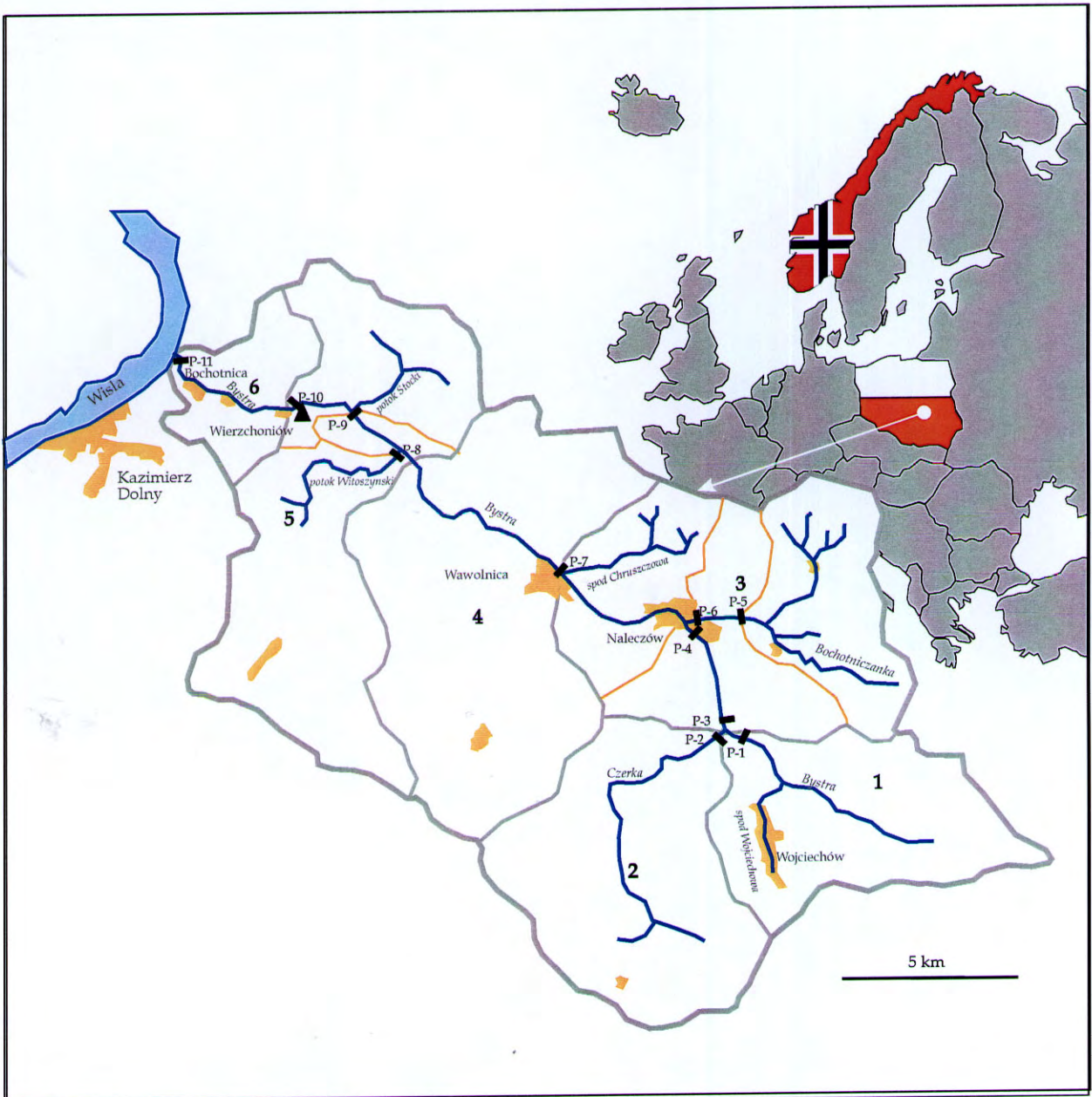


# Master and Action Plans Concept: Wastewater Management

*Norwegian Methodology Illustrated  
with a Case Study for the Bystra  
River Catchment, Poland*



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<b>Abstract</b> This project: "Strategy for integrated Water Supply, Wastewater Treatment and Disposal System for Small Communes in Poland: <i>Case study - Master and Action Plans (MaAP) for the Bystra river catchment</i> ", is a part of the Programme of Bilateral Co-operation between the Norwegian Ministry of Environment and the Ministry of Environmental Protection, Natural Resources and Forestry in Poland. It has been implemented by the Norwegian Institute for Water Research (NIVA) and has been funded by the Norwegian Pollution Control Authority (SFT). The Institute of Environmental Protection (IOS) in Poland has been responsible for the co-ordination in Poland, sponsored by the National Foundation for Environmental Protection and Water Management.  This report presents the principles of the Norwegian methodology for making master plans for wastewater management, based on the guidelines from SFT. The methodology is illustrated with a case for the Bystra river catchment in Poland.
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**Master and Action Plans Concept:  
Wastewater Management**

*Norwegian Methodology  
Illustrated with a Case Study for the  
Bystra River Catchment, Poland*

O - 96154

## Preface

This project: “*Strategy for Integrated Water Supply, Wastewater Treatment and Disposal Systems for Small Communes in Poland; Case study – Master and Action Plan (MaAP) for the Bystra River Catchment*”, is part of the Programme of Bilateral Co-operation between the Norwegian Ministry of Environment and the Ministry of Environmental Protection, Natural Resources and Forestry in Poland. From the Norwegian side, the Norwegian Institute for Water Research (NIVA) has implemented the project, funded by the Norwegian Pollution Control Authority (SFT). The Institute of Environmental Protection (IOS), Warsaw, has been responsible for the co-ordination in Poland, sponsored by the Polish National Foundation for Environmental Protection and Water Management.

Six reports have been written during this project, namely:

- Programme of Sanitation and Water Protection in the Bystra River Catchment, Phase I (IOS, September 1996)
- Programme of Sanitation and Water Protection in the Bystra River Catchment, Phase II (IOS, December 1996)
- Strategy for Integrated Water Supply, Wastewater Treatment and Disposal Systems for Small Communes in Poland; Phase I, Data gathering (NIVA, April 1997)
- Programme of Sanitation and Water Protection in the Bystra River Catchment, Phase III (IOS, May 1997)
- Master & Action Plans Concept; Wastewater Management; Norwegian Methodology Illustrated with a Case Study for the Bystra River Catchment, Poland (NIVA, September 1998)
- Strategy for Integrated Water Supply, Wastewater Treatment and Disposal Systems for Small Communes in Poland; Final Report (NIVA, September 1998).

This report presents the principles of the Norwegian methodology for making master and action plans for wastewater management, based on SFT guidelines. The methodology is illustrated with a case study for the Bystra river catchment in Poland.

Key persons in the project have been:

- Prof. dr. Barbara Osmulska-Mròz, Polish Project Manager (IOS; Institute of Environmental Protection, Poland)
- Ms Grazyna Englund, Norwegian Project Manager (NIVA; Norwegian Institute for Water Research)
- Dr. Krzysztof Wierzbicki, Chairman of the Steering Committee (IBMER; Institute for Building, Mechanisation and Electrification of Agriculture, Poland)
- Mr Gunnar Fr. Aasgaard, Norwegian member of the Steering Committee (ANØ; Romerike Environmental Competence Centre, Norway)
- Mr Stig A. Borgvang, Project co-worker Manager (NIVA; Norwegian Institute for Water Research).

We would like to thank the Polish partners for their contribution. A special thanks to prof. dr. Barbara Osmulska-Mròz and assoc. prof. dr. Pawel Błaszczyk, IOS for constructive comments to this report.

Oslo, September 1998

*Grazyna Englund*  
*Project manager*

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## Summary

The project «Strategy for Integrated Water Supply, Wastewater Treatment and Disposal Systems for Small Communes in Poland» was established in 1996, as a bilateral project between Poland and Norway. The goals for the project were technology transfer, development of professional competence and network and educational input. Potential follow-up activities should also be identified in the project.

Presentation of the Norwegian methodology for elaboration of master plans for wastewater management represents the main Norwegian contribution to the project. According to Norwegian guidelines (SFT, 1994) two versions of such a plan are recommended:

- Plan version 1; for politicians. Conclusions and the main assumptions and evaluations should be emphasised.
- Plan version 2; for the administration. This main report will in detail present facts, assumptions, evaluations and measures. Procedures for future control and documentation of achieved results should also be presented in this report.

The Norwegian methodology is briefly presented in Section 2. In Section 3 this methodology is used for the Bystra river catchment, based on the above-mentioned «Plan version 1». The Polish partner in the project, Institute of Environmental Protection (IOS), has prepared all the necessary information required for the «Plan - version 2».

In addition to the presentation of the Norwegian Master Plan methodology, some recommendations are given for the forthcoming process in the four Bystra communes, with regard to the implementing of the proposed measures. The main recommendations are:

- ➔ *To continue the monitoring of the water quality in the Bystra river, including some flow proportional samples. This will make it easier to develop a mass balance budget in the catchment for phosphorus, organic matter and other relevant parameters. Such a mass balance is necessary in order to estimate the benefits of future measures.*
- ➔ *To perform a cost-effective analysis when deciding on centralised or decentralised wastewater solutions.*
- ➔ *To prepare the wastewater treatment plants for chemical precipitation, to be implemented at a later stage, in order to reduce the eutrophication of the Bystra river.*
- ➔ *To evaluate centralised sludge treatment at the Nalęczów wastewater treatment plant, using a filter press for dewatering and lime stabilisation, for further use as fertiliser.*
- ➔ *To establish one central operational unit to operate and manage the wastewater treatment plants in the Bystra catchment, including the sewerage systems.*
- ➔ *To design and implement an environmental surveillance programme and to present the results in the Annual Report for the wastewater sector.*
- ➔ *To design and implement a tariff structure based on «full cost recovery».*
- ➔ *When planning the new central and local wastewater treatment plants, combined treatment with the industrial wastewater should be evaluated.*
- ➔ *The process in Wawolnica, trying to motivate the farmers to aggregate their farms into larger units, should be continued, and the other three communes should also define a strategy to reduce the pollution from agriculture.*

# 1. Purpose and Structure of the Report

There are three main purposes of this report:

1. To provide politicians and other decision makers of communes, local authorities and Regional Boards of Water Management connected with the Bystra river catchment with brief and concise information as regards the sanitation in the area, based on which they can decide on measures to improve the situation
2. To provide parties without technical background with information about issues connected to the development of a Master Plan for wastewater management
3. To contribute in the further development of Polish Master Plan methodology, using the Bystra river catchment as a demonstration case for a conceptual presentation of Norwegian methodology.

The structure of the report is based on the current Norwegian Master Plan guidelines for wastewater management (SFT, 1994). Elements from the Norwegian guidelines for setting environmental objectives for water resources (SFT, 1998) are also included in the report.

Each section begins with a brief presentation of the Norwegian approach to the subject. Thereafter a summary of the Bystra catchment situation is given.

The Polish partner in this bilateral project, the Institute of Environmental Protection (IOS), Warsaw, has prepared the necessary information and data for preparation of tendering documents, presented in three volumes (IOS-I, 1996; IOS-II, 1996 and IOS-III, 1997). Most information about the Bystra river catchment in this report is based on these three IOS reports. The direct contacts between NIVA and the Polish partners during visits of the catchment represent an additional indispensable source of information.

## 2. Methodology

### ***2.1 Introduction: Trends in Wastewater Policy in Norway***

#### «Management by setting Objectives» in the Wastewater Sector

The Master Plan methodology used in this report is based on the Norwegian guidelines, published in 1994 (SFT, 1994). This section gives a summary of these guidelines.

The municipalities are facing large environmental challenges, both of regional and local character. To attain the environmental objectives, without being a threat to other important public goals, the politicians demand a cost-effective strategy.

In Norway, it is recommended that each municipality develops a Master Plan in order to get an integrated approach to the wastewater sector, and to balance different elements influencing the water quality. For the environmental authorities, the plan will be a contribution to the municipalities when setting environmental goals for the water resources. This reflects the Norwegian policy with more frequent use of *environmental* standards instead of detailed *technical* standards. «Management by setting objectives» will then be the local approach for wastewater management, and achieved results will be reported to the authorities.

#### Quality Control through «Environmental Audition»

Norwegian authorities prepare the framework for the municipal process on setting environmental *objectives* for the water resources. The municipalities are responsible for the quality control (internal control), based on a monitoring programme, agreed by the regional authorities.

The quality control from the *authorities* will be based on «environmental auditions», which means that officers from the regional environmental authorities visit the municipality to discuss reported “gaps” between the environmental objectives and the current situation.

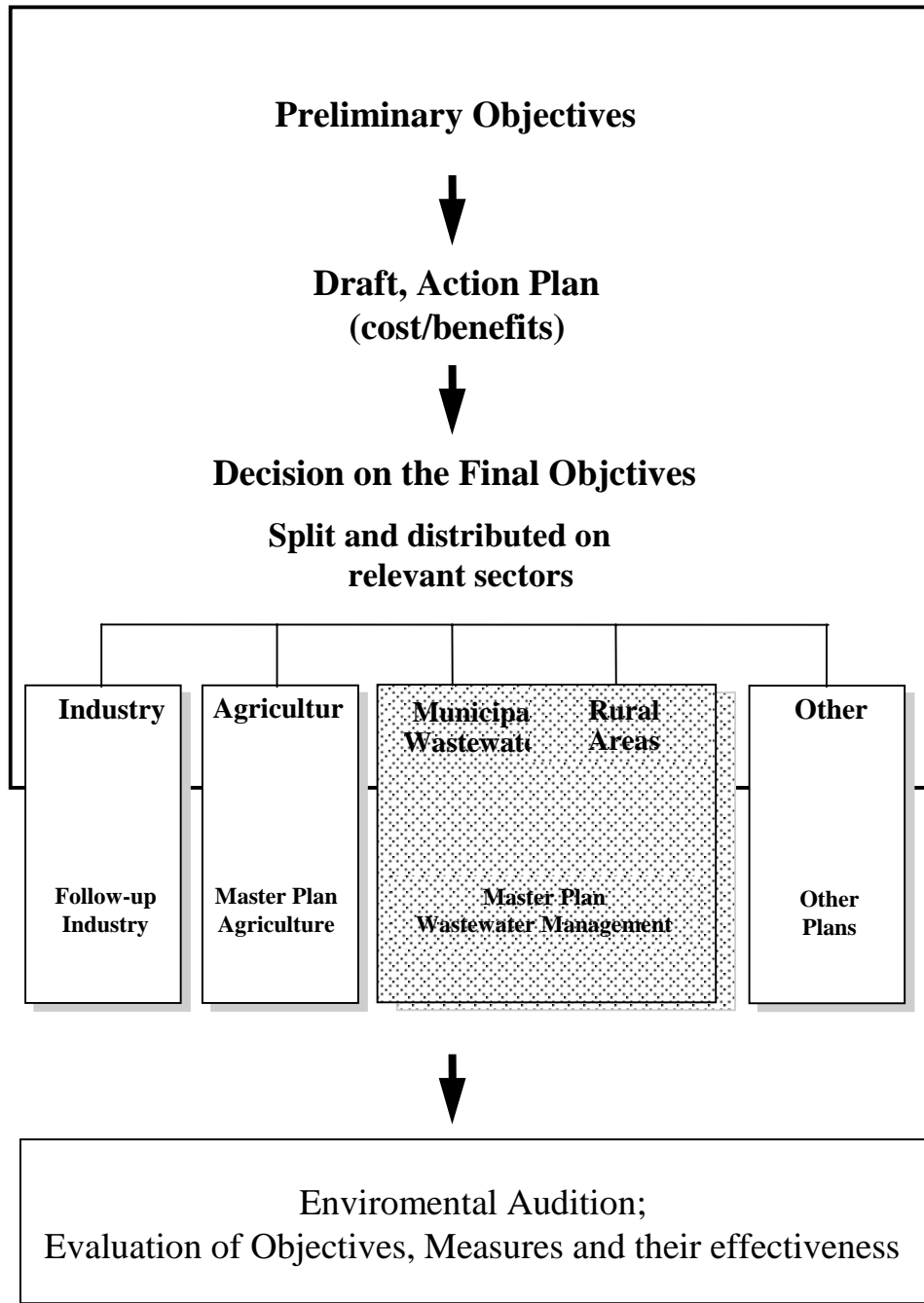
Figure 1 illustrates the link between setting of municipal environmental objectives and Master Plan for wastewater management.

#### Total costs recovering

An adequate charging system should ensure that sufficient funds are available to enable the efficient operation of wastewater systems, including asset maintenance and replacement.

The Norwegian environmental authorities have envisaged that the municipalities charge their users with 100 % of the total costs for the construction, operation and maintenance of the wastewater system.





**Figure 1.** The links between environmental objectives and a Master Plan

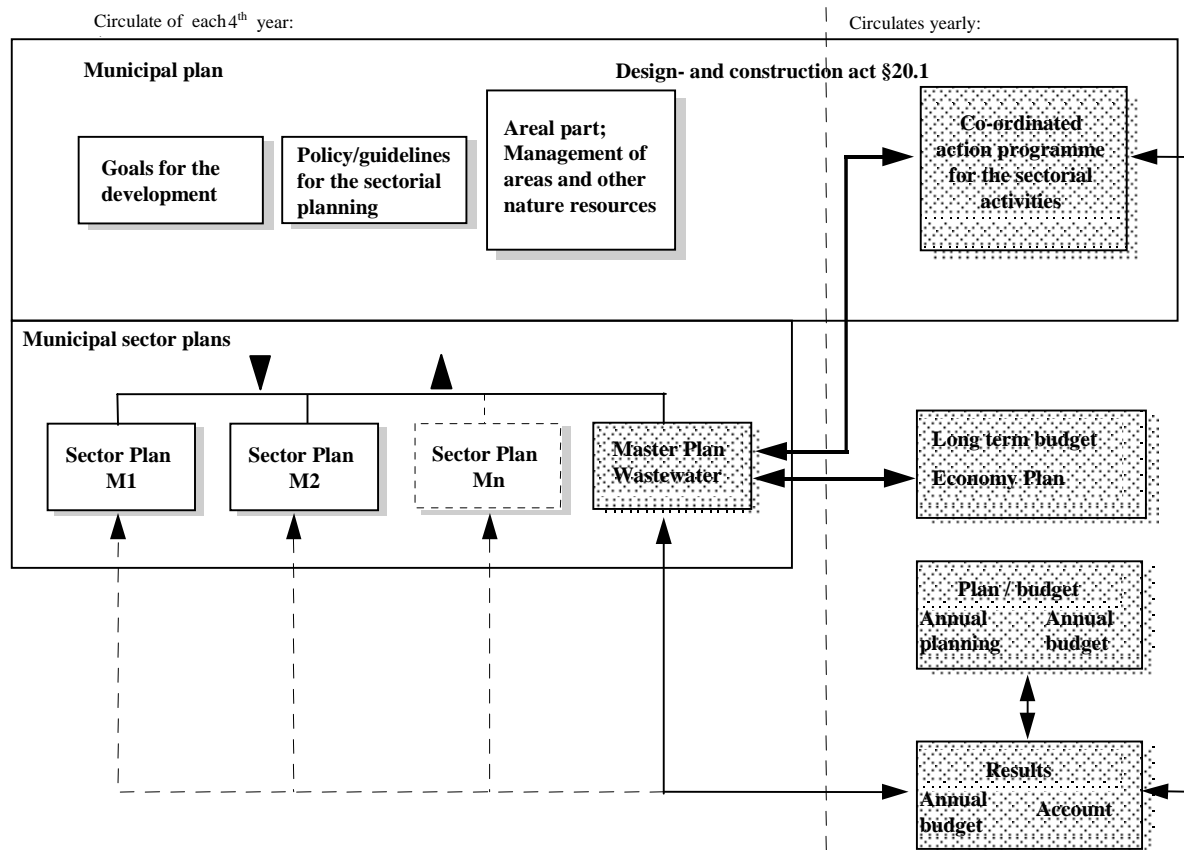
## ***2.2 Municipal Plan and Master plan for Wastewater Management***

The Municipal Plan is the most important tool to ensure co-ordination and control of all production and use of resources in the municipalities. The plan describes the long-term goals for the municipal development, policy for the planning process in the various sectors and an areal part, which describes management and use of areas and other nature resources. The long-term section has a 12-15 years perspective. Municipality *sector* plans (Master Plans) for the relevant sectors in the municipality

(schools, health services, roads, agriculture, solid waste management, wastewater management, etc.) are generally upgraded every fourth year, following the frequency for election of members to the local government. The concept for these sector-wise municipality plans may vary dependent on the national (or regional) policy and procedures for each sector.

The short-term section consists of a yearly upgrading of the measures and actions described in the Master Plan.

Figure 2 illustrates the concept for the municipal planning, according to Norwegian procedures.



**Figure 2.** Concept for municipal planning procedures in Norway

Long -term budget

Budget consequences, according to the Master plan, are included in the long-term budget («Economic Plan») in the municipalities. The following elements should be included:

- Plan for investments, with milestones
- Operational and capital costs
- Plan for financing the costs
- Calculation of expected total fees for the wastewater sector.

### Annual planning and budgeting

The Action Plan developed from the Master Plan should be reflected in the annual budgets and plans for all the departments in the municipality, which have tasks within Wastewater Management.

### Regional co-operation

To obtain cost-effective solutions, the municipalities are encouraged to co-operate in setting water quality objectives for the regional water resources, and in planning/implementing measures to reach these objectives.

Several municipalities in Norway have established co-operation within water supply and wastewater management. The benefits from such co-operation are expected to increase as the tasks get more complicated and more resource demanding.

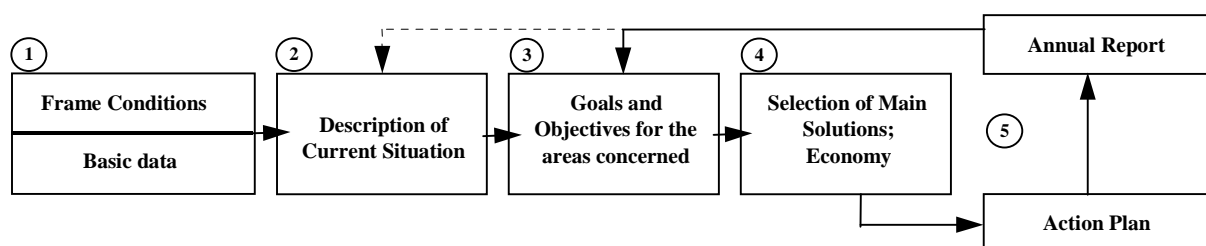
A regional plan for a catchment area must identify and emphasise the consequences for each municipality. The plan may then be integrated in the Master Plans in the municipalities, with links to the local budgets.

## 2.3 Concept and Content of a Master Plan for Wastewater Management

Since the Master Plan is promoting the connection between objectives and measures, including the implementing costs, this plan is well adapted to be a document for political management. The *concept* of a Master Plan for wastewater management, which is presented in this section, is recommended for all Norwegian municipalities, without regard to the size or complexity of the wastewater system. Local conditions, however, will of course influence the content and comprehensiveness of each Master Plan.

### Plan document

The emphasise on objectives, measures and costs is common for all Master plans. The concept is shown in Figure 3.



**Figure 3.** The concept of a Master Plan

The Master Plan should be «user friendly», both for politicians and administrators. Two versions of the plan are recommended:

- Plan - version 1: *for politicians*: Conclusions, main assumptions and evaluations should be emphasised
- Plan - version 2: *for the administration*: This main report should present, in detail, facts, assumptions, evaluations and measures. Procedures for future control and documentation of achieved results should also be presented in this version.

The Norwegian Pollution Control Authority (SFT) recommends that the political part of the Master Plan (plan - version 1) should have the following content:

PREFACE

SUMMARY

1. FRAME CONDITIONS

2. DESCRIPTION OF CURRENT SITUATION

2.1 *The water resources related to user interests in the area*

2.2 *Pollution sources*

2.3 *Infrastructure; location and technical condition*

2.4 *Management and institutional options*

2.5 *Economy*

3. GOALS AND OBJECTIVES

4. ABATEMENT STRATEGY AND MEASURES

4.1 *The gap between status and objectives*

4.2 *Identification of potential measures and their cost-effectiveness*

4.3 *Strategy to meet the objectives*

4.4 *Selection of measures for the planning period*

4.5 *Costs and financial options*

5. ACTION PLAN

6. ANNUAL REPORT

A brief indication of what should be presented in each section is given below.

Preface

*The municipality should briefly describe the background for the Master Plan and its links to other relevant plans and political documents. A presentation of the visions of the municipality, related to the environment and sustainable development, should also be included in the preface.*

Summary

*The summary should briefly describe the main objectives with regard to the water resources and wastewater sector, and present the main measures and their consequences for the overall municipality plan, including the long-term budget. The summary should also indicate how the costs would be implemented in the yearly planning and budgeting-process.*

1. Frame Conditions

*In the introduction to the Master Plan the frame conditions, from which the planning process in the municipality will be restricted, should be identified.*

2. Description of the Current Status

*A summary of the current situation should be presented in this section, in areas that are relevant for the wastewater sector. Main topics may be:*

- *The environmental conditions and user interests in the water resources; preferably by using national standards for water quality*
- *Pollution sources (point sources and diffuse sources); Municipal and industrial wastewater, surface run-off from agricultural fields, discharges from rural areas, aquaculture plants, tourist centres, natural background pollution, etc.*

- *The technical condition on the existing wastewater treatment plants and sewers, including pumping stations and facilities for sludge treatment*
- *Management and institutional options. Administrative structure and procedures for decisions, cross-sectorial and regional co-operation, and capability of implementing the Action Plan. All these elements are important factors for a successful implementing of a Master Plan in the wastewater sector*
- *Economy: Capital costs (from investments), annual costs for operation, maintenance and administration and how the costs are financed (fees, grants, loans).*

### 3. Objectives

*The state of the local water environment - the receiving water quality - may require higher treatment efficiency in a wastewater treatment plant than set by legislation. This will, in part, be due to the user interests in the water resource (i.e. water supply, bathing, and recreation), both present and future. This leads to the concept of water quality objectives being used to determine discharge standards. Such objectives can be integrated into environmental protection through integrated river catchment and river basin management plans that take a holistic view of the combined impact of all discharges.*

*When decision for use of water has been made, the municipality has also decided upon the goals for the quality of the water resources, ref. national water quality criteria. To meet these goals, objectives for the areas concerned (i.e. municipal and industrial wastewater, agricultural run-off and discharge from rural areas) should be set.*

### 4. Abatement Strategy and Measures

*The output of the Master Plan should be a strategy and a list of measures, which enables the municipality to meet its objectives at lowest possible costs. The planning procedure should follow these five steps:*

- *Identify the gap between the current situation and the objectives. The validity of the data used, and the influence of natural variations from one year to another should be considered*
- *Identify potential measures and evaluate their cost-effectiveness*
- *Strategy to meet the objectives, where these elements should be evaluated:*
  - *Continued monitoring and documentation of the environmental situation, to improve the basis for decision on measures*
  - *Evaluation of centralised or decentralised solutions*
  - *Sludge treatment and disposal*
  - *Wastewater management: Run by the municipality itself, through regional co-operation or by a private wastewater company*
  - *Surveillance programme to evaluate effects of measures*
  - *Information policy*
  - *Financial strategy for cost recovery (capital and operational costs)*
  - *Strategy regarding industry and agriculture*
- *Decision on measures (concepts) to be implemented, which will be presented in more detail in the Action Plan*
- *Costs and financial options.*

---

### 5. Action Plan

*The Action Plan should be based on the Master Plan (Section. 3.1 - 3.6) and should present a yearly plan for actions to be done. The Action Plan should be a separate document, prepared for decision-makers and politicians in the municipalities involved, and for financial institutions supporting the implementation of the plan.*

*The Action Plan should be concise and exact. User friendly presentation of figures and costs should be emphasised. Below is a list of recommended content of the Action Plan:*

- *A list of prioritised measures and their costs*
- *Expected achievement of the objectives when implementing the measures*
- *Funding/cost recovery*
- *Milestones and co-ordination of cross-sectorial measures.*

### 6. Annual Report

*The Annual Report, to local politicians and regional environmental authorities, should give a presentation of the results and investments from the previous year, within the wastewater sector.*

*The main purpose is to document the achieved results related to the expectations and use of resources. This may lead to adjustments in the Action Plan for the following year. Evaluation of the implementation for the environmental effects should also be documented. By making a user-friendly document, the Annual Report might have a positive effect on the marketing of the wastewater sector.*

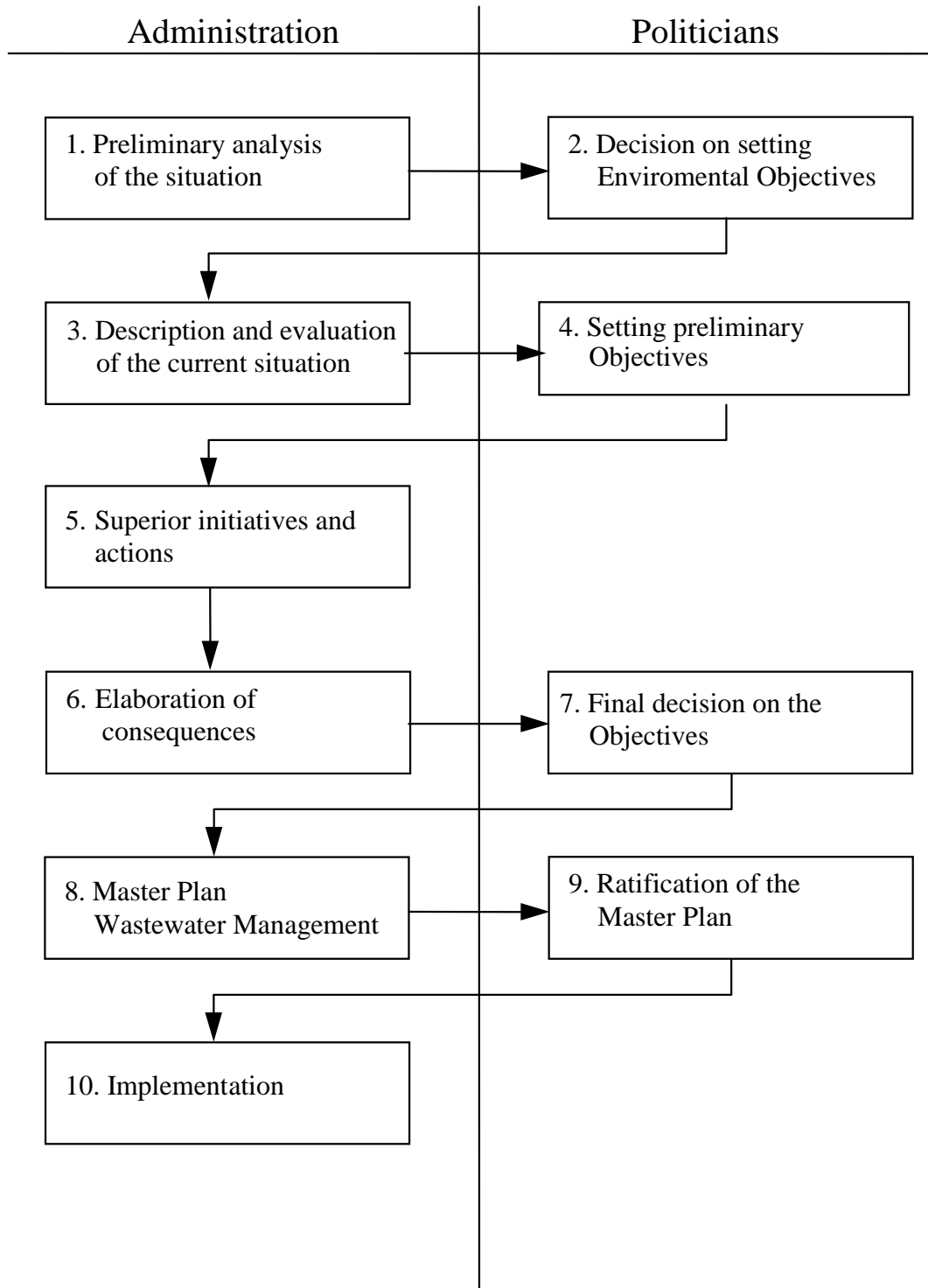
## **2.4 Organising the Elaboration of a Master Plan**

The administration should have the responsibility of taking the initiative, organise and run the planning process. This should, however, be performed in co-operation with and controlled by the politicians. A close co-operation between politicians and the administration from the start of the planning process is strongly recommended. This should result as a constructive, fruitful and efficient process.

A steering group should be appointed, with representatives from the head of the municipality (political and administrative leadership), municipal departments and other relevant organisations.

Employees in the technical department, eventually assisted by external consultants will usually carry out most of the work (fact-findings, calculations, evaluations and reporting).

An example of interaction between administrative and political involvement in elaboration of a Master Plan is presented in Figure 4.



**Figure 4.** An example of interaction between administrative and political involvement in the elaboration of a Master Plan

## 3. Master Plan for the Bystra River Catchment

### 3.1 Preface

*The municipality should briefly describe the background for the Master Plan and its links to other relevant plans and political documents. A presentation of the visions of the municipality, related to the environment and sustainable development, should also be included in the preface.*

#### **The Bystra River Catchment:**

The four municipalities in the Bystra River Catchment; Nałęczów, Kazimierz Dolny, Wąwolnica and Wojciechów, have established a co-operation project (Association for the Bystra Valley), based on their common vision for the region:

- Firstly, to improve the sanitation living conditions by establishing satisfactory treatment solutions for all inhabitants in the area concerned (extension of water supply facilities, sewerage systems, wastewater and waste management).
- Secondly:
  - To develop a «green region», with well established infrastructure - all based on a sustainable/ecological development
  - To improve the Bystra river quality to such degree that the users will be satisfied
  - To reduce erosion/sedimentation transport into the river.

The purpose of the Master Plan is to describe in a succinct way the tools necessary to establish the infrastructure required and to improve the environmental conditions. Local and regional authorities should use the plan when deciding on the strategy to be adopted in order to reach the goals set.

According to the Norwegian methodology for Master Plans (see section 2), it is recommended to produce two reports;

- One detailed, *technical oriented plan* meant for the technical administration in the municipality
- One *summary report*, addressing the politicians and decision-makers.

The technical report of the project has been developed by IOS and is presented in three volumes; Phases I, II and III.

This summary report is mainly aimed at decision-makers in the municipalities involved, focusing on the main results of the project. References are given to the three IOS-reports for details and background information. Part of the information was also obtained during direct discussions with representatives of the communes.

The structure of this summary report is based on the Norwegian guidelines for Master Plans (see Section 2).



### 3.2 Summary

*The summary should briefly describe the main objectives with regard to the water resources and wastewater sector, and present the main measures and their consequences for the overall municipality plan, including the long-term budget. The summary should also indicate how the costs would be implemented in the yearly planning and budgeting process.*

#### The Bystra River Catchment:

The focus for the Master Plan is to identify measures to meet the objective of establishing satisfactory sanitation conditions, with regards to *sewerage systems and treatment solutions*. In the *prioritisation* of the measures, the influence on the other identified objectives, listed in Section 3.5, and should also be evaluated.

#### Current situation

The current sanitation situation with regard to connection to municipal waterworks and wastewater treatment plants is shown in Figure 5.

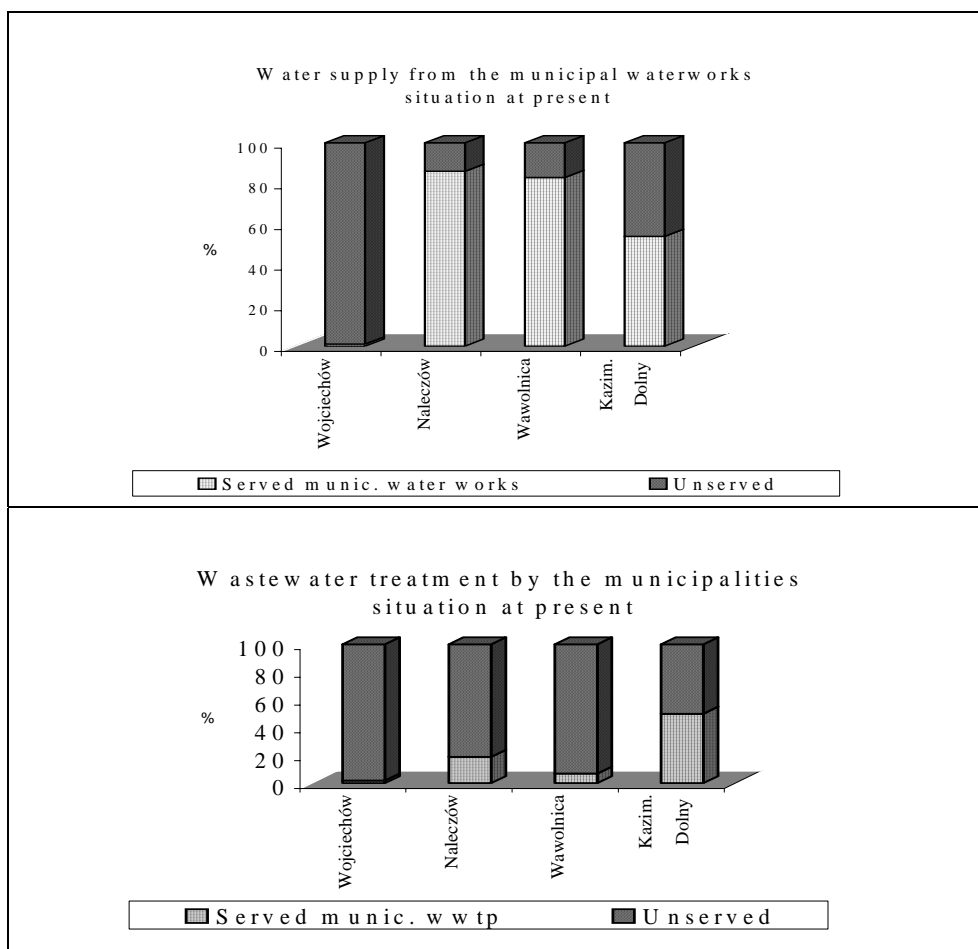


Figure 5. Current sanitation situation

## Abatement strategy

In the wastewater sector, three types of measures are evaluated:

- Central wastewater treatment
- Local wastewater treatment
- Individual treatment.

In a *central* treatment plant the wastewater from two or more places/villages is transported to one, central wastewater treatment plant. A *local* plant serves only one village.

The Polish Institute of Environmental Protection (IOS) has launched and evaluated three different approaches to wastewater management in the Bystra catchment, representing different combinations of the three categories of wastewater treatment, viz:

- Alternative I; 8 central and 7 local treatment plants, 17 sites with individual solutions
- Alternative II; 6 central and 6 local plants, 57 sites with individual solutions
- Alternative III; 9 central and 4 local plants, 38 sites with individual solutions.

Cost Effectiveness Analysis (CEA) is an important procedure for assuring the rational use of financial resources in achieving the environmental standards. CEA can be applied to select those options, which achieve the environmental standards at lowest cost.

In the Bystra catchment the CEA approach is used to select measures based on the ratio between the costs and the benefit of the measure. The parameters having the largest «gap» between the current situation and the defined objectives, ref. Table 4 in Section 3.6.1, should be used in the CEA. These parameters are:

- Number of persons without satisfactory sanitation conditions
- Phosphorus concentration in the Bystra river, and
- The bacteria concentration in the Bystra river.

## Recommended measures

Based on the cost-effective analysis (Section 3.6.2) alternative II was chosen as the best group of measures for the Bystra catchment. This alternative includes the following measures:

- 6 central wastewater treatment plants;  
Mechanical-biological treatment (activated sludge or biological filters), prepared for disinfection of the effluent and with an option of adding chemical precipitation. Container-plants are preferred when the capacity doesn't exceed 200 m<sup>3</sup>/d:
  - Palikije (204 m<sup>3</sup>/d)
  - Nałęczów (3320 m<sup>3</sup>/d)
  - Drzewce (180 m<sup>3</sup>/d)
  - Wąwolnica-Mareczki (410 m<sup>3</sup>/d)
  - Celejów (230 m<sup>3</sup>/d)
  - Bochońnica-Kazimierz Dolny (expansion of the existing wastewater treatment plant)
- 6 local wastewater treatment plants (same configuration as mentioned above):
  - Łubki (50 m<sup>3</sup>/d)
  - Czesławice (23 m<sup>3</sup>/d)
  - Łopatki (85 m<sup>3</sup>/d)

- Witoszyn (36 m<sup>3</sup>/d)
  - Wierzchniów (43 m<sup>3</sup>/d)
  - Stok (32 m<sup>3</sup>/d)
- 57 individual solutions (13 331 PE; 2000 m<sup>3</sup>/d); septic tanks with or without infiltration to the ground, dependent on local conditions (permeability, contamination of private wells).

Sludge treatment; central sludge treatment at Nałęczów wastewater treatment plant, using a filter press for dewatering and lime stabilisation, for further use as fertiliser.

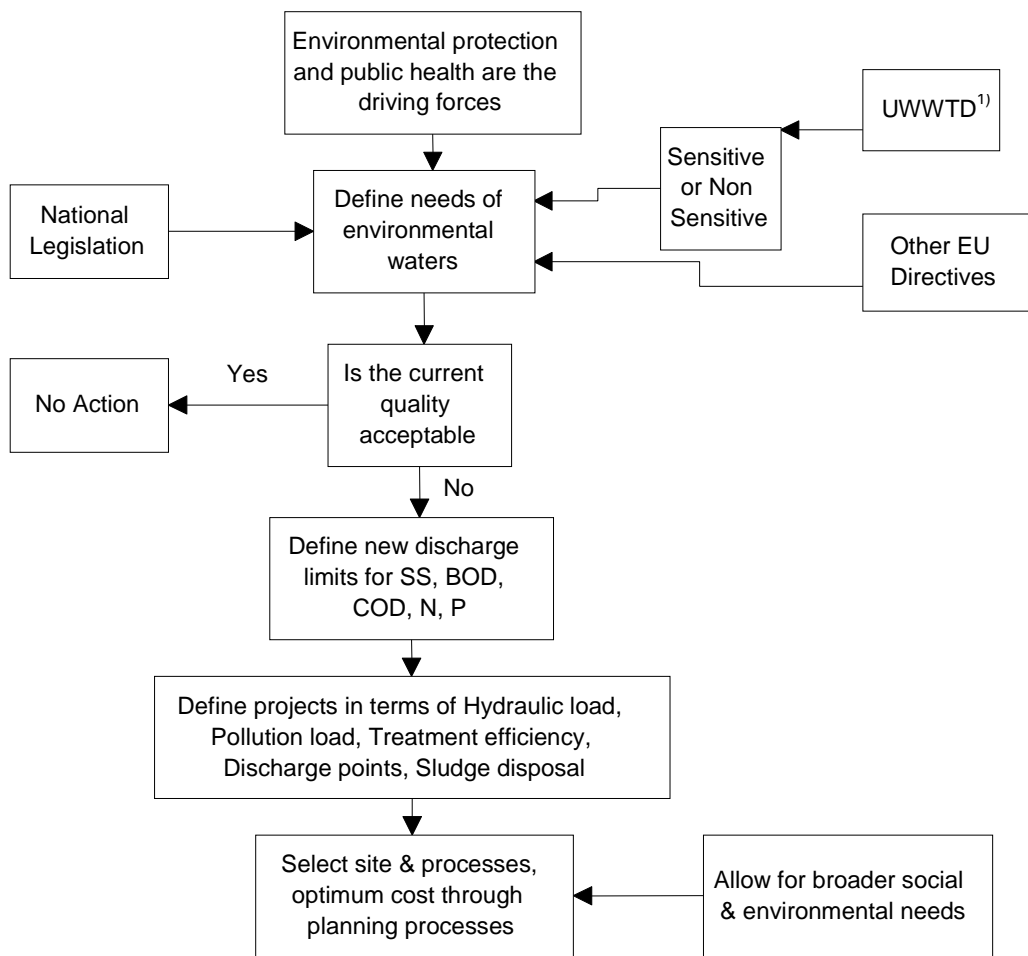
#### **Consequences for the short- and long term budgets**

Other than in exceptional circumstances, the full cost of providing a wastewater service, including charges for loans and depreciation, should be charged the users of the service.

The consequences for the short- and long-term budgets have not been evaluated in the project group.

### 3.3 Frame Conditions

*In the introduction to the Master Plan, the frame conditions should be identified. Examples of such frame conditions are presented in figure 6 (EEA, 1998).*



**Figure 6.** Potential frame conditions for making a Master Plan

<sup>1)</sup> UWWTD = Urban Waste Water Treatment Directive (Directive 91/271/EEC)

#### The Bystra river catchment:

For the Master Plan for the Bystra river catchment, national and international legislation, regional and local decisions and other relevant documents and activities have been considered, see the IOS-reports (IOS-I, IOS-II, and IOS-III).

### 3.4 Description of Current Situation

*In this section a summary of current situation should be presented, in areas which are relevant for the wastewater sector. Main topics may be:*

- *The environmental conditions and user interests in the water resources; preferably by using national standards for water quality*
- *Pollution sources (point sources and diffuse sources); Municipal and industrial wastewater, surface run-off from agriculture, discharges from rural areas, aquaculture plants, tourist centres, background pollution, ...*
- *The technical condition on the existing wastewater treatment plants and sewers, including pumping stations and facilities for sludge treatment*
- *Management and institutional options. Administrative structure and procedures for decisions, cross-sectorial and regional co-operation, and capability of implementing the Action Plan. All these elements are important factors for a successful Master Plan in the wastewater sector*
- *Economy; Capital costs (from investments), annual costs for operation, maintenance and administration and how the costs are financed (fees, grants, loans).*

#### **The Bystra river catchment:**

The Bystra river is a tributary of the Vistula river, they join downstream of Kazimierz Dolny, close to the Bochothnica village. The Bystra river catchment belongs administratively to Lublin Voivodship and is located in the unit area of water balance Z-1, managed by the Warsaw Regional Board of Water Management (RZWG).

The Bystra river catchment represents an area of 295.7 km<sup>2</sup> and is situated geographically on the Naleczów Plateau. The area includes two protected districts:

- The Kazimierski Landscape Park (27 % of the total catchment area) and its buffer zone (73%)
- The Sanatorium area in the Naleczów region.

The Bystra Valley is the ecological regional corridor connecting the protected area system of the main Lublin Highland rivers Bystrzyca and Wieprz. This valley has also important influence on the microclimate of the resort area.

The topography is extremely diversified with large number of loess ravines, which density varies from 2 to more than 10 km/km<sup>2</sup> (the largest values in Europe).

Twelve communes are located within the Bystra river catchment. The four main communes; Wojciechów, Nałęczów, Wąwolnica and Kazimierz Dolny represent 73 % of the total catchment area (215,3 km<sup>2</sup>). The current population is 28 220, predicted future population is 37 350 (year 2000) and there are 2 towns and 63 villages (IOS I, Tables 1.1, 2.1.1-2.1.5, 2.3.1-2.3.5 and 2.4.1-2.4.3).

Figure 7 shows an overview of the Bystra river catchment.

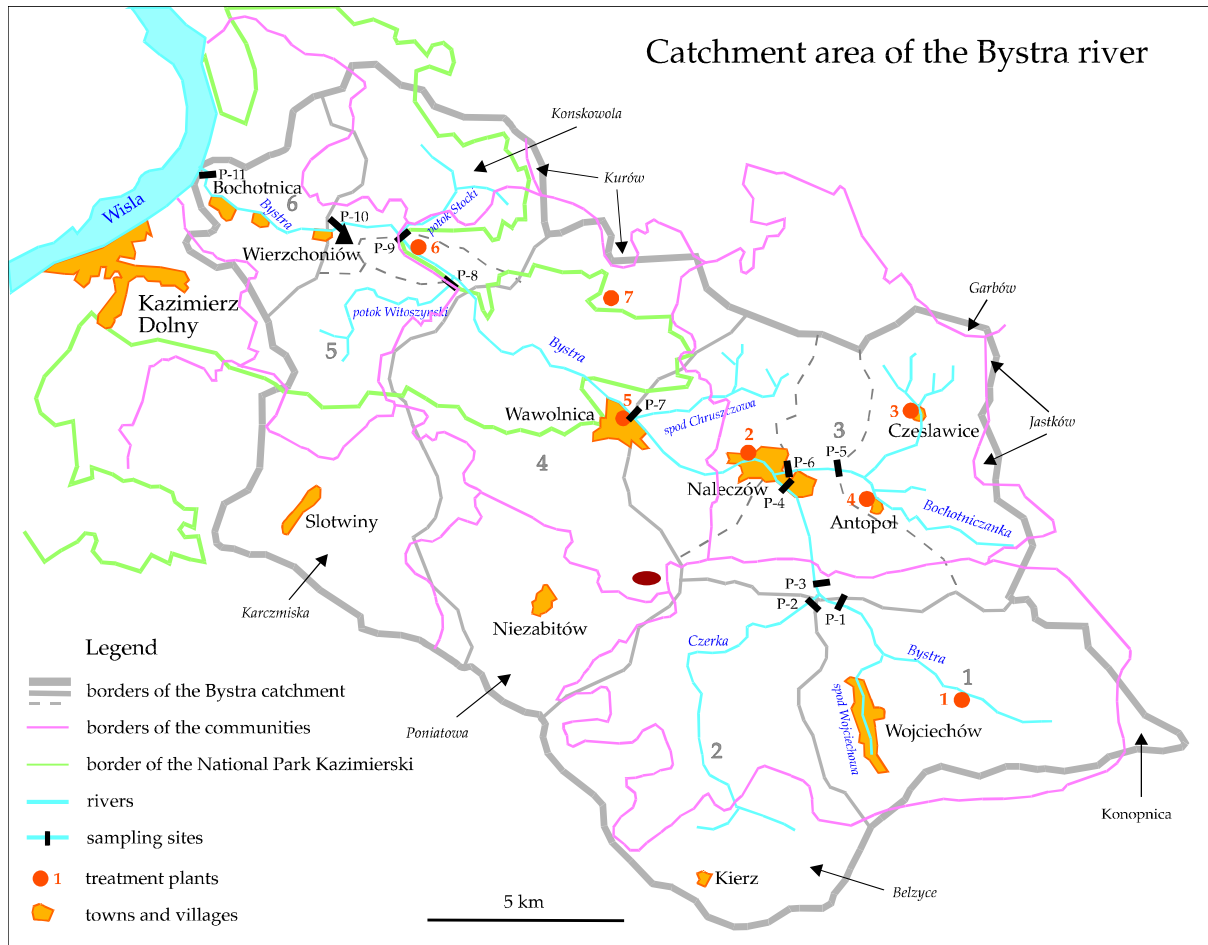


Figure 7. Map of the Bystra river catchment (1:100 000)

### 3.4.1 The water resources related to user interests in the area

Hydrological characteristics of rivers show very small values of average annual water flows and average minimum annual water flows, but big differences between low and high flows. The soil cover, geological structure and topography influence the intensive surface runoff and small water retention in the Bystra catchment. Several small water reservoirs/ponds are within the catchment, but their technical state is unsatisfactory. (IOS-I, Tables 3.1.1-3.1.3 and Map 3.3).

#### Ground water

There are two main user interests related to the ground water basins: mineral water production and water supply for institutions and households. Information from 29 public or institutional ground water intakes (depth 20-118 m; capacity 7-185 m<sup>3</sup>/h) in the Bystra catchment area indicates that there is generally good water quality according to the Polish Directives (from 1990). The content of iron (Fe) and manganese (Mn), however, exceeds the standards and in some small areas an enrichment of mineral substances (macro- and microelements) is observed. (IOS-I, Table 3.3.1).

There are 20 registered water-springs in the Bystra catchment. Nine of these springs are used for drinking water and/or for irrigation purposes. Another 3 are used as water supply for the institutions in Celejów and for the sanatorium in Nałęczów. Pilgrims and local inhabitants use frequently one spring in Wąwolnica as a “holy spring”. Seven of the springs are characterised as having a high natural value, and are classified as the monumental protection. (IOS-III, Appendix VIII).

#### *Bystra river and its tributaries*

The length of the Bystra river is 34 km. The river has two right-hand and three left-hand tributaries.

The water quality standards for surface waters in Poland are divided in three classes:

- I class of purity:  
Water suitable for human consumption, food processing and for breeding of *salmonoides*
- II class of purity:  
Water suitable for breeding livestock, for recreation and water sport purposes
- III class of purity:  
Water suitable for general industrial plant purposes and for agricultural irrigation.

The water quality in the Bystra river catchment has been monitored by WIOŚ Lublin (Voivodship Inspection of Environmental Protection) regularly since 1992. According to this monitoring programme the Bystra river and its tributaries are classified as either class III or «non-class» of purity, mainly due to the high bacteria and phosphorus content. Oxygen conditions were found to be good (IOS-I, Table 3.2.2 and Figures 3.2.1-3.2.8; NIVA, 1997; Annex 3).

There are three main user interests related to the Bystra river and its tributaries:

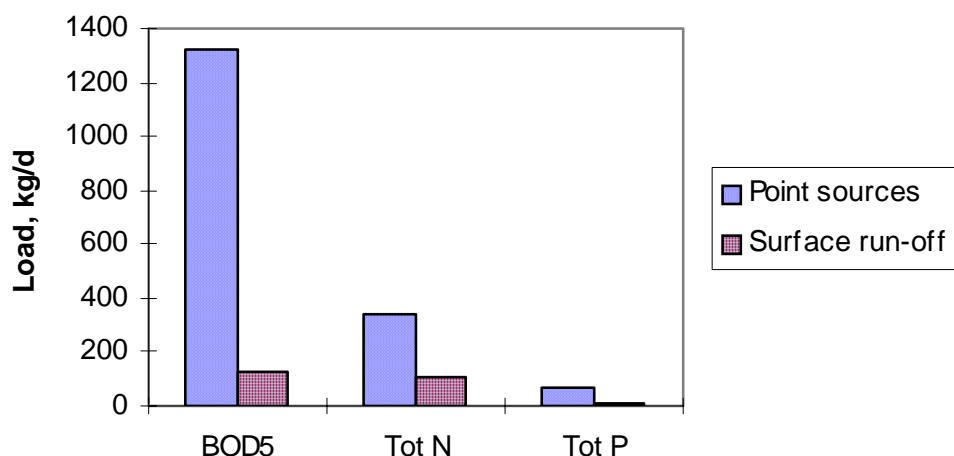
- Fishing:  
The ponds in the river are popular for sport fishing, but less fish has been caught over the last years. The erosion from the agricultural fields and sedimentation after heavy rainfall are the main reasons for this
- Bathing and other recreational activities:  
There is only a little bathing activity in the Bystra river and its tributaries today. Both natural and artificial ponds in the catchment area are planned for bathing as well as other recreational activities (agro-tourism), to become an important element in the «green area concept» for the region
- Agriculture/irrigation:  
The main activity in the region is agriculture, because of very productive soils. The arable land occupies from 62.1 to 88.2 % of the total area of the four municipalities. Forest covers from 5.5 to 12 %.

### **3.4.2 Pollution sources**

The main pollution sources of the water resources in the catchment area are; Point sources: as households, industry and institutions; and diffuse sources as surface run-off (mainly from agriculture) and some background pollution.

- Point sources:
  - Population (households). The number of inhabitants in the region was 28 220 in 1995 and is expected to be 37 350 by the year 2000.
  - Institutions and business activities. Because of the Kazimierzowski Landscape Park and Nałęczów sanatorium activities, the main part of the Bystra river catchment area is protected. There is therefore little industrial activity in the catchment and no plans to develop such activities in the future. There is one fruit processing plant (MATERNA-Poland) in the Łopatki, community of Wąwolnica (working seasonally), several workshops and a variety of service units
- Diffuse sources:
  - Run-off from agriculture. The basic activity in the communes is agriculture, because of the fertile soils. More than 6000 people (23 % of the inhabitants) have their main occupation linked to agricultural practices. The main types of production are:
    - Wheat (14 487 ha)
    - Mixed corn (3 432 ha)
    - Potato (2 451 ha)
    - Cattle (6 535 animals)
    - Pigs (15 659 animals)
    - Sheep (293 animals)
  - Background pollution is estimated by WIOŚ/Lublin (IOS-II, Table 9) to respectively 2,4 g/m<sup>3</sup> (BOD<sub>5</sub> and Tot N) and 0,18 gP/m<sup>3</sup> (Tot P).

The load contribution from point sources (households and industry) and surface run-off (mainly from agriculture) is illustrated in Figure 8.



**Figure 8.** Load from point sources and surface run-off in the catchment area

### 3.4.3 Infrastructure; location and technical condition

#### *Water supply*

The waterworks infrastructure is well developed in Nałęczów and Wąwolnica, where more than 80 % of the households are supplied by a water distribution net. The water systems serve about 54 % of the



households in Kazimierz Dolny, but only 0.6 % in Wojciechów. The other inhabitants have individual, uncontrolled water supply from private wells.

### *Wastewater*

The sewerage and wastewater treatment infrastructure is very poor in the Bystra river catchment. Biological treatment plants exist only in the two towns: Nałęczów and Kazimierz Dolny. These systems do not serve the total urban area and need modernisation and development.

There are additional small treatment units serving residential areas and production plants (IOS-I, Table 3.2.3 and Map 1.1). Two of them are of BIOVAC type. Sewage from non-seweraged areas is partly transported to the municipal treatment plants, but large quantities of wastewater are disposed in the environment, without any control (IOS-I, Maps 2.1-2.4).

Pollution loads removed by sewage treatment plants located in the Bystra catchment (IOS-II, Tables 2-12) are shown in Table 1.

**Table 1.** Pollution loads removed by wastewater treatment plants in the Bystra catchment

Plant	Capacity (m <sup>3</sup> /d)	BOD <sub>5</sub> (kg/d)	Tot N (kg/d)	Tot P (kg/d)
Nałęczów II	4540	240	7,1	1,4
Czesławice	40	7,7	1,3	0,14
Celejów	50	14	2,1	0,96
Palikije	100	7,8	1,6	3,5
Materna <sup>1)</sup>	120	1,4	3,6	0,6
Total	4850	271	15,7	6,6

1) Seasonal production; May - October

The Nałęczów wastewater treatment plant has well functioning facilities for sludge treatment; dewatering (Bellmer press) and drying beds. The capacity allows to some extent treatment of sludge also from other wastewater treatment plants in the area.

Approximately 14 tonnes dry mass of sludge/year is used for recultivating purposes in the area, mainly at the waste site. At present, lime granulation of the sludge, is performed. The end product is planned used by the local farmers, as supplement to conventional, organic fertilisers.

### *Waste*

The solid waste management is very poor and the littering of the river Bystra is visible. Only Kazimierz Dolny has communal waste deposit site, other communes are transporting part of their solid waste out of the Bystra catchment. There is designed a waste deposit site in Wąwolnica, close to the boarder to Nałęczów and Wojciechów. The intention was to serve all these three communes at this deposit site, but only Wąwolnica follows up this intention (1998).

The poor development of wastewater and solid waste infrastructure creates sanitary hazards, in particular during the tourist season and during numerous pilgrim visits in Wawolnica. This situation limits the future development of the Bystra river catchment area.

### 3.4.4 Management and institutional options

When setting environmental goals for a catchment area an open-minded approach and broad co-operation between relevant partners are needed. By establishing the «Association of the Bystra Valley» the politicians in the Bystra communes demonstrate that they are aware of these needs. No company or juridical body has been established, however, to follow up the visions of this association. Each commune must therefore still do the necessary decisions regarding the planning, budgeting and implementing processes.

Establishing and operating sewerage systems and wastewater treatment plants require relevant knowledge and capacity in the communes concerned. The current situation is presented in Table 2 (summer 1998).

**Table 2.** Technical administration in the four main Bystra communes

Commune	Inspectors (engineers)	Junior inspectors	Others	Total
Nałęczów	21 (6)	1	1	23
Kazimierz Dolny	25 (5)	-	1,5	26,5
Wąwolnica	16 (2)	-	2	18
Wojciechów	18 (2)	-	2	20

Only in Nałęczów and Kazimierz Dolny there is experience in running sewerage systems and wastewater treatment plants.

### 3.3.5 Economy

An overview of the current economic situation within the wastewater sector is presented in Table 3.

**Table 2.** Budget of the communes (1998)

Budget elements	Wojciechów		Nałęczów		Wąwolnica		Kazimierz Dolny	
	zl	%		%		%		%
Total budget:	4.805.738,-	100		100		100		100
Devided into sectors:								
- Schools	2.280.951,-	7,5						
- Roads / infrastructure	483.311,-	10,1						
- Agriculture	25.700,-	0,5						
- Water supply	30.000,-	0,6						
- Sewerage network	-	-						
- Wastewater treatment	70.000,-	1,5						
- Gas	70.000,-	1,5						
- Telephone	6.100,-	0,1						
- Cultural activities/other	1.839.676	38,2						
Fees zl/m <sup>3</sup> :								
- water								
- wastewater								
- gas								
- other								

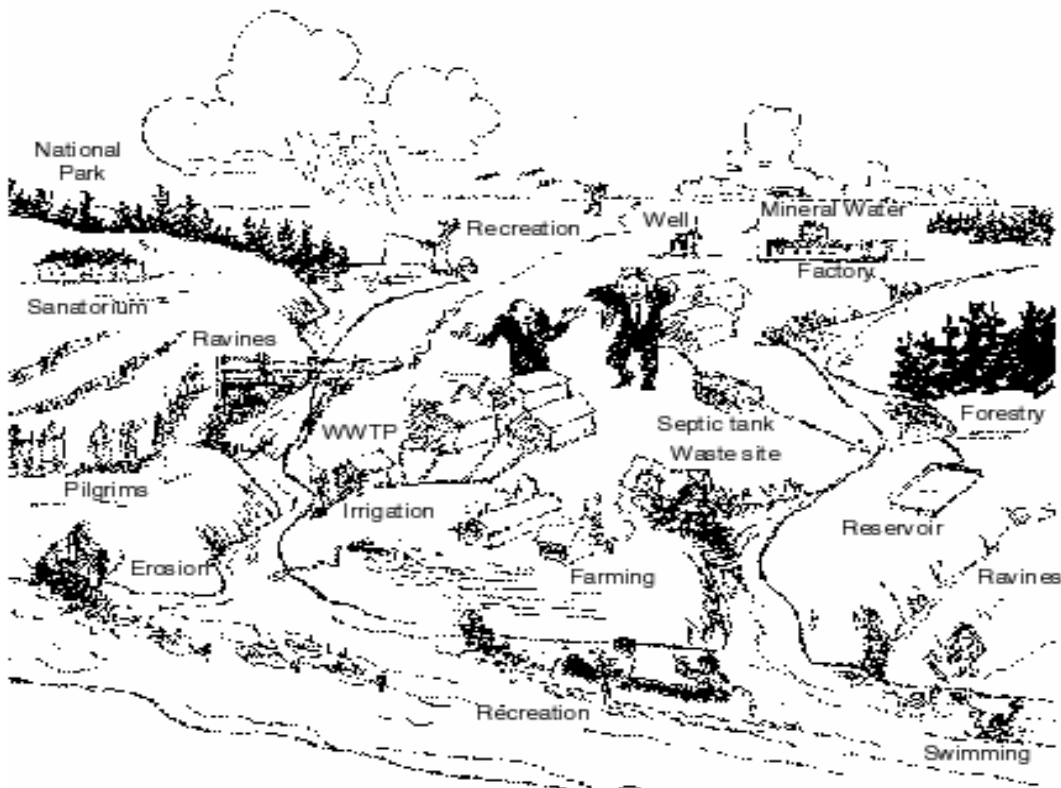
### 3.5 Objectives

*The state of the local water environment - the receiving water quality - may require a greater degree of treatment from a wastewater treatment plant, than stated in legislation. This is, in part, due to the user interests in the water resource (i.e. drinking water supply, bathing, and recreation), current and future. This may lead to the concept of water quality objectives being used to determine discharge standards. Such objectives can be integrated into environmental protection legislation through integrated river catchment and river basin management plans that take a holistic view of the combined impact of all discharges.*

*When decisions of use of water have been made, the municipality has also decided upon the goals for the quality of the water resources, ref. national water quality criteria. To meet these goals, objectives for the areas concerned (i.e. municipal and industrial wastewater, agricultural run-off and discharge from rural areas) should be set.*

#### The Bystra River Catchment:

An illustration of various user interests in the Bystra river catchment is presented in Figure 9.



**Figure 9.** User interests in the Bystra river catchment

The following objectives (prioritised goals) have been identified by the communes Wojciechów, Nałęczów, Wąwolnica and Kazimierz Dolny, for improving the environment in the river Bystra's catchment area. The goals are prioritised from 1 to 6:

1. To establish satisfactory sanitation conditions:
  - a) water supply for all inhabitants
  - b) sewage systems and treatment solutions for all inhabitants in the area concerned as regards sewage, i.e. individual, local or central treatment
2. To reduce erosion in order to avoid:
  - a) sedimentation/silting of the river Bystra and its tributaries
  - b) inputs of pesticides and fertiliser into the river Bystra and its tributaries
3. To establish three new retention "basins" in the river Bystra and its tributaries, having bathing water quality as regards chemical parameters and bacteria, in accordance with Polish Water Quality Criteria for bathing water/recreation
4. To prevent a further lowering of the ground water level in the river Bystra's catchment area
5. To develop satisfactory waste management facilities, including the establishment of waste sites for the communes concerned
6. To reinforce the "green area" image of the catchment by means of the above-mentioned and the promotion of ecological education.

These goals will form the basis for the development of the Master Plan of the area as regards:

- measures to be considered
- cost effectiveness analysis, and
- prioritisation of measures.

The focus for this Master Plan is to identify measures to meet the objective 1b; establishing satisfactory sanitation conditions with regards to *sewerage systems and treatment solutions*. In the *prioritisation* of the measures, however, also the influence on the other objectives listed above, is evaluated.

### 3.6 Abatement Strategy and Measures

*The output of the Master Plan should be a strategy and a list of measures, which enable the municipality to meet its objectives at lowest possible costs. The planning procedure should follow the five steps listed below:*

1. *Identify the gap between the current situation and the objectives. The validity of the data used, and the influence of natural variations from one year to another should be considered*
2. *Identify potential measures and evaluate their cost-effectiveness*
3. *Strategy to meet the objectives, where the following elements should be evaluated:*
  - *Continued monitoring and documentation of the environmental situation, to improve the basis for decisions on measures*
  - *Evaluation of centralised or decentralised solutions*
  - *Sludge treatment and disposal*
  - *Wastewater management; Run by the municipality itself, through regional co-operation or by a private wastewater company*
  - *Surveillance programme to evaluate effects of measures*
  - *Information policy*
  - *Financial strategy for cost recovery (capital and oper. costs)*
  - *Strategy regarding industry and agriculture*
4. *Decision on measures (concepts) to be implemented, which will be presented in more detail in the Action Plan*
5. *Costs and financial options.*

#### The Bystra River Catchment:

##### 3.6.1 The gap between status and objectives

Based on the registrations carried out by IOS (IOS-I and II, 1996), the gap between status and objectives is presented in Table 4.

**Table 3.** The gap between status and objectives

Objectives		Status <sup>1)</sup>					Gap				
Objective	Oper. goal <sup>2)</sup>	Wo	Na	Wa	KD	B	Wo	Na	Wa	KD	B
1a	100 %	1	86	83	54	-	99	14	17	46	-
1b	100 %	2	19	7	~ 50 <sup>3)</sup>	-	98	81	93	~ 50	-
2a-b	«PHARE» <sup>4)</sup>	-	-	-	-	-	-	-	-	-	-
3 <sup>5)</sup> ;	3 new basins	0	2	0	0 <sup>5)</sup>	-	1	0	1	1	-
- BOD5	< 8 mg/l	-	-	-	-	4,7	-	-	-	-	OK
- Tot N	< 10 mg/l	-	-	-	-	4,9	-	-	-	-	OK
- Tot P	< 0,25 mg/l	-	-	-	-	0,29	-	-	-	-	0,04
- Bacteria	< 0,1 (index)	-	-	-	-	0,4	-	-	-	-	0,3
4 <sup>6)</sup>	GWL>1998	-	-	-	-	-	-	-	-	-	-
5	In operation	No	No	No	Yes	-	Missing in 3 com.			OK	-
6	90 % score <sup>7)</sup>	-	-	-	-	-	-	-	-	-	-

Footnotes to Table 4:

- 1) The abbreviations: Wojciechów (Wo), Nałęczów (Na), Wąwolnica (Wą) and Kazimierz Dolny (KD) and Bystra river (B)
- 2) Operational goals; A proposal from NIVA, mainly to clarify the Norwegian methodology for the development of master plans
- 3) In the Bystra catchment (rough estimate, ref. IOS-II, 1996; Page 16 and Table 17)
- 4) The «PHARE»-project looks into the erosion/sedimentation problem in an area of Wąwolnica, as a potential effect of restructuring of the agricultural activity. The experiences from the project may be used for a strategy for the whole Bystra catchment with regard to this problem (Ministry of Agriculture and Food Management; Phare, 1998)
- 5) One basin in KD has been destroyed. Objective goals for the water quality to meet «II Class» according to the Polish standards for water quality. This will meet the identified user interests in Bystra river. The presented water quality data is the median value of the part of Bystra river with the highest concentrations in the 1995-inspection, performed by WIOŚ, Lublin.
- 6) GWL=Ground water level, preferably monitored regularly at 3-5 places in the Bystra catchment
- 7) Score in a market study in Lublin (inhabitants)

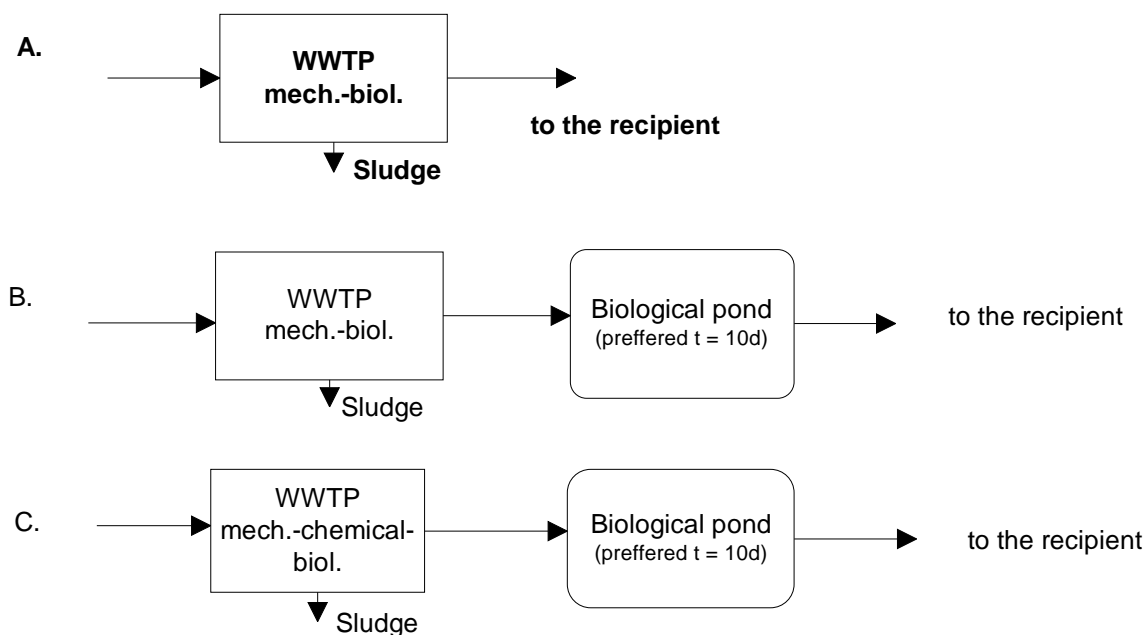
### 3.6.2 Identification of potential measures

In the wastewater sector, three types of measures are evaluated:

- Central wastewater treatment
- Local wastewater treatment
- Individual treatment

In a *central* treatment plant the wastewater from two or more places/villages is transported to one, central wastewater treatment plant. A *local* plant serves only one village. Three different concepts might be relevant for these wastewater treatment plants, as sketched in Figure 10.

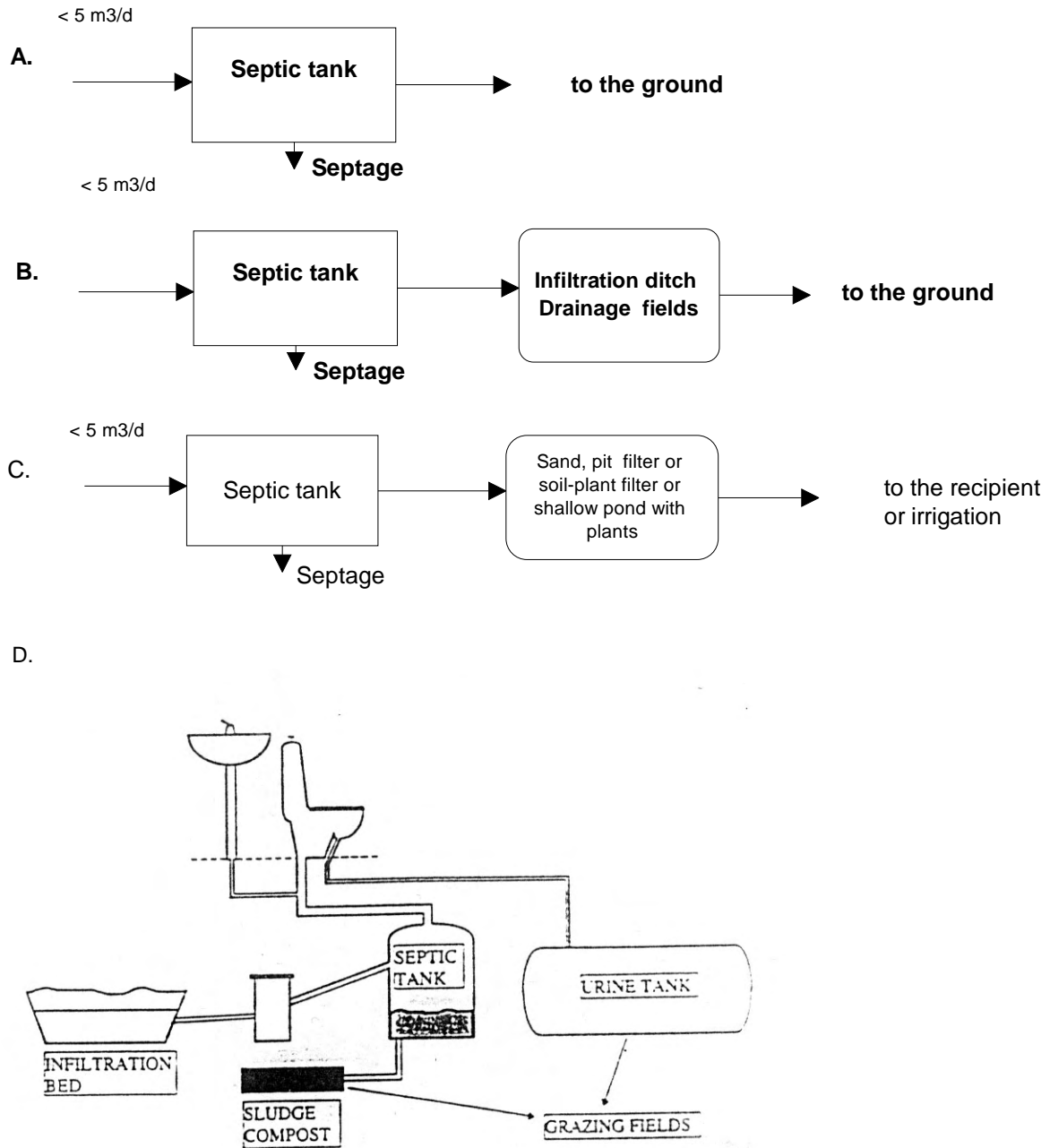
#### Central and local wwtp solutions



**Figure 10.** Potential concepts for central and local wastewater treatment plants

A typical *individual* treatment plant is a type of a septic tank, with a capacity of approximately 1 m<sup>3</sup>/d, serving 5-7 persons. The septic tank may be combined with filter, or a pond, or infiltration system, as illustrated in Figure 11.

### Individual solutions



**Figure 11.** Potential concepts for individual wastewater treatment solutions

The type of recipient and Polish standards for the three category treatment plants are shown in Table 5.

**Table 4.** Recipient and standards for central, local and individual treatment plants

Plant category	Recipient	Standards	
		Q<2000 m <sup>3</sup> /d	Q>2000 m <sup>3</sup> /d <sup>2)</sup>
Central and local WWTP	Surface waters <sup>1)</sup>	BOD <sub>5</sub> <30g/ m <sup>3</sup> Tot N<30g/ m <sup>3</sup> Tot P<5g/ m <sup>3</sup>	BOD <sub>5</sub> <15g/ m <sup>3</sup> Tot N<30g/ m <sup>3</sup> Tot P<1,5g/ m <sup>3</sup>
Individual treatment	Ground <sup>1)</sup>	The quantity must not exceed 5 m <sup>3</sup> /d	

1) The effluent quality has to meet the Polish standards (Directive from 1991, No. 116, pos. 503)

2) From year 2000.

IOS has launched and evaluated three different approaches to wastewater management in the Bystra catchment, representing different combinations of the three categories of wastewater treatment;

- Alternative I; 8 central and 7 local treatment plants, 17 sites with individual solutions
- Alternative II; 6 central and 6 local plants, 57 sites with individual solutions
- Alternative III; 9 central and 4 local plants, 38 sites with individual solutions.

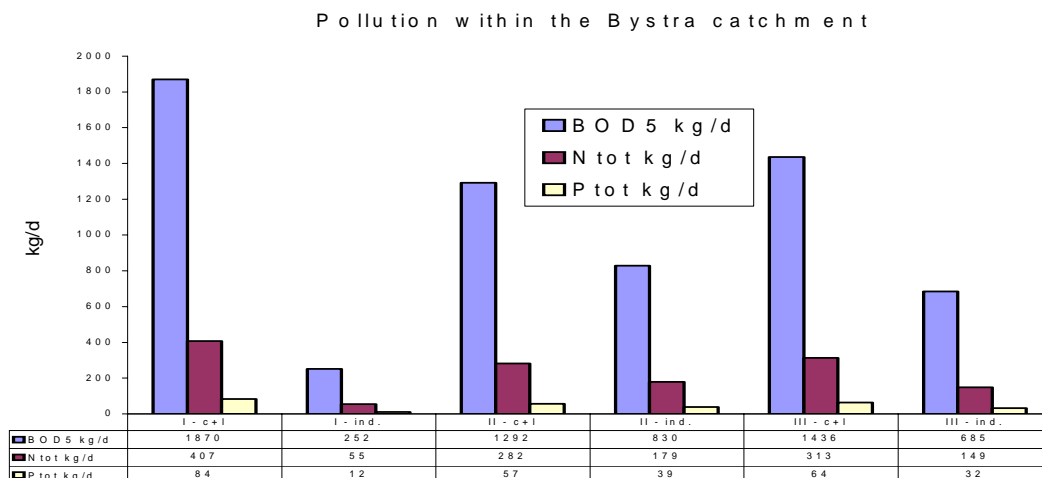
Some key figures for these three alternatives are presented in Table 6.

**Table 6.** Pollution load for alternative approaches for wastewater management

Alternative	No. of persons connected (future)			Flow m <sup>3</sup> /d	Pollution load (kg/d)		
	Inside catchm.	Outside catchm.	Total		BOD <sub>5</sub>	N <sub>tot</sub>	P <sub>tot</sub>
ALT. I;							
- central treatm. plants	23019	1408	24427	5485	1663	362	75
- local treatm. plants	3153	305	3458	428	207	45	9
- individual solutions	1791	2402	4193	269	252	55	12
SUM, Alternative I	27963	4115	32078	6182	2122	461	96
ALT. II;							
- central treatm. plants	14157	2311	16468	4155	1185	258	52
- local treatm. plants	1779	0	1779	268	107	24	5
- individual solutions	13331	500	13831	1996	830	179	39
SUM, Alternative II	29267	2811	32078	6420	2122	461	96
ALT. III;							
- central treatm. plants	16822	2600	19422	4555	1362	296	60
- local treatm. plants	927	305	1232	139	74	16	3
- individual solutions	10321	1103	11424	1548	685	149	32
SUM, Alternative III	28070	4008	32078	6242	2122	461	96

The pollution load (before treatment) to the treatment plants is graphically presented in Figure 12.





**Figure 12.** Pollution load to the treatment plants in the three alternative approaches

### 3.6.3 Cost effectiveness analysis

Cost Effectiveness Analysis (CEA) is an important procedure for assuring the rational use of financial resources in achieving the environmental standards. CEA can be applied to select those options, which achieve the environmental standards at lowest cost.

In the Bystra catchment the CEA approach is used to select measures based on the ratio between the costs and the benefit of the measure. The parameters having the largest «gap» between the current situation and the defined objectives, ref. Table 4 in Section 3.6.1, should be used in the CEA. These parameters are:

- Number of persons without satisfactory sanitation conditions
- Phosphorus concentration in the Bystra river
- The bacteria concentration in the Bystra river.

An evaluation of the cost effectiveness of the three main alternatives is based on the process configurations presented in Table 7.

**Table 7.** Process configurations for central, local and individual treatment solutions

Treatment concept	Configuration A	Configuration B
Central and local wastewater treatment <sup>1)</sup>	Mechanical/biological treatment (Figure 10a)	Mechanical/biological treatment (Figure 10a)
Individual treatment solutions	Septic tanks only <sup>2)</sup> (Figure 11a)	Septic tanks with infiltration ditches <sup>3)</sup> (Figure 11b)

1) Desinfection before discharge to the recipient should be an option for all the alternative configurations. The effluent quality is assumed to meet the standards listed in Table 5.

2) The treatment efficiency is assumed to be receptively 90 % (BOD<sub>5</sub>) and 8 % (Tot. N and Tot. P), according to Norwegian guidelines (SFT-88, TA-514)

3) The treatment efficiency is assumed to be receptively 90 % (BOD<sub>5</sub>), 20 % (Tot. N) and 90 % (Tot. P), according to the guidelines mentioned above.

The efficiency of the three alternative concepts, using the two configurations from Table 7, is presented in Figures 13-14.

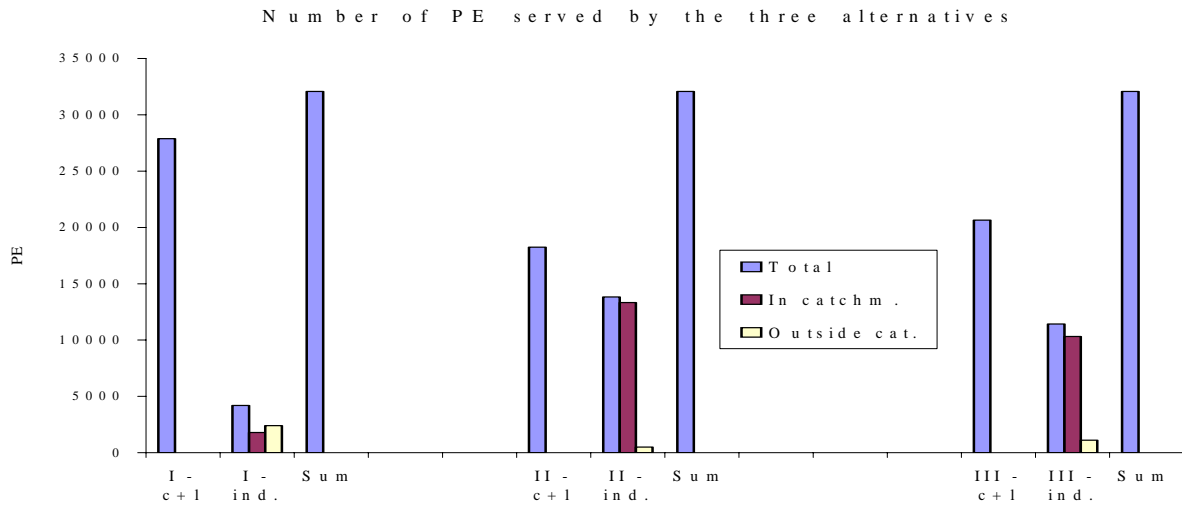


Figure 13. Effects of improved sanitation conditions

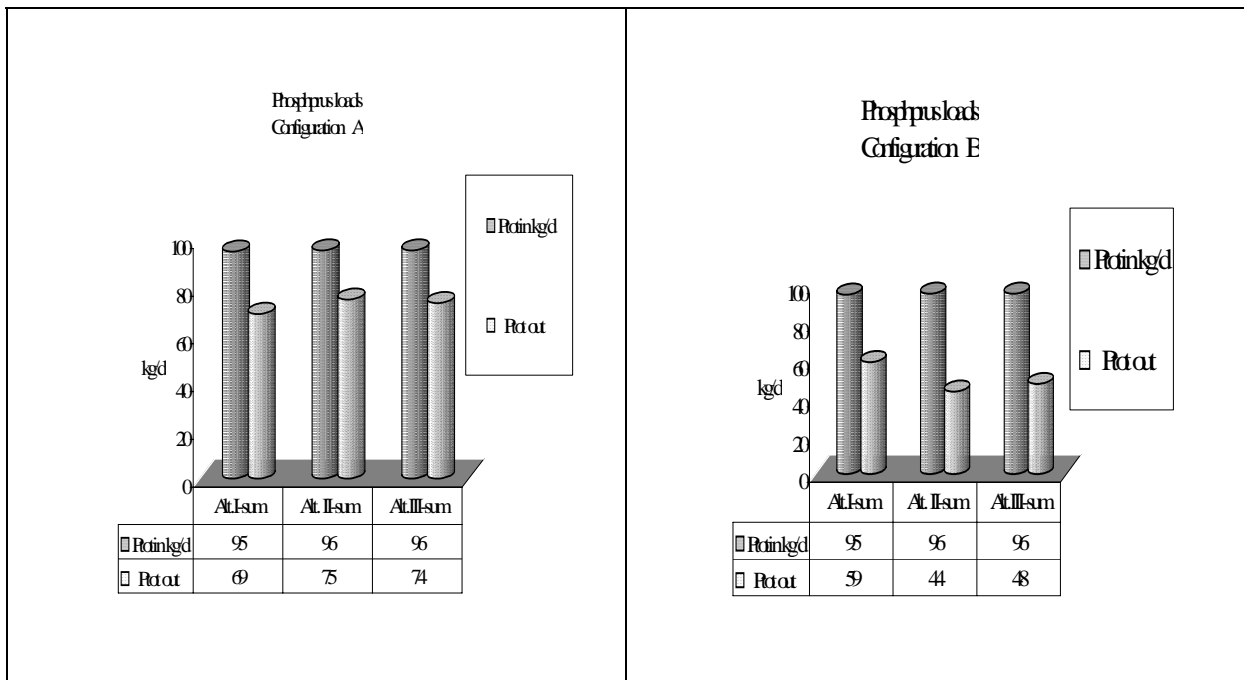


Figure 14. Effects on phosphorus removal for the two configurations

The results of the cost effectiveness analysis are presented in Tables 8-11.

**Table 8.** Cost effectiveness based on the number of persons connected; Configuration A

Alternative	Investment costs mill. zł	No. of persons connected	Flow m <sup>3</sup> /d	Cost effectiveness		Priority A
				zł/PE	zł/m <sup>3</sup>	
Alternative I;						
- Central/local	64,7	27885				
- Individual	4,2	4193				
- Total	68,9	32078	6842	3741	10070	3
Alternative II;						
- Central/local	37,3	18247				
- Individual	13,8	13831				
- Total	51,1	32078	6842	1593	7469	1
Alternative III;						
- Central/local	42,4	20654				
- Individual	11,4	11424				
- Total	53,8	32078	6842	1677	7863	2

1) Investment costs for central and local solutions from IOS-3, Tables 9-11. Assumed cost for septic tank of 1.000 zł/PE

**Table 9.** Cost effectiveness based on the number of persons connected; Configuration B

Alternative	Investment costs mill. zł	No. of persons connected	Flow m <sup>3</sup> /d	Cost effectiveness		Priority B
				zł/PE	zł/m <sup>3</sup>	
Alternative I;						
- Central/local	64,7	27885				
- Individual	10,5	4193				
- Total	75,2	32078	6842	2344	10991	3
Alternative II;						
- Central/local	37,3	18247				
- Individual	34,6	13831				
- Total	71,9	32078	6842	2241	10509	2
Alternative III;						
- Central/local	42,4	20654				
- Individual	28,6	11424				
- Total	71	32078	6842	2213	10377	1

1) Investment costs for central and local solutions from IOS-3, Tables 9-11. Assumed cost for septic tank of 2.500 zł/PE

**Table 10.** Cost effectiveness based on reduced discharges of phosphorus to the Bystra river; Configuration A

Alternative	Investment costs mill. zł	Reduced Tot.P-discharge ton/year	Cost effectiveness zł/PE	Priority A
Alternative I;				
- Central/local	64,7	9		
- Individual	4,2	0,4		
- Total	68,9	9,4	7260	3
Alternative II;				
- Central/local	37,3	6		
- Individual	13,8	1		
- Total	51,1	7	7000	2
Alternative III;				
- Central/local	42,4	7		
- Individual	11,4	1		
- Total	53,8	8	6700	1

1) Investment costs for central and local solutions from IOS-3, Tables 9-11. Assumed cost for septic tank of 1.000 zł/PE

**Table 11.** Cost effectiveness based on reduced discharges of phosphorus to the Bystra river; Configuration B

Alternative	Investment costs mill. zł	Reduced Tot.P-discharge ton/year	Cost effectiveness zł/PE	Priority A
Alternative I;				
- Central/local	64,7	9		
- Individual	10,5	4		
- Total	75,2	13	5791	3
Alternative II;				
- Central/local	37,3	6		
- Individual	34,6	13		
- Total	71,9	19	3795	1
Alternative III;				
- Central/local	42,4	7		
- Individual	28,6	10		
- Total	71	17	4064	2

1) Investment costs for central and local solutions from IOS-3, Tables 9-11. Assumed cost for septic tank of 2.500 zł/PE

### 3.6.4 Strategy to meet the objectives

The strategy to meet the environmental objectives in Bystra river catchment is concretised in nine elements (a-i);

- a) *Continued monitoring and documentation of the environmental situation, to improve the basis for decisions on measures*
- b) *Evaluation of centralised or decentralised solutions*
- c) *Importance of phosphorus removal*
- d) *Sludge treatment and disposal*
- e) *Wastewater management; conducted by the municipality itself, through regional co-operation or by a private wastewater company*
- f) *Surveillance programme to evaluate the effects of measures*
- g) *Information policy*
- h) *Financial strategy for cost recovery (capital and operational costs)*
- i) *Strategy regarding industry and agriculture.*

#### Element a; Continued surveillance and documentation

The overall goal in the Bystra catchment is currently to improve the sanitation situation for the inhabitants. Measures are identified to improve this situation. In the «next generation» of measures, however, the benefits will be more marginal. Trustworthy information about water quality, infrastructure and other topics will then be even more important than today, when the most cost effective solutions will be selected.

⌋ *It is therefore recommended to continue the monitoring of the water quality in the Bystra river, but the surveillance programme should also include some flow proportional samples. This will make it easier to develop a mass balance budget in the catchment for phosphorus, organic matter and other relevant parameters. Such a mass balance is necessary in order to estimate the benefits of future measures.*

#### Element b; Centralised or decentralised solutions

There are many good wastewater treatment systems available in the market, also for small wastewater treatment plants. The conventional sewerage systems, connecting large areas to one central wastewater treatment plant are therefore seldom the most cost-effective approach to wastewater management. Decentralised solutions, combined with remote control run by a central operational unit, would more often be the best concept.

⌋ *In each case a cost-effective analysis should be performed.*

#### Element c; Importance of Phosphorus removal

Phosphorus and phosphorus concentrations represent the largest gap between the current situation and the objectives, regarding the water quality in Bystra river. This indicates increased eutrophication, which does not necessarily represent a major problem in the *river*. In the planned *retention basins*, however, eutrophication represents an important problem, with algal blooms as a potential effect.

⌋ *It is therefore recommended that the central and local wastewater treatment plants be prepared for chemical precipitation, to be implemented at a later stage.*

Element d; Sludge treatment and disposal

Nalêczów wastewater treatment plant has well functioning facilities for sludge treatment; dewatering (Bellmer press) and drying beds. The capacity allows to some extent treatment of sludge also from other wastewater treatment plants in the area.

∫ *It is therefore recommended to evaluate if the sludge from the whole catchment could be transported to Nalêczów wastewater treatment plant, using a filter press for dewatering and lime stabilisation.*

Element e; Wastewater management

A wastewater treatment plant represents complex mechanical, biological and chemical processes. Skilled personal is required to run such plants. The larger the plant, the higher is the need for competence and capacity. In the Bystra catchment, the construction of several treatment plants is planned, which will be operating in the near future.

∫ *It is recommended to establish one central operational unit to run these plants, including the sewerage systems, for all the communes involved.*

A central operational unit will be able to recruit and educate staffs, which could run and maintain effectively the central and local wastewater treatment plants and sewerage systems, based on proper control systems for alarms and process control. This unit could also supervise the individual treatment solutions, both for technical control and to ensure that the septic tanks are emptied according to agreed frequency.

A central operational unit could be administrated from the four communes involved, as an external technical department or a company. Such a department (company) could also be responsible for the whole wastewater management in the catchment, including the financial arrangements. If a company is established, it could be 100 % owned by the four Bystra communes.

∫ *It is strongly recommended that such collaboration between the four Bystra communes will be elaborated.*

Element f; Surveillance programme to evaluate effects of measures

There are plans for implementing many pollution abatement measures in the Bystra catchment the forthcoming years. These measures are expected to have well defined effects, both for the inhabitants directly and for the environment. Documentation should be made on these effects, in order:

1. To motivate the inhabitants and the politicians to fulfil the actions proposed in the Master Plan for Wastewater Management
2. To adjust or alter the measures based on the experienced effects.

∫ *It is recommended that such a surveillance programme is designed and implemented, and that the results are reported yearly in the Annual Report, ref. Section 3.8.*

Element g; Information policy

It will be costly to upgrade the infrastructure in the four Bystra communes. Most of the costs will probably have to be paid by the inhabitants, directly through fees for water and wastewater and

indirectly through local taxes. The inhabitants should be informed about the need for these infrastructure investments, operational and maintenance costs, as a motivation for their payment.

Regularly, external information about the environmental situation in Bistro catchment could also be an effective element in marketing the catchment as a «green area», supporting the tourism in the four communes. An Internet based environmental information system might be a proper tool for such information.

#### Element h; Financial strategy for cost recovery

The «customers»; inhabitants, institutions and business activities should finance the costs for water supply, wastewater treatment and waste management. This is a major principle in Norway, where the municipalities are expected to charge the users 100 % of the running costs (capital costs, operational and maintenance costs) for these services.

A full cost recovery policy may be easier to implement if the wastewater management is completely delegated to an external company, as mentioned above.

#### Element i; Strategy regarding industry and agriculture

There is very little industrial activity in the Bystra catchment, a situation that is not expected to change in the future.

⌋ *When planning the new central and local wastewater treatment plants, combined treatment with the industrial wastewater should, however, be evaluated.*

The agricultural activity in the Bystra catchment, however, is of great importance for the water quality in the Bystra river and its tributaries, as well as for the Bystra communes in general.

Several measures should be implemented to reduce the environmental impact of agricultural activity. This is, however, not included in the Master Plan for Wastewater Management. Wawolnica commune has an interesting approach to the problem, trying to motivate the farmers to aggregate their farms into larger units. Larger farms will more efficiently enable the change of land use and improve operational procedures, all leading to reduced discharges of nutrients and pesticides into the water resources.

⌋ *It is strongly recommended that this process in Wawolnica is continued, and that the other three communes also define a strategy to reduce the pollution from agriculture.*

### **3.6.5 Selection of measures for the planning period**

Based on the cost-effective analysis (Section 3.6.2) alternative II was chosen as the best group of measures for the Bystra catchment. This alternative includes the following measures:

- 6 central wastewater treatment plants;
  - Mechanical-biological treatment (activated sludge or biological filters), prepared for disinfection of the effluent and with an option of adding chemical precipitation. Container-plants are preferred when the capacity doesn't exceed 200 m<sup>3</sup>/d:
    - Palikije (204 m<sup>3</sup>/d)
    - Nałęczów (3320 m<sup>3</sup>/d)
    - Drzewce (180 m<sup>3</sup>/d)
    - Wawolnica-Mareczki (410 m<sup>3</sup>/d)
    - Celejów (230 m<sup>3</sup>/d)

- Bochoznica-Kazimierz Dolny (expansion of the existing wastewater treatment plant)
- 6 local wastewater treatment plants (same configuration as mentioned above):
  - Łubki (50 m<sup>3</sup>/d)
  - Czesławice (23 m<sup>3</sup>/d)
  - Łopatki (85 m<sup>3</sup>/d)
  - Witoszyn (36 m<sup>3</sup>/d)
  - Wierzchniów (43 m<sup>3</sup>/d)
  - Stok (32 m<sup>3</sup>/d)
- 57 individual solutions (13 331 PE; 2000 m<sup>3</sup>/d); septic tanks with or without infiltration to the ground, dependent on local conditions (permeability, contamination of private wells).

Sludge treatment; central sludge treatment at Nałęczów wastewater treatment plant, using a filter press for dewatering and lime stabilisation, for using it as fertiliser.

### 3.6.6 Costs and financial options

This Section is based on «Urban Wastewater Projects - A Layperson's Guide» (EEA, 1997).

Other than in exceptional circumstances, the full cost of providing a wastewater service, including charges for loans and depreciation, should be charged the users of the service.

Although charging according to use or benefits derived seems simple, there are a number of complex issues involved. The development of user charges may be divided into three phases:

- Phase I : Identify the total costs to be recovered from the customers
- Phase II : Allocate these costs to different customer classes
- Phase III : Design a tariff structure to recover the costs from each customer class.

#### Phase I; Identifying total costs

In determining the total costs to be recovered, or annual revenue requirement, the approach may vary, depending on ownership, regulatory requirement, local policies and local circumstances. Generally, however, revenue should be sufficient to maintain current service levels, to meet new demands and to plan for future needs.

Publicly owned systems tend to determine revenue requirements using either a cash basis or a utility basis:

- Using a cash basis, the revenue is set to provide the annual cash flow to meet all operating and capital requirements, including the servicing of debts
- A utility approach determines revenue requirements so that they are sufficient to cover operating and maintenance expenditure, depreciation and a return of assets.

Whichever approach is used, the basic revenue requirement should be reduced by any miscellaneous income that results from charges, other than main wastewater charges.

#### Phase II; Allocating costs to customer classes

This phase is concerned with allocating costs to different customer classes in a way that corresponds with the service provided to these classes. It consist of three basic steps:



- analyse costs by activity
- allocate activity costs to cost drivers
- reallocate cost driver totals to customer classes.

Activity analysis

Analysing costs by activity and recognising those that remain fixed over the short to medium term and those which are variable provides a number of advantages:

- It provides a useful insight into the way costs are incurred. This may have implications for cost allocation and subsequent tariff structures.
- The impact on revenue levels based on fixed or unavoidable costs can be determined.
- Minimum revenue levels based on fixed or unavoidable costs can be determined.
- Contractual conditions (perhaps with large developments) which involve a fixed component can be determined.
- The evaluation process provides new information for budgeting and accounting for the future.

Cost drivers

The cost driver for a particular cost or group of costs is that characteristic that is predominant in determining the size and cost of the activity under consideration. Some examples of activities and cost drivers are given below.

<b>Activity</b>	<b>Cost driver</b>
Customer billing	Number of customers
Reception and conveyance of effluent	Effluent volume; pollution load; polluter pays
Wastewater treatment	Wastewater volume; pollution load (BOD+SS)
Sludge disposal	Level of suspended solids

Allocation to customer classes

The next step is to reallocate the costs for each driver to the different customer classes. The details of reallocation will vary depending on the cost driver, but will normally be supported by statistical evidence. For example, customer numbers drives the level of customer billing costs. Knowledge of customer numbers in each class allows a simple reallocation.

Phase III; Designing a tariff structure

There are three basic approaches to be considered as the basis for setting tariffs:

- user charge; i.e. charge according to use of service
- flat rate charge; i.e. charge each user the same amount
- *ad valorem* tax; i.e. charge according to ability to pay.

Each of these can be assessed against a number of objectives in order to determine the most suitable charging basis in given circumstances. The objectives relate to economical efficiency, social efficiency and administrative efficiency.

The user charges approach scores high in terms of economical efficiency, by relating levels of charge to levels of service use. However no account is taken of the ability of the customers to pay and this approach is judged poor in terms of social efficiency. Because it requires the service use by each customer to be measured regularly, subsequent to billing, it is also regarded as administratively inefficient.

Similar arguments can be made to show that the flat rate charge approach is administratively efficient, but not economically or socially feasible, whereas, ad valorem taxes have their strength in social efficiency, but are not economically and administratively feasible.

### User charges

User charges are often comprised of both a fixed and a volume or load/emission related element. The higher the fixed element, the greater the income certainty to the utility. The higher the volumetric charge the greater the control that can be exercised by the customer over total charge by regulating service use.

Customers` use of wastewater services is commonly estimated by reference to measured clean water services received, after deducting an estimated amount for water that is not discharged into the sewer. This deduction is often standard for domestic customers, but assessed individually for larger commercial and industrial customers. For some customers, who discharge large wastewater volumes, it may be appropriate to install specific waste meters.

### Ad valorem taxes

Ad valorem taxes are often related to property values. The somewhat imprecise logic suggests that the higher the value of the property, the greater the ability to pay and therefore the higher the charge. These taxes have developed as a traditional means of supporting local government services, including environmental and wastewater services. The relationship between service use and property values is; however, somewhat weak and ad valorem taxes often include large fixed charges in order to moderate the range of charges resulting from different property values.

### Industrial wastewater tariffs

Domestic effluent, whether discharged from domestic properties or non domestic properties (i.e. offices), is essentially homogeneous in any particular location e.g. the strength and complexity of the waste does not vary greatly. It is reasonable, therefore to charge for this effluent on the basis of volume.

Trade and industrial effluent, the strength of which can differ significantly from average domestic discharges, may warrant a charging system that is based on both the volume and character of the wastewater. Such a system may be applied to customers individually, necessitating a regular sampling regime or assessment, or effluent characteristics may be agreed on for a certain type of trader, i.e. car washes, and a standard strength applied.

The range of characteristics on which charges can be based varies. The most common charging systems are based on volume, treatment costs for the removal of BOD and suspended solids. Less commonly, charges may relate to the levels of phosphorus, nitrogen, COD and other pollutants.

The basic characteristic based charging system can be further refined in a number of ways, i.e. basing volume rates on standard strengths and charging for specific pollutant loads only above a certain threshold level.

The most common formula for deriving a charge for an industrial effluent is:

$$C_r = C_q + \frac{BOD_i}{BOD_s} \times C_B + \frac{SS_i}{SS_s} \times C_S$$

- $C_r$  = Total cost per  $m^3$  industrial effluent  
 $C_q$  = Cost per  $m^3$  of providing + operating sewer system pumping sediment and effluent disposal  
 $BOD_i$  = Biochemical oxygen demand of the industrial effluent (mg/l)  
 $BOD_s$  = Biochemical oxygen demand of the combined sewage (mg/l)  
 $C_B$  = Cos per  $m^3$  of providing and operating biological treatment  
 $SS_i$  = Suspended solids of the industrial effluent (mg/l)  
 $SS_s$  = Suspended solids of the combined sewage (mg/l)  
 $C_s$  = Cost per  $m^3$  of providing and operating sludge treatment

*COD (Chemical Oxygen Demand) or TOC (Total Organic Carbon) may replace BOD*

The characteristics of the industrial effluent and of the combined sewage are obtained from sampling and analysis programmes. The costs are derived from the actual costs of financing the construction of the sewage system and wastewater treatment works as well as operating and maintaining them.

### Summary

To sum up, the design of a wastewater charging system, based on a full recovery of costs, should follow a logical set of steps. These start by identifying the costs of service provision that must eventually be recovered from customers. When these costs have been grouped according to activity, they can be allocated by use of cost drivers to customer classes, once the total revenue requirement from each customer class has been determined. Consideration needs to be given to the type of tariff structure appropriate to the service, given the often-conflicting objectives of economical, social and administrative efficiency.

### 3.7 Action Plan

*The Action Plan will be based on the Master Plan (Section 3.1 - 3.6) and will present a yearly plan for actions to be carried out. The Action Plan should be a separate document, prepared for decision-makers and politicians in the municipalities involved, and for financial institutions supporting the implementation of the plan.*

*The Action Plan should be succinct and exact. User-friendly presentation of figures and costs should be emphasised. The recommended content of the Action Plan is as follows:*

- *A list of prioritised measures and their costs*
- *Expected achievement of the objectives when implementing the measures*
- *Funding/cost recovery*
- *Milestones and co-ordination of cross-sectorial measures.*

#### **The Bystra river catchment:**

An action plan will be made after political discussions in the four Bystra communes, based on the recommended measures from IOS (see Section 3.6.5).

Some measures have already been implemented, as informed about in the seminar in Warsaw 18. September 1998. The main part of the proposed measures, however, is so far not funded, and it may take some time to allocate the needed financial resources.

In this situation, the strategy for the communes should be to split the proposed measure concept (Alternative 2) into individual measures. Measures, which are functional or logical dependent on each other (i.e. sewerage system and wastewater treatment plant in the same area) should be defined as *one* measure.

A cost-effectiveness analysis should be performed for each measure, and the measure(s) with the highest score should be implemented first. In this prioritising procedure, also other parameters than the defined «benefits» might be evaluated, for adjustments of the prioritised list of measures.

In the definition of measures, a pre-defined schematic could be used. An example of such a schematic is shown in Figure 15.

<b>Action Plan for Bystra River Catchment</b>		Schedule Start:	Revision No.:
<b>Measure no.:</b>	Related to:	End:	Date:

<b>Title:</b>	
<b>Objective:</b>	
<b>Description</b>	
• Text:	
• Figures:	

<b>Estimated costs:</b>	Investments (zł)	Operation (zł/year)	Annual costs (zł/year)
Prefeasibility study			
Engineering			
Construction			
Operation			
<b>Total</b>			

**Figure 15.** Description of defined measures; an example

### 3.8 Annual Report

*The Annual Report prepared for politicians and regional environmental authorities should give a presentation of the results and investments from the previous year, within the wastewater sector.*

*The main purpose is to document the achieved results related to the expectations and use of resources. This may lead to adjustments in the Action Plan for the following year. Effects of the implementation on environment should also be documented. By making a user-friendly document, the Annual Report may also have a positive effect on the marketing of the wastewater sector.*

#### **The Bystra River Catchment:**

The first report might be written for the year 1998, presenting the following items:

- Results of the political discussions and decisions in the four Bystra communes, on the Master Plan for Wastewater Management
- Updated information of the water quality in the Bystra river, based on the monitoring programme for the year 1998
- List of measures that have been implemented in 1998 (if any)
- List of measures to be implemented in 1999 (Action Plan)
- Investments done in 1998 and financial arrangements for 1999
- Describing the effects of the implementation on environment.

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