WATER POLLUTION ABATEMENT PROGRAMME THE CZECH REPUBLIC

PROJECT 5.2

Water toxicity testing in protection and improvement of water ecosystems

Project report for phase I and II:

Toxicity screening of industrial wastewater in Odra river basin

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Abstract:

The effluents from 24 major industries in the Odra river catchment have been characterised as regards toxicity to fresh water organisms and chemical composition. Toxicity screening included tests with bacteria, algae, crustacean and fish. Three effluents with particularly high toxic potential have been identified. Certain other industries with less toxic effluents or small discharge volumes may also be of concern because of low dilution capacities in the receiving waters. Heavy metals have been identified as the toxic components in several wastewaters, but also organic substances may contribute to the toxicity. Industries that should be subjected to further characterisation and development of pollution control startegies have been selected.

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Ostrava
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CONTENTS

INTRODUCTION 3
METHODS 3
Sampling 3
Toxicity testing 4
Chemical analysis 5
RESULTS 5
Odra River Catchment 5
BOCHEMIE - chemical works (10A) 5
ZELEZARNY A DRATOVNY (ZDB) - iron and steel works (9A) 6
HRUSOVSKE CHEMICKE ZAVODY (HCHZ) - chemical works (8A) 6
MORAVSKE CHEMICKE ZAVODY (MCHZ) - chemical works (6A) 7
OPTIMIT - rubber processing works (1A) 7
AUTOPAL (2A) 7
MASSAG - metal processing works (3A) 8
LONKA - textile factory (4A) 8
TATRA - car factory (5A) 8
The Olse River Catchment 9
TRINECKE ZELEZARNY (TZ) - iron and steel works (2B) 9
ZEZARNY A DRATOVNY (ZDB) - iron and steel works (3B, 4B) 9
ELEKTROPRAGA (1B) 9
Opava River Catchment 10
OLSANSKE PAPIRNY - paper mills (6C) 10
KOVOHUTE - non-iron metal works (5C) 10
GALENA - pharmaceutical works (3C) 10
BRANO - metal processing factory (7C) 10
PRADELNA - laundry (1C) 11
SLEVARNA NEZELEZNYCH KOVU - non-iron metal processing plant (2C) 11
MORAVOLEN - textile works (4C) 11
Ostravice River Catchment 11
BIOCEL - pulp and paper mill (3D) 11
NOVA HUT - iron and steel works (4D, 5D) 12
VALCOVNY PLECHU - sheet mills (1D, 2D) 12
VITKOVICE - iron and steel works, machinery (6D-10D) 13
CONCLUSIONS AND RECOMMENDATIONS 14
ACTIVITIES IN 1994 16

INTRODUCTION

The water pollution abatement programme was launched in 1991 as part of a bilateral agreement between Norway and the Czec Republic on co-operation in the field of environmental protection. The use of toxicity testing in protection and improvement of water ecosystem was selected as subject for one of the projects in the program. This project is carried out in co-operation between the Water Research Institute, Ostrava (WRI-O) and the Norwegian Institute for Water Research (NIVA), with assistance from Povodi Odry (PO).

The activities during 1992-93 have been focused on screening of industrial discharges in the Odra River basin with the objective to identify the most important sources of toxic effluents. The work has included:

- collection of information on industrial discharges
- collection of data on waste water quality and quantity
- toxicity screening of waste waters, receiving waters and sediments
- chemical analysis of waste waters

In addition some inter calibration exercises of test methods have been performed.

The team members that have taken part in the above activities are:

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METHODS

The toxicological monitoring of industrial pollution sources in the river basin was carried out using available testing facilities at WRI(O) and NIVA. Screening toxicity tests were selected as a means to identify major sources of toxic pollution. In addition some chemical characterisation has been carried out.

Sampling

The study has covered most major industrial discharges in the Odra River basement. We have divided the Odra River Basin into the four river catchments (the Odra River and its tributaries) in which we have tested toxic impacts of the main industrial pollution sources. Random sampling of effluents were made at the discharge sites. The locations sampled are indicated on maps (fig. 1 and 2).

Samples for toxicity testing and chemical analysis were collected on glass or polyethene bottles, and stored at 3-6 °C until tests and analysis was carried out. Samples for analysis of metals were collected on acid washed (HCl) glass vials.

In cases when collecting effluent samples was impossible, samples of water and/or sediments were taken from the recipients. Recipient samples were taken on profiles downstream of the effluent discharge, where complete mixing with the receiving water was assumed. Samples upstream of the pollution sources were taken for comparison.

The sampling was carried out during 1992-93, with most samples taken on 2-3 November 1992. Additional sampling for toxicity screening were made on several occasions.

Toxicity testing

Screening toxicity tests were carried out on undiluted waste or recipient water samples. Acidic or basic samples were neutralised before testing to exclude pH impact. The tests included:

• Microtox	Impact on bacterial luminescence (*Photobacterium phosphoreum*)	DIN 38 412, teil 34
• Algal test	Inhibition of growth of algae (*Scenedesmus quadricauda*)	ISO 8692, OECD 201
• Daphnia test	Inhibition of motility of *Daphnia magna*	OECD 202
• Fish test	Mortality of fish (*Poecilia reticulata*)	OECD 203

Sediment samples were centrifuged (2500 rpm. for 20 min.). 100 g dry weight of the sediment samples was added to 200 ml standard dilution water and shaken for 30 min. This mixture was tested on *Daphnia magna* and the planarian *Planaria tigrina*. Lethality was checked after 48 h.

For testing of sediment toxicity with Microtox, samples were dried at 50 °C. The fraction <0.063 mm was separated by sieving and this fraction extracted in a 10% methanol solution. A mixture of the sample and standard dilution water 1:2 was shaken and centrifuged at 3000 rpm. 2x20 min. The supernatant was tested (5% methanol is non-toxic to the bacteria in the Microtox test).

Results are expressed in the three-degrees scale:

inhibition/mortality	degree
0 - 10 %	1
10 - 50%	2
50 - 100%	3

The screening tests of waste water and sediment tests were carried out at WRI-O, Some parallel tests with *Daphnia magna* were made at NIVA.

Full algal toxicity tests according to OECD Guideline 201; "Alga, growth inhibition test" were carried out to describe the concentration/response relationship for toxic effluents. The green alga *Selenastrum capricornutum* was used as test organism. The algal tests were made at NIVA on samples taken on 2-3 November 1992. The results are expressed as EC50-values. The EC50-value is the concentration of waste water which causes 50% effect i.e. 50% inhibition of the algal growth rate.

Chemical analysis

BOD data are recalculated to average concentrations from Povodi Odry´s figures for annual discharge. Additional BOD data are provided from WRI(O) (ZDB and Nova Hut). All other data in table 1 refer to analysis of random samples collected during the study and analysed at WRI(O) or NIVA. Data given as ranges refer to minimum and maximum concentrations found in analysis of several samples, carried out at WRI(O) (pH, COD, cyanide and some metals). Other metal analysis were carried out at NIVA on samples taken 2-3 November 1992.

RESULTS

The results of the toxicity screening have been compiled into table 1, together with information on chemical composition, discharge volumes and recipient flow. Data on discharge and river flow are provided by Povodi Odry and are representing annual averages (QA), and the discharged exceeded 355 days/year (Q355), based on recordings in 1992. The dilution rate of the waste water effluents have been calculated based on QA and Q355 and the average effluent discharge (QE) The dilution rates are defined as:

- Average concentration of effluent of effluent: $CA = 100 \frac{QE}{QA}$
- Low flow concentration of effluent: $C355 = 100 \frac{QE}{Q355}$

For those effluents where an EC50-value has been established (usually for effect on algal growth), the toxicity emission factor (TEF) has been calculated as:

$$TEF = \frac{QE}{EC50}, \text{ where}$$

QE= Effluent discharge rate (l/s) and
EC50= Concentration of waste water (as %) which causes 50% effect.

The ratios CA/EC50 and C355/EC50 have also been calculated to assess the potential of toxic effects in the receiving water. A ratio CA/EC50 = 1 means that the concentration of the waste water after complete dilution in the receiving water is high enough to cause 50% inhibition on the algal growth. If it is assumed that the effluent concentration must be less than 10% of the EC50-value in order to avoid acute toxic effects in the receiving water, it follows that the ratios QA/EC50 or Q355/EC50 have to be <0.1.

Comments on the results of characterisation of discharges from various industries are given below.

Odra River Catchment

BOCHEMIE - chemical works (10A)

Bochemie, located in Bohumin is a chemical industry producing chloramine, mercury chloride, hydrogen chloride etc. The waste water is expected to contain various organic and inorganic substances. The waste water (9.5 l/s) is discharged to Bohumin Brook, where the average flow is estimated at 200 l/s.

Toxicity screening tests carried out in May, September and November, all showed high toxicity (inhibition/mortality 50-100%). The EC50-value for algae was 0.1%. The chemical analysis showed very high concentrations of copper and zinc. The copper concentration in the undiluted waste water (54 mg/l) corresponds to 540 µg Cu/l at the EC50-value. This is approximately 10 times higher than the concentration of Cu^{2+} normally required to reduce the growth rate of the test alga 50%. Also the zinc concentration is higher than normally required to obtain the observed growth inhibition. This implies that a fraction of the metals may be present in chemical forms which are not readily available. The high chemical oxygen demand (COD=580 mg/l) indicates that the waste water also contain a substantial amount of organic compounds. The organic fraction may reduce the availability of metals by chelation, but also contain toxic substances which have not been identified.

The TEF-value of the discharge is 95, which means that this industry is a major source of toxic discharge to the Odra River. Due to the low dilution capacity of the brook receiving the effluent, the CA/EC50 is very high (48). This means that severe toxic effects may be expected in the receiving water.

ZELEZARNY A DRATOVNY (ZDB) - iron and steel works (9A)

This iron and steel works produces steel, rolling products, wire products, castings and forgings. The expected pollutants are metals, oil and cyanide. The effluents, after mechanical and chemical treatment, are discharged to the Bohumin Brook, downstream of the effluent from Bochemie.

The screening toxicity tests of samples taken in Nov. 92, Sept. and Oct. 93 showed high toxicity (50-100% effect) on algae and Daphnia and low toxicity to fish (<10% lethality). However, the inhibition of algae in the sample taken on 2. Nov. 92 was low (EC50>100%). The waste water contains very high concentrations of iron (102 mg/l), and lead (120 µg/l) which may cause toxicity.

The TEF value based on the algal test is <2. Still the CA/EC50 may be as high as 0.95, because of the low dilution capacity of the receiving water.

The different degree of toxicity shown by the screening tests and the full algal toxicity test indicates that there may be a considerable variation of the composition of the waste water. Because of the low dilution capacity and large discharge, episodic toxic conditions can be expected to occur in the Bohumin Brook because of this discharge.

HRUSOVSKE CHEMICKE ZAVODY (HCHZ) - chemical works (8A)

HCHC chemical works, located in Ostrava-Hrusov, produces various products of barium chemistry, textile bleaching agents and hydrosulphide. Various inorganic and organic pollutants may be produced. The effluent is discharged after neutralisation to the Odra River (25 l/s).

The screening toxicity tests on effluent samples from Nov. 92 and Aug. 93 showed high toxicity on all tested organisms. This was confirmed by the algal toxicity test, where the EC50-value was 0.11%.

The chemical analysis indicate that the toxicity may be caused by a high content of zinc (92 mg/l) in the waste water, which corresponds to 100 µg/l at the EC50-value. The low pH-values recorded in effluent samples (2.7-4.3) show that the neutralisation before discharge is insufficient.

The high toxicity in combination with a rather large discharge volume results in a very high TEF-

value (231). The average flow rate in Odra river is sufficient to dilute the waste water to below the EC50-value (CA/EC50 = 0.55). At low flow, however, the EC50-value may be exceeded (C355/EC50 = 4). This indicates that the effluent causes a significant toxic stress in the receiving water.

MORAVSKE CHEMICKE ZAVODY (MCHZ) - chemical works (6A)

MCHC chemical works produces aniline, sorbitol, oxalic acid, cyclohexylamine, isopropylamine, phenolic plastics, calcium ammonia nitrate, sodium nitrite and sulphuric acid. Many kinds of organic and inorganic pollutants may be generated from the processes.

The effluents produced from different processes are collected in a channel with discharge to Odra River (290 l/s). In addition a minor effluent (3.2 l/s) is discharged to the Black Stream.

Screening toxicity tests of water from the Black Stream downstream the discharge showed low toxicity. However, the sediments were toxic (>50% lethality), indicating accumulation of toxic components which may stem from previous discharges.

The main effluent to the Odra river, sampled in Nov. 92 and Nov. 93 showed low toxicity in the screening tests. This is confirmed by the algal toxicity test, where EC50 was >100%. The chemical analysis showed low concentrations of metals.

The TEF-value based on the algal toxicity was 3. Due to a low toxicity and a high dilution capacity in the receiving water the CA/EC50 is less than 0.01 and C355/EC5 less than 0.08. These results do not indicate that the discharge, in spite of the high volume, would cause acute toxic effects in the receiving water.

OPTIMIT - rubber processing works (1A)

Optimit, located in Odry, produces various rubber products, which is expected to generate mainly organic pollutants. The waste water (25 l/s) is discharged to Odra river.

Screening toxicity tests performed on a effluent sample taken in Apr. 92 showed low toxicity (<10% effect). Full algal toxicity test and metal analysis have not been performed. The COD-analysis shows that organic compounds are present, and a rather low ratio BOD/COD indicates that some of these may not be readily biodegradable.

The low toxicity and favourable dilution conditions (dilution factor = 140x at average river flow) suggests that the effluent discharge from Optimit does not represent an important source of toxicity.

AUTOPAL (2A)

Autopal, which is located in Novy Jicin produces electrical car devices. The expected pollutants are mainly metals. A small effluent (3.2 l/s) is discharged to Jicinka River. Samples of the effluent have not been tested for toxicity. Screening toxicity tests of river water downstream of the discharge showed low toxicity to Daphnia, Microtox and fish.

The reported COD-value shows that the waste water probably contains a significant amount of organic compounds. In spite of that the BOD is low, indicating that the organics may not be readily degraded.

The low discharge volume, and the lack of toxicity in the receiving water downstream of the discharge suggests that this discharge does not cause a significant toxic impact on the receiving water.

MASSAG - metal processing works (3A)

Massag metal works in Bilovka produces small metal components including their surface finishing. The expected pollutants are mainly metals. Three small discharges enter the Bilowka River. The main discharge is only 3.2 l/s.

Screening toxicity tests on samples from April, May, Sept. and Nov. 92 showed high toxicity in all three waste water streams. High toxicity (>50% effect) was also found in sediment from Bilovka River downstream the factory. Also the river water was toxic (10-50% lethality of Daphnia and fish). The algal toxicity test confirmed these observations. The EC50-value was 4.3%.

The chemical analysis show that the neutralisation of the waste water prior to discharge is not efficient (pH 11-12). Zinc has been identified as the main toxic component. The concentration in the main discharge stream, 4.25 mg/l, corresponds to 180 µg Zn/l at the EC50, which is sufficient to explain the observed inhibition of the algal growth. In addition the waste water contains rather high concentrations of chromium and cyanides.

The TEF value calculated from the algal toxicity test is 1. The ratios CA/EC50 and C355/EC50 are 0.27 and 3.69 respectively. These values indicate that the discharge can reach toxic concentrations in the receiving water - as was also confirmed by toxicity tests of the river water.

LONKA - textile factory (4A)

The Lonka textile factory discharges a rather small effluent stream (3.8 l/s) to Lubina River. The main pollutants are expected to be organic compounds.

The effluent has a rather high pH-value. No further information on the chemical characteristics of the effluent is available. Screening toxicity tests on samples taken in May 92 showed 10-50% effect on Daphnia, Microtox and fish. Algal toxicity test has not been performed.

Due to favourable dilution conditions in the receiving water the discharge from Lonka textile factory is not expected to cause acute toxicity in Lubina River although the effluent contains unidentified toxic components.

TATRA - car factory (5A)

Tatra car factory, which is located in Pribor produces various car components. The production is expected to generate metals and oil as major potentially toxic pollutants. The waste water discharge is rather low; 3.8 l/s. The receiving water is Lubina River.

Toxicity tests have only been performed on receiving water samples from May 92. The samples from Lubina downstream of the factory showed low toxicity (<10% effect) on Daphnia, Microtox and fish. There are no data on the chemical composition of the waste water. The dilution rate of the effluent is 450x at average river flow.

The Olse River Catchment

TRINECKE ZELEZARNY (TZ) - iron and steel works (2B)

TZ is located in Trinec and produces special steel and coke. The production is expected to generate metals and phenol as pollutants. A major waste water stream (1670 l/s) is discharged to the Olse River.

Only receiving water has been tested for toxicity. No toxicity (less than 10% effect) was observed in the receiving water downstream the factory in Apr. 92. There are no data on chemical composition of the effluent.

Although no toxicity was found in the receiving water, further characterisation of the chemical composition and toxic potential of the effluent from TZ should be performed since the discharge volume is high compared to the dilution capacity of Olse River.

ZEZARNY A DRATOVNY (ZDB) - iron and steel works (3B, 4B)

ZDB steel works in Bohumin produces steel, rolling products, wire products, castings and forgings. Expected potentially toxic pollutants include metals and oil from metal processing. Two waste water streams are discharged to Bajcuvka Brook. The main discharge of waste water after mechanical and chemical treatment amounts to 35 l/s.

The screening toxicity tests on samples from the main discharge in Apr. and Nov. 92 and Sept. 93 showed from high toxicity on Daphnia to low toxicity on fish. 10-50% inhibition of algae in screening tests was confirmed by the full test with algae where the EC50-value was 95%. No analysis of metals have been performed. COD-analysis show that the waste water may contain a substantial amount of organic material. Still the BOD value is fairly low.

The TEF-value calculated from the algal test is 0.41. Possible effects in the receiving water can not be calculated since data on flow from the Bajcuvka Brook is not available. The results from the toxicity tests indicate that at least 10x dilution is required to avoid acute toxicity in the brook. This dilution rate is probably not always achieved, and thus, toxic effects may occur.

ELEKTROPRAGA (1B)

Electropraga, located in Jablunkov produces electrical home devices. Possible toxic pollutants are mainly metals. A small effluent (1.3 l/s) is discharged to Olse River.

Screening toxicity tests on a sample from April 92 showed approximately 50% lethality on Daphnia and fish. No further toxicity or chemical data is available. The dilution factor for the effluent is 2500x at average flow in Olse River and 230x at 355 days low flow. Because of the favourable dilution conditions acute toxic effects in the receiving water should not be anticipated.

Opava River Catchment

OLSANSKE PAPIRNY - paper mills (6C)

Olanske paper mill is a pulping industry producing paper. The production is expected to generate chlorinated organic substances and other toxic organic pollutants. The effluent (25 l/s) is discharged into Moravice River.

Screening toxicity tests performed in May 93 showed low toxicity (<10% effect) on Microtox and Daphnia. Chemical data includes only concentrations of COD and BOD, which show that the effluent contains organic degradable compounds.

The dilution factor for the effluent is 260x at average flow in Moravice and 24x at 355 days low flow. Thus, the waste water is not expected to cause acute toxic effects in the receiving water. However, chlorinated organics, if present, may have long term toxic consequences that are not disclosed by the current screening test.

KOVOHUTE - non-iron metal works (5C)

Kovohute metal works, located in Bridlicna, produces different aluminium products. Potential toxic pollutants are mainly metals. Waste water (35 l/s) is discharged to Moravice River.

Screening toxicity tests carried out on a sample from May 93 showed low toxicity (<10% effect) on Daphnia and Microtox. No further toxicity tests or metal analysis have been performed. The COD-analysis indicate the presence of organic components in the effluent.

The dilution conditions for the effluents are 80x at average flow and 10x at 355 days low flow. The results give no reason for immediate concern regarding acute toxic effects of the discharge.

GALENA - pharmaceutical works (3C)

The galena factory, located in Opava-Komarov, produces different pharmaceutical products. The expected pollutants are mainly organics. The waste water amounts to 25 l/s, which is discharged to Opava River.

Only samples from the receiving water have been tested for toxicity in May 92. The result showed low toxicity (less than 10% lethality of Daphnia and fish). The chemical analysis show that the waste water contains rather much organic material (COD = 40-170 mg/l).

The dilution conditions for the effluent are good (dilution factor 920x at average flow). Considering the low toxicity of the effluent, no acute toxicity in the receiving water should be anticipated.

BRANO - metal processing factory (7C)

The Brano factory, located in Hradec, produces different metal components, and metals are the most probable toxic pollutants. The waste water discharge is only 1 l/s to Moravice River.

The effluent toxicity screening, which was carried out in May-93 showed low toxicity (less than 10%

effect) on Daphnia and Microtox). No further toxicity testing have been made. The low toxicity is in conflict with reported concentrations of chromium in the range 260-2100 µg/l. This level of chromium is normally toxic to most aquatic organisms. The low toxicity found in the toxicity screening may be due to that the concentration of chromium was lower than normal when samples for toxicity testing were taken, or that the availability of the chromium is low.

Low discharge volume, low toxicity and good dilution conditions suggest that the effluent from Brano does not have any significant toxic effect in the Moravice River.

PRADELNA - laundry (1C)

Pradelna laundry in Krnov performs washing and chemical cleaning of textiles. The effluent is supposed to contain detergents and other organic pollutants. The effluent is discharged to Opava River, but the discharge volume is not known.

Toxicity screening in May 93 showed that the effluent was highly toxic (50-100%) effect on Daphnia and slightly less toxic to Microtox. No other toxicity or chemical data are available. The reason for the toxicity may be tensides, which are known to be acute toxic down to concentrations 1-10 mg/l or even lower.

SLEVARNA NEZELEZNYCH KOVU - non-iron metal processing plant (2C)

Slevarna Nezeleleznych Kovu, located in Opava produces metal components, and the main pollutants are expected to be metals. The waste water is discharged to Opava River, but the amounts are not known.

The screening toxicity tests in May 93 showed different toxicity to the different species; The effluent was highly toxic to algae (50-100% effect), less toxic to Microtox (10-50% effect) and least to Daphnia (less than 10% lethality). No chemical data are available.

The possible impact of the effluent in Opava River can not be assessed due to conflicting data on toxicity and lack of information on discharge volume and chemical composition.

MORAVOLEN - textile works (4C)

Moravolen in Bruntal is a textile factory, with organic compounds as major expected pollutants. A rather large effluent (140 l/s) is discharged to the Black Brook.

The effluent was highly toxic to algae (50-100% inhibition) but low-toxic to Microtox (less than 10% effect). No data on chemical composition are available. The effluent may represent a toxicity problem in the recipient, where the dilution capacity is rather low.

Ostravice River Catchment

BIOCEL - pulp and paper mill (3D)

The Biocel pulp and paper mill in Paskov produces bleached chemical (magnesium bisulphite) pulp,

cellulose, paper and fatened proteins - Torula. About 50% of the pulp is bleached using chlorine, the rest is bleached with permanganate. The production is expected to generate chlorinated and other toxic organic compounds. The effluent is discharged to Ostravice River after mechanical-chemical and biological treatment. The discharge volume is 300 l/s.

Screening toxicity tests, carried out in Nov. 92, Sept. and Oct. 93 showed low toxicity to Daphnia and Microtox. EC50 in the algal test was approx. 50%. A high COD and the brown colour of the effluent show that the waste water contains much dissolved organic material.

In spite of the rather concentrated waste water, as indicated by the colour and organic load of the effluent, the toxicity is low compared to many other pulp mills. The TEF-value is 6. The dilution factor is from approx. 40x at average flow to 5x at 10 days low flow (Q355) in Ostravice River. The ratios CA/EC50 and C355/EC50 are 0.05 and 0.39 respectively.

The effluent from Biocel does not seem to represent a major toxicity problem, although effects can not be ruled out under low flow conditions in Ostravice River. In addition, chlorinated organics, if present, may have long term toxic consequences that are not disclosed by the current screening test.

NOVA HUT - iron and steel works (4D, 5D)

Nova Hut in Ostrava produces pig iron, steel, rolling products, casting and forging and coke. Expected toxic pollutants are oil from metal processing and polycyclic aromatic hydrocarbons (PAH) from the coke plant. The plant has two major discharges to the Lucina and Ostravice Rivers respectively. The discharge to Lucina River is 650 l/s and to Ostravice River 32 l/s. The main effluent to Lucina River is discharged after chemical treatment.

An algal toxicity test has been carried out on the effluent to Lucina River. This showed that the toxicity was rather high. The EC50-value was 4.7%. The reason for the toxicity is not indicated by the chemical analysis. The concentrations of the metals that were analysed are not high enough to explain the toxic effect on algae, and the organic content of the effluent is low. Later toxicity tests (Aug. 93) with Daphnia and fish, however, showed low toxicity (less than 10% lethality).

Due to the toxicity and the large effluent volume, the TEF-value for the discharge to Lucina River is as high as 90. The ratio CA/EC50 is 3.8 and C355/EC50 is 35. These figures indicate that the effluent may cause significant toxic effects in Lucina River even at average river flow.

The discharge to Ostravice River showed low toxicity in the screening tests with Daphnia and Microtox, and the EC50-value for algae was >100%. The concentrations of all metals analysed for were low. The TEF-value for this effluent was less than 0.32 and the potential concentrations after dilution in the river are too low to cause any acute toxic effects.

VALCOVNY PLECHU - sheet mills (1D, 2D)

Valcovny Plechu, located in Frydek-Mistek, produces sheet cold rolling and sheet hot rolling. Expected toxic pollutants are metals and oil from metal processing. Two effluents (130 and 73 l/s) are discharged to Ostravice River after neutralisation and precipitation.

The screening toxicity tests carried out in Nov. 92 and Sept. 93 showed high toxicity to Daphnia, but low effects on algae and Microtox (less than 10% inhibition). The full toxicity test with algae also indicated low toxicity and the EC50-value was >100%. The chemical analysis showed rather low

concentrations of metals, except for chromium (70 µg/l). This concentration of chromium is, however, not high enough to explain the toxicity to Daphnia, which normally is affected only at concentrations above 150 µg/l).

The TEF-value of the main discharge is <1, based on the results from the algal test, and the ratios CA/EC50 and C355/EC50 are 0.01 and 0.1 respectively. These figures do not indicate a high potential for toxic effects in the recieving water, but since Daphnia was significantly more sensitive than algae for this effluent, protection of some species may require a higher dilution rate.

The second effluent from Vakovny Plechu was less toxic to Daphnia, but more toxic to Microtox and algae. The EC50-value for effect on algal growth was 38%. The chemical analysis showed very high concentration of iron (100 mg/l), which may be the reason for the toxicity. The concentrations of other metals were rather low.

The TEF-value for the second discharge is 2, and the ratios CA/EC50 and C355/EC50 are 0.02 and 0.15 respectively. These figures indicate that the discharge is probably not causing significant acute toxicity in Ostravice River.

VITKOVICE - iron and steel works, machinery (6D-10D)

Vitkovice iron and steel works in Ostrava produces pig iron, steel, rolling products, rolling tube, mills cold rolling, casting and forging, and coke. Possible toxic components generated by the production include metals and oil from metal processing and PAH from the coke plant. Four different effluents have been identified, all are discharged to the Ostravice River.

The main discharge (approx. 390 l/s) has been tested only on algae and was found to be low-toxic (EC50>100%). The concentrations of metals were also low. The TEF-value is <4 and the CA/EC50 and C355/EC50 are <0.03 and <0.25 respectively.

A second discharge from the factory, "discharge A" amounts to 150 l/s. This effluent had low toxicity to Daphnia, Microtox and fish. The EC50 for algae was 78%. The metal concentrations were generally low, and the component responsible for the moderate toxicity to algae is not known.

The TEF-value for drainage A is 2. and the ratios CA/EC50 and C355/EC50 are 0.02 and 0.13 respectively.

The discharge volume for the effluent from the dump site is not known. Screening toxicity tests of this effluents showed low toxicity (less than 10% effect) on Daphnia, Microtox and fish. The electrical conductivity indicates a low content of dissolved organics. No further chemical data is available.

The effluent from the fly-ash ponds amounts to 120 l/s. This waste water had low toxicity to Daphnia, microtox and fish, and the EC50 for algae was >100%. The available chemical data indicate low metal concentrations but some cyanides (50-90 mg/l). The TEF value of this effluent is <1.

All effluents from Vitkovice are low-toxic and the results of the toxicity tests do not indicate a high potential for toxic effects in the receiving water. The total volume of effluents is, however about 40% of the 355 days low flow in Ostravice River and under situations of low flow in the river even slightly toxic effluents may affect organisms in the receiving water.

CONCLUSIONS AND RECOMMENDATIONS

The toxicity screening has disclosed some industrial effluents with a high potential of causing toxic effects in the receiving water. Effluents of particular concern are those which have a high production of toxic effluents (i.e. high TEF-values) and those where the concentrations after dilution in the receiving water exceeds the concentration needed to cause toxic effects. For practical reasons this may be expected to be the case when CA/EC50>0.1.

Three wastewaters with high TEF-values have been identified;

Industry	**discharge to**	**TEF**
HCHZ Hrusov	Odra River	231
Bochemie	Bohumin Brook	95
Nova Hut	Lucina River	90

These effluents may have a potential of causing large scale effects. Further assessments are needed to identify the toxic component(s) and to quantify the toxic potential on different organisms. This information will make it possible to assess the impact of the effluent on the receiving water, and guide the measures to control the toxic pollution.

The effluent from **HCHZ Hrusov** gets a high TEF-value mainly because of high toxicity. Several changes in the production have been made lately, and it is not known to which extent this has changed the composition of the waste water, but toxicity tests showed that the effluent was still highly toxic to Daphnia and fish in August 1993. The initial screening has indicated that zinc is the major toxic component, but this has to be further established by chemical analysis. A full dose/response relationship has only been established for algae, and extended tests should be performed also with Daphnia and fish. By comparison of results from these tests with chemical analysis of the same waste water samples it will be possible to disclose whether zinc is causing the toxicity.

The effluent from **Bochemie** was similar to HCHZ Hrusov in toxicity to algae, but because of lower discharge volume it receives a lower TEF-value. The concentrations of copper and zinc are high enough to explain the observed toxicity, but the waste water also contains high concentrations of organic compounds that may have the effect of masking the toxicity of metals but also contributing themselves to the toxicity. As for HCHZ Hrusov, further studies should be done to obtain full concentration/response relationships for Daphnia and fish.

The ratio BOD/COD indicates that some organic components in the effluent are not easily degraded. The organic fraction should therefore be characterized in terms of chemical composition, toxicity and biodegradability.

The main effluent from the treatment plant of **Nova Hut** was toxic to algae according to the results obtained from a sample in November 92. Because of the toxicity in combination with a high discharge volume, this effluent is obtaining a high TEF-value, which calls for further investigations. However, screening toxicity tests with Daphnia and fish carried out in 1993 have not confirmed the toxicity. Therefore screening tests including an algal test should be repeated 2-3 times to disclose if the effluent contains a component which is specificly toxic to algae, or if the algal toxicity observed in the sample from Nov. 92 was an extraordinary situation.

The industrial discharges that are expected to be most harmful to the receiving water, when the toxicity and the dilution capacity of the river is considered are:

Industry	**dischage to**	**CA**	**EC50**	**CA/EC50**
Bochemie	Bohumin	4.76	0.10	48
HCHZ Hrusov	Ostrava	0.06	0.11	0.55
Massag	Bilovka	1.17	4.3	0.27

The effluent from **Bochemie** obtains a very high CA/EC50 ratio due to a combination of high toxicity and low dilution capacity of the Bohumin Brook. From the local conservation point of view, reduction of the toxic discharge is therefore urgent. Further studies necessary for guidance on pollution control measures have been listed above.

In spite of the favourable dilution conditions in Ostrava River the concentration after dilution of the effluent from **HCHZ Hrusov** is still high enough to cause toxic effects as indicated by the inhibition of algal growth. This further emphisizes the need for further studies and pollution control measures as discussed above.

The effluent discharge from **Massag** prosessing works is rather small, but because of its toxicity and the low dilution rate of the Bilovka River, the concentration after dilution in the receiving water may be high enough to cause toxicity. Full toxicity tests with Daphnia and fish should be performed to establish the concentration/response relationship. This would allow an assessment of the potential of toxicity of the effluent as a function of flow rate in the river. Also further chemical characterization should be made in connection with the toxicity tests in order to confirm the finding from the initial testing; that zinc is the main toxic component, or to identify other sources of toxicity.

For some of the effluents that have been studied, the results indicate a high toxic potential, but the available data are either not sufficient to make an assessment or data are conflicting. In both cases the screening should be completed or repeated to clarify the situation.

The effluent discharge from **ZDB** iron and wire work to Bohumin Brook is of the same order as the average flow in the brook. Therefore even a moderate toxicity of the effluent may cause severe effects in the receiving water. The screening toxicity tests show conflicting results, with high toxicity to Daphnia and algae observed on one occasion, in Nov. 92. However, the fish test and the full algal test carried out on a parallel sample showed no effect. Also samples taken in 1993 were not toxic to Daphnia and fish. The results indicate specific effects and variations in the effluent composition. Because of the low dilution capacity of the Bohumin Brook, even toxic discharges of short duration may be harmful. Screening toxicity tests of this effluent should be repeated to investigate variations in toxicity.

The **Movarolen** Textile factory may be a significant pollution source in the Black Brook, where the dilution factor for the effluent is only approx. 5 times at average flow. The screening test showed high toxicity to algae but low to Microtox. No data on chemical composition of this effluent is available. The toxicity screening of this water should be repeated and extended to include Daphnia. A COD-analysis should be performed to indicate the concentration of organic material in the effluent.

For the effluent from **Nova Hut** to Lucina River there are conflicting data on toxicity, indicating either specific effects on algae or variations in toxicity. Since this is a major discharge, diluted only 5.6 times at average flow in Lucina River, the toxicity of this effluent should be checked by repeated screening tests.

Trinecke Zelezarny iron and steel work discharges a large volume of effluent into Olse River. Toxicity screening of the receiving water did not indicate toxic effects, but also the effluent should be characterized by screening tests.

ACTIVITIES IN 1994

The following activities will be carried out in the project in 1994:

1. Extended studies of selected effluents

Sampling of the effluents from HCHZ Hrusov and Bochemie will be carried out in March 1994. Full toxicity tests with fish and Daphnia and algae will be carried as listed below. A biodegradation test will be made on the waste water from Bochemie at a concentration slightly 2x the LC50 for Daphnia (wastewater diluted in water from the Bohumin Brook, upstream of the effluent discharge). The toxicity after degradation will be checked by repeated tests with Daphnia. Samples of the wastewaters will be frozen to allow further chemical characterisation as necessary.

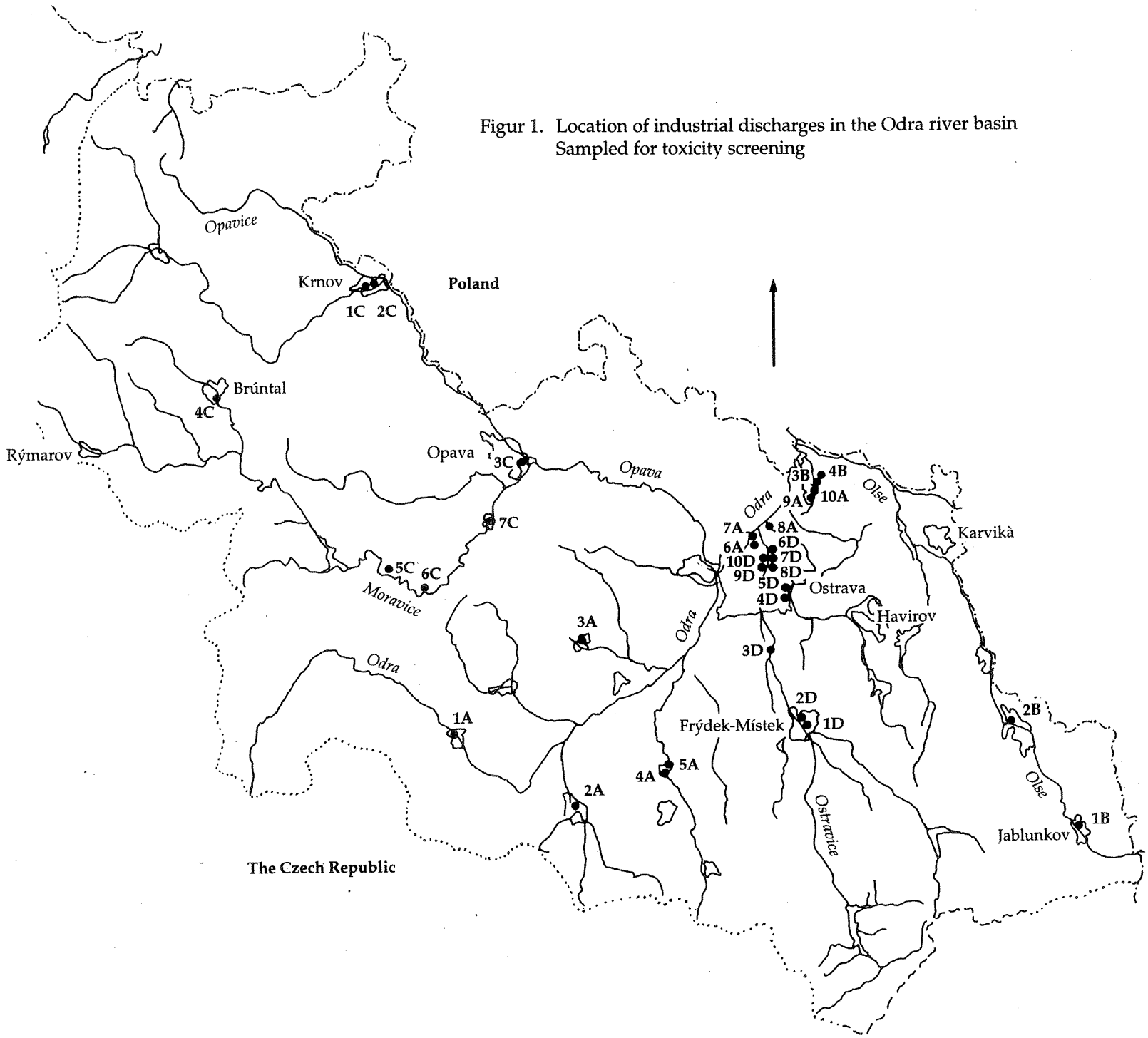
Effluent	**Testing WRI(O)**	**Testing NIVA**	**Chemistry**
HCHZ Hrusov	Daphnia, fish	algae, Daphnia	Zn, Cu, Cd, Cr
Bochemie	Daphnia, fish, biodegradation +Daphnia	algae, Daphnia	Zn, Cu, Cd, Cr, COD,

2. Repeated toxicity screening

Screening toxicity tests including Daphnia, fish and Microtox will be made of the effluents from ZDB (Bohumin), Movarolen textile factory and Nova Hut (Lucina). The tests will be carried out by WRI(O) on three occasions during 1994. Sampling and toxicity screening of the effluent from Trinecke Zelezarny iron and steel works will be carried out at least once.

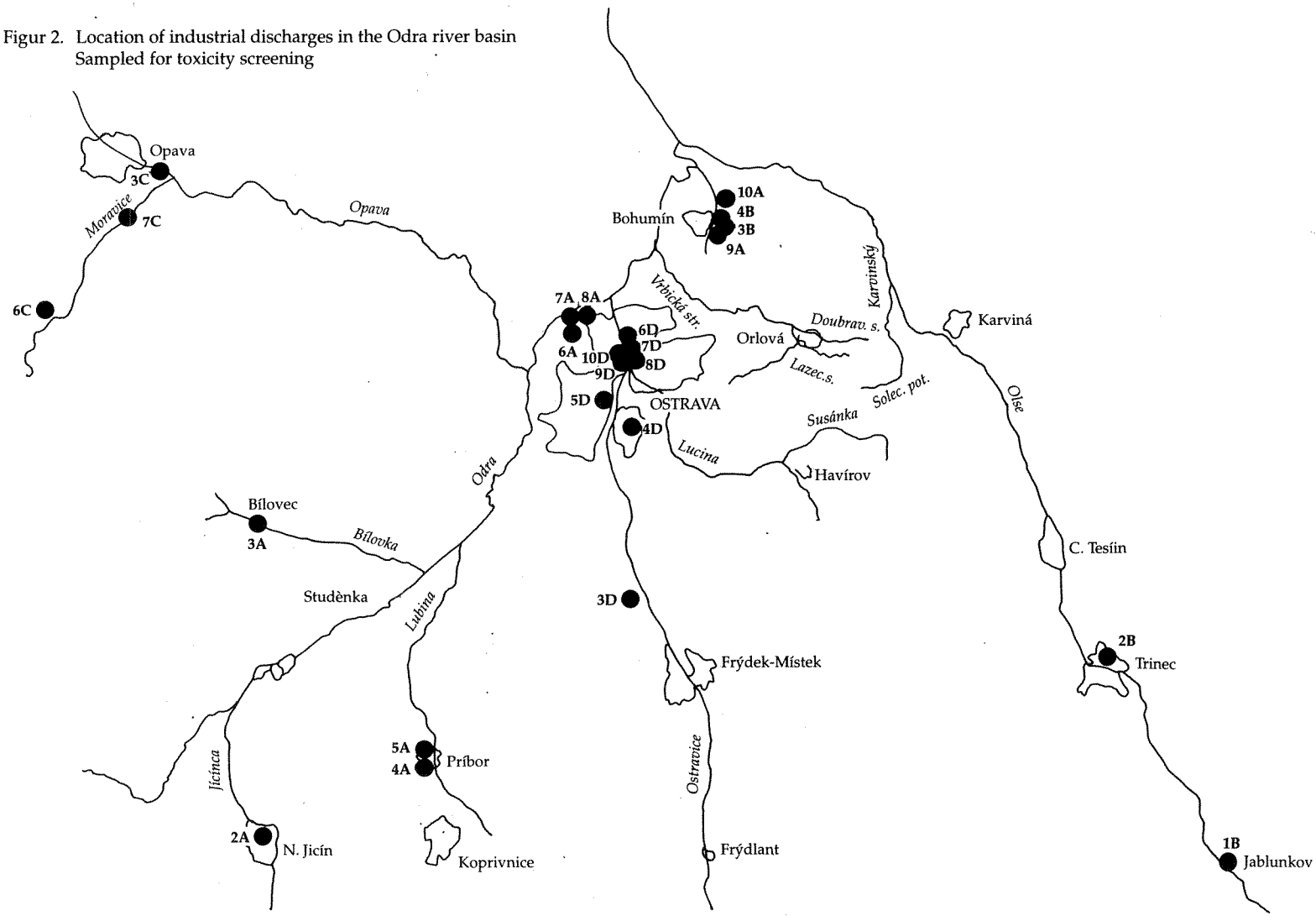
3. Intercalibration

WRI(O) and NIVA will participate in the OECD ring test of the Daphnia reproduction test, which will be used in the next phase of characterisation of selected effluents.



Figur 1. Location of industrial discharges in the Odra river basin Sampled for toxicity screening

Figur 2. Location of industrial discharges in the Odra river basin
Sampled for toxicity screening



Tab. 1. Data on industrial effluents in the Odra river basin

Industry in the North Moravian part of Odra River Basin

Map code	Fact. name	English name	Ind. Type	Products	Location	Discharge to	QA l/s	Q355 (l/s)	Discharge vol. (l/s)	Main pollut.	pH	Conduct. (mS/cm)	BOD mg/l	COD mg/l	Cu (ug/l)	Zn (mg/l)	Cd (ug/l)	Cr (ug/l)	Pb (ug/l)	Hg (ug/l)	Fe (mg/l)	CN (ug/l)	Phenol (mg/l)	EFFLUENT TOXICITY Screening Daph.	Algae	Microt.	Fish	Algal EC50 (%)	RECIPIENT TOXICITY Sediment Daph.	Plan.	Surface water Daph.	Algae	Microt.	Fish	Conc. in recipient (%) CA	C355	CA/EC50	C355/EC50	TEF
Odra																																							
10A	Bochemie Bohumin	Bochemie	Chem	Chloramin, Mercury-chloride, Hydrogen-chloride, Diconite	Bohumin	Bohumin brook	200	200	9.5	organic inorganic mercury?	5-7.68	11.92	99.7	581	54 000	81	140	50	32.1	0.52			<0.26 <0.15	3	3	3	3	0.1	3	3					4.76	4.76	47.56	47.56	95
9A	Zelezarny a Dratovny	Iron and Wire	Metal	White cast Iron, Wire	Bohumin	Bohumin brook	200	200	190.3	metals/cyanid	5.54	4.94	8	20.3	16	0.5	<0.1	3.1	120		102			3	3	2	1	>100							95.13	95.13	<0.95	<0.95	<2
8A	HCHZ Hrusov	Hrusov Chemi	Chem	Barium chemistry Textile Bleaching Ag. Hydro-sulphites	Ostrava-Hrusov	Odra	42000	5830	25.4	organic inorganic	2.7-4.3	1.3		56.4	25.2	92	8.7	21.5	1.1		7.4			3	3	3	3	0.11							0.06	0.44	0.55	3.96	231
6A	MCHZ-Dusikarny	Moravian Che	Chem.	Anilin, Cyclohexanon Phenolic resins Addesives based on urea, formaldehyde	Ostrava - Mar.Hory	Black Stream			3.2	organic	"6-8		99	26-110															3	3	1		1	1					
7A	MCHZ (waste water chanel)					Odra	27700	3780	291.7		6.6	0.7	9.2	23.2	6.1	0.03	0.26	3.2	3.1		0.86			1		1		>100							1.05	7.72	<0.01	<0.08	<3
1A	Optimit Odry	Odry	Other	Rubber products	Odry	Odra	3700	160	25.4	organic	7.2		6.1	50										1		1	1		1	1					0.69	15.85			
2A	Autopal Novy Jicin	Autopal	Machine	Spare parts - Cars	Novy Jicin	Jicinka	1090	60	3.2	metal	8.3-8.5	3.2-5.4		150			<0.1	"10-20				"7-8										1		1	1	0.29	5.28			
3A	Massag Bilovec	Massag	Machine	Met. buttons etc.	Bilovec	Bilovka	270	20		metals	11													3		3	3		3	3					0.00	0.00			
						Bilovka	270	20			11													3		3	3		3	3					0.00	0.00			
						Bilovka	270	20	3.2		12	5.36		75.6	100	4.25	<0.1	380	1.1	0.5	0.43	118		3	3	3	3	4.3	3	3	2			2	1.17	15.85	0.27	3.69	1
5A	Tatra	Tatra	Machine	Cars	Pribor	Lubina	1710	110	3.8	metals, oil																						1		1	1	0.22	3.46			
4A	Lonka	Lonka	Textile	Textile products	Pribor	Lubina	1710	110	3.8	organic	11.1													2		2	2									0.22	3.46			
Olse																																								
2B	TZ Trinec	Trinec Iron an	Metal.	Coke plant, Special Steel	Trinec	Olse	6370	570	1671.1	metals, phenols			3.2																			1		1	1	26.23	293.18			
3B	ZDB Dratovny	Iron and Wire Works				Bajcuvka brook							4.8	30.9																									
4B	ZDB Zelezarny					Bajcuvka brook			39.4		11.38	10.1	3.4	68-210										3	2	1	1	95												0.41
1B	Elektropraga	Elektropraga		Electrical appliances	Jablunkov	Olse	3260	300	1.3	metals	7													"1-2		"1-2									0.04	0.42			
Opava																																								
6C	Olsan. Papirny	Olsan Paper M	Pulp & P.	Paper manufacturing and processing	Zimrovice	Moravice	6650	600	25.4		6.5-7.4		"86.8	40-170										1		1									0.38	4.23			
5C	Kovohute Bridlicna	Non-iron Meta	Metal	Aluminium products	Bridlicna	Moravice	2850	350	34.9		7.6	0.26	10	50										1		1									1.22	9.97			
3C	Galena Komarov	Galena	Pharm.	Pharm. prod.	Opava - Komarov	Opava	14120	2120	15.4	organic	7.2-7.4		19.6	40-174	20-40												2			1			1	0.11	0.73			
7C	Brano (Branecke zelez	Brano	Metal	Metal components	Hradec n. Moravici	Moravice	6800	860	1.0	metals	7.6	0.28	16-84	50-130			<0.1	260-2100				"9-90		1		1									0.01	0.11			
1C	Pradelna	Laundry	Service	Organic, inorganic	Krnov	Opava	3900	660			10.8													3		2									0.00	0.00			
2C	Sievarna nezeleznych	Non-iron Meta	Metal	Metal components	Krnov	Opava	3900	660			5.4													1	3	2									0.00	0.00			
4C	Moravolen	Moravolen	Textile		Bruntal	Black brook	780	70	139.5		7.3													1	3	1									17.89	199.32			
Ostravice																																								
3D	Biocel Paskov	Biocel	Pulp & P.	Pulp mill Mg-sulfite bleached.	Paskov	Ostravice	11800	1530	301.2	organic chlorinated	7.56	5.08	50	309										1		1	1	~50							2.55	19.69	0.05	0.39	6
4D	Nova Hut	New Metallurg	Metal	Var. kinds of steel products, pig iron, coke	Ostrava	Lucina	2390	260	424.4	metals	7.91	1.28	4.3	24.2	130	1.71	18	0.8	16.8		0.2	25.2	0.1	1			1	4.7							17.76	163.23	3.78	34.73	90
5D						Ostravice	11800	1530	41.6	metals	7.12	0.93	3.2	<10	2.6	0.21	0.23	2.1	0.7		0.27	5	0.11	1			1	>100							0.35	2.72	<0.01	<0.02	<0.32
1D	Valcovny plechu (Mai	Sheet Mills	Metal	Sheet rolling	Frydek-Mistek	Ostravice	10450	1310	133.2	metals	"11.84	2.91	3.4	14.4	19.4	0.35		70	1.6		3.69		0.017	3	1	1		>100							1.27	10.17	0.01	0.10	1
2D	Valcovny plechu (Sec /Vedl. Opad/	Sheet Mills	Metal	Sheet mills, Black Pickling, Rolling	Frydek - Mistek	Ostravice	10450	1310	72.9		5.92	0.28	2	75.6	3.8	0.02		0.5	34.8		102		0.009	1		2	1	38							0.70	5.57	0.02	0.15	2
6D	Vitkovice /main discharge/			Heavy machinery, blast		Ostravice	11800	1530	386.9		8.53	0.72		<10	6.7	0.13	<0.1	0.5	6.6		1.09			1		1		>100							3.28	25.28	<0.03	<0.25	<4
7D	Vitkovice (Black lake)	Vitkovice Iron	Metal	furnace, rolling mills, pickling, casting	Ostrava - Vitkovice						7.2-7.8	0.5-1.1	3.0-4.4	16-60		0.13-8.2						34-40	<0.14	1		1													
8D	Vitkovice(dumping site outlet)								3.2		7.28	1.31												1		1	1												
9D	Vitkovice (drainige A)					Ostravice	11800	1530	152.2	phenols/oil	8.37	0.68	13.7	26.5	19.4	0.13	1.25		72.1			<80	<0.19	1		1	1	78							1.29	9.95	0.02	0.13	2
10D	Vitkovice (fly ash ponds)						11800	1530	120.5		9.56	1.02		9.9		0.02-0.19						50-90	<0.08	1		1	1	>100							1.02	7.88	<0.01	<0.08	<1

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