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Transposition and Implementation of the EU Water Framework Directive in Latvia

Technical Report No. 1A

Typology of surface water and procedure for characterisation of waters

Final

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LIST OF ABBREVIATIONS

CM	Cabinet of Ministers
CMR	Cabinet of Ministers Regulation
CHARM	European Commisions 5th Research and Technology Framework Programmes Project "Characterisation of the Baltic Ecosystem: Dynamics and Function of Coastal Types"
CIS	Common Strategy on the Implementation of the Water Framework Directive
COAST	CIS working group 2.4 created to produce Coast Guidance
COAST Guidance	Guidance on typology, reference conditions and classification Systems for transitional and coastal waters
DANCEE	Danish Co-operation for the Environment in Eastern Europe
DEPA	Danish Environmental Protection Agency
ELV	Emission Limit Value
EIA	Environmental Impact Assessment
EPD	Environmental Protection Department
EU	European Union
HMA	Hydrometeorological Agency
IMPRESS	Guidance on identification of pressures and assessment of impacts
LEA	Latvian Environmental Agency
LWM	Latvian Law on Water Management
MoE	Ministry of Environment
PSU	Practical Salinity Unit
RB	River Basin
RBD	River Basin District
RBMP	River Basin Management Plan
RBMA	River Basin Management Authorities
REB	Regional Environmental Board
SEI	State Environmental Inspectorate
UNCLOS	United Nations Convention on the Law of the Sea
SGS	State Geological Survey
WFD	Water Framework Directive (2000/60/EC)
ToR	Terms of reference
TR	Technical Report
WG	Working Group
WRUP	Water Resource Use Permit

TABLE OF CONTENTS: PAGE

TABLES:

FIGURES:

1. Introduction

The present report is part of the reporting for the project financed by the Danish Environmental Protection Agency (DEPA):

Transposition and implementation of the EU Water Framework Directive in Latvia.

The report describes the WFD requirements in Annex II of characterisation of water, the links to the Latvian Water law, and contains input to the draft text for a new CM regulation on Characterisation of water.

The report is No. 1 in the following list of reports:

Technical reports:

- TR 1A: Typology of surface waters and procedure for characterisation of waters
- TR 1B: Classification and presentation of status of waters
- TR 2: Monitoring programs for surface water and groundwater and CM Regulations on requirements for establishment of monitoring programs
- TR 3: Draft Action Plan on how to define ecological status of fresh and coastal water
- TR 4: Revision of the draft Regulation on WRUP
- TR 5: Elaboration of a specification of requirements and ToR for a data management/information system

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Outputs:

A: Draft legal acts for the transposition of Annexes II and V of the WFD
B: Assistance to MoE in preparation of information material on the WFD
C: Specification of requirements and ToR for a data management/information system

The main basis for the report is the following articles in the WFD:

Article 4:	Environmental objectives
Article 5:	Characteristics of the river basin district, review of the environmental impact of human activity and economic analysis of water use
Article 7:	Water used for abstraction of drinking water
Annex II:	Characterisation and identification of pressures on surface water and groundwater

The input to the Regulation is structured according to the headlines in Annex II:

Surface water
Characterisation of surface water body types
Establishment of type-specific reference conditions for surface water body types

Identification of pressures
Assessment of impact

Groundwater
Initial characterisation
Further characterisation
Review of the impact of human activity on groundwaters
Review of the impact of changes in groundwater levels
Review of the impact of pollution on groundwater quality

EU CIS Guidances
EU working groups under the WFD "Common Implementation Strategy" have produced several specific CIS Guidances. This TR are based on the following guidances:

Horizontal guidance document on the application of the term "water body".

Guidance for the analysis of pressures and impacts in accordance with the water framework directive.

Guidance on establishing reference conditions and ecological status class boundaries for inland surface waters.

Guidance on typology, reference conditions and classisfication systems for transitional and coastal waters.

Guidance document on identification and designation of heavily modified and artificial water bodies.

Background Technical notes
This technical report is based on 3 technical notes:

TN04: Requirements and approach for freshwater typology
TN13: Groundwater characterisation, input to TR1.
TN14: Typology of coastal and transitional waters

2. The Law on Water

The Latvian **Law on Water Management** states the following of relevance to surface water and the groundwater characterisation:

Art. 5: (10) The Cabinet of Ministers determines:

1) characterisation of surface water body types and the corresponding classification of surface water bodies, as well as the procedure for identification of anthropogenic pressures;
2) classes of groundwater bodies and classification criteria, the procedure for identification of anthropogenic pressures, as well as the procedure for review of available groundwater resources;
3) quality elements for surface and groundwater as well as elements for high, good and moderate water status;
4) a list of priority substances and the relevant emission controls procedure.

Re. 2) there are not *classes* of groundwater bodies except the terms *good* and *poor*. The *status* of the groundwater bodies should be classified as good or poor.

The mentioning of procedure for characterising and classification of groundwater status is **missing** in the Art. 5(10). However, the procedure for the characterisation is included below.

Re. 3) The quality elements for groundwater required by the WFD comprise only 5 parameters, but according to Art. 17.4 of the WFD Latvia must establish criteria for assessing good groundwater chemical status within 22.12.2005, because the Commission has not yet proposed these criteria. These criteria should be defined under the CM on Classification.

This technical report only considers the characterisation as well as the procedure for assessment of anthropogenic impact (WFD Annex II).

3. Aim, definitions, authorities and deadlines.

3.1. Aim

The procedure for characterisation of surface water shall be to categorise surface water, divide categories into types and identify water bodies. Anthropogenic pressures shall be identified and the resulting impact assessed for each water body. For water bodies at risk of failing to achieve their specified environmental objective further characterisation shall be carried out in order to optimise monitoring programmes and programme of measures.

The characterisation of groundwater is an analysis of the quality and quantity of the groundwater and the pressures affecting it.

The aim of the regulation is to enable the characterisation of surface water and groundwater to evaluate their status in order to differentiate these bodies of water on the basis of natural conditions and the impact of human activity on the status thereof.

3.2. Definitions

Definitions are already covered in the Latvian Water Law, Art. 1.

3.3. Responsible authorities

According to the Latvian Law on Water Management (Article 9 a) a Co-ordination Committee shall be established for each of the four river basin districts to co-ordinate the management within the river basin district.

There are three institutions in Latvia responsible for practical implementation, coordination and supervision of water management related issues defined by the Law on Water Management (LWM). Those are:

- State Geological Survey and its regional units;
- The Latvian Environmental Agency;
- The State Environmental Inspection.

The **State Geological Survey** and its regional units - river basin authorities, shall:

1) establish and update drafts of management plans and programmes of measures;
2) carry out an economic analysis of the use of water resources;
3) ensure participation of the public in preparation and updating of management plans and programmes of measures and informs about the plans and programmes those municipalities, having their administrative territories covered by these documents;
4) co-ordinate the implementation of programme of measures;
5) develop the budget proposals necessary for the implementation of the programme of measures;

6) facilitate activities of the Co-ordination Committees;
7) co-operate with the competent authorities of the relevant countries to ensure the achievement of the environmental objectives for the whole international river basin district, as well as implement joint programmes of measures;
8) participate in the development and implementation of the programmes for monitoring of water status.

The **Latvian Environmental Agency** shall:

1) develop programmes for monitoring of water status (hereinafter monitoring programmes) within each river basin district;
2) develop budget proposals for the implementation of the monitoring programmes;
3) co-ordinate and arrange implementation of the monitoring programmes;
4) provide the European Commission with the information specified by the Cabinet of Ministers.

The **State Environmental Inspection** shall supervise implementation of the programme of measures.

3.3.1. Proposal for defining institutional responsibilities

Characterisation of surface water bodies and identification of groundwater bodies are specific activities, which have to be done based on existing information and before specific monitoring programmes required by WFD are initiated. The institutional responsibilities for the given issues are not clearly defined by LWM. There are three possible options on how to split the institutional responsibilities for characterisation of surface water bodies and identification of groundwater bodies between the State Geological Survey and the Latvian Environmental Agency. Those are following:

Option 1:

SURFACE WATER:

I - identification and characterisation of surface water bodies

1. The **State Geological Survey** is responsible for identification of surface water bodies and characterisation of the status thereof ;
2. The first characterisation of the status of surface water bodies shall be completed by 22 December 2004;
3. The **Latvian Environmental Agency** is responsible for data providing to characterise surface water body status within definite River Basin District.

II - revision of first characterisation of surface water

4. The **State Geological Survey** is responsible for revision of first characterisation of surface water;
5. The characterisation shall be revised by 22 December 2013 and every 6 years thereafter;

6. The **Latvian Environmental Agency** is responsible for data providing to characterise surface water bodies status within definite River Basin District.

GROUNDWATER
<u>**I -** identification and characterisation of groundwater bodies</u>

7. The **State Geological Survey** is responsible for identification of groundwater bodies and characterisation of the status thereof;
8. The identification of groundwater bodies shall be completed by 22 December 2004;
9. The **State Geological Survey** is responsible for data providing to characterise groundwater bodies status within definite River Basin District.

Option 2:

SURFACE WATER:

<u>**I -** identification and characterisation of surface water bodies</u>

1. The **Latvian Environmental Agency** is responsible for identification of surface water bodies and characterisation of the status thereof ;
2. The first characterisation of the status of surface water bodies shall be completed by 22 December 2004;
3. The **Latvian Environmental Agency** is responsible for data providing to characterise surface water body status within definite River Basin District.

<u>**II -** revision of first characterisation of surface water</u>

4. The **Latvian Environmental Agency** is responsible for revision of first characterisation of surface water;
5. The characterisation shall be revised by 22 December 2013 and every 6 years thereafter;
6. The **Latvian Environmental Agency** is responsible for data providing to characterise surface water bodies status within definite River Basin District.

GROUNDWATER:
<u>**I -** identification and characterisation of groundwater bodies</u>

7. The **State Geological Survey** is responsible for identification of groundwater bodies and characterisation of the status thereof;
8. The identification of groundwater bodies shall be completed by 22 December 2004;
9. The **State Geological Survey** is responsible for data providing to characterise groundwater bodies status within definite River Basin District.

Option 3:

SURFACE WATER:

I - identification and characterisation of surface water bodies

1. The **Latvian Environmental Agency** is responsible for identification of surface water bodies and characterisation of the status thereof ;
2. The first characterisation of the status of surface water bodies shall be completed by 22 December 2004;
3. The **Latvian Environmental Agency** is responsible for data providing to characterise surface water body status within definite River Basin District.

II - revision of first characterisation of surface water

4. The **State Geological Survey** is responsible for revision of first characterisation of surface water;
5. The characterisation shall be revised by 22 December 2013 and every 6 years thereafter;
6. The **Latvian Environmental Agency** is responsible for data providing to characterise surface water body status within definite River Basin District.

GROUNDWATER:

I - identification and characterisation of groundwater bodies

7. The **State Geological Survey** is responsible for identification of groundwater bodies and characterisation of the status thereof;
8. The identification of groundwater bodies shall be completed by 22 December 2004;
9. The **State Geological Survey** is responsible for data providing to characterise groundwater body status within definite River Basin District.

3.4. Deadlines

The following deadlines for implementation of typology and characterisation related activities are required by Directive and have to be incorporate into Cabinet Ministers Regulation on TPC:

- The first characterisation of the status of surface water bodies - shall be completed by 22 December 2004;
- First characterisation - shall be revised 22 December 2013, and next characterisations - every 6 years thereafter;
- Identification of groundwater bodies – shall be completed by 22 December 2004.

4. SURFACE WATER

The first sections of chapter 4 are directed to the local legal expert to draft the CM Regulation. The last part covers the background for the proposal of Latvian typology for rivers, lakes, transitional and coastal water.

The Directive requires surface waters within the River Basin District to be split into water bodies that represent the elemental classification and management unit of the Directive.

The following hierarchical approach is suggested (from CIS COAST Guidance):

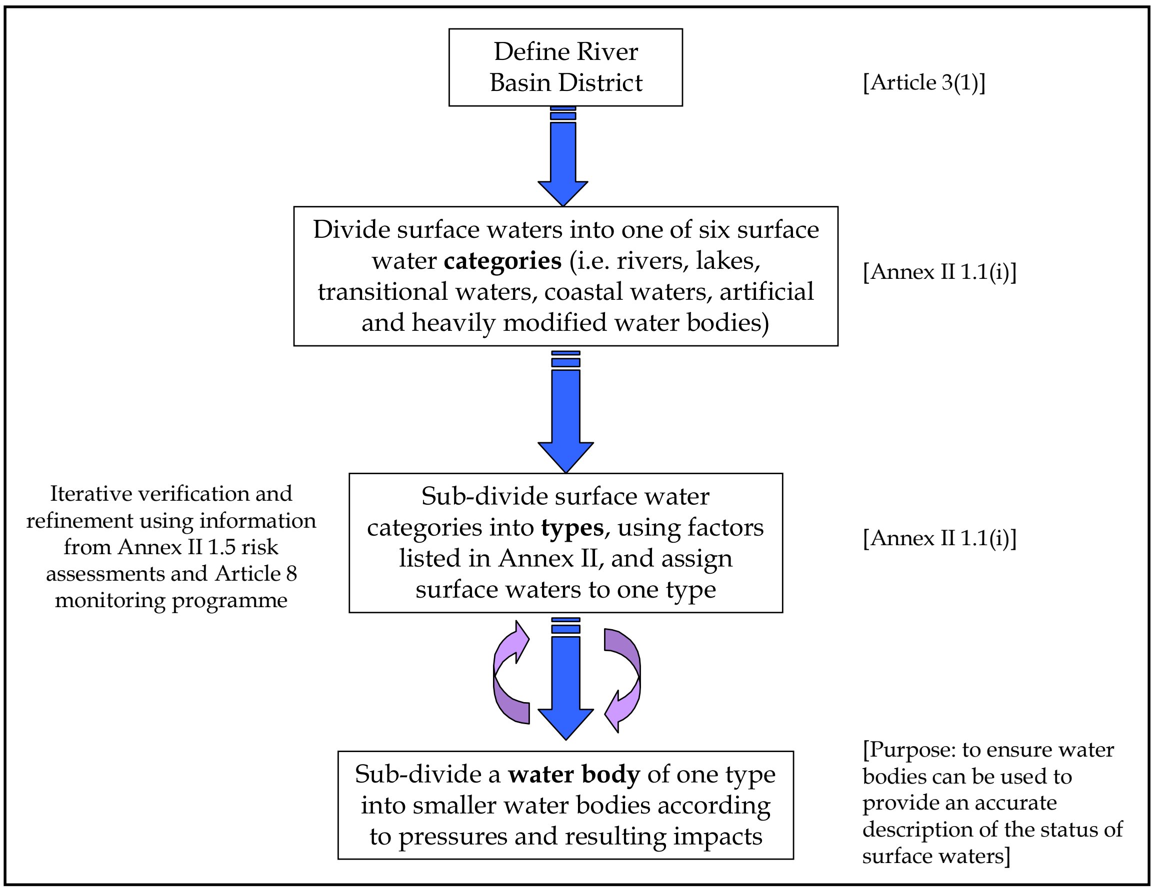

Figure 4-1: Suggested approach in the CIS guidance

4.1. Procedure for division of surface water into categories and further differentiation into types.

4.1.1. Aim

In order to enable the characterisation surface water shall be categorised and differentiated into types. The aim of typology is to enable type specific reference conditions to be established which in turn is the anchor of the classification system (CMR Surface water body types, their characterisation, classification and procedure for identification of anthropogenic pressures). Assigning water bodies to a physical type is done to ensure valid comparisons of its ecological status and environmental objectives can be made.

4.1.2. Procedure

Categories

Surface water bodies shall be divided into one of the following categories of surface water:

- Rivers
- Lakes
- Transitional waters
- Coastal waters
- Artificial surface water bodies and heavily modified surface water bodies.

A body of surface water may be ascribed to an artificial or heavily modified water body when:

- restoration of hydro-morphological characteristics of the body necessary for the achievement of good ecological status would have significant adverse effects on e.g. the wider environment, navigation, recreation, power generation, flood protection and land drainage;
- the beneficial objectives served by the modified characteristics of the water body cannot, for reasons of technical feasibility or disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option.

To be a candidate for a designation as a heavily modified water body the physical alteration of the water body must have resulted in:

- long-term changes,
- changes in both morphological and hydrological characteristics,
- changes preventing the water body from achieving a good status as the original water body type (e.g. a significant reservoir established by damming of a river).

An Artificial Water Body is a surface water body that has been created in a location where no water body existed before and is physically influenced regularly by the designated use.

Types

Surface waters that belongs to the category of rivers, lakes, transitional water or coastal waters shall be differentiated according to types using the values for the obligatory factors and optional factors described below. The responsible authority can decide to choose more optional parameters from the table below and even to use others suggested in the table. The system shown in the table corresponds to the Directives system B and is selected because it ensures enough factors to cover the difference in biological compositions and community structures.

Table 4-1: Factors used for differentiation of water bodies in the category of rivers, lakes, transitional water and coastal waters

RIVERS	**Physical and chemical factors that determine the characteristics of the river or part of the river and hence the biological population structure and composition**
Obligatory factors	altitude latitude longitude geology size
Optional factors	distance from river source energy of flow (function of flow and slope) mean water width mean water depth mean water slope form and shape of main river bed river discharge (flow) category valley shape transport of solids acid neutralising capacity mean substratum composition chloride air temperature range mean air temperature precipitation

LAKES	**Physical and chemical factors that determine the characteristics of the lake and hence the biological population structure and composition**
Obligatory factors	Altitude latitude longitude depth geology size
Optional Factors	mean water depth lake shape residence time mean air temperature

	air temperature range mixing characteristics (e.g. monomictic, dimictic, polymictic) acid neutralising capacity background nutrient status mean substratum composition water level fluctuation

TRANS-ITIONAL WATERS	**Physical and chemical factors that determine the characteristics of the transitional water and hence the biological population structure and composition**
Obligatory factors	latitude longitude tidal range salinity
Optional Factors	depth current velocity wave exposure residence time mean water temperature mixing characteristics turbidity mean substratum composition shape water temperature range

COASTAL	**Physical and chemical factors that determine the characteristics of the coastal water and hence the biological community structure and composition**
Obligatory factors	latitude longitude tidal range salinity
Optional Factors	current velocity wave exposure mean water temperature mixing characteristics turbidity retention time (of enclosed bays) mean substratum composition water temperature range

For artificial and heavily modified surface water bodies the differentiation shall be undertaken in accordance with the factors for whichever of the surface water categories most closely resembles the heavily modified or artificial water body concerned;

The Ministry of Environment (State Geological Survey or Latvian Environmental Agency) shall prepare a map or maps (in a GIS format) of the geographical location specifying the differentiated types of surface water bodies, the locations and boundaries of the identified surface water bodies.

4.2. Procedure for identification of surface water bodies

4.2.1. Aim

All surface water shall be identified as surface water body (types) in order to enable a characterisation of them. The surface water bodies represent the elemental classification and management unit of the River Basin Management Plan.

4.2.2. Procedure

The identification of water bodies shall be carried out following the 4 steps:

- identify the boundaries of the surface water categories.
- identify the boundaries between surface water types.
- identify boundaries of water bodies using distinct physical features that are likely to be significant in the context of aquatic ecosystem characteristics and in order to ensure that the water body is discrete and significant.
- identify boundaries on other relevant criteria as: a)pressures and impacts to ensure that one water body is assigned to a single ecological class b) different uses as drinking waters and existing protected areas c) morphological changes.

General rules:

The "water body" is a coherent, discrete and significant sub-unit in the river basin to which the environmental objectives of the directive must apply.

A water body must be capable of being assigned to a single ecological status class with sufficient confidence and precision through the monitoring programmes (CMR Requirements for monitoring and monitoring programmes for surface waters, groundwater and protected area).

The State Geological Survey or Latvian Environmental Agency shall carry out the identification and differentiation of surface water bodies.

Surface water bodies shall be identified on the basis of the specific (discrete) features of their status. When identifying surface water bodies, criteria shall be applied ensuring a possibility to establish reliable biological conditions for water bodies so that these conditions could be compared with reference conditions. For this purpose, part of a river, lake, transitional or coastal water may be regarded as a separate water body if this helps to carry out a more precise characterisation of the body of water and to compare it with reference conditions. At the other hand surface waters that belong to different categories may not be ascribed to one body of water.

Surface water bodies must not overlap with each other and a surface water body must not cross the boundaries between surface water body types (because the reference conditions are type-specific).

It may be necessary to divide an area of one type further into two or more separate water bodies. The need to keep separate two or more water bodies of same type depends on pressure and resulting impacts. A discharge may cause an organic enrichment in one water body, but not in the other. Such an area of type could therefore be divided into two separate water bodies with different classifications.

All significant surface water lying within River Basin Districts shall be identified, including coastal and transitional waters. Rivers with a catchment area less than 10 km^2, or lakes with a size between 0.50 km^2 and 1 km^2 with minor significance in the context of the Directive's purposes and provisions (e.g. minor ecological importance; no significant adverse impacts on other surface waters in the river basin district) do not have to be identified as a water body. Two or more rivers the catchment area of which is less than 100 km2, or two or more lakes with an area is less than 1 km2 or smaller may be grouped into one body of water in order to avoid complicated management of water protection if they are belonging to the same category and type and influenced by the same pressure category and level. Bodies of surface water which provide more than 10 m^3 of water intended for human consumption a day as an average or serving more than 50 persons and bodies of water which are likely to be intended for such use in future shall be identified as independent bodies of water irrespective of the figures specified herein.

Boundaries of protected areas shall be considered for the identification of water bodies.

See also section 6.2 for a more detailed explanation of the procedure.

4.3. Establishment of type-specific reference conditions for surface water body types

Establishment of type specific reference conditions is a part of Annex II in WFD and is closely connected to classification (WFD Annex V). The project has recommended defining type-specific reference condition in the Regulation on Classification instead of CM on characterisation. The description of methods and selection of reference sites is covered by TR1B.

4.3.1. Aim

The aim is to establish reference conditions that are specific to the identified surface water body types. The reference condition is a description of the biological elements that exist or would exist-, at high status, that is, with no, or very minor disturbance from human activities. The objective of setting reference condition standards is to enable the assessment of ecological quality against these standards.

4.3.2. Procedure

For each type reference conditions shall be established. Reference conditions are a description of the biological quality elements at high status.
For each surface water body type characterised in accordance with section 4.1 and 4.2 the Latvian Environmental Agency shall establish:

- Type-specific biological reference conditions-, representing the values of the biological quality elements for that surface water body at high ecological status.
- Type-specific hydromorphological and physicochemical conditions representing the values of the hydromorphological and physicochemical quality elements for that surface water body type at high ecological status.
- Reference conditions for heavily modified and artificial surface water bodies shall represent hydro-morphological and physicochemical parameters and the values of biological quality elements for that surface water body type at maximum ecological potential. The values for maximum ecological potential shall be reviewed every 6 years.

In establishing type-specific reference conditions for surface water body types, the following criteria shall be observed:

- Hydro-morphological and physicochemical parameters may not deviate or may deviate only to a very minor extent from the parameters that are typical of the surface water bodies of a given type under undisturbed conditions;
- Concentrations of the priority substances on the list of which is given in Annex X to the Water Framework Directive and other synthetic toxic substances must be close the zero value or below the detection limit;
- Concentrations of other pollutants must be close to the value typical of the surface water bodies of a given type under undisturbed conditions.

Reference conditions for a surface water body type may be established based on monitoring and/or on the basis of modelling using historical and paleoecological data, or may be derived using a combination of these methods. Where it is not possible to use these methods, reference conditions shall be established using expert judgement.
For the purpose of establishment of type-specific biological reference conditions for a surface water body type, the Latvian Environmental agency on the basis of monitoring shall develop a reference network for each surface water body type. The network shall contain a sufficient number of sites of high status to provide a sufficient level of confidence about the values for the reference conditions.

The methods of defining type-specific reference conditions and selection of reference sites are covered by TR1B.

4.4. Procedure for identification of pressures and assessment of impacts

4.4.1. Aim

The Geological Survey of Latvia/LEA shall carry out an identification of pressures, which affects or may affect the surface water bodies in order to review the impact of the pressures on the water body types. The purpose is to identify water bodies at risk of failing to achieve their specified environmental objectives. Further characterisation shall be carried out for these water bodies to optimise monitoring programmes and programmes of measures.

The review shall be included in the management plans for the River Basin Districts.

4.4.2. Procedure

Identification of pressure and assessment of human impact will be a 4-step process:

- Describe the driving force especially the land use, urban development, industry, agricultures and other activities which lead to pressures.
- identify pressures with possible impacts on water bodies and water uses by considering the magnitude of the pressure and the susceptibility of the water body.
- assessing the impacts resulting from the pressures
- evaluating the likelihood of failing to meet the objective.

For the purpose of identifying the type and magnitude of the anthropogenic impacts and to assess water bodies at the risk of failing to achieve good ecological status in due time, data shall be collected and analysed on significant pollution of surface water bodies from urban, industrial, agricultural and other installations of economic activities by the State Geological Survey or Latvian Environmental Agency. Both point and diffuse source pollution shall be estimated.

For the purpose of assessing the impact of human activity on the status of surface water bodies, the State Geological Survey l/LEA shall use existing monitoring data as well as data obtained from Regional Environmental Departments and other relevant institutions.

Data shall be provided according to the pressure list and shall cover:

- pollution of surface water bodies from waste water treatment plants and other economic entities as well as on abstraction of water for the needs of cities, towns, industry and agriculture, including seasonal variations in water abstraction and the total annual demand
- pollution of surface water bodies from the largest economic entities;
- pollution of surface water bodies by hazardous substances;
- significant morphological changes in surface water bodies or other anthropogenic impacts on the status of surface water bodies (data shall be provided in the annual reports of the responsible institution).

The State geological Survey or LEA shall assess the data specified above and establish the susceptibility of the surface water status to the impact of human activity and the risk of failing to meet the water protection objectives in due time before 22 December 2004. Modelling techniques may be utilised for such assessment.

If, during the assessment of the impact of human activity on the status of surface water bodies, water bodies are identified as being at risk of failing to meet their specified environmental objectives, further characterisation shall, where relevant, be carried out to optimise the design of the monitoring programme and to select adequate programmes of measures to be applied.

The pressures listed in annex B of Annex 1 shall be reviewed for each of the identified water bodies.

Information about the pressures may be found at the following institutions:

- State Geological Survey
- Latvian Environment Agency
- Regional Environmental Boards
- Marine Protection Board
- Nature Protection Board
- Municipalities
- Municipal enterprises such as "Rīgas ūdens"(Rīga Water Works)
- State Environmental Inspection
- State Inspection for Heritage Protection
- Ministry of Agriculture
- University of Agriculture
- Latvian Forestry Research Institute
- State Fishery Board
- State Fisheries Research Institute
- Rural and Regional Support Services
- Ministry of Welfare – National Environmental Health Centre
- Research Institute on Water Management and Land
- Institute of Aquatic Ecology, University of Latvia
- Institute of Biology
- Institute of Limnology
- Latvian Ornithological Society
- Latvian Nature Fund
- Environmental department of Riga City Council
- State Joint Stock Company "Latvenergo"
- Regional Environmental Centre
- Enterprise Vides projekti
- Consulting companies Geo Consultants and Carl Bro Latvia
- State Enterprise "Meliorprojekts"
- Union of Local and Regional Governments of Latvia

The textboxes below present a pragmatic approach for identification of water bodies at risk for the purpose of the first characterisation of river basins.

Discharge of hazardous and priority substances

The water body should be identified as being at risk, if it is expected that the concentration of hazardous and/or priority substances exceeds the water quality standards. Assessment shall be made based on:

- Existing monitoring data (monitoring of both effluent and receiving waters)
- Inventory of industrial activities and discharges (simple dilution models should be applied to assess compliance with water quality standards downstream from discharges)
- Inventory of polluted territories (e.g. former military sites)

Pesticides should be monitored at selected sites situated in intensive agricultural areas.

Waste water discharges

1. River reaches downstream wastewater discharges are considered to be at risk for non-compliance with good status or good potential if the specific waste water discharge is estimated to increase the annual average BOD concentration in the river by >0.2 mg/l.

   Assumptions used:
   The average annual river flow is assumed to correspond to 200 mm/year from the catchment corresponding to 200,000 m^3/km^2 year. A BOD increase of 0.2 mg/l corresponds to 40 kg/year. If sufficient wastewater discharge monitoring results are not available the BOD from 1 person is assumed to be 20 kg BOD/year (untreated or mechanically treated). For biologically treated wastewater the load from 1 person is assumed to be 4 kg BOD/year. It is generally assumed that degradable organic matter from one discharge point is mineralised before reaching the next downstream wastewater discharge point. Dry weather discharges from one town to the same river are summarised and considered as one wastewater outlet.
   BOD from wastewater, calculated criteria:
   An annual discharge of *above 40 kg BOD/km^2 year* will lead to an identification of the reach downstream the discharge point to be at risk. This corresponds approximately to a discharge of untreated wastewater from 2 persons/km^2 catchment at the discharge point or biologically treated wastewater from 10 persons/km^2.

2. A lake is considered to be at risk because of wastewater discharges in its catchment if the estimated increase in annual average total P concentration of inflowing water is above 10 mg P/m^3.

   Assumptions used:
   The average annual river flow is assumed to correspond to 200 mm/year from the catchment corresponding to 200,000 m^3/km^2 year. An increase of 10 mg P/m^3 corresponds to 2 kg P/km^2 year. If sufficient wastewater discharge monitoring results are not available the total P from 1 person is assumed to be 2 kg/year from untreated, mechanically, or biologically treated wastewater. For wastewater with P removal the contribution is assumed to be 0.5 kg P/year.
   Phosphorus from wastewater, calculated criteria:
   An annual discharge of *above 2 kg total P/km^2 year* in a lake catchment will lead

to an identification of the lake to be at risk. This corresponds approximately to a discharge of wastewater from 1 person/km^2 catchment area of the lake (with treatment plants with P removal from 5 persons). All discharges from the entire lake catchment are summarised.

Dams

Dams prevent the natural migration and spreading of the freshwater fauna. Further, the river ecosystem is changed upstream a dam, if the damming of a river creates a significant reservoir. Such reservoirs can not meet the requirements for a good status, but possibly the requirements for a good potential. The water bodies in the entire catchment upstream an artificial dam should be designated as water bodies at risk of not meeting good status unless well functioning passage possibilities are established at the dam for upstream and downstream migration.

However, the character of the impact of a dam on upstream water bodies differs widely from the impacts from a discharge of pollutants and local physical modifications of a water body. Some water bodies upstream dams and otherwise unpolluted can in fact in most aspects have a high status if not otherwise impacted. Therefore, the identification of water bodies at risk because of damming is in practice made by a separate identification of the sites of dams on a GIS map. This identification of the upstream water bodies at risk will in most cases not require a further operational monitoring to be able to decide upon the measures needed to establish the needed passage possibilities.

Nutrients from agriculture

Cultivation of land leads to increases in nutrient losses. Especially increased P loadings from the catchment will contribute to a eutrophication of lakes. The relations between agricultural activities and P losses are insufficiently known and widely different from field to field.
Criteria for agricultural impact
Agricultural activities in a catchment to a lake are considered to lead to a risk of non-compliance if more than 50% of the catchment is classified in the CORINE land use maps as agricultural areas (cultivated, pastures, gardens etc.). If more than 25% of the lake catchment can be identified as intensively cultivated (e.g. though agricultural statistics) the lake is also considered being at risk.

See also section 6.3 for more detailed explanation of the procedure for identification of water bodies at risk and TR2, Annex 2, where this approach is presented:

4.5. Typology of Latvian freshwater

4.5.1. Approach used

One of WFD's objectives is to establish framework for the protection of water quality preventing future deterioration and protection of water ecosystems. The first step of implementation of WFD is the characterisation of water bodies, which is based at first on typology and second on existing impacts to environment. It means that the purpose of typology is to group sites where the biology is similar in the absence of human impact. Therefore typology is a tool for defining the ecological status, which determines:

- Establishment of classification procedure;
- Classification of water bodies in practice;
- Definition of reference conditions;
- Establishment of reference monitoring network;
- Performing reference monitoring.

If typology is simple it have to be complemented by more detailed complex of parameters very precisely describing the reference condition. Classification of water bodies is simple and a limited amount of resources is needed to establish a reference network and to perform monitoring. If typology is complex, the simple complex of parameters describing reference conditions is used, while more resources are needed to establish a reference network and to perform monitoring. Therefore typology have to be as simple as possible, but as complicated as needed to enable adequate prediction of reference conditions.

The meaning of the WFD typology is a physical division of water bodies, which is based on ecologically relevant factors. Therefore it is very import to develop simple typology, where the most important parameters defining ecological status of water body are taking into consideration.

The other important criteria for development of national typologies, is that typology have to be common and easily comparable for use all over Europe, but also that is describes regional peculiarities of the water bodies, which are essentially important for defining of reference conditions. Therefore System B, which offers flexibility both in the choice of description and in assigning numerical values for boundaries between types is preferable for pre-accession countries.

The development of Latvian typology has been based on the assumption that obligatory factors defined by WFD will be used for physical dividing of water bodies, while the ecologically relevant characteristics of water bodies have to be ensured by the optional parameters chosen.

The basic principles used for development of Latvian typology can be stated us follows:

- The typology has to be **as simple as possible** in order to insure easy implementation in practice; and
- The typology has to be **as exact as** possible in order to insure easy classification and to avoid difficulties for further definition of ecological status.

4.5.2. Typology of rivers

4.5.2.1. Obligatory factors used for differentiation of rivers

The following obligatory factors listed in Annex II of the Directive the Member State should be used for typology of running waters:

- Altitude
- Latitude
- Longitude
- Geology
- Size.

(a) Altitude, latitude and longitude

No significant ecological differences of running water status are detected in Latvia, which are determined by altitude, latitude and longitude. Therefore it is decided to use one class for altitude, latitude and one longitude for typology of Latvian rivers.

(b) Geology

Geology determines such parameters as mineralization and conductivity. The Latvian rivers are characterised by:

- weak mineralization (>200mg/l); or
- medium mineralization (200-500 mg/l).

Therefore Latvian rivers are accountable to the group of calcium under the class of hydrocarbons. Conductivity in case of Latvian rivers to the contrary of lakes[1] characterises mainly anthropogenic impact on river quality and can be used as parameter for classification of rivers in ecological classes. It is recommended to use one geology class for typology of Latvian running waters.

(c) Size

The rivers in Latvia are relatively young – 10-11 thousand years and they originated after the last glacial period. Rivers are considered small in Latvia if their length is less than 100 km and their water catchment area is below 1000 km^2.

There are:

- 17 rivers big rivers;
- 880 small rivers in Latvia; and
- approx. 1 500 with length characteristics < 10 km

[1] Conductivity, which is determined by geology, commonly is used as key parameter for typology of lakes,

Table 4-2: Characteristics of Latvian rivers – rivers length

Length	Number	Total length	Percentage
> 100 km	17	2706 km	1,9
100 – 50 km	64	4278 km	7,3
50 – 20 km	214	6241 km	24,3
20 – 10	585	7617 km	66,5
Total:	**880**	**20842 km**	**100**

Traditionally Latvian running waters are divided into classes based on rivers length characteristics, and two running water classes - big rivers (>100 km) and rivers & streams (<100 km), are commonly used in Latvia. Therefore existing biological monitoring system and methods for assessment of biological quality of rivers[2] was developed for the 2 mentioned classes of rivers.

The approach of the WFD approach is to use the size of catchment area of rivers. The following classes are recommended to be used for typology of Latvian rivers:

< 1000 km^2 – streams
1000-10000 km^2 – rivers
> 10 000 km^2 - big rivers.

The high density of rivers is typical form Latvia (mean density of the river network – 588 m per 1 km2). The well-developed network of rivers is determinated by uneven moraine relief, wet climate and peculiarities of geographical structures. Most of the Latvian rivers are short (with length under 10 km) and characterised by small size of catchment area. Characteristics of Latvian rivers according to size of catchment area are summarised in Table 4-3.

Table 4-3: Characteristics of Latvian rivers – size of catchment area

River	Size of catchment area	Number of rivers
< 100 km2	<10 km2	422
	10 - 49 km2	1219
	50 - 99 km2	192
	Total number:	**1833 or 90 %**
100 – 1000 km2	100 - 199 km2	97
	200 - 299 km2	34
	300 - 399 km2	16
	400 - 499 km2	16
	500 - 599 km2	9
	600 - 699 km2	7
	700 - 799 km2	5

[2](1)Biological Monitoring of Small Rivers - carried out by REB; (2) Monitoring of anthropogenic impact of biggest agglomerations and pollution sources to big rivers - carried out by LEA (previously by HMA)

	800 - 899 km2	3
	900 - 999 km2	5
	Total number:	**192 or 9%**
> 1000 km2	1000 - 1999 km2	10
	2000 - 2999 km2	5
	3000 - 3999 km2	1
	4000 - 4999 km2	0
	5000 - 5999 km2	1
	6000 - 6999 km2	1
	7000 - 7999 km2	1
	8000 - 8999 km2	1
	9000 - 9999 km2	1
	Total number:	**21 or 1%**
1000 – 10 000 km2	-	-
> 10 000 km2	-	-

According to the requirements in WFD for size of catchment area, all Latvian rivers belong to one group. In order to test proposed typology and to determine reference condition the analyses of existing monitoring data were carried out. Obtained results very clearly defined that rivers with catchment area <100 km2 and rivers with catchment area >100 km2 have to be separated and the same characteristics of reference condition cannot be addressed to both of mentioned groups of rivers. Therefore the following catchment area size to be use for typology of Latvian rivers is recommended:

< 100 km2 – streams
100-1000 km2 – rivers
>1000 km2 - big rivers.

Taking into account that Latvian rivers predominantly has small catchment areas (90% of Latvian rivers has catchment area <100 km2) it is recommended only streams with catchment area from 50 to 99 km2 to separate as independent water bodies.

Characteristics of obligatory factors used for typology of Latvian rivers is summarised in Table 4-4.

Table 4-4: Obligatory factors used for differentiation of water bodies in the category of rivers

Status of factor	**Physical and chemical factors that determine the characteristics of the river or part of the river and hence the biological population structure and composition**	
	Factors	**Characteristics**
Obligatory	Altitude:	
	Latitude:	$55^0$40' and $58^0$05' northern latitude

	Longitude:	$20^0$58' and $28^0$14'east longitude
	Geology:	Group of calcium under the class of hydrocarbons
	Size: Medium Large Very large	Catchment area: < 100 km^2 – streams 100-1000 km^2 – rivers >1000 km2 - big rivers

4.5.2.2. Optional factors used for differentiation of rivers

(a) References, materials and approach used

The typology and particular designation of optional parameters should be based either on knowledge of how biological condition of river ecosystems is determined by physiogeographical condition or on physical and biological monitoring data from reference sites. The combination of both approaches has been used for development of typology for Latvian rivers. Proposal for typology of Latvian rivers was developed on knowledge of how reference condition of rivers is determined by physiogeographical condition and further in order to test validity of proposed typology the existing monitoring data was analysed.

The following scientific publications, project documents and sources of monitoring data are used for the development of typology for Latvian rivers:

Biological diversity of freshwater ecosystems; 1993-1995 (*state ordered program*);
Monitoring of waterbodies of protected areas; 1994-2002; (*state ordered program*);
Environmental Quality in Latvia; 1998 (*Environmental data Centre*);
Environmental Indicators in Latvia; 2002 (*Latvian Environmental Agency*);
Chemistry of Surface Waters in Latvia; 2002; Riga (*M.Klavins, V.Rodinovs, I.Kokorīte*)
A Latvian catalogue of indicator species of freshwater saprobity. Proceedings of Latvian Academy of Sciences; 1995; Riga (*Cimdins P., Druvietis I., Liepa R., Urtane L., Urtans A., Parele E.*);
River typology: parameters for evaluation of their environmental State; 1995; Riga (*P.Cimdins*);
Application of saprobity systems in ecological studies of rivers; 1995; Riga (*P.Cimdins*)
Recultivation effect of River Jaunupe on the formation of phytozoocomplexes in the River Jaunupe; 1999; Riga (*Urtans A., Urtane L.);*
Report – River and lake typology and ecological status; 2002 (*Latvian – Swedish Daugava river basin project*).

(b) Slope as a optional parameter for differentiation of fast-floating and slow running rivers

The basic principles in typology of running waters have been developed by J.Illies (1961). This typology suggests the impact of two basic factors – stream velocity and water temperature. Therefore all running waters can be divided into two large physiogeographical groups – rhitral and potamal.

I – the potamal rivers are found in plains, they are slow-running (velocity < 0,2 m/s), sandy, and silty, and temperatures in summer months are over 20^0C;
II – the rhitral rivers are sandy and stony, and are found in highland and mountains. The summer temperature is below 20^0C. Latvian rivers are rhitral due to their temperature, and their bottom composition and velocity (> 0,2 m/s).

For both of the mentioned parameters stream velocity and water temperature, are determined by river slope, while river depth composition is determined by stream velocity. It is clearly stated that sediment composition is formed from big particles – stones and gravel, if stream velocity is > 0,2 m/s and that sediment is formed of silt which is covered by mud and organic debris, if the velocity is < 0,2 m/s.

In order to develop simple and exact typology of rivers it was decided to find one optional factor that characterised differences between potamal and rhitral rivers. Based on analyses of existing monitoring the correlation between characteristics of velocity and river slope is found. Therefore the river slope and value - 1,0 m/km within 1 to 3 km long river stretch is use for typology of Latvian rivers.

The critical aspect for river slope based typology is natural biological diversity, which is determined by the continuity of river. The river continuity concept prescribe that natural biodiversity of upper reaches of river is lower in comparison with biodiversity figures which characterises lower reaches of rivers. Nevertheless this can be avoided if bioindicators are used to determine water quality.

4.5.2.3. Proposal for typology of rivers

Factors used for typology of Latvian rivers and its characteristics are summarised in Table 4-5, typology of Latvian rivers is shown in Figure 4-2.

Table 4-5: Characteristics of Latvian rivers.

Obligatory factor - size	Optional factor - slope	Type of river		Characteristics of river type
Medium – < 100 km2	Big – >1,0 m/km within 1 to 3 km river stretch	**1**	Fast-floating stream with medium size catchment area	Streams are fast-floting (velocity is >0,2 m/s) and shallow with sandy and stony sediments. Water temperature in summer months is below 20^0C.
	Small – <1,0 m/km within 1 to 3 km river stretch	**2**	Slow-running stream with medium size catchment are	Streams are slow-running (velocity is <0,2 m/s) and shallow with sandy and silty sediments which are covered by organic debris. Water temperature in summer months is over 20^0C.
Large – 100- 1000 km2	Big – >1,0 m/km within 1 to 3 km river stretch	**3**	Fast-floating river with large size catchment area	Rivers are fast-floting (velocity is >0,2 m/s) and medium deep with sandy and stony sediments. Water temperature in summer months is below 20^0C.

	Small – <1,0 m/km within 1 to 3 km river stretch	**4**	Slow-running river with large size catchment area	Rivers are slow-running (velocity is <0,2 m/s) and medium deep with sandy and silty sediments which are covered by organic debris. Water temperature in summer months is over 20^0C.
Very large – >1000 km2	Big – >1,0 m/km within 1 to 3 km river stretch	**5**	Big fast-floating river with very large size catchment area	Rivers are fast-floting (velocity is >0,2 m/s) and medium deep to deep with sandy and stony sediments. Water temperature in summer months is below 20^0C.
	Small – <1,0 m/km within 1 to 3 km river stretch	**6**	Big slow-running river very large size catchment area	Rivers are slow-running (velocity is <0,2 m/s) and medium deep to deep with sandy and silty sediments which are covered by organic debris. Water temperature in summer months is over 20^0C.

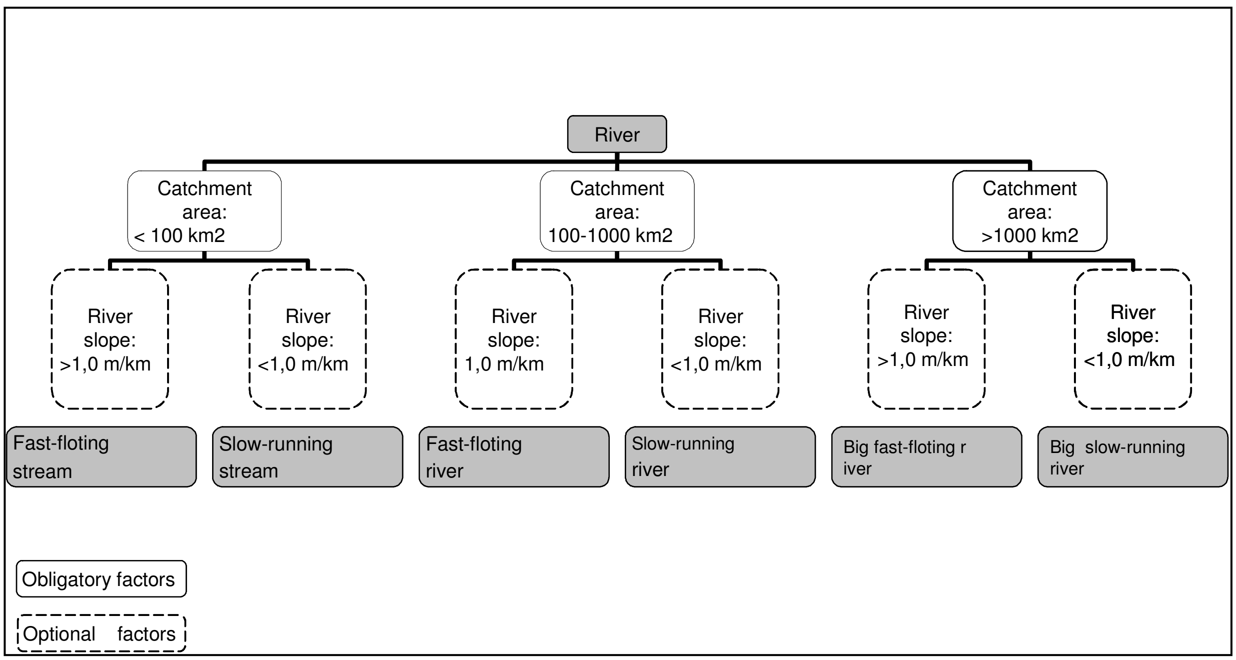

Figure 4-2: Typology of Latvian rivers

4.5.3. Typology of lakes

4.5.3.1. References, materials and approach used

The typology and particular designation of optional parameters should be based either on knowledge of how biological condition of lake ecosystems is determined by chemical-geological cycling of chemical substances physiogeographical condition or on physical and biological monitoring data from reference sites. The combination of both approaches has been used for development of typology for Latvian lakes. Proposal for typology of Latvian lakes was developed on knowledge of how reference condition of lakes is determined by morphometrical characteristics of lakes and further in order to test validity of proposed typology the existing monitoring data was analysed.

The following scientific publications and project documents are used for the development of typology for Latvian lakes:

Biological diversity of freshwater ecosystems; 1993-1995 (*state ordered program*);
Development of lake monitoring system in Latvia; 1992 (*state ordered program*);
Monitoring of waterbodies of protected areas; 1994-2002; (*state ordered program*);
Environmental Quality in Latvia; 1998 (*Environmental data Centre*);
Environmental Indicators in Latvia; 2002 (*Latvian Environmental Agency*);
Report – River and lake typology and ecological status; 2002 (*Latvian – Swedish Daugava river basin project*).
Zooplankton as bioindicator for typology of Latvian lakes; 1997 (*L.Urtane – Ph.study*);
Investigations of biodiversity in freshwater ecosystems of Latvia, Hydrobiological Research in the Baltic Countries. Part I. Rivers and Lakes. Vilnius; 1999 (*G.Spriņģe, A.Briede, I.Druvietis, E.Parele, V.Rodinovs, L.Urtane*);
Limnological studies in the lakes of the Teici Bog reserve; 1997 (Urtane, L., Briede, A., Druvietis, I., Klavins, M., Parele, E., Rodinovs, V., Springe, G.);
Zooplankton community of Lake group with different content of humic substances in Latvia. Case study; 1995 (*Urtane L., Klavins M.*);
Studies on Planctonic Communities in Small Brown Water Lakes in Teicu Bog Reserve; 1995 (*Druvietis I., Urtane L., Springe G., Briede A., Klavins M.*).

4.5.3.2. Obligatory factors used for differentiation of lakes

The following obligatory factors listed in Annex II of the Directive the Member State should be used for typology of standing waters:
altitude
latitude
longitude
depth
geology
size.

(a) Altitude, latitude and longitude

No significant ecological differences of running water status are detected in Latvia, which are determined by altitude, latitude and longitude. Therefore it is decided to use one class for altitude, latitude and longitude class to use of typology of Latvian lakes.

(b) Depth

Latvian lakes usually are shallow with a flat bottom and only 8 lakes are deeper than 10 m (mean depth). Shallow lakes with a mean depth of 1-6 m are most common (70%). Ten of 16 Latvian biggest lakes (surface area > 10km2) can be included in the group of shallow lakes.

WFD approach is to use mean depth for typology of lakes and dividing based on following depth characteristics is required:

< 3 m;
3-15 m;
> 15 m.

According to requirements for mean depth characteristics determined by WFD almost all Latvian lakes corresponds to first and second group and such grouping of lakes exclude possibility to separate very shallow lakes which describe peculiarities of Latvian nature condition. In order to define limiting characteristics of mean depth figures typical for Latvia the results of analyse how morphological characteristics of lakes determine ecological condition of lakes was evaluated (state ordered investigations - Development of lake monitoring program; 1992; Zooplankton as bioindicator for typology of lakes; 1997).

Obtained results very clearly define that characteristics of mean depth - 2m, have to be used in order separate very shallow lakes from shallow lakes and that the same characteristics of reference condition cannot be addressed to both of mentioned groups of lakes. Similarly a characteristic of mean depth – 9m, in Latvian condition is limiting value for separation of shallow and deep lakes. Therefore the following characteristics of mean depth is recommended for typology of Latvian lakes:

< 2 m – very shallow lakes;
2-9 m – shallow lakes;
> 9 m – deep lakes.

(c) Geology

The geological structure of Latvia consists of two main compartments – the crystalline basement and a cover of sedimentary rocks. The upper sediment layers – Quatenary sediments, mainly determined quality of surface water in Latvia (Chemistry of Surface water in Latvia; 2002). These sediments are quite recent and are composed of minerals differing in weathering sequences.

The rock composition and presence of carbonic minerals in sediment (moraine) are two main factors, which determine the chemistry of the watershed soil and ultimately the reference condition of lake. **Conductivity**[3] is determined by geology and characterised the lake's ability to assimilate pollutants and maintain nutrients in solution. Therefore the conductivity commonly is used as key parameter for typology of lakes. According to conductivity lakes can be divided as:

hardwater lakes; or
softwater lakes.

[3] Electrical **conductivity** estimates the amount of total dissolved salts, or the total amount of dissolved ions in the water

Lakes with high concentrations of the ions calcium (Ca^{+2}) and magnesium (Mg^{+2}) are called hardwater lakes, while those with low concentrations of these ions are called softwater lakes. Concentrations of other ions, especially bicarbonate, are highly correlated with the concentrations of the hardness ions, especially Ca+2. Analyses of ecological condition of Latvian lakes conducted by project indices that hardwater lakes will be separated from softwater lakes if parametric value 165 mkS/cm is used as limiting value.

(d) Size

The genesis of the territory of Latvia has supported development of a comparatively high number of lakes. There are more as 2 thousands natural lakes with surface area >1 ha and more as 10 thousands natural lakes with surface area < 1 ha. Most of lakes in Latvia are small. Characteristics of Latvian lakes according to surface area size are summarised in Table 4-6.

Table 4-6: Characteristics of Latvian lakes – surface area size

Size	Number of		Percentage	
	lakes	reservoirs	lakes	reservoirs
> 0,01 km2 (1 ha)	2256	796	99,3 %	99,6%
> 10 km2	16	3	0,7%	0,3 %

Taking into account that very limited number of lakes is bigger as 10 km2 and also that ecological condition of lakes is determined mainly by morphometry of lake (mean depth, max depth, min depth) it was decided only one size group to be used for typology of Latvian lakes.

Characteristics of obligatory factors used for typology of Latvian lakes is summarised in Table 4-7.

Table 4-7 Obligatory factors used for differentiation of water bodies in the category of lakes

Status of factor	Physical and chemical factors that determine the characteristics of the river or part of the river and hence the biological population structure and composition	
	Factors	Parameter
Obligatory	Latitude:	$55^0$40’ and $58^0$05’ northern latitude
	Longitude:	$20^0$58’ and $28^0$14’east longitude
	Mean depth:	< 2 m – very shallow 2-9 m - shallow > 9 m – deep
	Geology:	<165 mkS/cm - hard water >165 mkS/cm - soft water
	Size:	> 0,5 km^2

4.5.3.3. Optional factors used for differentiation of lakes

The following optional factors listed in Annex II of the Directive the Member State should use for typology of running waters:

mean water depth
lake shape
residence time
mean air temperature
air temperature range
mixing characteristics (e.g. monomictic, dimictic, polymictic)
acid neutralising capacity
background nutrient status
mean substratum composition
water level fluctuation.

In order to develop simple lake typology system it was decided to determine only one optional factor for differentiation of Latvian lakes.

Concentration of **organic mater** indicates the condition of water body and therefore is important parameter to assess water quality of surface water. Concentration of organic substances, which occurs as dissolved organic substances, particulate organic substances and organic matter in sedimentary phase commonly is used for characteristics of organic substances of surface water in Latvia. General indicators of organic substances in surface water are and colour, chemical oxygen demand (COD) and total concentration of organic carbon (TOC).

Colour of water bodies located in bog areas is determined by humic substances[4],.which have high capacity to bind nutrients in stable unsolvable form and therefore influence ecological condition of waterbody. The water color is expressed in degrees and usually either cobalt - platinum scale or Forel-Ule color scale is used.

In order to separate lakes, which are influenced by presence of bogs in catchment area, the colour is regarded as optional factor for typology of Latvian lakes and based on colour characteristics lakes can be divided as polihumic and oligohumic lakes.

Characteristics of optional factors used for typology of Latvian lakes is summarised in Table 4-8.

Table 4-8: Optional factors used for differentiation of water bodies in the category of lakes

Status of factor	Physical and chemical factors that determine the characteristics of the river or part of the river and hence the biological population structure and composition		
	Factors	Parameter	Characteristic
Optional factors	Organic mater:	Colour	<80 Pt-Co - Oligohumic
			>80Pt-Co - Polyhumic

4.5.3.4. Proposal for typology of lakes

Factors used for typology of Latvian lakes and its characteristics are summarised in Table 4-9.

[4] High molecular, acidic, dark coloured substances formed in the environment as a product of decomposition of living materials

Table 4-9: Characteristics of lake types

Mean depth	Geology	Colour	Type	Name
Very shallow: < 2m	Hard water: >165mkS/cm	Oligohumic: <80 Pt-Co	**1**	Very shallow hard water oligohumic lake
		Polyhumic: >80 Pt-Co	**2**	Very shallow hard water polyhumic lake
	Soft water: <165 uS/cm	Oligohumic: <80 Pt-Co	**3**	Very shallow soft water oligohumic lake
		Polyhumic: >80 Pt-Co	**4**	Very shallow soft water polyhumic lake
Shallow: 2-9m	Hard water: >165mkS/cm	Oligohumic: <80 Pt-Co	**5**	Shallow hard water oligohumic lake
		Polyhumic: >80 Pt-Co	**6**	Shallow hard water polyhumic lake
	Soft water: <165 uS/cm	Oligohumic: <80 Pt-Co	**7**	Shallow soft water oligohumic lake
		Polyhumic: >80 Pt-Co	**8**	Shallow soft water polyhumic lake
Deep: >9m	Hard water: >165mkS/cm	Oligohumic: <80 Pt-Co	**9**	Deep hard water oligohumic lake
	Soft water: <165 uS/cm	Oligohumic: <80 Pt-Co	**10**	Deep soft water oligohumic lake

4.5.4. International cooperation

The development of typology for lakes and rivers within Baltic Ecoregion is under development. At the moment Latvia is only of Baltic countries where typology schemes already are incorporated in the legislation. The current status of national typology schemes are discussed and presented in several working group meetings and seminars. Project staff has participated and presented final proposal of Latvian typology in following international seminars:

- Assessment of biological monitoring (data availability and methodology) for classification of water bodies: implementation of the WFD; BEF meeting 20-21 November, 2003, Sigulda, Latvia;
- Sustainable river basin management and public participation; 8 – 10 October, 2003, Tartu, Estonia

4.5.4.1. Typology of lakes in the Baltic countries

In general similar approach for development of national typology schemes is used in all Baltic countries. It is suggested for typology purposes to use System B by modifying system A and following common preconditions is used for typology of lakes:

- One altitude, one latitude and one longitude class accordingly to use for typology of lakes;
- One size class to use for typology of Estonian and Latvian lakes;
- Characteristics of geology and organic matter to use for typology of lakes.

(a) Proposed typology of Estonian lakes

Depth: shallow, deep
Size: one class
Geology: organic, inorganic
Geology – *alkalinity*: soft hardness, medium hardness, hard
Organic matter – *colour*: light, dark

Table 4-10 Proposed typology of Estonian lakes

Depth	Geology		Colour	Type
	Alkalinity	Organic/inorganic		
Shallow	Hard	M	Light	**1**
	Med hard	M	Light	**2**
		O	Light	**3**
	Soft	M	Dark	**4**
		O	Dark	**5**
Deep	Hard	M	Light	**6**
	Med hard	M	Light	**7**
		O	Light	**8**
	Soft	M	Dark	**9**
		O	Dark	**10**

(b) Proposed typology of Lithuanian lakes

Mean depth: shallow (< 3 m) , deep (> 3 m)
Size: small < 0,5 km^{2,},large > 0,5 km^2
Geology – ***alkalinity***: soft (< 0,2 meq/l), hard (> 0,2 meq/l)
Organic matter – ***colour*****:** light (< 90 mg Pt/l), dark (> 90 mg Pt/l)

Table 4-11: Proposed typology of Lithuanian lakes

Depth	Size	Alkalinity	Colour	Type
Shallow	Small	Soft	Light	**1**
			Dark	**2**
		Hard	Light	**3**
			Dark	**4**
	Large	Soft	Light	**5**
			Dark	**6**
		Hard	Light	**7**
			Dark	**8**
Deep	Small	Soft	Light	**9**
			Dark	**10**
		Hard	Light	**11**
			Dark	**12**
	Large	Soft	Light	**13**
			Dark	**14**
		Hard	Light	**15**
			Dark	**16**

In general the same approach is used for development of lakes typology in Baltic Ecoregion countries. The characteristics of morphometry (mean depth), geology (alkalinity) and organic matter (colour) are basic parameters for typology. Exception is Lithuania where the size of lakes also is used for typology of lakes.

The above mentioned basic parameters is the same that are used for developing typology in Scandinavian countries also but due to differences in natural conditions the values differs between the countries.

4.5.4.2 Typology of rivers in the Baltic countries.

(c) Proposed typology of Estonian rivers

Size of catchment area: small (10 to 100 km²); medium (100 to 1000 km²); large (1000 to 10 000 km²); very large: > 10 000 km²:
Organic matter: humic rivers (high colour); non humic (low colour); clay rivers
River slope: are considered

Table 4-12: Proposed typology of Estonian rivers

Size of catchment area	Geology	Type
Small: 10 -100 km2	humic rivers	**1**
	nonhumic rivers	**2**
	clay rivers	**3**
medium size: 100-1000 km2	humic rivers	**4**
	nonhumic rivers	**5**
Large: 1000- 10000 km2	humic rivers	**6**
	nonhumic rivers	**7**
Very large: >10 000km2	nonhumic rivers	**8**

(d) Proposed typology of Lithuanian rivers

Size of catchment area: small (10 to 100 km²); medium (100 to 1000 km²); large (1000 to 10 000 km²); very large: > 10 000 km²:
River slope: are considered

Table 4-13: Proposed typology of Lithuanian rivers

Size of catchment area	Type
Small: 10 -100 km2	**1**
medium size: 100-1000 km2	**2**
Large: 1000- 10000 km2	**3**
Very large: >10 000km2	**4**

In general the same approach is used for development of rivers typology in Baltic Ecoregion countries. The characteristics of catchment area size are basic parameters for typology. Exception is Estonia where characteristics of geology are used for typology of rivers.

Taking into account that river slope (velocity) is parameter which naturally divides river into two types – slow flouting rivers (also cyprinid rivers) or fast running rivers (also Salmonid rivers) both in Lithuania and Estonia it is under consideration to use mentioned parameter for typology of rivers.

4.6. Typology of coastal and transitional water

4.6.1. Definitions of transitional and coastal waters

WFD Directive defines **transitional waters** as:

Article 2 (6)
"'Transitional waters' are bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows."

When defining transitional waters for the purposes of the WFD, the setting of boundaries between transitional waters, freshwaters and coastal waters must be ecologically relevant. In accordance with WFD article 2(6) transitional waters are:

(1) located "...in the vicinity of a river mouth" meaning close to the end of a river where it mixes with coastal waters;
(2)"...partly saline in character" meaning that the salinity is generally lower than in the adjacent coastal water;
(3)"...substantially influenced by freshwater flow" meaning that there is a change to salinity or flow.

COAST Guidance states "if riverine dynamics occur in a plume outside the coastline because of high and strong freshwater discharge, the transitional water may extend into the sea (allowed in definition 1)". Further considerations on delimitation of transitional water bodies, especially, on definition of the seaward boundary of transitional waters will be given in the following chapter 6.

WFD defines coastal waters as:

Article 2 (7)
"'Coastal water' means surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters."

The ecological status of coastal waters should be classified offshore out to one nautical mile from the baseline. According to the United Nations Convention on the Law of the Sea (UNCLOS) the baseline is measured as the low-water line except along the mouths of estuaries and heads of bays where it cuts across open water. Baseline can be drawn as a straight line along highly indented coastlines, bays, mouths of estuaries or coastlines with islands. Each Member State has a legislative baseline associated with this definition.

4.6.2. Defining Surface Water Bodies within Transitional and Coastal Waters

The first stage in describing surface water bodies is to assign all surface waters to a surface water category – rivers, lakes, transitional waters or coastal waters – or to artificial surface water bodies or heavily modified surface water bodies (WFD Annex II 1.1.(i)).

WFD provides a generic definition for the 'water body' term:

Article 2(10)
"*Body of surface water*" *means a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water*[5].

Water bodies thus represent the elemental classification and management unit of the Directive. Identification of waterbodies is a step of major importance for the whole implementation process because water bodies represent the units that will be used for reporting and assessing compliance with the Directive's principal environmental objectives.

Water bodies may not spread over two types because reference conditions and hence environmental objectives are type specific. However, to assign a single classification and effective environmental objectives to a water body it may be necessary to divide an area which is of one type further into two or more separate water bodies. The need to keep separate two or more contiguous water bodies of the same type depends upon the pressures and resulting impacts.

For example, a discharge may cause effect in one water body but not in the other. Such an area of one type could therefore be divided into two separate water bodies with different classifications. If there were no impact from the discharge it would not be necessary to divide the area into two water bodies as it would have the same classification and should be managed as one entity. Sub-divisions of coastal and transitional waters into small water bodies that do not support clear, consistent and effective application of WFD objectives should be avoided.

According to the definition in WFD, water bodies must be "discrete and significant". This means, that they must not be arbitrary sub-divisions of river basin districts, that they must not overlap with each other, nor be composed of elements of surface water that are not contiguous. In the case of coastal waters, stretches of open coast are often continuous (unless divided by transitional waters); here subdivisions may follow significant changes in substratum, topographies or aspect.

4.6.3. Selection between typology systems A and B

Annex II of WFD gives instructions on how typology should be carried out and the obligatory and optional factors that can be used. Water bodies within each surface water category shall be differentiated according to type using a system of typology as defined in this Annex II of the Directive. Member States may choose to use either System A or System B:

[5] Underlined by the author

> **Annex II 1.1(ii)**
> *"For each surface water category, the relevant surface water bodies within the river basin district shall be differentiated according to type. These types are those defined using either 'system A' or 'system B'"*

If system A is used the type must first be assigned to an Ecoregion as shown in Map B of the Directive. In transitional waters the surface water type is then described according to mean annual salinity and mean tidal range. In coastal waters mean annual salinity and mean depth are used to describe the type.

System B uses a series of obligatory (e.g. tidal range and salinity) and optional factors (e.g. mean substratum composition, current velocity) in order to classify surface waters into types.

WFD states that if Member States choose to use system B at least the same degree of differentiation must be achieved as if system A were used:

> **Annex II 1.1(iv)**
> *"If system B is used, Member States must achieve at least the same degree of differentiation as would be achieved using System A. Accordinly, the surface water bodies within the river basin district shall be differentiated into types using the values for the obligatory descriptors and such optional descriptors, or combinations of descriptors, as are required to ensure that type specific biological reference conditions can be reliably derived."*

Most Member States have expressed the opinion that system B will be applied. This is because the differences in biological compositions and community structures normally depend on more descriptors than those in system A. Also the COAST working group held the opinion that the class limits defined for the various descriptors by system A are not always ecologically relevant for the local environmental conditions.

As concluded in COAST Guidance, on the basis of the 'Obligatory Factors' in system B (latitude, longitude, tidal range and salinity), it is possible to split the maritime area into three basic Ecoregions/Ecoregion Complexes:

- **Atlantic/North Sea Ecoregion Complex** comprises North Atlantic Ocean, North Sea, Norwegian Sea and the Barents Sea Ecoregions. A general physical description shows mostly full salinity regimes and moderate to higher hydrodynamic properties;
- **Baltic Sea Ecoregion** with brackish waters and mostly low hydrodynamic properties;
- **Mediterranean Sea Ecoregion** with euhaline waters and moderate hydrodynamic properties.

Further by use of those optional factors from the set given in Annex II that are most applicable to their own ecological situation, Member States should achieve appropriate degree of differentiation of their transitional and coastal water bodies.

4.6.4. Approach

Focus has been kept on developing the proposed typology as simple as possible for the following reasons:

1. As it was noted earlier, a simple typology system needs to be complemented subsequently by more complex reference conditions that cover ranges of biological conditions. Unnecessary complex typology system of transitional and coastal water bodies will require more resources for:
    - definition of reference conditions,
    - establishing of reference monitoring network,
    - performing monitoring of reference stations,
    - establishing of classification system,
    - classification of water bodies.
2. The data available at present for water body characterization are limited. If a complicated typology is established it will be more difficult to revise it in accordance with the improved understanding and knowledge of the ecological properties of transitional and coastal waters gained from the WFD monitoring programmes.

4.6.5. Defining boundaries of transitional waters

The Directive defines transitional waters as:

Article 2 (6)
"'Transitional waters' are bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows."

When defining transitional waters for the purposes of the WFD, it is clear that the setting of boundaries between transitional waters, freshwaters and coastal waters must be ecologically relevant.

If riverine dynamics occur in a plume outside the coastline because of high and strong freshwater discharge, the transitional water may extend into the sea area (allowed in definition 1).

Transitional waters are usually characterised by their morphological and chemical features in relation to the size and nature of the inflowing rivers. Various different methods might be used to define them but the method should be relevant ecologically. This will ensure reliable derivation of type-specific biological reference conditions.

4.6.5.1. Defining the seaward boundary of transitional waters

For larger rivers the influence of freshwater is likely to extend into the coastal waters. To assist Member States in defining the seaward boundary of transitional waters, CIS COAST Working Group has proposed four methods:

The use of boundaries defined under other European and national legislation such as the Urban Waste Water Treatment Directive;
Salinity gradient;
Physiographic features;

Modelling.

Taking into consideration that no outer (seaward) limit of estuaries that might be used to define the seaward border of the potential transitional waters have been defined in Latvian legislation, and no natural morphological features such as headlands, islands, bar-built estuary mouths *etc.* that may be used to define estuary seaward boundaries exist in Latvian waters, Project proposes to use salinity gradient (method 2) as a factor to identify the seaward border of transitional waters.

It is suggested to use the long-term mean annual surface (0-10m) water salinity. For purpose of developing the first RBMPs measurements done during the last 10 years (1993-2002) shall be applied in calculation. Then the seaward boundary of the transitional water is determined as an isohaline line enclosing the sea area where mean annual surface salinity is ten and more per-cent lower then in the adjacent coastal area.

For example, if the mean annual sea surface salinity of the whole coastal area is 8 PSU, the isohaline of 7.2 PSU mean annual sea surface salinity will delimit the area where salinity is usually substantially lower than that of the adjacent coastal water, and which may be attributed to the transitional water because of this feature. By definition, the transitional water must also be substantially influenced by freshwater flows.

For the practical purpose, the empirical isohaline boundary might be rectified to a reasonable degree to simplify geographic description of the transitional water. It is clear that all transitional waters must connect to freshwater, leaving no section of the system unassigned to a surface water category.

Project finds that sufficient amount of long-term salinity measurements exist in the southern part of the Gulf of Riga, the coastal area in the vicinity of Daugava and Lielupe estuaries, thus it is not necessary to apply modelling (method 4) to estimate the area of decreased water salinity.

4.6.5.2. Defining the freshwater boundary of transitional waters

Annex II 1.2.3. and 1.2.4 of WFD defines freshwater as having less than 0.5 PSU salinity. Project suggests using this boundary to delimit the inner border of the transitional waters. Since the actual saltwater/freshwater limit might be temporally variable due to variations in river flow and sea surge it is advised to use man annual depth-integrated salinity for definition of the border between transitional water and freshwater.

4.6.5.3. The Minimum Size of Transitional Waters

WFD gives no indication of the minimum size of transitional waters to be identified as separate water bodies. Although catchment size may be used as a guideline for the size of identified transitional waters, it should be considered with other factors such as the size, length, volume, river, discharge and the nature of the mixing zone. Most importantly it must meet the water body definition (Article 2.10) of being a ‘discrete and significant’ element of surface water. Significant could mean in terms of size or risk of failing to meet good ecological status.

The horizontal guidance on water bodies gives no guidance on the minimum size for transitional or coastal water bodies. It does however state that Member States have the flexibility to decide whether the purposes of the Directive, which apply to all surface waters, can be achieved without the identification of every minor but discrete element of surface water as a water body**.**

4.6.6. Assigning transitional and coastal waters within the river basin district

In case of transitional waters it is clear that they shall be assigned within the River Basin District of the river whose estuary they include. Where possible the transitional water body should be assigned to the River Basin District most likely to influence its quality.

If two or several rivers constituting independent River Basin Districts have common estuary, and hence share the same transitional water the common transitional water should be established. In this case, the management plans of both river basins should acknowledge the problem and work together to resolve any issues. Free exchange of substances from river basin districts to the open sea takes place in coastal waters.

Therefore coastal waters must be assigned to a River Basin District. Article 3.1, WFD prescribes that:

"Coastal waters shall be identified and assigned to the nearest or most appropriate river basin district or districts."

This may involve the splitting of stretches of coastal water that might otherwise be considered as single water bodies. When assigning a stretch of coastal water to a River Basin District the objective is to ensure that coastal waters are associated with the closest possible or the most appropriate natural management unit and to minimise any unnecessary splitting of coastal stretches. To ensure consistency in the approach, the following principles should be applied:

i) Where possible, existing administrative boundaries could be used.
ii) The boundaries between two adjacent types should be used wherever possible to minimise unnecessary splitting of the coastline;
iii) In the general case, the coastline should be split at open coast areas rather than through natural management units such as bays or inlets. However, specific situations may exist where the splitting of natural units for management purposes cannot be avoided.

When managing coastal water bodies it must be recognized that water bodies in different river basin districts may interact to affect water quality in adjacent water bodies or even further away. In this case, the management plans of both river basins should acknowledge the problem and work together to resolve any issues.

Where possible the coastal water body should be assigned to the River Basin District most likely to influence its quality, particularly taking into account long-shore influences of any contaminants. Still, Article 3.1. permits the situation when one single River Basin District that most likely influences the quality of the coastal water basin in question could not be identified and consequently is attributed to the two neighbouring RBD concurrently.

4.6.7. Framework for the use of factors for system b

This chapter discusses:

- the common key optional factors within the Baltic Ecoregion;
- the order in which optional factors could be used to achieve the appropriate level of differentiation;
- the way in which the optional factors could be used.

Matters discussed below were investigated in the Baltic regional workshop of the COAST WG (January, 2002) and further developed on the scientific basis during the first annual meeting of CHARM project.

4.6.7.1. List of descriptors used for characterisation of transitional and coastal waters under typology system B

Factors listed in Annex II for characterization of transitional (Table 1.2.3.) and coastal (Table 1.2.4.) waters under System B are as follows:

Annex II 1.2.3. Transitional Waters
System B

Alternative Characterisation	***Physical and chemical factors that determine the characteristics of the transitional water and hence the biological population structure and composition***
Obligatory factors	*Latitude*
	longitude
	tidal range
	salinity
Optional factors	*Depth*
	current velocity
	wave exposure
	residence time
	mean water temperature
	mixing characteristics
	turbidity
	mean substratum composition
	shape
	water temperature range

Annex II 1.2.4. Coastal Waters	
System B	
Alternative Characterisation	***Physical and chemical factors that determine the characteristics of the coastal water and hence the biological population structure and composition***
Obligatory factors	*Latitude*
	longitude
	tidal range
	salinity
Optional factors	*current velocity*
	wave exposure
	mean water temperature
	mixing characteristics

	turbidity
	retention time (of enclosed bays)
	mean substratum composition
	water temperature range

From the set of factors listed in Annex II of the Directive, Member States should use the obligatory factors followed by the optional factors that are most applicable to their own ecological situation. However, as advised in COAST Guidance, even if only several factors from the listed are used to describe a type, it is suggested that Member States describe each water body using all factors in order to allow comparison of types between Member States. This will also aid the intercalibration exercise.

4.6.7.2. Hierarchy of the optional factors

It is suggested that a hierarchical approach is used for use of the optional factors when using System B.

First the obligatory factors shall be used:

- Latitude/Longitude/Tidal Range = Ecoregion (c.f. Annex 11 of the Directive, Map B) (figure reproduced in Annex 3);
- Salinity.

If ecological separation to define the type specific reference conditions according to types can not be achieved by using only the obligatory factors, then optional factors should also be used.

In **transitional waters**, the optional factors may be used in the following order:

- Mixing;
- Residence time;
- Other factors until an ecologically relevant type of water body is achieved.

In **coastal waters**, the optional factors may be used in the following order:

- Wave exposure;
- Depth (*not in Annex II list);*
- Other factors until an ecologically relevant type of water body is achieved.

CHARM WP1 (Typology) suggests following hierarchical sequence of factors to be used in coastal water characterization:

a. Salinity (PSU);
b. Duration of ice cover (average days per year), (applies only for oligohaline coastal waters);
c. Water residence time (days);
d. Mixing conditions.

Further factors may be involved until ecologically reasonable degree of differentiation is achieved.

4.6.7.3. Quantitative ranges of the factors used

Each factor has been split into several ranges on the basis of the ecological relevance across the Baltic Ecoregion. Working within the agreed ranges will

i) ensure true comparability between Member States on types;
ii) enable the identification of common types which could be used for intercalibration.

The COAST WG agreed on the understanding that Member States may further split descriptors within ranges if this is necessary to achieve an ecologically relevant type or may aggregate descriptors within these ranges if there is no biological difference. The following sub-chapters compare the range values proposed by COAST WG and CHARM WP1 (Typology). The first draft summary (status of May, 2003) of descriptors and their ranges supported by CHARM is reproduced in Annex 3.

Salinity

In defining types the ranges in line with system A of the Directive should be used. COAST Guidance gives following salinity ranges for coastal waters:

Freshwater	< 0.5
oligohaline	0.5 to 5 - 6
mesohaline	5 - 6 to 18 - 20
polyhaline	18 – 20 to 30
euhaline	>higher than 30

CHARM WP1 (Typology) generally accepts this scheme, the boundary separating oligohaline and mesohaline waters is suggested, however to be shifted to 7 PSU.

Still, for typing the coastal waters of Latvia the 6 PSU boundary would be more advisable because it supports ecologically important split between the open Eastern Gotland Basin coast (mean annual salinity >6 PSU) and the Gulf of Riga coast (mean annual salinity <6 PSU).

Mean Spring Tidal Range (astronomical)

micro tidal	< 1m
meso tidal	1m to 5 m
macro tidal	> 5 m

Tidal Range is irrelevant for the Baltic Sea because it has negligible tides. The whole area is therefore defined as microtidal.

Exposure (wave)

It has been agreed that a pan-European scale should be used defining the ranges of wave exposure.

Extremely exposed: open coastlines which face into prevailing wind and receive oceanic swell without any offshore breaks (such as islands or shallows) for more than 1000km and where deep water is close to the shore (50m depth contour within about 300m).

Very exposed: open coasts which face into prevailing winds and receive oceanic swell without any offshore breaks such as islands, or shallows for at least several hundred kilometres. Shallow water less than 50m is not within about 300m of the shore. In some areas exposed sites may also be found along open coasts facing away from prevailing winds but where strong winds with a long fetch are frequent.

Exposed	the prevailing wind is onshore although there is a degree of shelter because of extensive shallow areas offshore, offshore obstructions, or a restricted (<90°) window to open water. These stretches of coast are not generally exposed to strong or regular swell. Coasts may also face away from prevailing winds if strong winds with a long fetch are frequent.
Moderately exposed	these sites generally include open coasts facing away from prevailing winds and without a long fetch but where strong winds can be frequent.
Sheltered	at these sites there is a restricted fetch and/or open water window. Coasts can face prevailing winds but with a short fetch e.g. 20km or extensive shallow areas offshore or may face away from the prevailing winds.
Very sheltered	these sites are unlikely to have a fetch greater than 20km (the exception being through a narrow) and may face away from prevailing winds or have obstructions such as reefs offshore or be fully enclosed.

CHARM WP1 (Typology) does not consider this descriptor. Latvian local experts however considered the different wave exposure as one of the main factors supporting distinction between Eastern Gotland Basin coastal ecosystems experiencing prevailing onshore wind, however these stretches of coast are not generally exposed to strong or regular swell, and the Gulf of Riga coastal ecosystems that generally include open coasts facing away from prevailing winds and without a long fetch.

Depth

shallow	< 30 m
intermediate	30 m to 50 m
deep	> 50 m

Depth has not been considered as a reasonable descriptor enabling differentiation of coastal water types in the Baltic by CHARM WP1 (Typology).

Mixing

permanently fully mixed
partially stratified
permanently stratified

CHARM WP1 (Typology) suggested the same ranges of mixing intensity as the 3rd-level type descriptors for the Baltic.

Residence Time

short	days
moderate	weeks
long	months to years

CHARM WP1 (Typology) adapted the same ranges of water residence time. An exercise was performed to estimate the residence throughout the Baltic by modelling (Annex 3). This proofed, however, that water residence time is rather insensitive type descriptor, at least at the given degree of resolution. Majority of Baltic coastal waters except the most sheltered inner parts of archipelagos, enclosed lagoons, bodens, and some Danish fjords, felt into <7 day residence time class.

Substratum
hard (rock, boulders, cobble)
sand-gravel
mud
mixed sediments

In many cases different seabed substrata will occur within one water body type. The dominant substratum should be selected.

CHARM so far has left this factor outside its scope. Latvian experts on zoo- and phyto-benthos pointed out, however, that character of the bottom substratum is one of the defining factors for development of benthic plant and animal communities. Hence, if biological quality elements as macroalgae and angiosperms and benthic invertebrate fauna are to be applied for defining of high, good and moderate ecological status in transitional and coastal waters as required in Annex V (1.2.3., 1.2.4.), the types characterized shall represent reasonably uniform bottom substrata.

For this reason project suggests to apply substratum as a useful factor for characterization of Latvian coastal water bodies.

Current Velocity

weak	<1 knot
moderate	1knot to 3 knots
strong	> 3 knots

Average current velocities should be used from measurements, tidal atlases or modelling. COAST WG concluded that in case if current velocities throughout the ecoregion are expected to be week (< 1 knot), Member States may further divide this class into < 0.5 knots and 0.5 – 1 knot.

Duration of Ice Coverage

irregular	
short	< 90 days
medium	90 to 150 days
long	> 150 days

In parts of the Baltic Sea ice coverage has an important influence on the ecosystem, therefore expert's advice to include this factor in the set of optional descriptors. CHARM WP1 (Typology) included ice coverage as a 2^{nd}-level typology descriptor. The single range boundary of ice cover of less or more than 150 days per year is proposed. It is recognised that the boundary of 90 d might be necessary to include at a later stage.

According to Latvian experts, ice coverage in the whole coastal area of Latvia may be described in a long term as <u>irregular</u>.

4.6.8. Characterisation of bodies of transitional and coastal waters of Latvia

4.6.8.1. Identification of transitional water.

As motivated in next section in this chapter, the ≥10% deviation from basin's annual mean salinity is being suggested as criterion for establishing of transitional water in the large river plume extending offshore. Figure 1 gives graphic representation of mean annual surface layer (0-10m) salinity in the Gulf of Riga part covered by Latvian marine environmental monitoring programme, data of 1992- 2001. According to this data pool the average salinity of the surface layer is 5.26 PSU.

Consequently, the -10% deviation from the average will be represented by 4.7 PSU isohaline. In Northern and Eastern directions from Daugava and Lielupe river moth area freshwater flows might be experienced even several miles beyond this limit. Based on these considerations we propose to establish a transitional water body in the southern part of the Gulf of Riga. This transitional water is delineated by the sea coast, borders freshwaters in mouths of Daugava and Lielupe. The seaward border of the transitional water body follows deflected line connecting geographical points: 56°58.80'N; 23°33.50'E (coastline at Bigauņciems), 57°04.25'N; 23°38.50'E, 57°14.00'N; 23°53.80'E, 57°15.45'N; 24°22.20'E, and 57°15.20'N; 24°24.10'E (coast at the mouth of Inčupe in Saulkrasti). Area thus delimited includes specific ecosystem shaped by the presence of the mixing zone, characteristic by presence of both freshwater and brackish water species in plankton and benthos and stressed by excess nutrients, dissolved and particulate allochtonous organic matter, and contaminants that originate from Daugava and Lielupe drainage basins (Annex 3). The average depth of the transitional water basin is ca. 22 m, thus according to the mixing conditions it may be classified as "partially stratified" (acc. to COAST) or "temporary stratified" (acc. to CHARM).

4.6.8.2. Characterisation and typology of coastal water basins.

Salinity

Water salinity in the coastal water of Latvia varies greatly with the inflow of freshwater, which is considerably higher during winter and spring, still, the analysis of data accumulated in the database reveals that salinity along the Gulf of Riga coast is generally lower then 6 psu while that along the open Baltic coast exceeds this value. This differentiation evokes major differences between ecosystems of the Gulf and the open Baltic. Dissimilarities express both in species composition of planktonic and benthic flora and fauna as well as in quantitative structure of the communities.

Depth

Seaward border of Latvian coastal waters drawn according to the provisions of Article 2(6), WFD typically goes between isobaths of 10 and 15 m along the Latvian coast. The only exception being the coastal stretch in the Gulf of Riga between Kolka and Roja, where coastal water reaches maximal depths of ca.25 m. This is because the baseline which extends up to 7 km offshore in this area. Thus, the average depth of majority of Latvian coastal waters does not exceed 7 m, with the exception of Kolka – Roja coastal water stretch having ca 13 m average depth.
According to depth ranges proposed in COAST Guidance all these waters nevertheless fall into "shallow" (<30 m) class.

Wave exposure

Along with the salinity Latvian local experts considered different wave exposure as the factor justifying ecologically reasonable distinction between Eastern Gotland Basin coastal ecosystems experiencing prevailing onshore wind, and the Gulf of Riga coastal ecosystems that generally include open coasts facing away from prevailing winds and having the length of wind fetch not exceeding 100 km. Consequently, according to this factor Latvian open Baltic coast is defined as "exposed", and the Gulf of Riga coast as "moderately exposed".

Mixing

Minimal depth of the seasonal termocline exceeds 15 m both in the Gulf of Riga and in the open Baltic proper, thus according to considerations described in sub-chapter 9.2.2. all Latvian coastal waters may be characterized as permanently fully mixed. Short-lived stratification may occur there only during irregular events of wind-induced coastal upwelling.

Substratum.

Bottom substrate off the Latvian coast consists of sand and gravel of different granulometric size that is interrupted by more or less extensive aggregations of boulders and smaller stones and, at some places – by underwater exposures of limestone. None of these bottom classes are found in a pure form along long coastal stretches. After analysis of the existing data and consultations with local experts, following significant coastal water stretches heve been identified according to the dominant bottom type:

Border with Lithuania – Akmeņrags -	predominantly stony bottom;
Akmeņrags – Kaltene -	predominatly sandy bottom;
Kaltene – Engure lighthouse -	predominantly stony bottom;
Engure lighthouse – Bigauņciems –	predominantly sandy bottom;
Saulkrasti – Border with Estonia -	predominantly stony bottom.

Considering the descriptors abowe, following our types of coastal water are preliminary proposed for Latvia:

- Open Baltic sandy coast;
- Open Baltic stony coast;
- Gulf of Riga sandy coast;
- Gulf of Riga stony coast.

Annex 3 summarizes the ranges of descriptors used to define those types.

4.6.9. Delineation of Latvian coastal waters

Based on the considerations expressed above Project proposes local authorities to consider following geographical delimitation of Latvian coastal water basins[6]:

<u>Basin A, type: South-eastern exposed, stony-</u>

Delineated by the coastline and line connecting geographical points –
56°04.20'N, 21°03.80E (coast at border with Lithuania);
56°03.90'N, 21°02.00E;
56°13.30'N, 20°56.90E;
56°22.40'N, 20°56.30E;
56°31.30'N, 20°57.20E;
56°41.65'N, 21°01.50E;
56°50.60'N, 21°01.30E;

[6] Geographical coordinates given below are indicative; they shall be re-checked by local authorities before implementation in regulatory documents.

56°49.90'N, 21°03.40E (coast at Akmeņrags lighthouse).

Basin B, type: South-eastern exposed, sandy-
Delineated by the coastline and line connecting geographical points –
56°49.90'N, 21°03.40E (coast at Akmeņrags lighthouse);
56°50.60'N, 21°01.30E;
57°01.95'N, 21°21.80E;
57°16.10'N, 21°22.80E;
57°18.50'N, 21°23.60E;
57°35.20'N, 21°40.50E;
57°46.90'N, 22°37.10E;
57°45.50'N, 22°36.20E (coast at Kolka horn).

Basin C, type: Gulf of Riga moderately exposed, sandy-
Delineated by the coastline and line connecting geographical points –
57°45.50'N, 22°36.20E (coast at Kolka horn);
57°46.90'N, 22°37.10E;
57°30.20'N, 22°52.00E;
57°28.90'N, 22°55.30E;
57°27.65'N, 22°53.00E (coast at Kaltene).

Basin D, type: Gulf of Riga moderately exposed, stony-
Delineated by the coastline and line connecting geographical points –
57°27.65'N, 22°53.00E (coast at Kaltene);
57°28.90'N, 22°55.30E;
57°22.45'N, 23°09.00E;
57°00.60'N, 23°15.40E;
57°10.00'N, 23°13.95E (coast at Engure lighthouse).

Basin E, type: Gulf of Riga moderately exposed, sandy -
Delineated by the coastline and line connecting geographical points –
57°10.00'N, 23°13.95E (coast at Engure lighthouse)
57°00.60'N, 23°15.40E;
57°03.20'N, 23°25.10E;
57°04.25'N, 23°38.50E;
56°58.80'N, 23°33.60E (coast near Bigauņciems).

Basin F, type: Gulf of Riga moderately exposed, stony-
Delineated by the coastline and line connecting geographical points –
57°15.20'N; 24°24.10'E (coast at the mouth of Inčupe in Saulkrasti)
57°15.45'N; 24°22.20'E
57°42.00'N; 24°19.40'E
57°49.50'N; 24°18.10'E
57°53.25'N; 24°19.35'E
57°52.50'N; 24°21.10'E (coast at border with Estonia)

Graphic presentation of these coastal water bodies is given in Annex 3

4.6.10. Assignment of Latvian transitional and coastal water bodies with the River Basin Districts

Project proposes that coastal water bodies A, B, C, D and E are assigned to Venta River Basin District

Transitional water body in the southern part of the Gulf of Riga shall be assigned jointly to Daugava and Lielupe River Basin Districts.
Coastal water body F shall be assigned to Gauja River Basin District

4.6.11. International cooperation

The cooperation with the other Baltic States are strongly supported, especially Lithuania. The typology has been discussed with the parallel WFD project in Lithuania. Local expert responsible for preparation of this TN has acted as a member CIS COAST WG and is also one of the partners involved in CHARM project.
The use of a common system of typology would simplify the work, improve the exchange of knowledge on the WFD in general and benefit the cooperation in implementation of WFD in the Baltic transitional and coastal waters.

4.6.12. Intercalibration

Working Group 2A (Ecological Status) under the Common Implementation Strategy has made an overview of common intercalibration types for the selection of Intercalibration sites. It represents the first stage of the two-stage procedure that has been agreed for the establishment of the intercalibration network: Selection of the surface water body types for each of the surface water categories (rivers, lakes, transitional and coastal waters), and possibly the artificial and heavily modified waters in each ecoregion, which will be included in the intercalibration network.

5. Characterisation of Groundwater Bodies

The characterisation is an analysis of the quality and the quantity of the groundwater and the pressures affecting it. The analysis shall focus on parameters, which are - or can be - affected by human activities.

The procedure for characterisation of groundwater bodies can be divided into the following parts:

1. Initial analysis, comprising:
   a. delineation of groundwater bodies
   b. assessment of pressures from human activities on the groundwater bodies
2. further analysis of groundwater bodies at risk

5.1. Procedure for delineation of groundwater bodies

5.1.1. Aim

The Geological Survey of Latvia shall delineate the groundwater bodies, defined as in the Law, in order to enable an analysis of them. The delineation shall be included in the management plans for the River Basin Districts.

5.1.2. Procedure

The general definitions in the Law on Water Management, Chapter 1 apply.

When delineating the groundwater bodies, the following properties shall be taken into account:

- Geological boundaries, horizontally and vertically. The bodies can overlap vertically.
- Hydrogeological conditions, such as groundwater divides, flow directions and water balance
- Quaternary aquifers may be considered a separate groundwater body in each river basin, because surface-related impacts will first appear in the uppermost groundwater body,

and if necessary according to existing knowledge, also

- Chemical composition, in order to avoid too big variations in the background values of key parameters.

The delineation should be coordinated with the delineations used in Lithuania and Estonia, so that transboundary groundwater bodies are defined in a common way.

The bodies shall each be assigned to the River Basin District, which is most appropriate for the management of it, typically the District which covers the biggest area of the groundwater body.

The delineation shall comprise all groundwater bodies, for which

- present abstraction of water intended for human consumption is providing more than 10 m³/day of water as an average or serving more than 50 persons, and bodies intended for such future use
- there are directly dependent surface water bodies or ecosystems

The character of the top layers in the catchment area from which the groundwater body receives its recharge, shall be described, in order to assess the vulnerability of the groundwater and the water balance of the groundwater body.

5.2. Procedure for assessment of the impact of human activities

5.2.1. Aim

As part of the initial (preliminary) characterisation the Geological Survey of Latvia shall carry out an identification of pressures, which affects or may affect the quality or the quantity groundwater bodies, in order to review the impact of human activities on all groundwater bodies.

The purpose is to identify water bodies at risk of failing to achieve the environmental objectives set for the groundwater bodies in accordance with the Law on Water Management. The assessment shall be included in the management plans for the River Basin Districts.

5.2.2. Procedure

Groundwater bodies may be subdivided or grouped for the purpose of the assessment.

The assessment of pressures shall comprise

- location and boundary of the groundwater bodies
- diffuse sources of pollution
- point sources of pollution
- abstraction
- artificial recharge

and may employ existing data on hydrogeology, geology, soil types, vulnerability, land use and other data. A list of potential pollution sources is given in Annex B of Annex 1.

The impacts of these pressures on the groundwater bodies shall be analysed, having special regard to the natural condition, and including an assessment of infiltration rate of pollutants in aquifers.

The natural conditions, including geographical variations in the general chemical composition of the groundwater, shall be evaluated in order to sort out the natural anomalies. An anomaly caused by nature cannot be changed and therefore it is not a direct target for the impact assessment, but it must be identified in order to evaluate the risk of intrusions from the anomaly to areas of drinking water abstraction.

The assessment shall identify the general character of the overlying strata in the catchment area from which the groundwater body receives its recharge, and those groundwater bodies for which there are directly dependent surface water ecosystems or terrestrial ecosystems.

The Geological Survey of Latvia shall identify groundwater bodies, which are at risk of failing to meet the water protection objectives set out in Article 11 in the Law on Water Management. A review of the delineation of the groundwater body may be undertaken if the data on pressures and impacts indicates that it may be helpful to subdivide bodies.

Where there are no monitoring data for a groundwater body, the likely presence or absence of pressures and impacts should be considered when making a decision of the likely status of the groundwater body.

Example:
Well fields are not necessarily causing a risk for the objectives of a groundwater body.

- If the abstraction is in balance with the infiltration without causing an unacceptable decrease of surface water flows, and without showing increased concentrations due to big draw-downs and release of problematic substances from the aquifer, then the groundwater body is not at risk.
- If a big abstraction is concentrated in a small area, near a stream, or near a chemical anomaly, it is possible that the groundwater body is at risk. In this case, if the catchment area is not very big compared to the groundwater body, the catchment area may be defined as a sub-body during further investigation of the status. Such a definition should not be changed within a management plan period, i.e. 6 years. If this is not done, the whole GW body shall be defined as being at risk, until it has been clarified whether the status is good or poor.

Appointment of a sub-body for the above reasons or due to chemical characteristics (polluted sites or areas) may be relevant in order to narrow the size of a groundwater body with poor status.

Note, that the procedure for comparison of status with objectives for the groundwater bodies is not included in this report, as that is part of Annex V in the Directive, and this report only concerns Annex II.

5.3. Further analysis of groundwater bodies at risk

5.3.1. Aim

The Geological Survey of Latvia shall carry out a more precise assessment ("further characterisation" or further analysis) of the groundwater bodies, which have been identified as being at risk of not fulfilling the objectives. The initial and further characterisation described in Annex II should provide the basic information for designing targeted and cost-effective monitoring programmes and programmes of measures.

The review shall be included in the management plans for the River Basin Districts.

The aim is common for surface and groundwater.

5.3.2. Procedure

For the groundwater bodies 'at risk' (and for groundwater bodies with insufficient data to decide whether or not they are at risk) a more precise assessment shall be carried out. This shall identify any measures to be required for the achievement of the water protection objectives. For this purpose, the Geological Survey of Latvia shall collect and analyse information on the impact of human activity on the said bodies of water, including

- geological characteristics of the groundwater body including the extent and type of geological units;
- hydro-geological characteristics of the groundwater body including hydraulic conductivity, porosity and confinement;
- characteristics of the superficial deposits and soils in the catchment from which the groundwater body receives its recharge, including the thickness, porosity, hydraulic conductivity, and absorptive properties of the deposits and soils;
- stratification characteristics of the groundwater within the groundwater body;
- an inventory of associated surface systems, including terrestrial ecosystems and bodies of surface water, with which the groundwater body is dynamically linked;
- estimates of the directions and rates of exchange of water between the groundwater body and associated surface water systems, and
- calculation of the long term annual average rate of overall recharge, based on data on precipitation, evaporation and flow measurements in rivers in the relevant river basin. Evaluation of water balance, including use of numerical models, may be applied for this purpose.
- characterisation of the chemical composition of the groundwater, including specification of the contributions from human activity.

The pressures listed in Annex B of Annex 1 shall be reviewed for each of the identified water bodies.

Pressures that have a direct effect on the surface water bodies, are only of indirect relevance for the groundwater bodies, through the interaction (water exchange) between surface and groundwater. This exchange should be quantified, where the impacts on surface water bodies is high.

For groundwater the pressures related to land use are relevant mostly for the shallow aquifers, while pressures related to abstraction (e.g. salt water intrusion) are of relevance mainly for deeper aquifers. Registration of the abstractions should be done at an annual basis and the data should be used for calculation of water balance for each river basin district (or sub-basins or catchment area) where relevant. Groundwater models may be applied in this task, which should be the responsibility of the Geological Survey.

The pressure checklist (Annex B in Annex 1) contains an uncompleted list of pressures considered as part of the WFD pressures and impacts assessment. The pressure checklist is presented in two stages. First, in Table 1 the pressures are grouped into four main classes of driving forces that may impact the different water body categories and prevent them from meeting the objectives. Second in Table 2, the various pollution sources within the driving forces are listed.

Information about the pressures may be found at the following institutions:

- State Geological Survey
- Latvian Environment Agency
- Regional Environmental Boards
- Municipalities
- Municipal enterprises such as "Rīgas ūdens"(Rīga Water Works)
- State Environmental Inspection
- State Inspection for Heritage Protection
- Ministry of Agriculture
- University of Agriculture
- Latvian Forestry Research Institute
- State Fishery Board
- State Fisheries Research Institute
- Rural and Regional Support Services
- Ministry of Welfare – National Environmental Health Centre
- Research Institute on Water Management and Land
- Institute of Aquatic Ecology, University of Latvia
- Institute of Biology
- Institute of Limnology
- Latvian Ornithological Society
- Latvian Nature Fund
- Environmental department of Riga City Council
- State Joint Stock Company "Latvenergo"
- Regional Environmental Centre
- Enterprise Vides projekti
- Enterprise Geo Consultants and Carl Bro Latvia
- State Enterprise "Meliorprojekts"
- Union of Local and Regional Governments of Latvia

For groundwater the checklist in Table 1 of Annex B in Annex 1 comprises impacts from pollution sources such as households, agriculture, forestry and industry, mines and dumps. In addition the abstraction from and recharge to groundwater must be analysed. The category numbers are repeated in Table 2, so that pollution sources relevant for groundwater can be identified there.

When reviewing each type of pressure, it is essential to make a ranking system, in order to focus on the right issues and areas. This can be done by systemising the information and make calculations such as m^3/km^2 or tonnes/ha or units/km^2 within each river basin, or within each district, if the information only is available on district level.

When a ranking order within each type of pressure has been carried out, the focus should be directed e.g. to the top 20 % of the specific pressures within each category in order to use available resources in an optimal way and to gather experience in the evaluations for future use.

The impact of the pressures shall be compared to the natural condition, which means no human impact. The natural condition may be assessed on basis of existing monitoring data of water quality and groundwater levels.

The assessment of the human impact should focus on the areas (and groundwater bodies), where the review of pressures shows a known or *potential* impact. If the available data are insufficient to conclude if there is an impact or not, more data should be collected through the river basin management plans.

As a first approach, the available data may be compared on district level. This could be livestock units, tonnes of fertilisers per year, abstraction of water, number of people served by a specific landfill, all divided on the area within a district (political district, or in the future, river basin district).

When the ranking of the pressures has been made, the evaluation of monitoring data, i.e. the evaluation of *impact* can be carried out, focusing on the issues and locations topping the ranking list.

Examples
As an example, groundwater analyses for nitrate should be compared with the number of livestock and use of fertilisers, as far as the information is available.

Another example: water abstraction in m^3/year should be compared to the areas and the estimated infiltration in the areas. The most intensively utilised resources should be reviewed most thoroughly through evaluation of water level data and derived effects such as increase in content of chloride, sulphate, iron, manganese, nickel etc. although such parameters are not directly included in the WFD.

Human impact and anomalies
Note, that natural anomalies, i.e. water bodies with a poor *natural* water quality, may be considered “good quality” in the frame of the WFD, because they are undisturbed by human activity. This is the case even if the water may be unsuitable for production drinking water because of need for advanced or expensive treatment, because it is poor from nature’s hand, not because of human impact.

In order to increase the amount of available data it is advisable to include data from water works. Care should be taken when doing this, because the assessment should be focusing on the raw water quality, i.e. before treatment. Most water works only have analyses on the treated water, i.e. the water distributed to the network. This water has a different quality than the raw water, i.e. the quality parameters mentioned above will all be affected by the treatment.

Examples
Chloride, which is an indicator of abstraction-related impact (saltwater intrusion), is not affected by treatment and therefore the network analyses may be included for this parameter when reviewing the impact of abstraction.

Conductivity has not been measured in older analyses. However, based on the concentrations of primary ions in older analyses it is possible to calculate the conductivity, and this way make an assessment of conductivity based on longer time series than the ones where it has actually been measured.

Sulphate and iron, and also nickel, may be generated in areas where the abstraction has created depression cones and subsequent aerobic conditions in aquifers rich in pyrite. Although this change is caused by abstraction (not necessarily *excessive* abstraction), the adverse impact is seen on the water quality.

Pesticides - and some other chemicals used in the agriculture – are not analysed in general and the data may be insufficient to evaluate the impacts. In the review of this impact focus should be directed to areas where the use is known, based on statistical land-use and information if available.

Data distribution
In the future the reviews should be presented for the river basins, but if at present the data exist only on district level, this is acceptable as a first approach.

As an example existing information on water use may exist only as totals for districts, not river basins. Comparing with other information on district level, such as use of fertilisers, livestock density etc, this will give better information than the division on river basins, because such a division cannot be correctly made today.

Preparations should be made in order to enable future presentations for the river basins.

6. Implementation, surface water

In this chapter notes to the different steps in the implementation of characterisation and assessment of impact are collected to express some of the issues in more details than in Chapter 4.

6.1. Procedure for identification of surface water bodies

The WFD definition of a surface Water Body is outlined below:

> "Body of surface water" means a **discrete and significant element** of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, transitional water or a stretch of coastal water.

Water body is a unit to which the environmental objectives of the directive must apply ("compliance checking unit").

Annex II of the WFD requires:

> Member States shall identify the location and boundaries of bodies of surface water and shall carry out an initial characterisation of all such bodies

The Directive requires Member States to identify "water bodies" as part of the analysis of the characteristics of the river basin districts (under Art. 5 and Annex II). The first such analysis must be complete by 22 December 2004. The analysis must be reviewed, and where necessary, updated by 22 December 2013 and then every six years.

However, identification of water bodies will require information from the Article 5 analyses and reviews, and the Article 8 monitoring programmes. Some of the necessary information will not be available before 2004. The information that is available is likely to be updated and improved in the period prior to the publication of each river basin management plan.

EU working group on identification of water bodies under the Common Implementation Strategy of WFD has developed a document CIS Horizontal Guidance on the Application of the Term “Water Body” in the Context of the Water Framework Directive. The purpose of the guidance document is to develop a common understanding of the definition of water bodies and specific practical suggestions for the identification of water bodies under the Water Framework Directive. The text below is based on the guidance.

The Water Framework Directive covers **all** waters, including inland waters (surface water and groundwater) and transitional and coastal waters up to one sea mile (and for the chemical status also territorial waters which may extend up to 12 sea miles) from the territorial baseline of a Member State, independent of the size and the characteristics.

This totality of waters is, for the purpose of the implementation of the directive, attributed to geographical or administrative units, in particular the **river basin**, the **river basin district**, and the “**water body**”. In addition, groundwaters and stretches of coastal waters must be associated with a river basin (district).

The success of the Directive in achieving this purpose and its related objectives will be mainly measured by the status of “water bodies”. “Water bodies” are therefore the units that will be used for reporting and assessing compliance with the Directive’s principal environmental objectives. However, it should be emphasised that the identification of a “water body” is a tool not an objective in itself.

It is evident that for the first RBMP, all waters must be assigned to water bodies and their status must be described. However, practical approaches may be required in particular for large numbers of pristine waters in remote areas where it can be demonstrated that no significant pressure exist.

“Water bodies” are the units that will be used for reporting and assessing compliance with the Directive’s principal environmental objectives. However, it should be emphasised that the identification of a “water body” is a tool not an objective in itself.

The “water body” should be a coherent sub-unit in the river basin (district) to which the environmental objectives of the directive must apply. Hence, the main purpose of identifying “water bodies” is to enable the status to be accurately described and compared to environmental objectives[7].

The **main criteria** for delineation of water bodies are outlined below:

1. A surface water body must belong to only one category: river, lake, transitional waters and coastal waters. The boundary of a water body may be

[7] *An estimate of the status of water bodies will be required to assess the likelihood that they will fail to meet the environmental quality objectives set for them under Article 4 [Article 5; Annex II 1.5 & 2]. The status of water bodies must be classified using information from the monitoring programmes [Article 8, Annex V 1.3, 2.2 & 2.4]. The status of water bodies must be reported in the river basin management plans [Article 13, Annex VII] and, where necessary, measures must be prepared [Article 11, Annex VI].*

established where two different category “meet” Figure 6-1

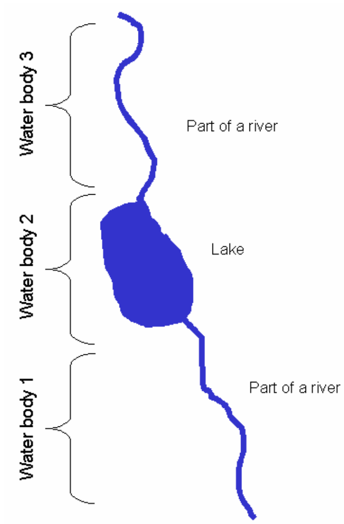

Figure 6-1 Example of delineation of surface water bodies in river-lake-river system

2.	Water bodies must not overlap with each other or be composed of elements of surface water that are not contiguous.

3.	A surface water body must not cross the boundaries between surface water body types. It must be of one type or another since one purpose of characterising surface water bodies is to differentiate them into types.

4.	Physical features (geographical or hydromorphological) that are likely to be significant in relation to the objectives of the Directive should be used to identify discrete elements of surface water. For example, the confluence of one part of a river with another could clearly demarcate a geographically and hydromorphologically distinct boundary to a water body (Figure 6-2).

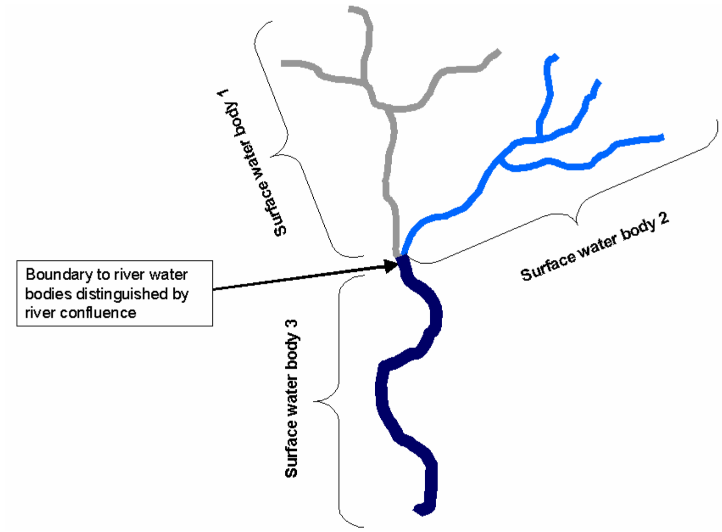

Figure 6-2. Example for delineation of water bodies based on physical features (confluence of rivers)

5.	Heavily modified water bodies may be identified and designated where good ecological status is not being achieved because of impacts on the hydromorphological characteristics of a surface water resulting from physical alterations.

<u>Other criteria</u> for delineation of surface "water bodies"

6.	A discrete element of surface water should not contain significant elements of different status. A "water body" must be capable of being assigned to a single ecological status class with sufficient confidence and precision through the Directive's monitoring programmes (**Error! Reference source not found.**).

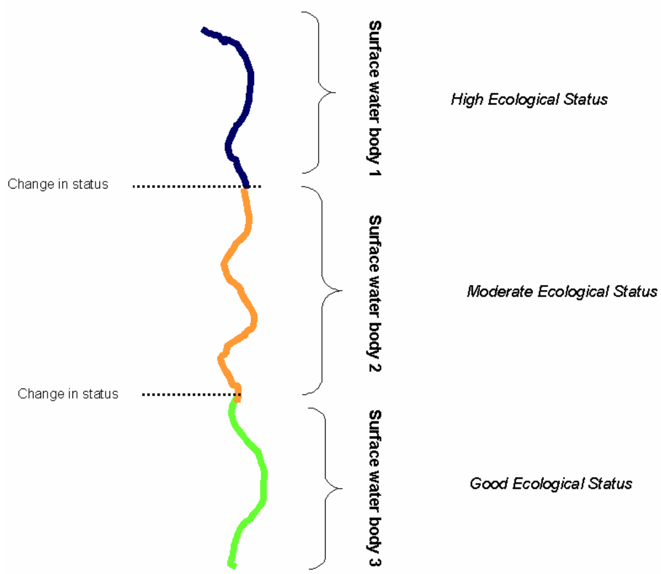

Figure 6-3 Example of delineation of water bodies based on status.

It may be appropriate to use the analysis on pressures and impacts as a surrogate for status. As understanding of status improves, the boundaries of water bodies can be adjusted. Contiguous elements of surface water within a type that are of the same status may be recombined to avoid unnecessary sub-division of surface waters.

NOTE: It will be necessary to balance the requirement to adequately describe water status with the need to avoid the fragmentation of surface waters into unmanageable numbers of water bodies. In addition, the aggregation of water bodies may be appropriate, under certain circumstances, to reduce meaningless administrative burden

The CIS Horizontal guidance propose the following approach for small elements of surface water (Figure 6-4):

- Include small elements of surface water as part of a contiguous larger water body of the same surface water category and of the same type, where possible.
- Where this is not possible, screen small elements of surface water for identification as water bodies according to their significance in the context of the Directive's purposes and provisions (e.g. ecological importance; importance to the objectives of a Protected Area, significant adverse impacts on other surface waters in the river basin district). In such a case, small elements:

  (1) belonging to the same category and type,

  (2) influenced by the same pressure category and level and

  (3) having an influence on another well-delimited water body, may be grouped for assessment and reporting purposes.

- for those small elements of surface water not identified as surface water bodies, protect, and where necessary improve them to the extent needed to achieve the Directive's objectives for water bodies to which they are directly or indirectly connected (i.e. apply the necessary basic control measures under Article 11).

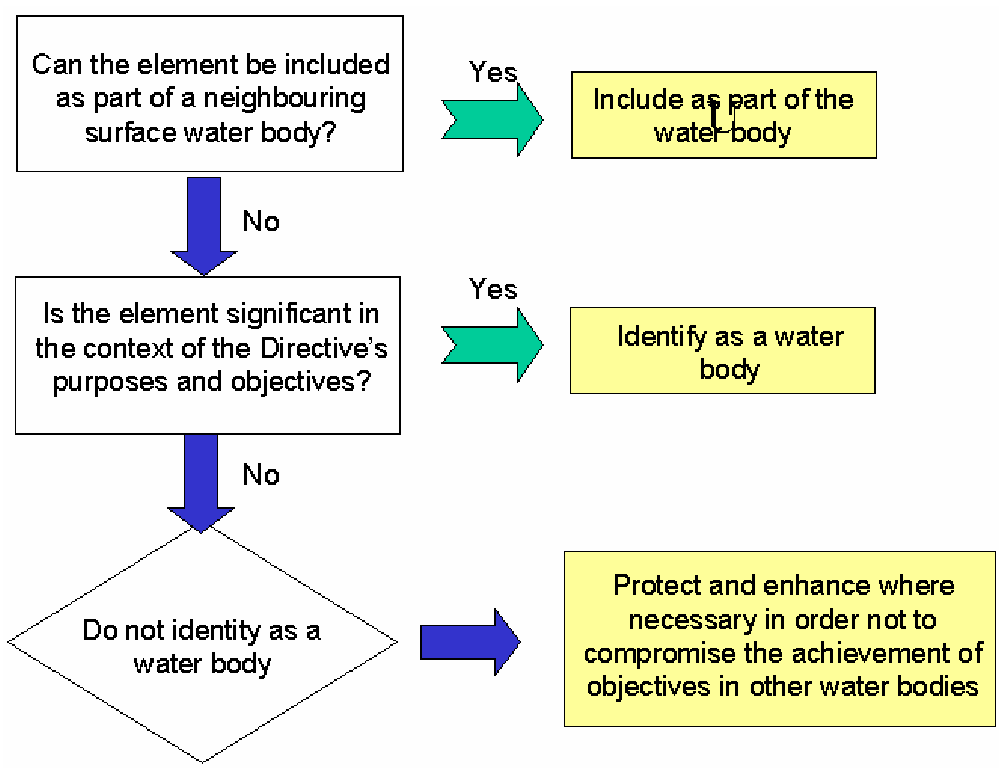

Figure 6-4: Approach for delineation of water bodies to ensure appropriate protection of smallest surface water units

Procedure for identification of surface water bodies proposed by the project is described in the text boxes below.

Rivers:

1. Rivers belonging to the same type are regarded as one water body if there are no significant changes in pressures.
2. Rivers are subdivided into several water bodies when:
    a. River changes type (e.g. change from small river upstream to medium size);
    b. River passes large lake (> 0,5 km^2);
    c. Significant change in status of the river due to pressures (e.g. dam, discharge from UWWTP).
3. Ditches and small streams (streams without names) are not taken into account when identifying water bodies (assigned to nearest or most appropriate water body).
4. Rivers passing through small lakes (<0,5 km^2) are regarded as continuous water body (not segmented to river-lake-river stretches)

5. Small streams (<100 km^2) are not cut to smaller units for the purpose of identification of water bodies, unless it is feasible to address changes in landuse or other pressures
6. Small streams (<100 km^2) of similar status (based on pressures) within the same subbasin are mapped but clustered together and described as one water body.
7. Pressures that can be expected to change the status of the WB (e.g. sewage outlet of a size which compared to the summer water flow can be expected to influence the flora and fauna of the stream, damming)

Lakes:

1. Large lakes (>0,5 km^2) are identified as individual water bodies
2. Small lakes (< 0,5 km^2) are mapped but not identified as individual water bodies (clustered together and described as one water body in area/areas with similar pressures, e.g. land use)
3. Outstanding examples of small lakes of different status as compared to general status of lakes in the catchment can be identified as separate water body (e.g. few small lakes of high status in an agriculture dominated catchment)

Aggregated assessment of surface water bodies

The Directive's requirement that water bodies contain "significant" elements indicates that a fine breakdown into small areas would be a mistake. On the other hand, cruder breakdown into large areas would lead to worries about incorrect classification. The CIS guidelines emphasise that within water bodies no major difference should occur with respect to the status of its water elements. So if, in a particular water body, elements with good status and moderate status were classified as "good" overall, there would appear to be no reason for measures to upgrade the "moderate" element.

Where dense data are available for the water body and allows very detailed findings (e.g. for the systematic mapping of river morphology using the on-site method), appropriate transparent aggregation rules should be derived.

6.2. Heavily modified bodies and artificial bodies

Heavily modified bodies and artificial bodies of surface water are to be identified and designated.

Article 4 (3) prescribes that the designation of an artificial or heavily modified water body is presented and justified in the management plan required under Article 13. While the final designation of these heavily modified water bodies must be carried out by 2008/9 and reviewed every 6 years, bodies of surface waters in the categories rivers, lakes, transitional waters and coastal waters (see No. 112) must already be provisionally identified as artificial surface water bodies or heavily modified surface water bodies pursuant to Annex II of the WFD, by 2004.

The provisional identification as "heavily modified" is undertaken where necessary for those bodies of water which are not expected to achieve good ecological status due to hydromorphological interventions and are, in their physical character, heavily modified. Subsequently, a study must be made by 2008/9 of the necessary improvement measures to achieve good ecological status and their impacts on uses, and other environmental options are to be examined (Article 4, (3), a, b). The findings of this study will determine the final designation or non-designation of a water body.

Under Article 2 (8) of the WFD an "artificial water body" means a body of surface water created by human activity. We have here a surface water body that was created at a site where no water body previously existed. An artificial water body has, moreover, been created neither by the direct physical alteration of an existing water body nor by its repositioning or levelling.

Where an existing water body has been altered or relocated (i.e. to a site that had previously been dry land), it should be classified, if appropriate, as heavily modified and not as artificial. The same applies to water bodies that have been assigned to another category as a result of physical alterations. Such water bodies (e.g. impounded lakes crated from a river by damming) are to be classified as heavily modified water bodies and not as artificial water bodies. The category of artificial bodies of surface water includes, for instance:

- canals built for the purposes of navigation, for hydropower uses and for irrigation and drainage, which meet the above conditions,
- lakes formed in pits, quarries and open-cast mines, ponds,
- impounded reservoirs and artificial storage basins fed by transferred water,
- docks.

These surface waters can be designated as artificial water bodies, but they do not have to be so designated. Under certain conditions they may also be classified as natural water bodies (e.g. old lakes formed in mining landscapes. Artificial bodies of surface water are, however, certainly not natural waters that have been modified by hydroengineering measures, e.g. to become canals or reservoirs. These are usually to be regarded as heavily modified water bodies. Thus, artificial water bodies cannot, by definition, be designated as heavily modified water bodies.

All other bodies of surface water are first to be treated as natural waters, and their reference condition should be set in accordance with high ecological status.

If it can be demonstrated that an ecological status of at least “good” can be achieved as part of the management plan within 15 years of the WFD entering into force, a designation of the water/body of surface water as heavily modified is not possible. However, bodies of surface water which are being considered for classification as heavily modified must be provisionally classified as such by 2004. A heavily modified body of water is, under Article 2 No. 9 of the WFD, "a body of surface water which as a result of physical alterations by human activity is substantially changed in character".

Should the environmental objective of “good ecological status” under Art. 4 not be achievable in designated body of surface water, we must then examine whether the reason for the failure to meet targets does in fact lie in anthropogenic physical changes. If this is the case, and if the conditions defined in Art. 4 (3) a and b (negative effects, technically unfeasible, disproportionate costs, ...) are not fulfilled, the water or body of surface water may be designated as heavily modified.

The designation of heavily modified bodies of surface water therefore occurs as the final step of an examination. Thus, an initial and provisional classification of bodies of surface water as “heavily modified” should be made in the course of the inventory by 2004, and the formal designation by 2008/9. The designation shall be subject to regular reviews every six years.

Unlike the case of natural water bodies, the reference condition for artificial or heavily modified bodies of surface water is the “maximum ecological potential” (review every six years).The maximum ecological potential is derived from the water body type which is most similar to the body of surface water. In view, e.g. of the continuity of the water body, this is the best possible status that could be achieved after taking every appropriate measure that would be attainable (cf. Annex V, WFD). As an objective, the good ecological potential deviates only slightly from the maximum ecological potential in terms of biology.

As for the assessment of chemical status, the same requirements apply to artificial and heavily modified bodies of surface water as to natural water bodies.

The CIS Working Group 2.2 HEAVMOD has produced guidance for the identification and designation of heavily modified and artificial waters that was adopted by EU Water directors in November 200 in Copenhagen. Artificial and heavily modified surface water bodies are to be designated in accordance with these guidelines. Practical examples of preliminary classification and of designation can be found in a synthesis of 34 European case studies and a collection of examples (toolbox).

The work of characterising waters under Annex II involves a preliminary classification of heavily modified bodies of surface water , while the final designation shall only be made after various checks have been carried out as part of the production of the first management plan.

The artificial or heavily modified bodies of surface water are to be established in accordance with the criteria via a series of steps, bearing in mind that a distinction must be made between preliminary classification and the actual designation.

1st step: Survey to identify water bodies

2nd step: Designating bodies of surface water created by human activity as artificial waters (continues at step 8)

3rd step: "Screening" – exclusion of water bodies without hyromorphological alterations from the further process of designation (for the objective of good ecological status)

4th step: Establishing water bodies with significant hydromorphological alterations (according to structure classes 6 and 7) and description of these significant alterations

5th step: Identifying surface water bodies that might fall short of good ecological status due to significant hydromorphological alterations (check whether the type-specific "biology" is correct)

6th step: Preliminary classification as "heavily modified" if water bodies have been significantly altered in character in the form of physical changes resulting from human interventions 7th step: Determining improvement measures that would be needed to achieve good ecological status. Examining whether these measures have significant impacts on the environment in the broad sense or on the "uses listed" (if no negative impacts , the objective will be good ecological status)

8th step: Examining whether the uses cannot be realised by other, much better environmental options if these are technically feasible and not unreasonably expensive (if yes, then the objective will be good ecological status; for artificial waters, optimised ecological potential)

9th step: Designating heavily modified or artificial bodies of surface water in the management plan by 2008/9 (review every six years)

10th step: Defining the maximum ecological potential, by including all measures to limit ecological damage in the calculation which ensure the best approximation to ecological continuity (migration of fauna, appropriate spawning and growth habitats)

11th step: Defining good ecological potential where only a minor deviation of the biological parameters from the maximum ecological potential is calculated

6.3. Reference conditions

Under Annex II No. 1.3 of the Water Framework Directive, reference conditions are to be defined for all types of surface waters in line with the normative characterisation of high ecological status pursuant to Annex V, 1.2 of the WFD. The characterisations of good ecological status and of the differences between high and good as well as good and moderate will be determined at a later point in time (after 2004) and then "benchmarked" in the intercalibration process.

Reference waters are selected according to hydro-morphological characteristics (water balance, continuity and morphological conditions) and to existing pollution impact characteristics (water quality map, other environmentally relevant pressures). The selection is reviewed by surveying all the biological elements and additionally verified by analytical determination of the chemical elements (general physico-chemical parameters and specific pollutants).

For the individual water body types, the characterisation of surface waters to be completed by 2004 in compliance with Annex II of the WFD requires that a sufficient number of reference monitoring sites be designated to meet the statistical requirements (i.e. at least three per type if possible). In TR1B and TR2 proposals for reference conditions and establishment of reference network are described.

6.4. Establishing significant anthropogenic pressures

The Member States must compile and archive data on the type and magnitude of significant anthropogenic pressures. In particular, attention should be given to pressures from point and diffuse sources, water abstraction, flow regulation, hydromorphological alterations and land use. The aim is to arrive at an assessment of whether these pressures pose a threat to the good status of bodies of surface water and warrant the implementation of operational monitoring. The data are needed to draw up the programme of measures pursuant to Art. 11 and for the management plans pursuant to Art. 13 of the WFD.

In accordance with CIS Guidance (IMPRESS), significant pressures are those pressures that are a notable factor behind the fact that a water body is failing to meet the general environmental objectives of the WFD or is at risk of failing to meet these objectives (see also TR2, identification of water bodies at risk).

Extensive data on immissions and water quality are available in Latvia, providing a basis for arriving at a sound risk assessment, i.e. risk assessment is generally supported by actual observations of impacts and not merely by modelling the possible impacts of existing pressures. We therefore (only) need to examine the significance of pressures for water bodies / survey areas that are classified as being at risk or potentially at risk. For such water bodies / survey areas the pressures are collated as a basis for determining which pressures are critical to the existing threat. As a rule, this assessment is made locally. An attempt to derive universal rules here is of little use because the most varied sets of relationships have to be considered.

The announcement and designation of significant pressures is the starting point for public discussion, in particular, and for an initial estimate of the measures that may be needed. Whether the "significant" pressures must be reported has not yet been decided and this question will probably be clarified in the Commission Decision on reporting scheduled for June 2003.

The general approach to determining the anthropogenic pressures significant to risk assessment can be summarised in three steps :

1. Scrutiny of existing data

The first step is to examine the existing water resource management data. The WFD sets out in Annex II, 1.4 the data primarily to be considered. They include databases on point sources, diffuse sources, water abstractions, flow regulation, morphological modifications, on other anthropogenic impacts and on land use structures. Some data on these features are available, to varying degrees of comprehensiveness in the different river basin districts, and should be compiled, which simply means going through the existing sources of water resource management data.

The existing data to be assigned to point sources include above all data on local authority water treatment plants, industrial direct dischargers and food processing plants as well as combined sewer outlets.

In the case of diffuse sources, the principal data concerns nutrient emissions (nitrogen and phosphorous). Nutrient load data for whole sub-basin areas are to be archived for the general overview and the description of the features of the river basin district with regard to marine protection (water body status in coastal waters). Data from contaminated sites offer further pointers to diffuse pollution pressures.

Data on water abstraction are contained in license notifications and regulations (WRUP se also TR4).

Data on flow regulation measures are collected for some water registers and data on morphological modifications are collected through some river morphology mapping. In addition, there may be other anthropogenic impacts that can be determined and evaluated using local knowledge on site.

Land use structures can be seen from the CORINE Landcover layers and fishery use, from example, the figures on the implementation of the Directive on fresh water fish and shellfish waters.

2. Collation of data on signification pressures
The second step is to extract from this data pool the data on those factors that might have an impact on the biocoenosis and the chemical status and as such are to be regarded as significant. These data are to be collated and archived – if already possible and desirable by hydrological areas (sub-basin areas, sub-basin survey areas). Precisely which data and how much and in what form they should be included as an annex in the 2004 Report is still to be agreed. See also TR5.

3. Evaluation and risk assessment
Existing immissions data has already been used for quality assessments. It is therefore quite logical that these data be referred to as basis for judging the likelihood of a water body failing to achieve the environmental objectives set under the WFD (risk assessment) and included in the 2004 Report to the Commission.

Consequently all existing data has to be taken into account in order to establish whether there is a likelihood of failing to meet the objective of good water quality. If this is the case, operational monitoring has to be carried out in the respective bodies of surface water (see also TR2).

In TR2, Annex 2, there is a summary of the CIS guidance on analysis of pressures and impacts.

7. Implementation, Groundwater

7.1. Proposal for delineation of groundwater bodies

Currently, based on criteria given in Law of Water Management and Framework Directive, 14 groundwater bodies are defined, as shown in Table 7-1.

Maps of the groundwater bodies are included in Annex 2.

Basically, the regional aquitards were used for vertical delineation of groundwater bodies, while the groundwater divides were used for horizontal delineation of the groundwater bodies. The principles of delineation are explained in the following. .

Table 7-1 List of preliminary defined groundwater bodies

No	Groundwater body	Aquifers and multi-aquifer systems, integrated into the groundwater body	River Basin Districts within area of distribution of groundwater body
1	Q-1	Quaternary water-table aquifer	Daugava, Gauja
2	Q-2		Venta
3	Q-3		Venta
4	D_3-1	Quaternary aquifers, Famenian – Permian multi-aquifers system, Plavinas – Amula multi-aquifer system	Venta
5	D_3-2		Venta
6	D_3-3		Lielupe, Daugava
7	D_3-4	Quaternary aquifers, Plavinas – Amula multi-aquifer system	Gauja
8	D_3-5		Daugava
9	D_3-6		Daugava
10	D_{2-3}-1	Quaternary aquifers, Arukila – Amata multi-aquifer system	Venta
11	D_{2-3}-2		Venta, Lielupe, Daugava, Gauja
12	D_{2-3}-3		Venta
13	D_{2-3}-4		Gauja
14	D_1	Lower- Middle Devonian multi-aquifer system	Gauja

Three groundwater bodies are distributed within the different river basin districts. For the future management groundwater body Q-1 shall be assigned to the Daugava River Basin District, because the main part of this body and the main part of water-supplier belong to this basin. Assigning of groundwater bodies D_3-3 and D_{2-3}-2 to the one River Basin district is problematic and they shall be managed separately within each River Basin district.

It should be noted that proposed delineation of groundwater bodies is a preliminary delineation, because the digitisation of groundwater data in Latvia is not finished. Some of groundwater bodies may be divided or merged after completion of the SGSL Database "Wells" and after a more accurate determination of groundwater divides.

7.2. Initial Characterisation

According to the Framework Directive and Law on Water Management all groundwater bodies shall be defined, which provide or may provide in future for human consumption more than 10 m^3/day of water as an average or serving more than 50 persons. For evaluation of role of different aquifers and wells for human consumption the data about groundwater abstraction in 2002 was summarised in Table 7-2.

Table 7-2 Groundwater abstraction from identified wells or well fields

Multi-aquifer system	No of wells		Median groundwater abstraction from single well, m^3/day
	Total	with groundwater abstraction more than 10 m^3/day (yearly average)	
Quaternary Water-table	37	36	175
Quaternary semi-confined	34	23	24
Famenian – Permian	470	283	18
Plavinas – Amula	786	464	16
Arukila – Amata	1938	1315	25
Lower-Middle Devonian	37	21	18

(verified 2002 data of database “Water-2”)

The table shows that groundwater abstraction from the main part of wells within all multi-aquifer systems exceeds 10 m^3/day. As even single well typically products more than 10 m^3/day, several wells screened within each aquifer certainly provide more than 10 m^3/day. Therefore, all aquifers are important for water supply, including small-size low-yielding aquifers, which are unusable for centralised water supply and which were evaluated as insignificant before Framework Directive.

As all aquifers according the Framework Directive are important for water supply, during delineation of groundwater bodies thin or low-yielding aquifers shall be integrated vertically. Otherwise the total number of groundwater bodies delineated both vertically and horizontally increases up to many hundreds, which is preventing a practical management and monitoring of groundwater.

It should be noted, that the real number of Quaternary wells greatly exceeds the number given in Table 7-2, because the shallow wells (depth until 20 m) used for decentralised water supply do not registered in Latvia. Therefore, an individual management of many small water table or semi-confined aquifers is rather problematic. This is a second reason for integration of small-size Quaternary aquifers into the underlying pre-Quaternary groundwater bodies.

The first step for delineation of the groundwater bodies is the vertical splitting of upper part of artesian basin. Fresh groundwater occurs down to the depth 100 – 450 m within Quaternary sands and pre-Quaternary (i.e. Permian, Carboniferous and Devonian) sandstones, dolomites and limestones. In spite of the different lithology and genesis of the water-saturated sediments, typically the adjoining aquifers and multi-aquifer-systems are not hydraulically isolated. There are only two regional aquitards in Latvia within the fresh groundwater zone:

- Middle Devonian Narva formation within whole Latvia and
- Plavinas – Amula formation within south-west Latvia, where marl, clay and siltstone dominate in section of this formation. Within central and, especially, east Latvia this formation consists mainly of fractured dolomites and serves as high-yielding multi-aquifer system, rather than aquitard.

Other aquitards have a local importance and basically does not prevent the water exchange between the different aquifers. Nevertheless, some local aquitards may be taken into account for the Quaternary aquifers, characterising by small area of distribution, but having a big importance for centralised water supply.

There are many criteria suitable for the horizontal delineation of groundwater bodies, i.e. for the lateral splitting of aquifers bodies, mentioned in Framework Directive, Latvian Low of Water Management and related documents. Theoretically, the following properties may be taken into account:

- Boundaries of distribution of multi-aquifer systems.
- Boundaries of transmissivity of multi-aquifer systems.
- Boundaries of chemical composition of groundwater within multi-aquifer system. This can be necessary in order to avoid too big variations in the background values of key parameters within each groundwater body. Moreover, these boundaries should correspond with boundaries of areas of groundwater exploitation in water supply.
- Depth of the top of multi-aquifer system. Typically the multi-aquifer systems are not used for water supply within the areas of very deep occurring, if there is an alternative source of water.
- Horizontal boundaries between exploited and non-exploited areas of multi-aquifer system, which depend of groundwater chemistry, depth of aquifer and transmissivity of aquifer.
- Groundwater divides.

Nevertheless, several of the above-mentioned criteria cannot be used for delineation of the groundwater bodies or they have a limited importance.

Thus, the main criteria for delineation of groundwater bodies pursuant to the WFD are the geological boundaries, but for the multi-aquifer systems these have a limited importance for the groundwater balance. The thinning-out of the aquifer does not stop the groundwater flow. Thus, horizontally adjacent aquifers / multi-aquifer systems shall be merged as far as possible.

Boundaries of transmissivity have a significant importance only for the Quaternary aquifers. Pre-Quaternary multi-aquifer systems are characterised by gradual changes of transmissivity. Moreover, the pre-Quaternary multi-aquifer systems provide more than 10 m^3/day of water even within areas of smallest transmissivity (see Annex 2, Figures 4, 7, 11).

Using groundwater chemistry for delineation of groundwater bodies meets the following problems:

- Typically the groundwater chemistry within one multi-aquifer system changes gradually. Moreover, the changes of groundwater chemistry in vertical direction within the multi-aquifer system typically exceed the changes in horizontal direction. Due to both reasons the horizontal borders of groundwater chemistry within whole section of multi-aquifer system are very outstretched. This problem can be solved by delineation of chemistry borders within each thin aquifer, rather than within united multi-aquifer systems, but in this case the total number of groundwater bodies may increase dramatically.

- The chemistry borders are artificial borders without physical delineation, which depend on the choice of threshold value (for example on Drinking Water Standard). Moreover, very often groundwater is used for water supply in spite of poor natural quality. For example, in central Latvia many well fields abstract groundwater with sulphates 250 – 400 mg/l, because there are no alternative sources of drinking water. This means that higher threshold values would be necessary for such areas in case of delineation of sub-bodies based on chemical composition. This can be done, but requires further studies through the period of the first management plan.

The depth to the multi-aquifer systems was not applied for delineation of groundwater bodies due to following reasons:

- The layers are sloping
- Presence of water-supply wells is a more informative criterion for evaluation of usability of deep aquifers for the water supply.

The groundwater divides are the best criteria for delineation of the groundwater bodies, because they are the real borders of different groundwater flows. Moreover, many of them should correspond to the borders of river basins, which allow a combined management of groundwater and surface water.

Therefore a number of piezometric maps was prepared for determination of groundwater divides, based on the data of groundwater levels in the SGSL database "Wells" (see Annex 2, figures 5, 8, 12, 15). As result a lot of groundwater divides were identified accurately (see for example Annex 2, Figure 5). Nevertheless, many really occurring groundwater divides cannot be identified or verified at the moment, especially in east and central Latvia. The reasons are following:

- Insufficient data density within east Latvia, because the database of SGSL is not complete (see Annex 2, Figures 1, 8, 12).

- Numerous data errors, because the on-going verification of data in the database is not finished. These errors make it impossible at the moment to identify groundwater divides within the lowland areas, in which the piezometric pressure is characterised by small hydraulic gradients.

It should be mentioned that a valid identification and delineation of groundwater bodies in fact is impossible at the moment. Thus, the proposed delineation of the groundwater bodies is a very rough delineation, which can be significantly revised in future.

Some additional comments should be attached to the proposed delineation of the groundwater bodies:

- The geological borders define vertical borders of groundwater bodies. They are the regional aquitards between isolated ore semi-isolated multi-aquifer systems.
- Groundwater divides define horizontal borders of pre-Quaternary groundwater bodies basically. As not all groundwater divides were identified, geological borders defined some additional horizontal borders.

- Quaternary semi-confined aquifers were integrated into the appropriate pre-Quaternary groundwater bodies. Main part of Quaternary water-supply wells is screened within very narrow groundwater bodies of covered river valleys, embedded into pre-Quaternary aquifers. In fact within these areas one aquifer consists both of Quaternary and pre-Quaternary sediments.

Thus the groundwater of Quaternary and pre-Quaternary cannot be managed separately.

Small-size Quaternary water-table aquifers are also integrated into the appropriate pre-Quaternary groundwater bodies. There are only three exceptions. As there are no pre-Quaternary aquifers with fresh groundwater beneath the groundwater bodies Q2 and Q-3, these Quaternary groundwater bodies shall be managed separately.

Groundwater body Q-1 should be managed separately due to very big importance - it provides around 30% of the total groundwater abstraction in Latvia. Moreover, this is the most transformed groundwater body in Latvia, where groundwater quality and quantity directly depends on surface water (because the artificial recharge and river-bank well fields are applied). Horizontal borders of these 3 important water-table groundwater bodies were defined by lithological principle. They are the borders between the areas of big and small thickness of water-saturated Quaternary sands.

7.3. Pressures

The initial analysis of pressures on the proposed groundwater bodies is summarised in Table 7-3. The pressures include the abstractions listed above in Table 7-2.

It should be noted that the indication of “No risk” is preliminary. Data on the pressures must be evaluated in more detail to clarify if further characterisation is needed.

As part of the initial characterisation the natural groundwater quality has been analysed, and categories for the natural composition are shown in Table 7-3. The reason for including this is, that some groundwater bodies have a poor natural quality (which is **not** the same as poor status!) and when this fact is included in the evaluation, the basis for identification of impacts from human pressures is improved.

The categories for the natural composition are explained in detail in Table 7-4.

7.3.1. Groundwater bodies at risk

The groundwater bodies which are evaluated as being at risk on basis of the initial characterisation should be characterised further, i.e. the pressures on these bodies should be reviewed in more detail. At present it seems that a further characterisation is needed for the following GW bodies: Q-1 in Daugava/Gauja river basins, the D_3-1 and D_{2-3}-1 in Venta river basin and D_{2-3}-2, which covers all river basins. A subdivision of this groundwater body may be relevant, but at present the basis for such a division is not sufficiently clear.

Table 7-3 Initial characterisation of proposed groundwater bodies

Groundwater body	Main water-saturated sediments	Current importance for the local water supply	General changes of groundwater levels	Natural groundwater quality	General changes of groundwater quality	Main factors, affected groundwater quality of quantity	At risk of not fulfilling the objectives*
Q-1	Sands	Extremely high	Very significant	BO-1, B1-1, B2-3	Very significant	Artificial recharge, river-bank wellfields, over-exploitation, diffuse pollution	Yes
Q-2	Sands	High	Negligible	B2-3	Negligible	Diffuse pollution	No
Q-3	Sands	Low	Negligible	B1-1, B2-3	Negligible	Diffuse pollution	No
D_3-1	Dolomites, sandstones, limestones	Very high	Significant	B1-1, B1-3, B2-1	Significant	Over-exploitation, sea water intrusion, diffuse pollution	Yes
D_3-2		High	Insignificant	B1-1, B1-3, B2-1	Insignificant	Diffuse pollution	No
D_3-3		Moderate	Insignificant	B1-1, B1-3, B2-1	Insignificant	Diffuse pollution	No
D_3-4	Dolomites, limestones	Moderate	Insignificant	B1-1, B1-3, B2-1	Insignificant	Diffuse pollution	No
D_3-5		High	Insignificant	B1-1, B1-3, B2-1	Insignificant	Diffuse pollution	No
D_3-6		High	Negligible	B1-1, B1-3	Insignificant	Diffuse pollution	No
D_{2-3}-1	Sandstones	High	Very significant	B1-1, B1-3, B2-1	Insignificant	Over-exploitation, diffuse pollution	Yes
D_{2-3}-2		Very high		B1-1, B1-2, B1-3, B1-4, B2-1, B2-2	Significant		
D_{2-3}-3		High	Negligible	B1-1	Insignificant	Diffuse pollution	No
D_{2-3}-4		High	Negligible	B1-1	Insignificant	Diffuse pollution	No
D_1		Low	Negligible	B0-2, B1-1, B1-2	Negligible		No

* Indication of "No risk" is preliminary. Data must be evaluated further to clarify if further characterisation is needed.

Table 7-4 Groundwater composition by natural quality (for the initial characterisation of the groundwater bodies)

Quality category by treatment necessity	Quality type	Chlorides, mg/l	Sulphates, mg/l	Specific conductance, µS/cm (20^0C)	Hardness, meq/l	Iron, mg/l	Permanganate index, mg O_2/l)
BO-excellent quality, no treatment is necessary	BO-1	< 50	< 100	100 - 250	1.5 - 3	< 0.2	< 5
	BO-2	50 - 100		400 - 750	2 - 4		< 1
B1 – satisfactory quality, simple treatment is necessary	B1-1	<50		200 – 600	4 - 8	0.2 - 5	
	B1-2	50 - 250		600 - 1100	5 - 9		
	B1-3	< 50	100 - 250	600 - 750	6 - 10		
	B1-4	50 - 250		750 - 1300	9 –11		
B2-unsatisfactory, complicated treatment is necessary	B2-1	< 250	250 - 1800	800 - 3000	10 - 40		
	B2-2	250 - 1600	100 - 600	1300 - 5500	10 - 25		
	B2-3	<50	<100	200 - 350	3 - 5	3 - 10	5 – 50

The categories are defined on the basis of required treatment for drinking water purpose. Explanations for the categories are given in the following.

Background values for some microelements, which could be used for evaluation of chemical status, have been analysed, but this is related to classification more than characterisation, and is therefore presented in the technical report on classification: TR1B.

Explanation of categories of the natural composition of groundwater in Table 7-4**:**

B0 Excellent natural quality

B0 Excellent groundwater quality. Meets Drinking Water Standard without treatment.

B0-1 Calcium bicarbonate ultrafresh groundwater. This groundwater type locally occurs only in GW body Q-1.

B0-2 Sodium bicarbonate soft groundwater. This groundwater type locally occurs only in GW body D_{1-2}.

B1 Satisfactory natural quality

B1 Satisfactory quality, simple treatment is necessary for water supply. Typically these groundwater meet Drinking Water Standard after very simple removal of bivalent iron, somewhere manganese and, very seldom, ammonia (up to 1.5 mg/l) should be removed as well:

B1-1 Calcium bicarbonate groundwater. Dominating groundwater type within all groundwater bodies.

B1-2 Calcium bicarbonate groundwater with a heightened content of chlorides. Locally occurred groundwater type.

B1-3 Calcium bicarbonate groundwater with a heightened content of sulphates. Widely distributed groundwater type.

B1-4 Calcium bicarbonate groundwater with a heightened content both chlorides and sulphates. Rather rare groundwater type, occurred mainly in GW body D_{2-3}-2.

B2 Unsatisfactory natural quality

B2 Unsatisfactory quality, complicated treatment is necessary additionally to iron removal. This groundwater is supplied due to absence of the alternative water source.

B2-1 Calcium sulphate groundwater. Widely distributed groundwater type. The sulphate problem accompanies by the very high hardness.

B2-2 Sodium chloride groundwater. Besides, hardness is rather high. If the chloride exceeds 400 mg/l, sodium also exceeds Maximum Permissible Value (200 mg/l). This groundwater type occurs within small-size areas in central Latvia and along a coastline.

B2-3 Groundwater with a high content of organic matter. This problem occurs in GW body Q-3 and, with a lesser extent, in GW body Q-1. Water is strongly coloured (50-200 PCU), iron may reach 10 mg/l, also manganese, ammonia and phenol index exceed Maximum Permissible Values.

Several additional water quality problems occur in groundwater with a high content of dissolved solids, for example:

- Hydrogen sulphide may be formed in stained groundwater with high content of sulphates. This problem occurs in groundwater type B2-1, with a lesser extent - in groundwater types B1-3, B1-4 and B2-2.

- Chlorinating of groundwater with a high content of chlorides typically carried out for cleaning of the water mains may form bromates from bromides, which accompany chlorides in groundwater types B1-2, B1-4, B2-1 and, especially B2-2.

7.4. Transboundary groundwater bodies

This chapter will be completed after finalisation of Technical Note ''Final delineation of groundwater bodies and traunsboundary groundwater bodies''.