposed the list with industrial hot spots (table 14.)

## 3.4. Reduction of Water Pollution from Dump Sites

Special attention must be paid to solid waste management connected with leakages or leaches from dumpsites or landfills. The primary objective of measures on dumpsites and other similar localities is the remediation of previous damage, which poses acute hazards for human health and the environment. Main part of the remediation costs has been provided by commitments of the ***National Property Fund***, however, in many cases the responsibility has been very problematic. In addition to it there have been many hidden places comprising decomposed, toxic and dangerous substances in solid, liquid or gaseous phase. A lot of dump sites have not been more precisely identified hitherto. These places are often covered by earthy material.

In the course of the solution of the 'Project of the Morava River Basin" were many dump site localities simply identified. The inventory made by company Aquatis a.s. (from Brno) comprises about 1,000 places of these specific polluters of water bodies. Dump sites and their wastes were divided into 10 groups: sites with municipal wastes, industrial wastes, agricultural wastes, mixed wastes, wastes from building, wastes from wood-working industry, water treatment sludge, dangerous wastes, special wastes, other wastes. Volumes of dumpsites were quantified and the rate of dangerous impacts was preliminarily estimated. The reconnaissance and investigations of dumpsites have not been finished and there are many companies engaged in these tasks: GEOtest a.s. Brno, Bijo a.s. etc. The largest municipal dumpsites are near Brno (Cernovice... 15-20 million $m^3$) and Grygov (for city of Olomouc ... appr. 5 million $m^3$). Special attention must be always paid to former military activities in areas Libava (east from Olomouc), between Vyskov and Prostejov (in the Drahany Uplands), Sumperk, Stity and Bila Voda (in the northern part of the Morava River basin). The pollution sources were evaluated according to substances, to impacts on surface waters and groundwaters, on protected areas and zones of water resources, further to volumes and surface extent. Main threatened regions are as follows: floodplain-areas of the Morava River between Olomouc and confluences with the Becva River and Drevnice River, of the Svratka River between Brno and the confluence with the Jihlava River, of the Becva River between Valasske Mezirici and the mouth into the Morava River.

The "priority" dumpsites are according to hydrologic order as follows:

- Olsany (municipal and industrial waste, alluvium of the Morava River),
- Bila Voda (military wastes, discharge into the Brezna R.),
- Stity (military wastes, discharge into the Brezna R.),
- Prerov - Zeravice (municipal waste, sludge, alluvium of the Becva R.),
- Prerov - Henclov (chlorinated hydrocarbons, sludge of gypsum, ash etc. - from chemical factory Precheza Prerov and from the power and heating plant Teplarna Prerov; alluvium of the Becva R. and Morava R., groundwater resource Troubky),
- Holesov (municipal waste, water resource, near the Rusava R.),
- Hulin (municipal and industrial waste, alluvium of the Morava R.),
- Otrokovice (industrial waste from tannery Kozeluzny, alluvium of the Morava R.),
- Napajedla (municipal waste, alluvium of the Morava R., near of groundwater resource Knezpole),
- Spytihnev (municipal waste and oil pollution, alluvium of the Morava R., near the groundwater resource Knezpole),
- Stare Mesto (paints, sludge from WWTP, alluvium of the Morava R., near groundwater resources Ostrozska Nova Ves),
- Hluk (metallurgical sludge, water resource - near the Morava R.),
- Bzenec (municipal and dangerous waste in alluvium, near the Syrovinka Brook and then Morava R.),
- Svitavy (municipal waste, in headwaters of the Svitava River, near groundwater resource Brezova - for Brno which is the largest municipality in the Morava River basin),
- Horni Stepanov (municipal waste, near drinking water resource on the Bela R. which is the tributary of the Svitava R.),
- Uhrinovice (chemical waste, discharge into small brook and then Brtnice R.),
- Brtnice (chromium, discharge into the Brtnice R., then Jihlava R.),
- Nemcice (municipal waste, water resource, near Ivancice and Jihlava R.),
- Postorna (phosphate waste from Fosfa, alluvium of the Dyje R., near the border with Austria).

At present time attention to some other dangerous dump sites must be paid, above all in Pozdatky (hard-by Vladislav and near the district town Trebic), not far from the Jihlava River (leakages of sulphuric acid from the green vitriol).

Problems of dumpsites have been solved in different ways. Among priority hot spots of this material was chosen only one locality - above mentioned Fosfa Postorna. However, other old dump sites, e.g. of Colorlak Stare Mesto, of Precheza Prerov (both are mentioned in the Strategic Action Plan - they are in the phase of remedial works step by step), of Pozdatky, and minimum 30 - 50 localities wait for the best water quality solution and some of them have been always without projects, without proposals of rehabilitation or remedying works.

Rehabilitation of active and inactive waste dump sites of municipal, industrial and other solid or liquid waste is one of the most important task of the Czech Republic, in the Morava River basin.

## 3.5. Special Policy Measures

Special policy measures towards water pollution reduction have been at the development phase. It also refers to needful changes and improvement of legislation, to completing technical regulations for pollution reduction and water management. Some changes will have to focus especially on nutrient challenges. The similar situation concerns the creation of taxes - as steering tools to reduce emissions of nutrients in surface waters and groundwaters, e.g. taxes on mineral fertilizers, taxes stimulated the elimination of phosphate containing detergents in washing powder, adequate taxes on withdrawal of fresh water from surface water and groundwater resources, adequate charges concerning the wastewater discharges etc.

Similar tools must be probably used towards higher degree of sustainability in agriculture and forestry, towards organic farming, towards real ownership relations.

Among specific measures belongs the *rehabilitation of natural hydrological network* and of *wetlands*. The main task is rehabilitation of river floodplains, of floodplain forests and meadows - mainly in southern part of the Morava River basin, in lowlands near the confluences of Morava, Dyje, Svratka and Jihlava rivers. Some projects have been prepared here, especially with possible cooperation among Austria, Slovakia and Czech Republic on international and transboundary "*Trilateral Park*". There have been also prepared some "smaller" projects concerning the "Litovelske Pomoravi" (in English "Morava River Floodplains near Litovel") and the meander restoration in headwater floodplains etc.

# 4. Expected Effects of Current and Planned Projects and Policy Measures

Municipal and industrial point sources and agricultural non-point sources of pollution are responsible for a significant proportion of pollution discharged to watercourses and that is why it main attention must be paid to adequate solution of connected challenges. These problems initiated five or more years ago new approaches to wastewater, to need of their effective treatment, to water law and its amendments, to closer cooperation with downstream countries, to water protection and management. These changes along others lead to many new studies and projects, especially with regard to municipal and industrial water pollution issues. Above all after 1989 appeared many documents aimed at wastewater treatment, first as strategic bases or studies and then as concretized projects in detail - relevant to factual situation in rivers, basins, municipalities and industrial establishments in the Morava River basin.

In 1991 started the "Project of the Morava River Basin" which has been supported by Czech Ministry of Environment. Very great part played also international activities resulting from the Environmental Programme for the Danube River basin, from the "Convention on the Cooperation for Protection and Sustainable Use of the Danube", from the Strategic Action Plan 1995 - 2005 and other connected strategic materials or studies. The year 1990 was the beginning of new stage of environmental projects detail. It was the beginning of new water and environment policy dealing mainly with wide applying of remedying measures to improve essentially and generally natural, social, economic, cultural and hygienic conditions in all spheres of human life.

In carrying out mentioned "Project of the Morava River Basin" an examination of 50 municipal sources of pollution was conducted in terms of key water quality parameters $BOD_5$, $COD_{Cr}$, undissolved and dissolved compounds of nitrogen, dissolved oxygen, dissolved solids, suspended solids, metals as Fe, Mn, Hg, Cd, Pb, Zn etc. The examination of industrial and agricultural sources of pollution was focused on key mentioned localities or regions, which have caused the water contamination in the Morava River basin. According to the draft of national Action Plan of the Czech Republic (1996) and to part C "Water Quality" have been six key hot spots in the Morava River basin chosen and for these "priorities" have been prepared upgraded projects dealing with proposals of water pollution reduction downstream given "hot spots":

- municipal WWTP Brno (with discharge into the Svratka River),
- municipal WWTP Zlin-Malenovice (with discharge into the Drevnice River),
- municipal WWTP Uherske Hradiste (with discharge into the Morava River),
- municipal WWTP Hodonin (with discharge into the Morava River),
- industrial WWTP Kozeluzny Otrokovice (combined effect together with town of Otrokovice, discharge to the Morava River),
- remedial measures in the industrial area of Fosfa Postorna (combined effect of WWTP and measures round the dump site of factory, with discharge to the Dyje River)
- remedial measures and reduction of slurry production in the pig farm Gigant Dubnany (combined effect of lagoon and soil rehabilitation and of modernization).

From 1991 to 1998 were constructed, equipped and completed to operating phase wastewater treatment plants for municipalities with more than 5,000 inhabitants as follows:

- ➢ Holesov (discharge into the Rusava River and then Morava River),
- ➢ Hulin (discharge into the Rusava River and then Morava River),
- ➢ Bzenec (discharge into the Syrovinka Brook and then Morava River),
- ➢ Policka (discharge into the Bily potok Brook and then Svratka River),
- ➢ Kojetin (discharge into the Morava River),

- Hustopece (discharge into the Stinkovka Brook and Dyje River in area of Nove Mlyny Reservoirs)
- Uhersky Brod (discharge into the Oslava River),
- Litovel (discharge into the Morava River),
- Ivancice (discharge into the Jihlava River),
- Moravske Budejovice (discharge into the Rokytka Brook and then Rokytna River),
- Velke Mezirici (discharge into the Oslava River),
- Nove Mesto na Morave (discharge into the Bobruvka River),
- Lanskroun (discharge into the Moravska Sazava River),
- Kyjov (discharge into the Kyjovka River),
- Moravska Trebova (discharge into the Trebuvka River),
- Bystrice pod Hostynem (discharge into the Bystricka Brook and then Mostenka River),
- Bucovice (discharge into the Litava River)
- Dacice (discharge into the Moravska Dyje River)
- Napajedla (discharge into the Morava River).

At issue are expected effects of current and planned projects and policy measures to reduce significantly emissions and water pollution in watercourses till years 2004/2005. All implemented and planned measures would contribute to meet the limits by Czech Government Decree No. 171/1992 ($BOD_5$, $COD_{Cr}$, suspended solids, ammonia $N\text{-}NH_4$, phosphorus total $P_{Tot}$) and limits according to European standards. Only five municipalities between 5,000 and 10,000 inhabitants have no sewage treatment plant: Kunovice (with discharge into the Oslava River and then Morava River), Telc (half-built plant, with discharge into the Telcsky potok - Brook and then the Moravska Dyje River), Letovice (half-built, discharge into the Svitava River), Trest (discharge into the Trestsky potok - Brook and then Jihlava River), Moravsky Krumlov (half-built, discharge into the Rokytna River and then Jihlava River) and two municipalities Mutenice - Dubnany (half-built, discharge into the Kyjovka River).

On the other hand there are some projects whose implementation has started a short time ago or which have been prepared and which are dealing with water quality problems in larger towns - in mentioned municipalities Prerov, Prostejov, Znojmo, Breclav, Jihlava, Trebic, Kromeriz, Valasske Mezirici, Svitavy. However, some other WWTPs will have to be reconstructed in the course of next years: in Olomouc, Sumperk, Vsetin, Blansko, Vyskov and maybe in some other towns, too. Very large problems have been coherent with a lot of sewerage systems, which are often obsolete and not leak-proof. Main effort concerning these challenges would be awaited from municipalities and their budgets.

It is sure that all measures in question together with necessary policy means have contributed and will contribute to environmental improvement of water bodies. It would refer to reduction of nutrient emissions, to decreasing concentrations of hazardous substances, to mitigation of microbiological load in surface waters and groundwaters.

**Table 14    Summary of recommended projects for industrial hot spots**

| Hot Spot Name<br>River - *Location* | Parameters which Define the Problem | Ranking of the Problem | Name - Type of Project (Structural or Non-structural) | Project Strategy - Targets | Parameters - Values which Define Project Benefits | Project Beneficiaries |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **FOSFA a.s. Postorna**<br>Dyje - *Breclav* | mainly $P_{Tot}$ | 1/$P_{Tot}$, COD | Structural | 1 stage→ 2004 | WQ all 2005 | TI, EC, WM, FO, FI |
| **WWTP Kozeluzny Otrokovice s.r.o.**<br>Morava - *Otrokovice* | BOD, COD, N, Cr | 2/Cr, COD | Structural | 1 - 2 stages→ 2004 | WQ all 2005 | WM (WR), EC, FI, A, IN, R, FO, TI |
| HAME a.s.<br>Morava - *Babice* | BOD, $NH_4$ | 3/BOD, $NH_4$ | Structural | maybe 1 stage→ 2004 | WQ all 2005 | WM (WR), EC, A, FI, IN, R, FO |
| Tanex Vladislav a.s. -<br>Jihlava R. - *Vladislav* | BOD, COD | 4/BOD, COD | Structural | maybe 1 stage→ 2004 | WQ all 2005 | WM, EC, A, FI, IN, R, |
| Snaha Brtnice a.s. -<br>Brtnicka R. - *Brtnice* | BOD, COD | 5/BOD, COD | Structural | maybe 1 stage→ 2004 | WQ all 2005 | WM (WR potential), EC, FI, A, IN, R |

*Notes:*

- *ranking ... number conforming with significance of pollution, then the order according to pollutants*
- *WQ all 2005 ... all parameters according Czech Governmental Decree No. 171/1992 after 1.1.2005*
- *WM ... water management and water protection, WR ... near downstream water resources, IN ... industry (abstractions for industry downstream the profile), A ... agriculture, FO ... forestry (improvement of conditions in forested areas), FI ... fishery, EC ... improvement of environmental and ecological conditions, R ... water recreation, TI ... transboundary impacts; order conforming with the meaning*
- *column of Project Strategy - Targets: 1 stage→ 2004 or 2 stages→ 2004 or ..... → 2004 ... number of project stages towards 31.12.2004*

## 4.1. Reduction of Nutrient Emissions

Expected impacts of programmes and projects on reduction of nutrient emission - above all nitrogen and phosphorus) correspond to past environmental damages and to real or prepared remedial measures. Problems of most point-sources have been solved step by step - less slowly than rapidly - and not every time effectively. Mainly the removal of phosphates and phosphorus has not been sufficient and many issues refer to the nitrogen, to nitrites, nitrates, to ammonia and to organic nitrogen, too. Essential effort in the Czech Republic was focused on the improvement of other water quality parameters, especially on BOD, COD, dissolved oxygen, dissolved and suspended solids, acidity, alkalinity, some physical, chemical, biological and microbiological parameters (temperature, electrical conductivity, turbidity, ions related to salts, saprobic parameters, coliforms, fecal coliforms etc.). However, also the problems of nutrients, heavy metals and other priority pollutants had to be highlighted and it put the accent on requirement of their necessary reduction from waters; this tendency started in the course of recent two - three years.

The expected amount of nutrient reduction expected from each current or planned project has been quantified in detail, but all results will have to comply with limits or modified limits of Czech Governmental Decree No. 171/1992.

After implementation of projects referring to six point sources and key hot spots at once could be achieved nutrients parameters after 1.1. 2005 as follows (mg/l):

**Table 15 Awaited nutrient parameters by key hot spots after 01.01.2005**

| project relative to hot spot | parameters | |
|---|---|---|
| | $NH_4$ | $P_{Tot}$ |
| WWTP Brno | 5.0 | 1.0 |
| WWTP Zlin | 5.0 | 1.5 |
| WWTP Uherske Hradiste | 10.0 | 3.0 |
| WWTP Hodonin | 10.0 | 3.0 |
| Industrial WWTP Kozeluzny Otrokovice | 10.0 | 3.0 |
| Remedial works of Fosfa Postorna | 11.0 * | 0.4 * |
| Remedial measures of Gigant Dubnany | 11.0 ** | 0.4 ** |

*Note:*

*Almost all values correspond to discharges from WWTPs excluding Fosfa Postorna.*

* *Parameters of "Fosfa Postorna" are relative to the receiving Dyje River. Remedial works of Fosfa Postorna concern four special measures: industrial WWTP (with daily discharge into the river Q = 5.5 l/s, daily discharge of N-$NH_4$ = 1.45 kg, daily discharge of $P_{Tot}$ = 138 kg), hydraulic screen (with Q = 5.0 l/s, N-$NH_4$ = 4.01 kg/d, $P_{Tot}$ = 449 kg/d), flow of groundwaters under setting pits (Q = 4.3 l/s, N-$NH_4$ = 0.81 kg/d, $P_{Tot}$ = 178 kg/d), flow of groundwaters under building zone of company (Q = 7.5 l/s, N-$NH_4$ = 2.05 kg/d, $P_{Tot}$ = 29 kg/d). In total it represents values as follows: daily discharge into the river Q = 22.3 l/s, daily discharge of N-$NH_4$ = 8.33 kg (i.e. 4.3 mg/l ... it is good), daily discharge of $P_{Tot}$ = 792 kg (i.e. 412 mg/l ... it is very unfavorable).*

** *Parameters of "Gigant Dubnany" are relative to receiving Kyjovka River.*

However, the present efficiency of existing WWTPs and other measures to remedy with respect to discharged concentration of N-$NH_4$ and $P_{Tot}$ is mostly very low (according to data from 1995 - 1996):

**Table 16 Present purification effectiveness by key hot spots**

| WWTP | Purification effectiveness (%) | |
|---|---|---|
| | $N\text{-}NH_4$ | $P_{Tot}$ |
| Brno | 40 - 55 | 45 - 50 |
| Zlin | 10 - 20 | 30 - 45 |
| Uherske Hradiste | appr. 10 | appr. 50 - 60 |
| Hodonin | 50 - 65 | 30 - 45 |
| Olomouc | 85 - 90 | 25 - 40 |
| Prerov | 10 - 15 | appr. 50 |
| Prostejov | 20 - 40 | appr. 80 - 85 |
| Znojmo | 20 - 25 | 25 - 35 |
| Kromeriz | 10 - 15 | 35 - 55 |
| Kozeluzny Otrokovice | 30 - 35 | ... |
| Fosfa Postorna *** | ... | 90 - 95 |

*Note:*
*** *without other measures*

Other information referring to nutrients are included in chapters relating to municipal, agricultural and industrial hot spots. It is evident that the situation 2004/2005 would be almost *twice better* than now - on the presumption that all-important hot spots will be eliminated to the mentioned time.

It must be said that the reduction of nutrient emissions will depend on other necessary measures with a view to

- measures relating to non-point sources in agriculture and forestry in all region (measures against water erosion, implementation of organic farming, sustainable use of fertilizers, manure, slurry, dung-water, straw, pesticides, products of silage, restoration of small watercourses, meanders, meadows, forests, groves, floodplains and wetlands),
- economic and tax measures to reduce a use of washing powders with phosphate, of artificial fertilizers,
- educative and training activities relative to mentioned measures and to healthy nourishment, to consumption of albumen and substances containing nitrates and nitrites.

Quantifying of these effects is very complicated.

## 4.2. Hazardous Substances

Likewise the partially favorable impact of minimization of contamination of hazardous substances - with regard to heavy metals, persistent substances etc. has been from the year 1989 to 1997 evident. The situation is rather complicated by short-term sampling and monitoring of these substances. A regular monitoring started in the main three - four years ago and that is why there is few verified data concerning heavy metals, PAH, PCB, AOX, volatile halogenated hydrocarbons, organochloro-pesticides, chlorinated phenols and so forth.

Main sources of metals in water bodies of the Morava River basin are:

- localities of ore mining and ore treatment (mostly from the past - in the western and northern part of the Morava River basin),
- electricity supply and heating - thermal power plants (the most important is in Hodonin), power and heating plants, local heating (fly ash, leaches, scouring),
- metallurgical production of alloys and thermal treatment of metals (Olomouc, Prostejov, Veseli nad Moravou etc.),

- mechanical engineering (Brno, Prerov, Prostejov, Olomouc, Hlubocky, Jihlava, Trebic, Zlin, Sumperk, Unicov, Vsetin, Hranice, Kromeriz, Uherske Hradiste, Uhersky Brod, Hodonin, Breclav, Svitavy, Moravska Trebova, Boskovice, Blansko, Adamov, Kurim, Vyskov, Velke Mezirici, Dacice etc.),
- chemical production (paints, pigments, dilution of metals in acids - Brno, Valasske Mezirici, Zlin, Prerov etc.),
- electrical industry (Lanskroun, Roznov pod Radhostem, Vsetin, Valasske Mezirici, Kromeriz, Brno, Znojmo),
- paper and pulp industry (Lukavice - mercury),
- tanneries (Kozeluzny Otrokovice - chromium),
- transport (mainly on roads),
- agricultural means (fertilizers, special pesticides, feed-stuffs, former also seed dressing),
- practical use of coloring matters, paints, pigments, impregnation, soaking, tingeing and staining means,
- waste treatment (also from sewage treatment plants),
- laboratories, photograph services, printing and copy technique or services,
- medicine and so forth,
- air imissions and depositions from other regions (mainly from power plants).

All industrial, agricultural and service polluters must solve their problems with heavy metals, but a lot of “small” problems wait for future solution. Main issues in the region have been connected with zinc, mercury, iron, nickel, chromium and lead.

Likewise the pesticides belong to very important pollutants in the Morava River basin. Ten years ago there were approved 374 pesticides in the Czech Republic: about 40% of this amount pertained to herbicides, 25% to fungicides and 20% to insecticides. In the Morava River basin was applied about 4,000 - 5,000 t of pesticide substances in current year and about 15 - 35% of this amount could affect almost all water bodies and their quality in the Morava River Catchment, i.e. from 600 to 1,750 t pesticides were transferred into to water environment in current year. Lots of pesticides have been very persistent and have remained in soil, sediments, plants and animals. There have rested some residua of formerly used DDT or HCH there. Using of both chlorinated hydrocarbons in the Czech Republic was forbidden in 1974. Above all the DDT was used excessively - minimum about 30 - 35 years and consequently have remain smaller or greater residua in soil, sediments and water bodies.

Insecticides used in the Czech Republic and in the Morava River are chemically stable substances and they contain either chlorinated hydrocarbons or organic phosphates or carbamates, with hydrogen cyanide, sulphite oxid, dimethyldichlorovinylphosphate and other compounds of phosphorus, eventually of barium, fluor or thallium. Within this group are involved lindane, toxaphen, hexachlocyklohexan, fluor agents and mentioned DDT. “Czech” herbicides contain often very toxic matters, derivatives of phenols, phenoxy-aliphatic acids, triazines, amides, atrazines, carbamates or urea. Fungicides are formed by substances containing heavy metals (copper or mercury) or by hydrocarbons with sulphur. However, there have been other groups of pesticides used in the region of interest: rodenticides (against rodents and rats), acaricides (against mites, in paticular against ticks characterized by outbreak mass in the Morava River basin), nematicides (against plant-parasitic nematodes), repellents (for the purpose of animals repelling), algaecides (against algae in surface waters), bactericides (agents destroying bacteria), viricides (agents destroying viruses), plant-growth regulators, desiccants (drying agents oriented on plant roots), defoliants (chemical sprays those cause leaves to fall prematurely), agents for seed dressing (in the past, they often contain mercury e.g. the Czech product Agronal), pheromones (for baiting of forest insects in pheromone-baited traps), agents for staining of timber (containing fungicides - for instance pentachlorophenol - and insecticides mainly lindane).

Very dangerous are pesticides soluble in water and able to wash out and leach from a soil. Among them pertain toxic herbicides (paraquat), herbicides with phenoxy-acids, amides, then rodenticides, “flutriafol” (fungicide), residua of some “past” insecticides, acaricides etc.

The largest risk referring to water resources represent triazines, substituted urea, carbamates and chlorinated fatty acids (e.g. methylchloro - phenoxyacetic acid MCPA). From other pesticides were also used agents TCA (trichloroacetate), chloro - mequat, oxychloride Cu, chlorotoluron, atrazine, terbutryne. Especially lowland areas of “Dolnomoravsky uval” (Vale of Lower Morava River) and partially of “Hornomoravsky uval” (Vale of Upper Morava River) were in the past very loaded by pesticides. In the Morava River basin was in the year 1993 applied 60 - 114 kg “efficacious” pesticides on the surface 1 $km^2$, i.e. appr. 1,250 - 2,400 tons in all region. Very important are erosion and flood influences, e.g. by floods and flooding was the increased occurrence of terbutryne and atrazine found out.

In Czech “zones of hygienic protection” of surface waters and groundwaters is the use of round 90 herbicides forbidden. Number of used pesticides rose in the Czech Republic all the time till 1990, however the crucial “accrual tendency” was practically finished already 10 - 15 years ago. Likewise the pesticide consumption rose in the region of interest from the year to year and the consumption increased in the course of twenty years between 1970 - 1990 approximately 15 - 25 times. In the year 1991 there were registered round 650 pesticide agents in the Czech Republic and essential decreasing of this number has not been achieved hitherto. On the other hand the tendency is not unfavorable - according to decreasing total consumption, to increasing number of ecological farmers and biological agents. Large problems will remain in sectors of really non-privatized agriculture and forestry.

Very significant attention must be also paid to oil products other harmful organic matters occurring in water bodies in the Morava River basin. Some of these substances are toxic. The most priority pollutants are organic, only 15 are inorganic (mentioned heavy metals). Organic priority polluters have been represented here particularly by halogenated aliphatic compounds (trichloromethan etc.), polycyclic aromatic hydrocarbons PAH (benzoapyrene, fluoranthane), benzenes, halogenated benzenes, halogenated phenols, polychlorinated biphenyls (Delor 103, Delor 106), halogenated ethers, dinitrotoluenes, nitrophenols, nitrocresols, nitrosoamines, phthalates, cyanides, phenols, adsorbable organic halogens AOX and mentioned pesticides containing chlorine (residua of DDT, lindanes etc.). A lot of these substances are typical by teratogen, carcinogen and partially by mutagen effects. In the next table are limits of some organic pollutants according to different regulations and standards:

**Table 17 Czech and European water quality standards for surface waters - some hazardous substances**

| Parameter | unit | 171dw | 171nd | EU-$A_1$ | EU-$A_2$ | EU-$A_3$ | w.t. -A | w.t. -B | w.t. -C | s. w. | i.. w. | dr. w. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | mg/l | 0,01 | 0,05 | | | | | | | | | |
| Chlorotbenzene | mg/l | 0,003 | 0,01 | | | | | | | | | |
| Dichlorobenzenes | mg/l | 0,0003 | 0,001 | | | | | | | | | |
| PCB | ng/l | ULPD | 25 | | | | | | | | 50 | |
| Benzoapyrene | ng/l | 10 | 50 | | | | | | | | | |
| Fluoranthene | mg/l | | | | | | | | | | | 0,04 |
| Chloroform | mg/l | | | | | | | | | | | 0,03 |
| Phenols | mg/l | 0,02 | 0,1 | 0,001 | 0,005 | 0,1 | 0,001 | 0,003 | 0,1 | 0,02 | 0,2 | 0,05 |
| Organic bound Halogens | mg/l | | | | | | 0,005 | 0,005 | 0,01 | | | |
| Cyanides | mg/l | ULPD | 0,2 | 0,05 | 0,05 | 0,05 | 0,01 | 0,01, | 0,05 | 0,2 | 0,4 | 0,01 |
| Pesticides | mg/l | | | 0,001 | 0,0025 | 0,005 | | | | | | |

*171dw .... Czech Governmental Decree No. 171/1992 for watercourses chosen for drinking water supply, 171nd .... Czech Governmental Decree No. 171/1992 for other waster bodies, EU-$A_1$ ... limits of the European Union for category $A_1$, EU-$A_2$... limits of the European Union for category $A_2$, EU-$A_3$... limits of the European Union for category $A_3$, w.t.-A ... Czech standard CSN 75 7214 for water treatibility, category A, w.t.-B ... Czech standard CSN 75 7214 for water treatibility, category B, w.t.-C ... Czech standard CSN 75 7214 for water treatibility, category C, s.w. ... according to the Czech standard CSN 75 7221 for 3rd. category of surface water classification, i.w.. ... according to the Czech standard CSN 75 7143 water suitable for irrigation, dr.w. ... according to the Czech standard CSN 75 7111 - maximum limited value for drinking water supply, ULPD ... under the limit of possible determination.*

About 10 - 15% of oil contamination in watercourses of the Danube River basin has originated in the transport of oil products by lorries, trains and in particular by shipping. However, just the last-named possible polluter is not typical for the Morava River basin. Another important sources of oil pollution in the Danube River basin are given by places or regions with oil exploitation, oil production and activities in petroleum refineries. These anthropogenic works have been connected only with the environs of Hodonin, with floodplains and vale adjacent to downstream parts of the Morava River and the Kyjovka River before the confluences with the Dyje River. Some assumed oil sources - but not used at the present time - are situated near Kromeriz, near the middle reach of the Morava River. In its basin must be further highlighted other sources of oil pollution: petrol stations and their tanks, grease traps, stores of oils, oil products, greases and petrol, oil pipelines or oil product pipelines and their valves, outlets and fixtures, then cleaning shops, washing stations and equipment, workshops, repair-shops, garages, bus depots, lorry depots, car-parks, bus stops, taxi ranks, road systems of lay-by etc. Very significant rate of oil pollution have been shaped by lack of facilities to receive oil wastes, by pipeline or tank joints not being tight, by leakages etc, i.e. by unintentional or wilful oil accidents, by bad maintenance of constructions, equipment and devices, by ongoing though sporadic factor of existing negligence and insufficient responsibility. This approach has resulted sometimes and somewhere in direct soil or water pollution.

These sources are not simply identified and they are either non-point or scattered on numberless places and areas within the Morava River basin. Some water quality parameters in question have been by authorities prescribed here with respect to limits according to Czech Governmental Decree No. 171/1992 (only for watercourses, not for WWTPs or similar facilities), to standards CSN 75 7214 for water treatibility, 75 7221 for surface water classification, 75 7143 for irrigation, 75 7111 for drinking water supply, 56 7858 for suckling´s water. On the other hand the most these parameters are not directly mentioned in actual and planned projects. They will be mostly determined in following projects in detail and operation rules on the basis of updated available knowledge, of new monitoring, analyses and evaluations in the course of future operation. To the most important objectives and measures belong an improvement, rationalization and better reliability of monitoring network (towards less stations and chronologically dynamic and long-term-running information), together with following analyses and holistic evaluation.

The above mentioned facts are coherent with difficult estimation of quantifying the amount of hazardous substances reduction expected from each current or planned project. However, it is sure that all actual and planned projects contribute to a reduction of heavy metals and other hazardous substances in the Morava River basin.

## 4.3. Microbiological Contamination

With respect to improved wastewater treatment in many municipalities and industrial establishments may be expected a decrease of microbiological contamination within all Morava River basin. Taking into account that experiences concerning the occurrence of bacteria and viruses in other basins - in the Rhine R. basin, in the Thames R. basin and so forth - are not good resulting from the implementations of all necessary degrees in all important WWTPs etc.

Essential sources of water contamination by bacteria and viruses in the Morava River basin are agriculture, inhabitants and animals living in municipalities.

The reasons of microbiological pollution of water bodies in the region of interest are as follows:

- discharges of municipal sewages either untreated (from sewer systems and from surface washings in towns and villages) or treated by simple methods (privy vaults, cesspits) or treated with the aid of macrophyte-based wastewater treatment plants (or reed-bed plants) or of two or more degrees (e.g. partially by or more /less effectively by different WWTPs),
- rainfalls which catch and remove microbiological pollutants towards downstream places,

- washing from agricultural lands, removal of humus and manure or fertilizers with insufficient ploughdown,
- washing out from “open” manure heaps in the field and from bad stacks (storing the straw),
- runoff or leakages of agricultural wastewater, dung-water, liquid manure, liquids from silo pits, tanks of silage,
- washing out from controlled or non-controlled dumpsites or other places (e.g. for the purposes of taking out), with predominant rate of organic substances, with further microbiological decomposition.

In the next table are the values of allowable microbiological pollution conforming to the Czech standards CSN 75 7221 (classification of surface waters). Likewise the water quality by a microbiological pollution is divided into five categories.

**Table 18 Microbiological parameters of water quality**

| Parameter | unit | category | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| psychrophile bacteria | CCU/1 ml | <500 | <1.000 | <5.000 | <10.000 | >10.000 |
| Coliforms | CCU/1 ml | <1 | <10 | <100 | <1.000 | >1.000 |
| fecal coliforms | CCU/1 ml | <0,2 | <2 | <20 | <200 | >200 |
| Enterococcuses | CCU/1 ml | <0,1 | <1 | <10 | <100 | >100 |

Taking into account standards of the European Union the limits are as follows:

- coliforms for category $A_1$ ... 0, 5 CCU/1 ml, $A_2$ ... 50 CCU/1 ml, $A_3$ ... 500 CCU/1 ml
- fecal coliforms for category $A_1$ ... 0, 2 CCU/1 ml, $A_2$ ... 20 CCU/1 ml, $A_3$ ... 200 CCU/1 ml

In the same way were determined limited values according to the Czech standard CSN 75 7214 (for the treatibility of raw water) - for coliforms (by temperature of 37°C):

for category A ... 0, 5 CCU/1 ml, $A_2$ ... 50 CCU/1 ml, $A_3$ ... 500 CCU/1 ml (value in the Czech standard are written for 100 ml).

There are also similar microbiological values for bathing people in waters according to Czech hygienic standard (coliforms 100 CCU/1 ml, fecal coliforms 20 CCU/1 ml, fecal streptococcuses 1 CCU/1 ml, salmonella 0, enteroviruses 0).

Microbiological pollution in receiving water bodies in the Morava River basin has mostly originated in non-point sources. Therefore a quantifying the expected amount of reduction of microbiological contamination - with connection to realized measures of sewerage systems and of sewage treatment systems in municipalities and industries - is also not a simple task. In the Governmental Decree No. 171/1992 are mentioned these limited values:

- coliforms 20 CCU/1 ml (raw water for drinking water supply), 200 CCU/1 ml (other waters),
- fecal coliforms 4 CCU/1 ml (drinking water purposes), 40 CCU/1 ml (other waters),
- enterococcuses 2 CCU/1 ml (drinking water purposes), 20 CCU/1 ml (other waters).

A lot of microbiological parameters are not directly mentioned in actual and planned projects. These values will be mostly determined in followed-up projects in detail and operation rules on the base of updated available knowledge, of new monitoring, analyses and evaluations in the course of future operation. As much as by hazardous substances it must be said that to the most important objectives and measures belong an improvement, rationalization and better reliability of monitoring network (towards chronologically dynamic and continuously running data bases and information of high quality), of further analyses and systematic evaluation.

## 4.4. Adverse Environmental Effects

Some adverse environmental effects of the actual and planned measures of water pollution reduction correspond mostly to complicated recent situation of water management in the Czech Republic and in the Morava River basin. It is coherent with above-mentioned critical comments:

- rapid obsolescence and depreciation of former sewerage systems and of wastewater treatment plants,
- insufficient and delayed building up of sewerage and of sewage treatment systems in all region (owing to past communist deformations and to political or economic encroachments into water management processes),
- some qualitative defects on constructions and equipment which were carried out in the same "communist" time, following leakages from joints, valves etc.,
- lower efficiency of wastewater treatment plants, above all with regard to nutrients, heavy metals and other priority pollutants (pollution caused by these matters was short time before omitted),
- unsuitable and extent encroachments into the agricultural, forest, urban or other anthropogenic landscape,
- insufficiently effective management in many production sectors due to a permanent state planning and directives in each spheres.

Among new problems belong changes resulting from transition processes; these changes are sometimes hasty and unexpected. Companies for water supply and water sanitation have been also touched by these processes. The situation here has been stabilized rather slowly nevertheless step by step. It refers also to other water management companies and institutions, but some other changes will be awaited relative to law, to economic and tax tools, to water authorities and final regional arrangement.

Adverse effects of the actual and planned measures of water pollution reduction have consisted henceforth in

a. insufficient effectiveness aimed at nutrients (not only at phosphorus but also at nitrogen) ... excluding nitrogen by WWTP Olomouc it has referred to all actual WWTPs though finished not long ago,
b. bigger quantity of nutrients has been concentrated in sanitation systems,
c. utilization and treatment of sludge has not been every time solved with an eye to environmental requirements,
d. some WWTPs have been placed within the floodplain area (and with it is connected the water pollution caused by flooding and following damages - see consequences of floods in July 1997 in the Morava River basin),
e. efficiency reducing of smaller WWTPs and macrophyte-based wastewater treatment systems or reed-bed plants; it could be caused with the aid of special circumstances (overloading of capacities, inflow or income of unsuitable substances - e.g. foots, inorganic hazardous matters, mentioned flooding etc.),
f. problems connected with insufficient knowledge concerning the load by heavy metals, other hazardous substances and microbiological contamination (issues of suitable monitoring apparatus etc.).

The majority of mentioned issues will be also referring more or less to planned projects. However, the objectives of all projects are reducing of water pollution towards limits 2004 - 2005 and towards meeting transboundary and international requirements. Then will fall off points a., b., partially also f. On the other hand some problems will remain.

From the outline result some linkings to transboundary impacts. At present we highlight some important localities influenced the water quality regime in Austria and Slovakia:

- in the sub-basin of the Morava River - towards Slovakia and then Austria ... WWTPs Kromeriz, Hulin, Zlin, Otrokovice (Kozeluzny), Napajedla, industrial hot spot Babice (HAME), WWTPs Uhersky Brod, Uherske Hradiste, municipality Kunovice (without WWTP + agricultural hot spot), WWTPs Veseli nad Moravou, Bzenec, Straznice, Hodonin,
- in the sub-basin of the Dyje River upstream the Nove Mlyny Hydraulic Structure - towards Austria and more distantly to Slovakia ... Telc (without WWTP), WWTPs Dacice, Jemnice, Znojmo, agricultural hot spot Strachotice,
- in the sub-basin of the Svratka River - towards Austria and then Slovakia ... Tisnov, Blansko, Adamov, Brno, Bucovice, Slavkov, Velke Nemcice (agricultural hot spot),
- in the sub-basin of the Jihlava River - towards Austria and then Slovakia ... WWTP Trebic, industrial hot spot Vladislav (Tanex), WWTP Namest nad Oslavou, Moravsky Krumlov (WWTP is not finished), WWTP Ivancice,
- in the basin of the Lower Dyje River - towards Austria and in no time to Slovakia ... WWTPs Hustopece, Breclav, industrial area Breclav - Postorna (Fosfa), WWTPs Mikulov, Kyjov, Mutenice - Dubnany (WWTP is not finished) and agricultural hot spots Milotice and Dubnany (in the partial sub-basin of the Kyjovka River),
- in the sub-basin of the Vlara River (which is the tributary to the Vah River flowing in Slovakia) - towards Slovakia ... WWTPs Slavicin, Valasske Klobouky and Brumov - Bylnice.

More pronounced transboundary impacts could be awaited by **emphasized** hot spots (as Brno, Zlin, etc.). The quantifying of their effects may be expressed by water quality parameters in transboundary rivers (see tables from the end of chapter No. 3.; these tables represent list of important transboundary effects and impacts). On the other hand it is very complicated to evaluate truthfully the resulted transboundary effects of current and planned projects, to assess or estimate the transboundary effects of ongoing and planned projects as far as the water quality is concerned, to describe obvious effects or tendencies coherent with mentioned “transboundary” hot spots. Some amounts of pollution reduction expected further to implemented projects were mentioned in foregoing chapters.

# 5. Cost Estimation of Programmes and Projects

Recent investments related mostly to reconstruction or extension, or intensification of existing wastewater treatment plants built up mainly in municipalities are briefly characterized in chapters 2 and 3. From 1990 to 1997 there were also some other remedial investments concerning

- reconstruction of sewer systems (it was reimbursed mainly from municipality budgets, partially with support of State Environmental Fund),
- removal of environmental damages caused by waste sites and following leakages or leaches from many places and areas (a lot of these disposals have not been remedied, some projects aimed at remedying measures have been financially covered from the National Property Fund),
- building of macrophyte-based wastewater treatment plants (or reed-bed plants, constructed wetlands) in smaller villages financially mostly supported from the State Environmental Fund,
- restoration of rural landscape (from 1948 to 1990 relevantly damaged) ... covered from the Agricultural Supporting and Guarantee Fund,
- programme of rehabilitation of watercourse systems ... conforming to the Czech Governmental Decree No. 373/1992; mostly small investments covered from the state budget.

Most ongoing or planned measures must be divided in two or more stages. It depends on the extent of issues and challenges, on calculated or assumed costs, on timing of implementation, on local, national and international funds and capacities. The largest investment is the extension and intensification of the wastewater treatment plant for the city of Brno (WWTP in Modrice), then follow reconstruction and extension of WWTP Zlin (in the suburb Zlin-Malenovice), remedial measures for removal of previous environmental damages in area of company Fosfa Postorna a.s., reconstruction of technology systems in WWTP Uherske Hradiste, remedial measures and reduction of slurry production in the pig farm "Gigant Dubnany", then reconstruction, intensification and extension of WWTP Hodonin, intensification of WWTP Kozeluzny Otrokovice (the owner is "Cistirna odpadnich vod Kozeluzny, a.s."; in English "Wastewater treatment plant of Tannery"). From other problems out of the municipal WWTP Olomouc with finished reconstruction but with not effective reduction of phosphorus, notwithstanding the new investment project has not been prepared at this time. We set out other municipal hot spots here, with incidental stating of the given impact on the river and of investment preparedness: reconstruction of WWTP Znojmo (Dyje River, starting two years ago), reconstruction and extension of WWTP Prerov (Becva River and then Morava River, recently started), intensification and extension of WWTP Prostejov (Valova River and then Morava River, recently started), extension of WWTP Breclav (Dyje River, prepared), reconstruction of WWTP Kromeriz (Morava River, in the stage of study preparedness; situation is complicated by agricultural wastes from the pig farm Tesnovice) and some other WWTPs prepared or recently started.

Among important industrial hot spots have been further included: HAME Babice (Morava R., food-stuff industry, 1st stage of WWTP reconstruction finished not long ago, other projects are not prepared), Snaha Brtnice (Brtnice R., then Jihlava R. and then Dyje R., tannery, WWTP project partly prepared), Tanex Vladislav (Jihlava R., then Dyje R., tannery, at the beginning of preparedness).

There are also some agricultural hot spots represented by five high-capacity pig farms: Milotice (near Kyjovka River, then Dyje River and Morava River), Tesnovice (near Morava River and the town of Kromeriz), Kunovice (Morava River), Velke Nemcice (Svratka River, then Dyje River) and Strachotice (Dyje River). The investment preparedness of agricultural projects is different and many difficulties have been connected with vague ownership relations and with very slow transition procedures in agriculture.

At this time evaluated investment costs as regards six chosen hot spots are as follows:

*a) in CZK (Czech Crown)*

| | |
|---|---|
| WWTP Brno | 1,301 million CZK |
| WWTP Zlin | 354 million CZK |
| WWTP Uherske Hradiste | 165 million CZK |
| WWTP Hodonin | 76 million CZK |
| WWTP Kozeluzny Otrokovice | 77 million CZK |
| Remedial measures in area of company Fosfa Postorna | 110 million CZK |
| Remedial measures and reduction of slurry production in the pig farm Gigant Dubnany | 151 million CZK |
| Total needed amount | 2,234 million CZK |

*b) in US $ (US dollar)*

| | |
|---|---|
| WWTP Brno | 39.7 million US $ |
| WWTP Zlin | 10,8 million US $ |
| WWTP Uherske Hradiste | 5.0 million US $ |
| WWTP Hodonin | 2.3 million US $ |
| WWTP Kozeluzny Otrokovice | 2.4 million US $ |
| Remedial measures in area of company Fosfa Postorna | 3.4 million US $ |
| Remedial measures and reduction of slurry production in the pig farm Gigant Dubnany | 4.6 million US $ |
| Total needed amount | 68.2 million US $ |

There are some national and local financial sources and funds available, but the support from foreign funds is very needed as a consequence of domestic financial lack. All hot spots are also characterized by significant transboundary effect. However, after the termination of mentioned investment works the activities will have to continue, mainly with regard to WWTPs Zlin, Uherske Hradiste, Hodonin and remedial measures of Fosfa Postorna and of Gigant Dubnany. These needful future activities are connected with nutrient challenges and with urgency of water pollution reduction in this sense. The projects proposals were chosen due to the option of key hot spots in the Morava River basin.

The largest project is the extension and intensification of the existing municipal wastewater treatment plant for the city of **Brno**. The plant is situated in the local area of neighboring municipality Modrice and the first stage was built in 1960. From this time there have been done some partial steps of extension and improvement here. In 1981 started the operation of the second degree and by this step increased the capacity of biological part of plant. Then in 1989 followed the 3d phase by extension of mechanical parts (new sedimentation tanks etc.) of plant and the works have been ongoing at the beginning of ninetieth (4th phase - sludge thickeners, changes of technologies by sludge dewatering). The extension and intensification according to new project (Schüffl & Forsthuber) will consist in increased removal of phosphorus with cascade denitrification - by means of three completing tanks in the framework of biological part. There will be these tanks: anaerobic, anoxic and aerobic, completion of secondary settling system.

Among other important projects pertain the proposal aimed at reconstruction and extension of municipal WWTP **Zlin** situated in its suburb Malenovice. The original plant was constructed in the period of 1964 - 1966 and ten - fifteen years ago started the overloading of WWTP. First stage of reconstruction was finished in 1993 and it referred to extension of the mechanical pre-treatment, construction of two secondary settlers etc. Some reconstruction works were performed from 1994 to 1996: decantation and secondary settling tanks, equipment for sludge press etc. The project in question aims at the second stage of reconstruction with two phases: I. construction of new activation tanks (with nitrogen and phosphorus removal), completing secondary settler etc., II. reconstruction of the present activation and distribution tanks, reconstruction of sludge treatment etc. The project planned for years 1998 - 2000 was proposed by the firm Centroprojekt Zlin a.s.

The project of reconstruction of technology systems in municipal WWTP **Uherske Hradiste -** which is oriented mainly on biological parts - consists in mechanical pre-treatment, extension and upgrading of aeration tanks, reconstruction of secondary settlers and sludge treatment. All measures will contribute - also with the aid of additional structures and equipment in the course of following stage - to reduction of nitrogen and phosphorus load in waters. The operation of existing WWTP started in 1974, the latest reconstruction concerning the aeration system was implemented in 1994. On project parts dealing with biological systems have been participated Centroprojekt Zlin a.s. and Sigma Engineering Olomouc.

Main objectives of following project dealing with WWTP **Hodonin** are determined by necessary reconstruction, intensification and extension of some structures and equipment. The existing WWTP started its operation in 1982 and the last reconstruction works consisted in a dewatering and thickening of sludge. Main objectives of the proposed modernization of WWTP are decrease of carbon, nitrogen and phosphorus contamination (aeration, nitrification, denitrification and other biological and chemical ways) with harmony to governmental decree limits from the 1st January 2005. Main consulting firm is DUIS s.r.o. (from Brno in the Czech Republic).

Nearly identical purpose - as by typical municipal WWTPs - has the design intensification of WWTP **Kozeluzny Otrokovice. T**he owner of this plant is "Cistirna odpadnich vod Kozeluzny, a.s." (in English "Wastewater treatment plant of Tannery, joint-stock company"). The part of wastewater have sprung from the factory, but a lot of sewages have been originated from the town Otrokovice and partially also from neighboring city of Zlin. The first phase of existing combined WWTP (treated together industrial and municipal sewages) consisted in one mechanical degree built in 1962. The plant was from 1983 to 1993 extended by biological degree and new sludge disposal. The submitted project is preoccupied with upgrading of nitrification, with sludge reclaiming and denitrification. Excepting nitrogen pollution will be also reduced the existing contamination by carbon and hazardous substances . There are no special problems with phosphorus pollution here. The design of project was worked up by the firm Hydroprojekt Praha a.s.

Remedial measures for removal of previous environmental damages in area of company **Fosfa Postorna** are actions linking the 1st stage between 1995 - 1997. The project defined at this time represents the 2nd stage of rehabilitation works between years from 1998 to 2002 and its targets consist in further improvement of water quality conditions in the Dyje River and in alluvial aquifers. The projected activities will be related to some building works and mostly to operation issues: construction of water linkages, technology of remedial pumping of wastewater, surface finishing of setting pits, getting up in the decontamination station, extension of dump sites for dangerous wastes, wastewater treatment for liquids pumped from hydraulic antifiltering screen (downstream setting pits), remedial pumping of groundwaters. There have been two main measures: first with respect to wastewater treatment downstream the factory produced sulphuric acid, two types of phosphoric acid and second to leakages and leaches from existing setting pits storing substances as gypsum with phosphates, matters containing rests containing fluor, arsen, sulphates, ammonia etc. Fosfa Postorna is very near the border between Czech Republic and Austria and nearby the boundary between Slovakia and Austria. Projects have been worked up by the firm Ekoingstav Brno a.s.

There are two above mentioned steps of the project Remedial measures and reduction of slurry production in the pig farm **Gigant Dubnany**: a) measures to reduce the slurry production and application, b) reconstruction of pig farm, removal of contaminated sediments in lagoons an neighboring areas of the pig farm and their rehabilitation. The first stage of the Project will consist mainly in measures aiming for a quantity reduction of produced and applied slurry. The recent quantity 140,000 $m^3$ per year will be decreased at the value of 70,000 $m^3$/year. There will be used here new feeding technologies - "wet" feeding instead of "dry". Among other important steps will belong 6-month slurry storage in secured impermeable tanks with total volume of 35,000 $m^3$ -

40,000 $m^3$. The slurry quality will be treated by dosage of cattle straw and other substances. In combination it will be also used fermentation procedures towards a production of special organic manure. The second stage consists in reconstruction and upgrade of obsolete, cracked and impaired buildings, surfaces, pipelines, sewages, equipment in the pig farm. Projects were worked by firms Agroprojekta a.s. Uherske Hradiste, TOPGEO Brno s.r.o. and by team of specialists.

In next two tables (No. 19 and 20) are stated relevant cost elements of recent and ongoing projects (these ones in sums per year) a then of planned projects referring to mentioned six key hot spots.

The priority ranking of projects is as follows:

1. WWTP Brno
2. WWTP Zlin
3. WWTP Hodonin
4. Remedial Measures in the Area of Fosfa Postorna
5. Remedial Measures and Reduction of Slurry Production in the Pig Farm of Gigant Dubnany
6. WWTP Uherske Hradiste
7. WWTP Kozeluzny Otrokovice.

# 6. Planning and Implementing Capacities

## 6.1. Planning Capacities

Actual planning capacities of authorities, institutions and companies in the field of project preparation in the country concerning the water pollution reduction for structural and non-structural projects result from these simple expressions:

Main authority in the planning sphere has been the Czech Ministry of Environment, with the most important department of interest - department of water protection. However, there are some other departments dealing with water issues e.g. department of transboundary impacts etc. In the region of the Morava River basin have been operating above all three regional divisions of the same ministry: in Brno (south-western, southern and south eastern Moravia), Olomouc (northern and middle Moravia), Ostrava (district Vsetin in the eastern Moravia). The marginal parts of the Morava River basin are in charge of divisions in Ceske Budejovice (environs of Dacice) and in Hradec Kralove (environs of Lanskroun). However, competencies of mentioned divisions are very limited. On the other hand other authorities in district towns have been entrusted with very significant tasks, other large towns and cities and larger. The role of these "lower" authorities concerns mainly the permits of water quality limits, the environmental impact assessments in respective areas, the prompt contact with stakeholders. Water quality in rivers and some groundwater sources is monitored in the Czech Hydrometeorological Institute Praha (with two respective branches in Brno and Ostrava), by special water quality monitoring and evaluations are commissioned T.G.M. Water Research Institute Praha (with branches in Brno and Ostrava, too), GEOtest Brno a.s. (groundwaters) and other companies or institutions. Likewise the task of "Povodi Moravy, a.s." (in English "Morava River Basin Administration, plc.") is also very important in many directions: completing monitoring and evaluation of water quality in watercourses (also in some brooks), monitoring on two transboundary stations in Velke Nemcice (on the lower reach of the Svratka River) and in Lanzhot (on the Morava River upstream the confluence with the Dyje River), operation of water quality records of discharges from WWTPs etc., Czech focal point of the Environmental Programme for the Danube River basin, accident, emergency warning system in the framework of the Danube Programme). The Czech Inspection of Environment - with branches in Brno, Olomouc and Ostrava - has been instrumental in the water pollution searching, control and penalties. Principal problems were mentioned in the text above: a lot of existing issues are connected with need of upgrading of Czech water law and with urgent need of regional authorities in historically formed administrative territories and in hydrologically determined catchment areas.

There have been many Czech companies in the field of project preparation in the country concerning the water pollution reduction - especially for structural projects: Aquatis Brno a.s., DUIS s.r.o., Centroprojekt Zlin a.s., Hydroprojekt Praha a.s., Agroprojekta a.s. etc. Likewise the foreign aid has been very significant e.g. from the part of Austrian firms Schüffl & Forsthuber, Allplan Wien. The building control in the Morava River basin is very often in charge of company Vodohospodarsky rozvoj a vystavba a.s. Praha (in English: Water Management and Development Plc.; with division in Brno). The option of project implementing firm has resulted from competition processes and screenings.

The most part of non-structural projects has been assigned by Czech Ministry of Environment. Among the most important non-structural projects pertained (or has pertained) the above mentioned "Project of the Morava River Basin". This project was started from 1991 to 1992. Projects aimed at "Best available techniques" (BAP) and "Best environmental practice" (BEP) are at the beginning and in the development phase.

According to opinions of Czech authorities, specialists, experts, project or research workers and scientists the actual planning capacities of institutions, consulting and engineering companies or individual consultants have been sufficient for the preparation of project documents for bankable projects - by conditions of good organization of works, of stabilized political and economic situation, of sufficient funding coverage. Above all these fields of activities - towards an external foreign support and cooperation - are useful to the rapid development of water pollution reduction projects.

## 6.2. Implementing Capacities

### 6.2.1. Implementing Capacities for Structural Projects

The actual implementing capacities of construction companies in the Czech Republic for the construction of treatment plants for municipal and industrial wastewater have been rather affected by past political and economic processes and unaccomplished transition or ownership changes. However, it is sure that the performance quality of Czech firms - still in the development phase - would be improved in a very short time. On the other hand the cooperation with foreign companies for turn key projects will be very useful including procurement of some special equipment in sewage treatment plant (e.g. corrosion resistant devices, automatic regulatory items etc.).

### 6.2.2. Implementing Capacities for Non-structural Projects

A contingent need for international cooperation for implementation of non-structural projects will depend on many circumstances which could be unforeseeable at the present. However, the international cooperation in this sphere will be also desirable.

Some non-structural have been proposed in the course of the workshop in September 1998. However, they must be well defined and nailed down, jointly with financial, institutional and team organization analysis.

## Table 19 Compilation of actual investments (Million US$, Million CZK)

| No | Type/ Project or Programme | Total Capital Requirements | | Funding Period | National Funding Sources | | | | | International Funding | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Envir. Fund | Public Loans | Public Grants | | Others | Organisa tion | Grant | Loan | |
| | | | | | | Central Budget | Central Budget | Regional Budget | | | | | |
| | | mil. CZK | MUS$ | | mil. CZK | mil. CZK | mil. CZK | mil. CZK | mil. CZK | | MUS$ | MUS$ | |
| 1. | WWTP Prostejov | 442.0 | 13.12 | 1997 | | - | - | | - | | - | - | Started 12/97 |
| | | | | 1998 | | 88.4 | 265.2 | | 88.4 | | - | - | others: town,ind. |
| | | | | | | 20% | 60% | | 20% | | | | |
| 2. | WWTP Prerov | 292.0 | 8.66 | 1997 | | - | - | | - | | - | - | Started 5/98 |
| | | | | 1998 | | 58.4 | 175.2 | | 58.4 | | | | others: town,ind. |
| | | | | | | 20% | 60% | | 20% | | | | |
| 3. | WWTP Znojmo | 228.0 | 6.77 | 1997 | 20.0 | | | 20.0 | - | Phare | 0.30 | - | Started 11/96 |
| | | | | 1998 | 73.6 | | | 73.6 | - | Phare | 1.06 | - | |
| | | | | | 40% | | | 40% | | | | | |
| 4. | WWTP Breclav + sewers | 339.0 | 10.06 | 1997 | | 77.0 | 77.0 | | 53.0 | | - | - | Started 6/96 |
| | | | | 1998 | | - | - | | 24.0 | Phare | 3.20 | | others: town,ind. |
| All other environmental – water management projects till 1997 in the Morava River basin (Σ WWTPs + municipal sewers) | | | | | | | | | | | | | |
| | year 1993 | 656 | 19.5 | | 190 | 143 | | | 323 | | | | 52 actions |
| | 1994 | 936 | 27.8 | | 321 | 243 | | | 372 | | | | 55 actions |
| | 1995 | 1,218 | 36.1 | | 443 | 328 | | | 447 | | | | 97 actions |
| | 1996 | 1,305 | 38.7 | | 533 | 387 | | | 485 | | | | 102 actions |
| | 1997 | 1,260 | 37.4 | | 897 | 342 | | | 421 | | | | 94 actions |
| | | | | | | | | | | | | | (122 actions in total) |
| | | | | | | | | | | | | | others: mostly municipalities |

## Table 20 Compilation of planned investments (Million US$, Million CZK)

| No | Type/ Project or Programme | Total Capital Requirements | | Funding Period | National Funding Sources | | | | | International Funding | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Equity | Envir. Fund | Public Grants | | Others | Organisation | Grant | Loan | |
| | | | | | | | Central Budget | Local Budget | | | | | |
| | | mil. CZK | MUS$ | | mil. CZK | mil. CZK | mil. CZK | mil. CZK | mil. CZK | | MUS$ | MUS$ | |
| 1. | WWTP Brno | 1,301 | 39.7 | | 37,278 | 0 | | 167 | 186 | EU | 9.1 | 19.8 | others: either |
| | (Modrice) | | | 1998 | | | | 20 | - | EBRD | 1.5 | 3.0 | GEF(5.7MUS$) |
| | | | | 1999 | | | | 40 | 50 | | 2.0 | 4.5 | or syndicated |
| | | | | 2000 | | | | 40 | 60 | | 2.0 | 5.3 | loan |
| | | | | 2001 | | | | 40 | 46 | | 2.0 | 5.0 | |
| | | | | 2002 | | | | 27 | 30 | | 1.6 | 2.0 | |
| 2. | WWTP Zlin | 354 | 10.8 | | | 0 | 132 | 117 | | GEF | 1.6 | 1.6 | |
| | | | | 1999 | | | 40 | 35 | | | 0.4 | 0.4 | |
| | | | | 2000 | | | 40 | 35 | | | 0.5 | 0.5 | |
| | | | | 2001 | | | 35 | 30 | | | 0.5 | 0.5 | |
| | | | | 2002 | | | 17 | 17 | | | 0.2 | 0.2 | |
| 3. | WWTP Uherske | 165 | 5.0 | | | 0 | 75 | 64 | | GEF | 0.8 | 0.8 | |
| | Hradiste | | | 1999 | | | 15 | 10 | | | 0.2 | 0.2 | |
| | | | | 2000 | | | 20 | 15 | | | 0.2 | 0.2 | |
| | | | | 2001 | | | 20 | 20 | | | 0.2 | 0.2 | |
| | | | | 2002 | | | 20 | 19 | | | 0.2 | 0.2 | |
| 4. | WWTP Hodonin | 76 | 2.3 | | | 0 | 30 | 2.0 | | GEF | 0.4 | 0.4 | |
| | | | | 1999 | | | 5 | 5 | | | 0.1 | 0.1 | |
| | | | | 2000 | | | 10 | 5 | | | 0.1 | 0.1 | |
| | | | | 2001 | | | 10 | 5 | | | 0.1 | 0.1 | |
| | | | | 2002 | | | 5 | 5 | | | 0.1 | 0.1 | |
| 5. | WWTP Kozeluzny | 77 | 2.4 | | 340 | 0 | | 37 | 20 | GEF | 0.3 | 0.4 | others: loan or |
| | Otrokovice | | | 1999 | | | | 5 | 5 | | - | 0.1 | central budget |
| | | | | 2000 | | | | 12 | 5 | | 0.1 | 0.1 | |
| | | | | 2001 | | | | 10 | 5 | | 0.1 | 0.1 | |
| | | | | 2002 | | | | 10 | 5 | | 0.1 | 0.1 | |
| 6. | Remedial Measures | 110 | 3.4 | | 780 | 0 | | | 65 | GEF | 0.7 | 0.7 | others: Fund of |
| | Fosfa Postorna | | | 1999 | | | | | 25 | | - | - | National Assets |
| | | | | 2000 | | | | | 20 | | 0.3 | 0.3 | |
| | | | | 2001 | | | | | 10 | | 0.3 | 0.3 | |
| | | | | 2002 | | | | | 10 | | 0.1 | 0.1 | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7. | Remedial Measurures and Reduction of Slurry Production Gigant Dubnany | 151 | 4.6 | | | 0 | | | 99 | GEF | 0.8 | 0.8 | others: Fund of National Assets |
| | | | | 1999 | | | | | 15 | | - | - | |
| | | | | 2000 | | | | | 30 | | 0.2 | 0.2 | |
| | | | | 2001 | | | | | 30 | | 0.3 | 0.3 | |
| | | | | 2002 | | | | | 24 | | 0.2 | 0.2 | |

*Together: 2234 mil. CZK or 68.2 mil. US$*

# Annexes

1. **Impacts of Actual and Planned Projects and Measures (Expected Quantifiable Reductions)**
2. **Bibliography**

# Annex 1

## Impacts of Actual and Planned Projects and Measures (Expected Quantifiable Reductions)

# Impacts of Actual an Planned Projects and Measures (Expected Quantifiable Reductions)

This annexed chapter summarizes in the following table the values of expected favourable impacts relating to important actual, planned and proposed projects - in comparison of the present with the future state (between 1997 and 1.1.2005). Values are determined for average year discharge reduction (t/year) by nutrients, further values could be only percentually estimated - by hazardous substances and by microbiological pollution (values are not exactly specified):

| Hot spot | Parameter (t/year) | | | | Parameters (%) | | |
|---|---|---|---|---|---|---|---|
| | $N\text{-}NH_4$ | | $P_{Tot}$ | | Hazardous substances | | Microbio-logical Pollution |
| | 1997 | 2005 | 1997 | 2005 | | mainly | |
| *Actual Projects:* | | | | | | | |
| WWTP Prostejov | 215 | 70 | 20 | 18 | 25 | metals | 30 |
| WWTP Prerov | 135 | 37 | 10 | 6 | 20 | metals | 30 |
| WWTP Znojmo | 155 | 40 | 20 | 8 | 20 | | 30 |
| WWTP Breclav | 95 | 38 | 13 | 6 | 20 | | 30 |
| *Planned Projects:* | | | | | | | |
| WWTP Brno | 700 | 275 | 120 | 60 | 30 | metals | 35 |
| WWTP Zlin | 290 | 53 | 38 | 15 | 25 | | 35 |
| WWTP Uherske Hradiste | 80 | 28 | 25 | 8 | 20 | | 30 |
| WWTP Hodonin | 100 | 40 | 15 | 5 | 25 | | 30 |
| Industrial WWTP Otrokovice | 50 | 20 | 12 | 8 | 30 | metals | 30 |
| Fosfa Postorna | 15 | 12 | 25 | 5 | 15 | | ... |
| Gigant Dubnany | 60 | 30 | ... | ... | 25 | metals | 45 |
| *Further Proposed Projects:* | | | | | | | |
| WWTP Olomouc | 45 | 40 | 115 | 38 | 5 | | 5 |
| WWTP Kromeriz | 160 | 25 | 25 | 14 | 25 | | 35 |
| WWTP Jihlava | 175 | 48 | 8 | 7 | 30 | metals | 30 |
| WWTP Trebic | 85 | 40 | 18 | 10 | 30 | metals | 30 |

*Ladislav Pavlovský, Brno - 30. November 1998*

# Annex 2

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