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SCREENING OF EU AND NATIONAL LEGISLATIONS

in a scope of project

Screening of the geothermal utilization, evaluation of the thermal groundwater bodies and preparation of the joint aquifer management plan in the Mura-Zala basin

T-JAM

REPUBLIC OF SLOVENIA
GOVERNMENT OFFICE FOR LOCAL SELF-GOVERNMENT AND REGIONAL POLICY

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DEVELOPMENT AGENCY

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1. Introduction

Cross-border management of geothermal resources requires reconciliation of tasks and needs (from exploration to exploitation of these resources) extending between neighboring countries.

First of all it is inevitable to understand the natural system supplying this renewable energy source, i.e. the common understanding of the geological structure, thermodynamics, processes, climate change impacts and man induced impacts. Based upon this we are enabled to build up cross border conceptual model of natural system for further advanced evaluations, prognosis and adequate measures for transboundary resources management.

Secondly it is important to understand the common policy framework, common strategies and actual objectives. In this frame we are following the indicators that are set up to reveal and stimulate our capabilities and progress.

Management of geothermal resources is spread between Energy legislation and Natural resources legislation. The Energy legislation is strictly based on the energy production and directed to the promotion of renewable and sustainable resources exploitation. The Natural resources legislation is directed to sustainable use of all other environmental resources that could be affected directly or indirectly by the energy production.

As the most important carrier of Earth's heat energy is water (the aquifers and groundwater bodies are directly affected by this renewable source exploitation. Thus the Water framework directive and Groundwater directive are the most important EU natural resources legislation in cross-border geothermal resources management.

In this report an overview of the EU directives, international conventions and recommendations about geothermal energy utilization and environmental goals are given, as well as a summary on the related Slovenian and Hungarian legal framework, legislation and regulation.

2. Overview of EU legislation

Geothermal resources management consists of energy production management and environmental resources management. In the following the most important EU directives, definition and concepts that build the skeleton of the geothermal resources management are summarized.

2.1 Energy legislation

2.1.1 Promotion of the use of energy from renewable sources

EU Directive on Promotion of Renewable Energy Sources (*Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources* and amending and subsequently repealing *Directives 2001/77/EC* and *2003/30/EC*)

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:en:PDF

This Directive establishes a common framework for the promotion of energy from renewable sources. It sets mandatory national targets for the overall share of energy from renewable sources in gross final consumption of energy and for the share of energy from renewable sources in transport. It lays down rules relating to statistical transfers between Member States, joint projects between Member States and with third countries, guarantees of origin, administrative procedures, information and training, and access to the electricity grid for energy from renewable sources. It establishes sustainability criteria for biofuels and bioliquids.

Article 2:

(a) ‘energy from renewable sources’ means renewable nonfossil sources, namely wind, solar, geothermal, aerothermal, hydrothermal and ocean energy, hydropower, biomass, snow, landfill gas, sewage treatment plant gas and biogases;

(c) ‘geothermal energy’ means energy stored in form of heat beneath the surface of solid earth;

(d) ‘hydrothermal energy’ means energy stored in the form of heat in surface water;

Article 5:

(4) Aerothermal, geothermal and hydrothermal heat energy captured by heat pumps shall be taken into account for the purposes of paragraph 1(b) provided that the final energy output significantly exceeds the primary energy input required to drive the heat pumps. The quantity

of heat to be considered as energy from renewable sources for the purposes of this directive shall be calculated in accordance with the methodology laid down in Annex VII.

ANNEX VII - Accounting of energy from heat pumps

The amount of aerothermal, geothermal or hydrothermal energy captured by heat pumps to be considered energy from renewable sources for the purposes of this Directive, ERES, shall be calculated in accordance with the following formula:

ERES = Qusable * (1 – 1/SPF)

Qusable = the estimated total usable heat delivered by heat pumps fulfilling the criteria referred to in Article 5(4), implemented as follows: Only heat pumps for which SPF > 1,15 * 1/η shall be taken into account,

SPF = the estimated average seasonal performance factor for those heat pumps,

η is the ratio between total gross production of electricity and the primary energy consumption for electricity production and shall be calculated as an EU average based on Eurostat data.

By 1 January 2013, the Commission shall establish guidelines on how Member States are to estimate the values of Qusable and SPF for the different heat pump technologies and applications, taking into consideration differences in climatic conditions, especially very cold climates.

(31) Heat pumps enabling the use of aerothermal, geothermal or hydrothermal heat at a useful temperature level need electricity or other auxiliary energy to function. The energy used to drive heat pumps should therefore be deducted from the total usable heat. Only heat pumps with an output that significantly exceeds the primary energy needed to drive it should be taken into account.

Article 16

Member States in their national renewable energy action plans shall assess the necessity to build new infrastructure for district heating and cooling produced from renewable energy sources in order to achieve the 2020 national target referred to in Article 3(1). Subject to that assessment, Member States shall, where relevant, take steps with a view to developing a district heating infrastructure to accommodate the development of heating and cooling production from large biomass, solar and geothermal facilities.

In the case of heat pumps, Member States shall promote those that fulfill the minimum requirements of eco-labelling established in Commission Decision 2007/742/EC of 9 November 2007 establishing the ecological criteria for the award of the Community eco-label to electrically driven, gas driven or gas absorption heat pumps.

2.1.2 Energy statistics

The Eurostat Concepts and Definitions Database

Glossary: Geothermal energy (Code 5550)

Geothermal energy comprises energy available as sites for electricity generation using dry steam or high enthalpy brine after flashing or directly as heat for district heating, agriculture, etc.

Primary energy production (TJ) is the enthalpy difference between the fluid produced in the production borehole and of the fluid eventually disposed of (reinjection borehole).

Source: Eurostat/IEA/UN-ECE Joint Questionnaires on annual energy statistics

Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:304:0001:0062:EN:PDF

This Regulation establishes a common framework for the production, transmission, evaluation and dissemination of comparable energy statistics in the Community.

Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market and *Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market* require Member States to report quantitative energy data. In order to monitor progress towards the achievement of the objectives set in those Directives, detailed, up-to-date energy data are required.

Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings, *Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy service*s and *Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products* require Member States to report quantitative energy consumption data. To monitor progress towards the achievement of the objectives set in those Directives, detailed, up-to-date energy data, as well as a better interface between these energy data and related statistical surveys such as the population and housing censuses and transportation data, are required.

Member States have to transmit to the Commission (Eurostat) the annual national geothermal statistics.

2.1.3 Calculation methods for the contribution of renewables to thermal applications

There are many definition of geothermal energy. **EGEC** (European Geothermal Energy Council) suggests the definition of geothermal heat as the heat that is stored under the solid ground of the earth. EGEC view on statistics in regards to the Directive on Promotion of

Renewable Energy Sources geothermal energy exists and shall be counted in the following forms:

- Electric power generated from geothermal sources,

- Heat ((1) swimming, bathing and balneology, (2) space heating including district heating, (3) agriculture applications, (4) aquaculture applications and (5) industrial processes) produced directly from geothermal sources,

- Heat (mainly shallow geothermal) used as input to geothermal heat pumps,

- Cooling (mainly in geothermal heat pump plants).

Eurostat defines geothermal energy as the energy available as heat emitted from within the earth's crust, usually in the form of hot water or steam. It is exploited at suitable sites for electricity generation using dry steam or high enthalpy brine after flashing as well as for its direct use as heat for district heating, agriculture, etc. Geothermal heat is used where it is available either 'as extracted' or upgraded by burning fuels to 'add' heat to the geothermal flow.

Geothermal heat following the **THERRA** definition (www.therra.info) only covers heat from deep geothermal installations that use the heat directly. Shallow geothermal installations using heat pumps are covered by the method for ambient heat.

Due to practical reasons the total geothermal heat is usually distincted into two types: geothermal and ambient heat, according to the different way of utilisation. Geothermal heat is used directly, while for the use of ambient heat it is necessary to use heat pumps.

Ambient heat is defined here as energy taken from the environment that can be either ambient air or the ground (shallow geothermal energy). It is utilized by mechanical or absorption heat pumps. Heat pumps are devices for transferring heat from a cold source to a warmer source and may be used to draw heat from outside a building to warm the inside. They can provide an efficient means of space heating, domestic hot water production, district heating and heat recovery.

The EUROSTAT definition of a calculation method: The energy contained in the higher temperature output from a heat pump is the sum of the heat extracted from a colder source and the electrical energy required to work the pump. The heat extracted can be estimated by subtracting the electricity use from the total energy of the output. The extracted heat is considered as 'new' heat and included in the indigenous production of heat. The electricity used to operate the pump is reported as an input to a transformation process under the heading Heat pumps. The corresponding (transformation) heat output (equal to the electricity input) will be included in the total output from the heat pumps. In this manner the energy use of the pumps is identified and their total outputs are included in the heat supply. Note that the transformation sector heading 'Heat pumps' does not appear in published balances as it is too minor to merit identification, but the electricity used and heat produced from it is part of the figures reported under ''Other transformation'' in the IEA balance.

It seems acceptable to count the geothermal heat used through heat pumps first among the heat pumps – AMBIENT HEAT (but distinct from air and surface water), and then allow to add it to the TOTAL GEOTHERMAL HEAT.

The representation of the electricity used and heat supplied in the energy balance is a difficult task and a simplified approach has to be adopted. In the frame of the EU programme Intelligent Energy a project ThERRA was conducted. They prepared a methodology for counting of renewable share of heat pump energy production.

In this methodology used definitions are:

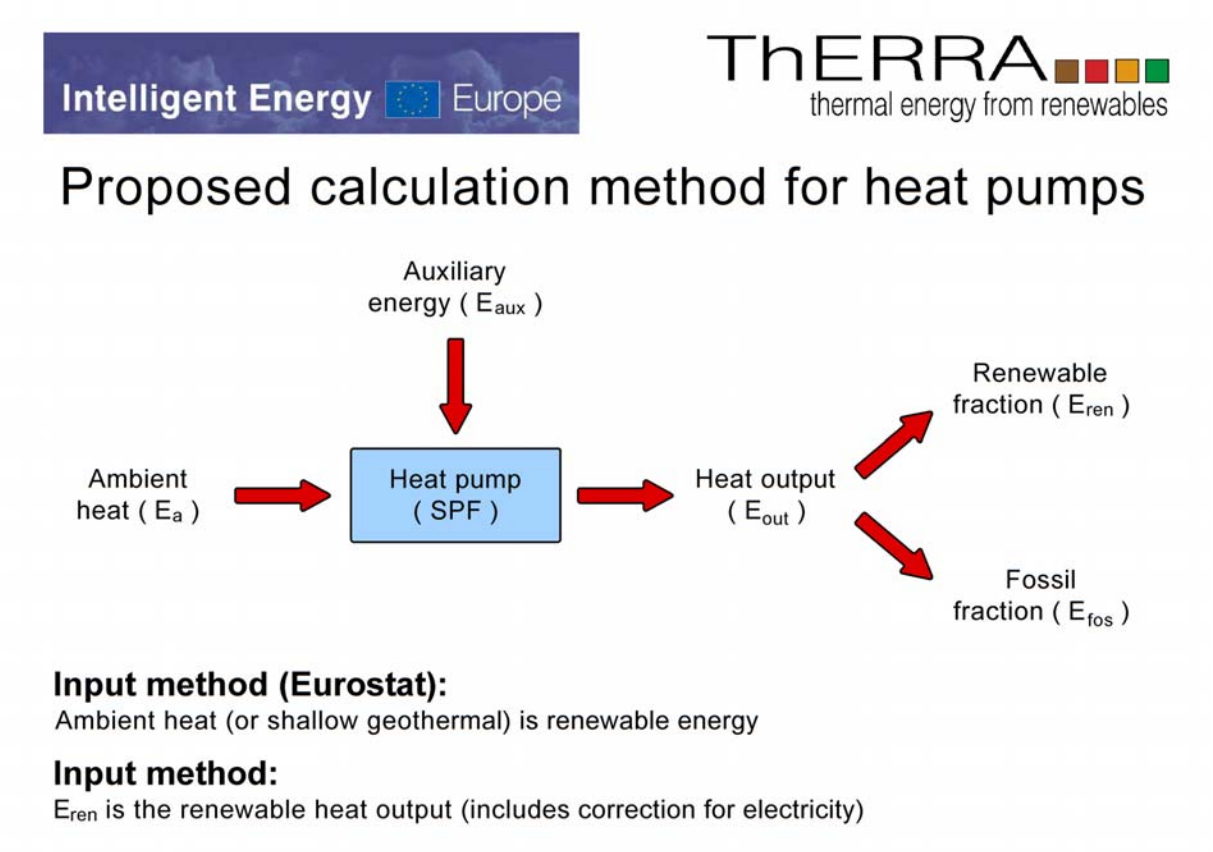
'Renewable energy' is energy that is derived from natural processes that are replenished constantly. Sources: solar, wind, geothermal, ambient, hydropower and ocean resources, solid biomass, biogas, liquid biofuels and renewable waste

'Renewable heat' is the energy content of a renewable source that is converted into heat. The renewable INPUT has to be distinguished from the renewable OUTPUT of the source. The renewable heat production can be calculated as primary heat input and as useful heat output.

The heat converted from geothermal or ambient heat sources with a heat pump can be included in this methodology.

The methodology can be made to fit the Eurostat and IEA methodology.

This methodology can help to assess if the European countries reach the EU-goal of 20% renewable energy in the year 2020.



2.1.4 Eurostat - indicators

Electricity generated from renewable sources (% of gross electricity consumption) [tsien050 -

http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsien050]

Short Description: This indicator is the ratio between the electricity produced from renewable energy sources and the gross national electricity consumption for a given calendar year. It measures the contribution of electricity produced from renewable energy sources to the national electricity consumption. Electricity produced from renewable energy sources comprises the electricity generation from hydro plants (excluding pumping), wind, solar, geothermal and electricity from biomass/wastes. Gross national electricity consumption comprises the total gross national electricity generation from all fuels (including autoproduction), plus electricity imports, minus exports.

Primary production of renewable energy - (1 000 toe) [ten00081 - http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=0&language=en&pcode=ten00081]

Short Description: Primary production of biomass, hydropower, geothermal energy, wind and solar energy are included in renewable energies.

Renewable energy primary production: biomass, hydro, geothermal, wind and solar energy - (1 000 toe) [ten00082 –

http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=ten00082]

Short Description: Primary production: biomass (heat content of the produced biofuels or biogas; heat produced after combustion during incineration of renewable wastes); hydropower covers potential and kinetic energy of water converted into electricity in hydroelectric plants (the electricity generated in pumped storage plants is not included); geothermal energy comprises energy available as heat emitted from within the earth's crust, usually in the form of hot water or steam; wind energy covers the kinetic energy of wind converted into electricity in wind turbines; solar energy covers the solar radiation exploited for solar heat (hot water) and electricity production

Share of renewable energy in gross final energy consumption

%[tsdcc110 - http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsdcc110]

Short Description: This indicator is calculated on the basis of energy statistics covered by the Energy Statistics Regulation. It may be considered an estimate of the indicator described in

Directive 2009/28/EC, as the statistical system for some renewable energy technologies is not yet fully developed to meet the requirements of this Directive. However, the contribution of these technologies is rather marginal for the time being. More information about the renewable energy shares calculation methodology and Eurostat's annual energy statistics can be found in the *Renewable Energy Directive 2009/28/EC* , the Energy Statistics Regulation 1099/2008 and in Renewable energy transparency platform of European Commission http://ec.europa.eu/energy/renewables/transparency_platform/transparency_platform_en.htm.

2.2 Natural resources legislation

Some of the key terms which have to be defined in the preparation of the management plan are:

Groundwater available for annual abstraction is recharge less the long term annual average rate of flow required to achieve ecological quality objectives for associated surface water. It takes into account the ecological restrictions imposed to groundwater exploitability, nevertheless other restrictions based on economic and technical criteria could also be taken into account in terms of accessibility, productivity and maximum production cost deemed acceptable by developers. The theoretical maximum of groundwater available is the recharge.

Recharge (of groundwater) is the total volume of water added from outside to the zone of saturation of an aquifer.

Source: OECD/Eurostat Joint Questionnaire - Inland Waters

Thermal pollution is the discharge of heated effluents from industrial processes such as electric power generation, atomic power stations and other factories at temperatures that can affect the life process of aquatic organisms.

Source Publication: Glossary of Environment Statistics, Studies in Methods, Series F, No. 67, United Nations, New York, 1997.

2.2.1 Protection of groundwater against pollution caused by certain dangerous substances

Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances

Article 1

The purpose of this Directive is to prevent the pollution of groundwater by substances belonging to the families and groups of substances in lists I or II in the Annex, hereinafter referred to as ‘substances in lists I or II’, and as far as possible to check or eliminate the consequences of pollution which has already occurred.

For the purposes of this Directive:

'Groundwater' means all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil;

'Direct discharge' means the introduction into groundwater of substances in lists I or II without percolation through the ground or subsoil;

'Indirect discharge' means the introduction into groundwater of substances in lists I or II after percolation through the ground or subsoil;

'Pollution' means the discharge by man, directly or indirectly, of substances or energy into groundwater, the results of which are such as to endanger human health or water supplies, harm living resources and the aquatic ecosystem or interfere with other legitimate uses of water.

Article 4

However, should prior investigation reveal that the groundwater into which the discharge of substances in list I is envisaged is permanently unsuitable for other uses, especially domestic or agricultural, the Member States may authorize the discharge of these substances provided that their presence does not impede exploitation of ground resources.

These authorizations may be granted only if all technical precautions have been taken to ensure that these substances cannot reach other aquatic systems or harm other ecosystems.

Member States may, after prior investigation, authorize discharges due to re-injection into the same aquifer of water used for geothermal purposes, water pumped out of mines and quarries or water pumped out for civil engineering works.

Article 6

Artificial recharges for the purpose of groundwater management shall be subject to a special authorization issued by the Member States on a case-by-case basis. Such authorization shall be granted only if there is no risk of polluting the groundwater.

Article 10

When disposal or tipping for the purpose of disposal which might lead to indirect discharge is authorized, authorization shall specify in particular:

- the place where such disposal or tipping is done,
- the methods of disposal or tipping used,
- essential precautions, particular attention being paid to the nature and concentration of the substances present in the matter to be tipped or disposed of, the characteristics of

the receiving environment and the proximity of water catchment areas, in particular those for drinking, thermal and mineral water,

- the maximum quantity permissible, during one or more specified periods of time, of the matter containing substances in lists I or II and, where possible, of those substances themselves, to be tipped or disposed of and the appropriate requirements as to the concentration of those substances,

- in the cases referred to in Article 4 (1) and Article 5 (1) the technical precautions to be implemented to prevent any discharge into groundwater of substances in list I and any pollution of such water by substances in list II,

- if necessary, the measures for monitoring the groundwater, and in particular its quality.

Article 17

With regard to discharges into transfrontier groundwater, the competent authority of the Member State which intends to grant authorization for such discharges shall inform the other Member States concerned before an authorization is issued. At the request of one of the Member States concerned and before an authorization is issued, consultations shall be held in which the Commission may participate.

Article 19

Where appropriate, one or more Member States may individually or jointly take more stringent measures than those provided for under this Directive.

2.2.2 Framework for Community action in the field of water policy

(Water Framework Directive) Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

(a) prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;

(b) promotes sustainable water use based on a long-term protection of available water resources;

(c) aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of

priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;

(d) ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and

(e) contributes to mitigating the effects of floods and droughts

and thereby contributes to:

- the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use,
- a significant reduction in pollution of groundwater,
- the protection of territorial and marine waters, and
- achieving the objectives of relevant international agreements, including those which aim to prevent and eliminate pollution of the marine environment, by Community action under Article 16(3) to cease or phase out discharges, emissions and losses of priority hazardous substances, with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.

The *Water Framework Directive (2000/60/EC)* is the most important legislation of (thermal) water management and management of transboundary aquifers. Article 8 of WFD gives provisions on the establishment of monitoring programmes of groundwaters. Monitoring of groundwaters related to the WDF concerns the entire groundwater body, but it also supports the integrated management of the catchment area and reaching its environmental targets. However it does not deal with those local processes and contaminations whose temporal and spatial formation does not influence status of the whole groundwater body, and does not threaten the fulfillment of its environmental targets.

The monitoring programme meeting the requirements of WFD includes survey of status and trends that serve the basis of quantitative and chemical (qualitative) monitoring.

The WFD monitoring includes the following elements:

Quantitative monitoring network which main goal is to supply data for the quantitative characterization.

Surveillance monitoring (qualitative/chemical monitoring) which aims to provide information on changes in the natural processes due to human interaction , as well as on tracking trends in the long-term variation in pollution concentration, thus serving the basis for qualitative status assessment of groundwater bodies.

Operational monitoring network gives information to register and follow trends in the concentration of pollutants in groundwater bodies in poor qualitative status or at risk (from a qualitative point of view).

Special regulations concern the cross-border groundwater bodies that are shared by two or more states. The monitoring strategy has to be formed based on bilateral agreements that

include needs for coordination, data exchange, and criteria for Quality Assurance (QA) and Quality Control (QC). Monitoring of transboundary aquifers should cover all those parameters that are related to the kinds of utilization aspects of the groundwater flow system.

The WFD requires that surveillance monitoring has to be performed in every planning period, and operational monitoring has to be implemented in the periods not covered by surveillance monitoring, but at least once a year.

Results given by the monitoring have to be processed regularly. The network and its operation have to be reviewed and optimized in every 6 years.

For the purposes of environmental protection there is a need for a greater integration of qualitative and quantitative aspects of both surface waters and groundwaters, taking into account the natural flow conditions of water within the hydrological cycle.

'Aquifer' means a subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater.

'Body of groundwater' means a distinct volume of groundwater within an aquifer or aquifers.

'Groundwater status' is the general expression of the status of a body of groundwater, determined by the poorer of its quantitative status and its chemical status.

'Good groundwater status' means the status achieved by a groundwater body when both its quantitative status and its chemical status are at least 'good'.

'Good groundwater chemical status' is the chemical status of a body of groundwater, which meets all the conditions set out in table 2.3.2 of Annex V.

'Quantitative status' is an expression of the degree to which a body of groundwater is affected by direct and indirect abstractions.

'Available groundwater resource' means the long-term annual average rate of overall recharge of the body of groundwater less the long-term annual rate of flow required to achieve the ecological quality objectives for associated surface waters specified under Article 4, to avoid any significant diminution in the ecological status of such waters and to avoid any significant damage to associated terrestrial ecosystems.

'Direct discharge to groundwater' means discharge of pollutants into groundwater without percolation throughout the soil or subsoil.

'Pollution' means the direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment.

Member States shall implement the necessary measures in accordance with Article 16(1) and (8), with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances without

prejudice to the relevant international agreements referred to in Article 1 for the parties concerned;

For groundwater:

(i) Member States shall implement the measures necessary to prevent or limit the input of pollutants into groundwater and to prevent the deterioration of the status of all bodies of groundwater, subject to the application of paragraphs 6 and 7 and without prejudice to paragraph 8 of this Article and subject to the application of Article 11(3)(j);

(ii) Member States shall protect, enhance and restore all bodies of groundwater, ensure a balance between abstraction and recharge of groundwater, with the aim of achieving good groundwater status at the latest 15 years after the date of entry into force of this Directive, in accordance with the provisions laid down in Annex V, subject to the application of extensions determined in accordance with paragraph 4 and to the application of paragraphs 5, 6 and 7 without prejudice to paragraph 8 of this Article and subject to the application of Article 11(3)(j);

(iii) Member States shall implement the measures necessary to reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity in order progressively to reduce pollution of groundwater.

Measures to achieve trend reversal shall be implemented in accordance with paragraphs 2, 4 and 5 of Article 17, taking into account the applicable standards set out in relevant Community legislation, subject to the application of paragraphs 6 and 7 and without prejudice to paragraph 8;

Article 11

(j) a prohibition of direct discharges of pollutants into groundwater subject to the following provisions:

Member States may authorize reinjection into the same aquifer of water used for geothermal purposes.

They may also authorize, specifying the conditions for:

- injection of water containing substances resulting from the operations for exploration and extraction of hydrocarbons or mining activities, and injection of water for technical reasons, into geological formations from which hydrocarbons or other substances have been extracted or into geological formations which for natural reasons are permanently unsuitable for other purposes. Such injections shall not contain substances other than those resulting from the above operations,

- reinjection of pumped groundwater from mines and quarries or associated with the construction or maintenance of civil engineering works,

- injection of natural gas or liquefied petroleum gas (LPG) for storage purposes into geological formations which for natural reasons are permanently unsuitable for other purposes,

- injection of natural gas or liquefied petroleum gas (LPG) for storage purposes into other geological formations where there is an overriding need for security of gas supply, and where the injection is such as to prevent any present or future danger of deterioration in the quality of any receiving groundwater,

- construction, civil engineering and building works and similar activities on, or in the ground which come into contact with groundwater. For these purposes, Member States may determine that such activities are to be treated as having been authorized provided that they are conducted in accordance with general binding rules developed by the Member State in respect of such activities,

- discharges of small quantities of substances for scientific purposes for characterization, protection or remediation of water bodies limited to the amount strictly necessary for the purposes concerned

- provided such discharges do not compromise the achievement of the environmental objectives established for that body of groundwater;

Presentation of Groundwater Status

Member States shall provide in the river basin management plan a map showing for each groundwater body or groups of groundwater bodies both the quantitative status and the chemical status of that body or group of bodies, colour-coded in accordance with the requirements of points 2.2.4 and 2.4.5.

River basin management plans:

River basin management plans shall cover the following elements:

(1) a general description of the characteristics of the river basin district required under Article 5 and Annex II. This shall include mapping of the location and boundaries of groundwater bodies;

(2) a summary of significant pressures and impact of human activity on the status of surface water and groundwater, including:

- estimation of point source pollution,

- estimation of diffuse source pollution, including a summary of land use,

- estimation of pressures on the quantitative status of water including abstractions,

- analysis of other impacts of human activity on the status of water;

(4) a map of the monitoring networks established for the purposes of Article 8 and Annex V, and a presentation in map form of the results of the monitoring programmes carried out under those provisions for the chemical and quantitative status of groundwater;

Definition of quantitative status for groundwater (Elements: Groundwater level):

Good status: The level of groundwater in the groundwater body is such that the available groundwater resource is not exceeded by the long-term annual average rate of abstraction.

Accordingly, the level of groundwater is not subject to anthropogenic alterations such as would result in:

- failure to achieve the environmental objectives specified under Article 4 for associated surface waters,
- any significant diminution in the status of such waters,
- any significant damage to terrestrial ecosystems which depend directly on the groundwater body,

and alterations to flow direction resulting from level changes may occur temporarily, or continuously in a spatially limited area, but such reversals do not cause saltwater or other intrusion, and do not indicate a sustained and clearly identified anthropogenically induced trend in flow direction likely to result in such intrusions.

2.2.3 Protection of groundwater against pollution and deterioration

(Groundwater Directive) Directive 2006/118/EC of the European parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration

This Directive establishes specific measures as provided for in Article 17(1) and (2) of *Directive 2000/60/EC* in order to prevent and control groundwater pollution. These measures include in particular:

(a) criteria for the assessment of good groundwater chemical status; and

b) criteria for the identification and reversal of significant and sustained upward trends and for the definition of starting points for trend reversals.

This Directive also complements the provisions preventing or limiting inputs of pollutants into groundwater already contained in *Directive 2000/60/EC*, and aims to prevent the deterioration of the status of all bodies of groundwater.

In the period between 16 January 2009 and 22 December 2013, any new authorisation procedure pursuant to Articles 4 and 5 of *Directive 80/68/EEC* shall take into account the requirements set out in Articles 3 (Criteria for assessing groundwater chemical status), 4 (Procedure for assessing groundwater chemical status) and 5 (Identification of significant and

sustained upward trends and the definition of starting points for trend reversals) of this Directive.

'groundwater quality standard' means an environmental quality standard expressed as the concentration of a particular pollutant, group of pollutants or indicator of pollution in groundwater, which should not be exceeded in order to protect human health and the environment;

'significant and sustained upward trend' means any statistically and environmentally significant increase of concentration of a pollutant, group of pollutants, or indicator of pollution in groundwater for which trend reversal is identified as being necessary in accordance with Article 5;

'input of pollutants into groundwater' means the direct or indirect introduction of pollutants into groundwater as a result of human activity;

'background level' means the concentration of a substance or the value of an indicator in a body of groundwater corresponding to no, or only very minor, anthropogenic alterations to undisturbed conditions;

'baseline level' means the average value measured at least during the reference years 2007 and 2008 on the basis of monitoring programmes implemented under Article 8 of *Directive 2000/60/EC* or, in the case of substances identified after these reference years, during the first period for which a representative period of monitoring data is available.

Without prejudice to any more stringent requirements in other Community legislation, Member States may exempt from the measures required by paragraph 1 inputs of pollutants that are:

(a) the result of direct discharges authorized in accordance with Article 11(3)(j) of *Directive 2000/60/EC*;

(b) considered by the competent authorities to be of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater;

(c) the consequences of accidents or exceptional circumstances of natural cause that could not reasonably have been foreseen, avoided or mitigated;

(d) the result of artificial recharge or augmentation of bodies of groundwater authorized in accordance with Article 11(3)(f) of *Directive 2000/60/EC*;

(e) in the view of the competent authorities incapable, for technical reasons, of being prevented or limited without using:

(i) measures that would increase risks to human health or to the quality of the environment as a whole; or

(ii) disproportionately costly measures to remove quantities of pollutants from, or otherwise control their percolation in, contaminated ground or subsoil; or the result of interventions in surface waters for the purposes, amongst others, of mitigating the effects of floods and droughts, and for the management of waters and waterways,

including at international level. Such activities, including cutting, dredging, relocation and deposition of sediments in surface water, shall be conducted in accordance with general binding rules, and, where applicable, with permits and authorizations issued on the basis of such rules, developed by the Member States for that purpose, provided that such inputs do not compromise the achievement of the environmental objectives established for the water bodies concerned in accordance with Article 4(1) (b) of *Directive 2000/60/EC*.

The exemptions provided for in points (a) to (f) may be used only where the Member States' competent authorities have established that efficient monitoring of the bodies of groundwater concerned, in accordance with point 2.4.2 of Annex V to *Directive 2000/60/EC*, or other appropriate monitoring, is being carried out.

The competent authorities of the Member States shall keep an inventory of the exemptions referred to in paragraph 3 for the purpose of notification, upon request, to the Commission.

2.2.4 Environmental impact assessment and strategic environmental assessment directives

Environmental assessment is a procedure that ensures that the environmental implications of decisions are taken into account before the decisions are made. Environmental assessment can be undertaken for individual projects, such as deep geothermal drillings, on the basis of *Directive 85/337/EEC*, as amended (known as 'Environmental Impact Assessment' – EIA Directive) or for public plans or programmes on the basis of *Directive 2001/42/EC* (known as 'Strategic Environmental Assessment' – SEA Directive). The common principle of both Directives is to ensure that plans, programmes and projects likely to have significant effects on the environment are made subject to an environmental assessment, prior to their approval or authorisation. Consultation with the public is a key feature of environmental assessment procedures.

The Directives on Environmental Assessment aim to provide a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation of projects, plans and programmes with a view to reduce their environmental impact. They ensure public participation in decision-making and thereby strengthen the quality of decisions. The projects and programmes co-financed by the EU (Cohesion, Agricultural and Fisheries Policies) have to comply with the EIA and SEA Directives to receive approval for financial assistance. Hence the Directives on Environmental Assessment are crucial tools for sustainable development. All info about EIA and SEA Directives are available at http://ec.europa.eu/environment/eia/home.htm.

2.2.5 Environmental liability with regard to the prevention and remedying of environmental damage

Directive 2004/35/EC of the European parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage

The purpose of this Directive is to establish a framework of environmental liability based on the ‘polluter-pays' principle, to prevent and remedy environmental damage.

Article 2

Definitions

For the purpose of this Directive the following definitions shall apply:

1. ‘environmental damage' means:

(a) damage to protected species and natural habitats, which is any damage that has significant adverse effects on reaching or maintaining the favorable conservation status of such habitats or species. The significance of such effects is to be assessed with reference to the baseline condition, taking account of the criteria set out in Annex I; Damage to protected species and natural habitats does not include previously identified adverse effects which result from an act by an operator which was expressly authorized by the relevant authorities in accordance with provisions implementing Article 6(3) and (4) or Article 16 of *Directive 92/43/EEC* or Article 9 of *Directive 79/409/EEC* or, in the case of habitats and species not covered by Community law, in accordance with equivalent provisions of national law on nature conservation.

(b) water damage, which is any damage that significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential, as defined in *Directive 2000/60/EC*, of the waters concerned, with the exception of adverse effects where Article 4(7) of that Directive applies;

(c) land damage, which is any land contamination that creates a significant risk of human health being adversely affected as a result of the direct or indirect introduction, in, on or under land, of substances, preparations, organisms or micro-organisms;

2. ‘damage' means a measurable adverse change in a natural resource or measurable impairment of a natural resource service which may occur directly or indirectly.

2.2.6 Eurostat – indicators

Groundwater abstraction, volume - Millions m³ [ten00004 - http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=ten00004]

Short Description: Abstraction of fresh water from underground deposits. These can be permanent or temporary, both artificially charged or naturally. Groundwater includes springs, both concentrated and diffused, which may also be subaqueous.

Surface and groundwater abstraction as a share of available resources - % of available surface and groundwater resources [tsdnr310 - http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsdnr310]

Short Description: This indicator looks at total water abstraction as a percentage of available resources, separated into groundwater and surface water. Annual total gross abstraction from groundwater is presented as a percentage of Member States' renewable groundwater resources available for abstraction, which are defined as long-term annual average groundwater available for abstraction. Annual total gross abstraction made from fresh surface water is presented as a percentage of Member States' renewable surface water resources available for abstraction, which are calculated as total long-term fresh water resources (external inflow plus precipitation less evapotranspiration) less groundwater available for abstraction.

3. International conventions and bilateral agreements

3.1 Helsinki convention on the protection and use of transboundary watercourses and international lakes

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) (http://live.unece.org/env/water/text/text.html) was drawn up under the auspices of the United Nations Economic Commission for Europe (UNECE) and signed in Helsinki on 17 March 1992.

Water Convention is intended to strengthen national measures for the protection and ecologically sound management of transboundary surface waters and groundwaters.

The Convention obliges Parties to prevent, control and reduce transboundary impact, use transboundary waters in a reasonable and equitable way and ensure their sustainable management. Parties bordering the same transboundary waters shall cooperate by entering into specific agreements and establishing joint bodies. The Convention includes provisions on monitoring, research and development, consultations, warning and alarm systems, mutual assistance, and exchange of information, as well as access to information by the public.

The Convention entered into force in October 1996 and includes important provisions on the monitoring and assessment of transboundary waters, the assessment of the effectiveness of measures taken to prevent, control and reduce transboundary impact, and the exchange of information on water and effluent monitoring. Other relevant aspects deal with the harmonization of rules for setting up and operating monitoring programmes, which includes measurement systems and devices, analytical techniques, data processing and evaluation techniques. In 1994, the UNECE established the Task Force on Monitoring and Assessment of Transboundary Waters, which drafted guidelines on monitoring and assessment of transboundary waters in four volumes:

Almássy, E., Buzás, Zs., 1999: Guidelines on Monitoring and Assessment of Transboundary Groundwaters Volume 1: Inventory of transboundary groundwaters. UN/ECE Task Force on Monitoring & Assessment under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992), Working Programme 1996/1999 Lelystad, Netherland.

van der Grift, B., van Dael, J.G.F., 1999: Guidelines on Monitoring and Assessment of Transboundary Groundwaters Volume 2: Problem-oriented approach and the use of indicators. UN/ECE Task Force on Monitoring & Assessment under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992), Working Programme 1996/1999 Lelystad, Netherland.

Arnold, G.E., Chriastel, R. Novak, V., Ognianik, N.S., Simonffy, Z., 1999: Guidelines on Monitoring and Assessment of Transboundary Groundwaters Volume 3: Application of models. UN/ECE Task Force on Monitoring & Assessment under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992), Working Programme 1996/1999 Lelystad, Netherland.

Uil, H., van Geer, F.C., Gehrels ,J.C., Kloosterman, F.H., 1999: Guidelines on Monitoring and Assessment of Transboundary Groundwaters Volume 4: State of the art on monitoring and assessment of groundwater. UN/ECE Task Force on Monitoring & Assessment under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992), Working Programme 1996/1999 Lelystad, Netherland.

The summary of guidelines is given in appendix 1.

3.2 Danube River Protection Convention and International Commission for the Protection of the Danube River

The Danube River Protection Convention (DRPC) forms the overall legal instrument for co-operation on transboundary water management in the Danube River Basin. The convention was signed on 29. June 1994 in Sofia, Bulgaria by eleven states from Danube river basin – Austria, Bulgaria, Croatia, Czech republic, Germany, Hungary, Moldova, Romania, Slovak republic, Slovenia and Ukraine, – and EU, and came into force in 1998. In Slovenia the ratified convention was published in Ur. l. RS, No. 47/98.

The International Commission for the Protection of the Danube River (ICPDR, www.icpdr.org) is a transnational body, which has been established to implement the Danube River Protection Convention. The work of the ICPDR is supported by a Secretariat located in Vienna, Austria.

In 2000, the ICPDR contracting parties nominated the ICPDR as the platform for the implementation of all transboundary aspects of the EU *Water Framework Directive* (WFD) in the Danube river basin district.

The main objective of the Danube River Protection Convention (DRPC) is to ensure that surface waters and groundwater within the Danube River Basin are managed and used sustainably and equitably and safeguarding the Danube's Water resources for future generation. This includes also protection, remediation and rational utilization of the surface waters and groudwaters.

3.3 Bilateral agreement between Slovenia and Hungary on the Water Management

The water management issues between Hungary and Slovenia are governed by the Agreement among Slovenia and Hungary on the Water Management (*Ur. l. RS, no. 2/95, ratified on 27. 5. 1995, Ur. l. RS, 10/1995; 41/2001 (III.14.) Governmental decree*) which is in concordance with the DRCP. On the basis of this agreement the permanent bilateral Slovenian – Hungarian water management commission was establish. Until now it held 15 meeting with notificated minutes.

Agreement provisions are related to:

- surface water and groundwater reserves,

- protection and defense against the harmful effects of water,
- the use and exploitation of water,
- protection against pollution and irrational use of water, examining the quality of waters at State borders,
- examination of the effects of interventions on the environment,
- research, design, implementation and exchange of information relating to previous points.

The thermal groundwater issues were opened in 2011 meeting. The permanent bilateral Slovenian – Hungarian water management commission is starting activities for transboundary management of thermal water body.

4. National legislation in Slovenia

4.1 Legislation framework

Laws are general legal acts that - in a state governed by the rule of law - regulate those rights and duties of legal entities which are not regulated by the Constitution. In terms of their form and content, laws are subordinate to the Constitution but superior to any other legal act in the country. Laws are adopted by the legislative body (parliament, assembly, congress; in Slovenia: the National Assembly) in the so-named legislative procedure. Executive acts include: decrees (adopted by the Government), rules (adopted by the Ministry), orders and instructions (adopted by local Communities or other bodies).

Geothermal energy in Slovenian legislation is regulated through laws Mining Act and Energy Act (under umbrella of Ministry of the economy / Directorate for Energy), Water Act and Environment Protection Act (under umbrella of Ministry of the Environment / Environment Directorate).

Working areas of the Energy Directorate (Ministry of the economy) are energy supply and EU affairs, energy planning and development, mineral resource management and coordination of administrative procedures, database management and economic analyses in the energy sector, restructuring of companies in the energy sector and harmonization of legislation and carrying out invitations to tender.

The Environment Directorate (Ministry of the Environment and Spatial Planning) deals with systemic legal issues concerning the environment, environmental policy, pollution prevention policy, biotechnology, nature protection, comprehensive environmental impact assessment and waters. It performs professional tasks in the field of systemic legal environmental issues, provides expert groundwork for the drawing-up of regulations in its area of work, develops systemic solutions and coordinates tasks falling within the competence of the Ministry.

Environmental Agency of Slovenia (ARSO) is permitting, monitoring and reporting institution as a body of Ministry of the Environment and Spatial Planning. It issues a variety of environmental permits (permits for large-scale polluters – i.e. IPPC permits, groundwater exploration permit, water permits, water consents) and provisions for water fees and taxes on water pollution, carbon dioxide emission and waste disposal. Agency keeps records of required monitoring and reports the status. Environmental Agency of Slovenia has local offices distributed on the main river basins: Upper Sava river, Middle Sava river, Lower Sava river, Soča river, Drava river, Mura river, Adriatic rivers and sea.

4.2 Mining and energy legislation

Mining Act: Geothermal energy resource is heat energy that is to be found in geological layers bellow surface and is renewed by the Earth heat flow.

Energy Act: Geothermal energy is heat energy that is exploited from the earth including aquifers.

Mining Act (Ur.l. RS, No. 61/2010)

Mining Act covers search, exploration and exploitation of mineral including earth heat resources. It is implementing the *Directive 94/22/ES* of the European Parliament and of the Council of 30 May 1994 on the conditions for granting and using authorizations for the prospection, exploration and production of hydrocarbons and *Directive 2009/31/EC* of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide.

Mining Act defines that mineral and earth heat resources are state property as natural resources. Search of mineral including earth heat resources is free. Mining right is granted for the exploration or exploitation of mineral resources for business purpose. Mining right for the exploration is a permit (issued as a written order to the legal or natural person) for the defined mineral primary material exploration on the defined area. Mining exploration is the activity for mineral resource exploration by excavation, shaft or borehole with no land use change. Mining right is not obvious exclusive for the defined Exploration area if the additional Mining exploration permit is granted for different mineral resource and if existing Mining right is not obstructed. Mining exploration permit is granted for no longer than 5 years and could be prolonged only for the period of the 'force majeure' duration. Earth heat resource exploitation is the abstraction of geothermal energy by horizontal or vertical heat exchangers (pumps) in the closed systems or by pumping groundwater as a thermal energy carrier and reinjecting it in the same aquifer (doublet), where pumping and reinjection well are at least 25 m distant. Mining right for the exploitation is issued as a concession to the legal or natural person for the defined mineral primary material exploitation on the defined area. Mining right is not required for the exploitation of earth heat. Mining exploration right could not be transferred, sold or rent to the other legal or natural person and also could not become bankruptcy estate. Mining right is granted by the Ministry of the economy.

Mineral resources management falls within the competence of the Republic (regulation, planning and control) and local Communities (defining areas designated to the mining according theirs spatial planning). State mining strategy is a basic document defining objectives, directives and conditions for reconciled exploration and exploitation of mineral resources including earth heat resources, the highest level of abstraction and conditions of reasonable exploitation. Document is adopted by the government. Energy mineral resources including earth heat are designated as strategic important resources for economic and social development of the Republic and the exploitation is of public interest on the whole territory of Slovenia.

Drilling the borehole deeper than 300 m is 'exacting basic mining operation'. The holder of Mining exploration permit has to announce the drilling or excavating operation to the Mining inspectorate at least 15 days in advance, as well as to all consents' institutions and also to

geological Survey of Slovenia. Ministry, competent for mining, issues the technical and protection measures regulation for mining operations, including for borehole drilling intended for mining exploration or exploitation. Borehole drilling outside of the mining area is under the jurisdiction of civil engineering inspectorate. The holder of Mining exploration permit has to enable Geological Survey of Slovenia to take samples from excavations, shafts or boreholes. Samples are allowed to be used only for State Geological Map updating.

Energy Act (Ur.l. RS, No. 79/1999)

Energy permit is issued by the Ministry of the economy.

Energy permit has to be obtained by the investor prior to the starting the physical planning procedure for the constructions, installations or networks:

- electricity production > 1 MW, linked to the public network,
- gas storage facilities,
- heat production > 1 MW for the district heating or further selling,
- direct distribution pipelines,
- cross-border transport pipeline,
- construction or economic whole areas with provided electricity consumption > 5 MW or > 5.000.000 m3 earth gas.

4.3 Environmental protection and water legislation with regard to geothermal energy

Water Act (ZV – 1) (Ur.l. RS, No. 67/2002)

This Act governs the management of marine, inland and ground waters, and the management of water and waterside land. Management of waters and of water and waterside land shall comprise the protection of waters, the regulation of waters and decision-making on the use of waters. This Act also governs public assets and public services in the area of waters, water facilities and installations, and other water-related issues.

The objective of the management of waters and water and waterside land is to achieve a good condition of waters and other water-related ecosystems, to ensure protection against the adverse effects of waters, to preserve and balance water quantities, and to promote the sustainable use of waters for various types of use, facilitating a variety of types of water use by taking into account the long-term protection of available water sources and their quality.

Considering the definition of thermal and thermo-mineral water used in the law it is obviously that it is not complete. Thermal water means ground water from a well, a spring or a

catchment area that complies with the prescribed criteria (criteria are not yet prepared in the subordinate regulation). Thermo-mineral water means thermal water that has the properties of mineral water.

Protected water area

Article 74

(1) In order to protect a water body used for obtaining or intended for supplying drinking water against pollution or other types of burden that could affect the health suitability or quantity of water, the government shall designate it as a protected water area.

(2) The government may, at the proposal of the holder of a water right to produce beverages, protect a ground water body used for obtaining mineral, thermal, thermo-mineral or other types of ground water for the production of beverages.

Designation of protected areas

Article 78

(1) Protected areas and bathing water areas must be designated.

(2) Protected water areas shall be designated by the provider of the compulsory local public service of supply of drinking water, with the exception of protected water areas for the use of mineral, thermal, thermo-mineral or other ground water for the production of beverages, in which case the holder of the water right shall have this obligation.

(3) The designation of bathing water areas shall be ensured by the local community.

(4) The minister shall prescribe the method of designating the areas referred to in the preceding paragraphs.

Compensation

Article 79

If the protected water area has been designated for the use of thermal, mineral, thermomineral or other ground water for the production of beverages, the entity obliged to pay compensation for damages or compensation in kind shall be the holder of the water right.

Research into ground waters

Article 115

(1) Legal or natural persons intending to research ground waters must fulfill the prescribed conditions and obtain a research permit prior to the implementation of work related to ground water research.

(2) The provisions of this Act referring to a water permit shall apply mutatis mutandis to the permit referred to in the preceding paragraph.

(3) The permit shall specify the conditions under which ground water research may be conducted.

(4) Water pumped by the persons referred to in the first paragraph of this article may only be used for research purposes.

(5) The persons referred to in the first paragraph of this article must submit all acquired data free of charge to the ministry within one month of completion of the ground water research.

(6) The government shall prescribe the conditions which the persons referred to in the first paragraph of this article must fulfill, and the types of data referred to in the preceding paragraph: *Rules on the content of application for acquiring water permit and on the content of application for acquiring groundwater research permit (Ur.l. RS, No. 79/2007)*

Water consent and water right

Water consents are granted for the 1) constructions of the state importance and 2) large-scale polluters – i.e. IPPC are issued by the Environmental Agency's central office (Department for water management in Ljubljana). Water consents for the other constructions are issued by local offices, depending on where the construction will take place.

Water right for own use (direct use) and for public water supply is granted by a water permit (issued directly by Environmental Agency's central office).

Water right for selling water (indirect use) and for thermal water use is granted by a concession (Decree adopted by the Government). Concession is required (according actual practice of Environmental Agency of Slovenia) for the use of water exceeding 20°C. For the lower temperature only water permit is required. Subordinate executive act is foreseen to regulate thermal water use.

Water permit

Article 125

A water permit must be obtained for the direct use of water for:

- the private supply of drinking water or the supply of drinking water provided as a commercial public service;
- technological purposes;
- the activity of bathing areas and natural health spas pursuant to healthcare regulations;
- the extraction of heat;
- the irrigation of agricultural land or other areas;
- the production of electricity in hydroelectric power plants directly connected to the public electricity network;
- propelling water mills, saws or similar installations;
- cultivation of water organisms for repopulation or private consumption;
- a port, if the investor is a person under public law;
- the provision of ski pistes with snow;
- the erection of a floating installation pursuant to regulations on maritime navigation and navigational safety on inland waters;
- other types of use that exceed general use pursuant to this Act for which a concession does need to be granted.

Concession

Article 136

(1) A concession must be obtained for the use of water for:

- the production of beverages;
- the needs of bathing areas and such like, if the use involves mineral, thermal or thermomineral water;
- the production of electricity in a hydroelectric power plant, if it is connected to the public electricity network;
- a port, if the investor is a person under public law;

- the removal of alluvium, except for the provision of public services pursuant to this Act;

- the cultivation of water organisms for the market.

(3) A concession may be acquired by a natural or legal person that fulfils the prescribed conditions.

(4) A concession shall be granted for a specified period of time not exceeding 50 years.

(5) A concession may be extended at the request of the holder if all conditions prescribed for its acquisition are fulfilled upon expiry.

(6) A concession shall be granted by the government on behalf of the grantor pursuant to the provisions of this Act.

Decree on groundwater status (Ur.l. RS, No. 25/2009) is implementing regulation of groundwater status assessment (chemical and quantitative) from Groundwater Directive and Water Framework Directive regarding:

- procedure for threshold values quantification for groundwater,
- parameters of chemical and quantitative status,
- quality standards for groundwater,
- conditions for good status of groundwater,
- criteria for significant unfavorable trend and trend reversal identification,
- criteria for definition of critical pressure point when measures have to be implemented,
- additional requirements for program of measures preparation.

Water Management Plan

River Basin Water Management Plan (RBMP) is under authority of Ministry for Environment and Spatial Planning. Ministry prepares RBMP for both rivers basin districts (Adriatic and Danube) (Ur.l. RS, No. 61/2011). The border area of thermal water resources between Hungary and Slovenia is a part of Danube river basin management plan in both states. In Slovenia the observed geothermal aquifer system contains several Groundwater Bodies: Dravska kotlina, Zahodne Slovenske gorice, Vzhodne Slovenske Gorice, Murska kotlina and Goričko.

Link:
http://www.mop.gov.si/si/delovna_podrocja/voda/nacrt_upravljanja_voda_za_vodni_obmocji_donave_in_jadranskega_morja_2009_2015/

Environment Protection Act (ZVO-1) (Ur.l. RS, No. 41/2004)

This Act regulates the protection of the environment against burdens, which is a basic condition for sustainable development, and within this framework lays down basic environmental protection principles, environmental protection measures, environmental monitoring and environmental information, economic and financial instruments for environmental protection, public services for environmental protection and other issues related thereto.

The purpose of environmental protection is to promote and direct such social development that ensures long-term conditions for human health, well-being and quality of life, and conservation of biological diversity.

Environmental protection objectives shall be in particular:

- to prevent and reduce environmental burdens,
- to conserve and improve the quality of the environment,
- to use natural resources sustainably,
- to reduce the use of energy and increase the use of renewable energy sources,
- to remedy the consequences of environmental burdens, to improve the disrupted natural equilibrium and recover its regeneration capacity,
- to increase material efficiency of production and consumption, and
- to abandon and substitute hazardous substances.

To achieve the objectives referred in the preceding paragraph the following shall be promoted:

- production and consumption patterns contributing to the reduction of environmental burdens,
- development and use of technologies preventing, eliminating or reducing environmental burdens, and
- pollution charges and the use of natural resources shall be paid.

The Environmental Protection Fund of the Republic of Slovenia is a public financial fund under the regulations on public funds that performs the duties concerning the promotion of development in the field of environmental protection by awarding credits, surety and other forms of financing, and promotion of development.

Fund's tasks in relation to the use of State budget resources

Article 144

(1) On behalf and for the account of the founder the Fund may perform tasks concerning the financing and co-financing from the State budget resources in accordance with the law.

(2) The tasks referred to in the preceding paragraph shall be in particular:

– to prepare and carry out public tenders for the allocation of State budget resources for:

- co-financing of investments in environmental protection infrastructure of national and local importance,
- co-financing with the purpose of promoting utilization of renewable energy resources, efficient energy use and co-generation of heat and electricity,
- financing of water related projects for which Fund's resources may be used, in accordance with the law,
- financing of national infrastructure in case of removal of consequences of natural disasters, in accordance with the law,
- financing of State obligations in relation to the action based on the principle of subsidiary;

– expert tasks to be performed in relation to the allocation of EU funds to be used for investments in environmental protection infrastructure and water management infrastructure of national and local importance, promotion of utilization of renewable energy resources, and cogeneration of heat and electricity, with the aim of:

- drafting of project programme,
- coordination, preparation, expert advice on and control of the drafting of investment and financial project documentation,
- cooperation with EU bodies in the procedure of approval of specific projects,
- expert advice on the drafting, review and approval of tender project documentation,
- management of tenders for the selection of project operator,
- monitoring of and reporting to the EU bodies on the suitability of appropriated use of resources of implemented projects,

– to monitor the suitability of appropriated use of resources referred to in the preceding points.

(3) The tasks referred to in the preceding paragraph shall be laid down in detail in the constituent instrument of the Fund.

Decree on the categories of activities for which an environmental impact assessment is mandatory (Ur.l. RS, No. 78/2006, 72/2007, 32/2009)

Article 4

Environmental impact assessment is mandatory for geothermal resources exploitation when water is discharged on surface if water temperature is at least 4 °C higher than average annual temperature of the site area or when water mineralization is 1.000 mg/l or more.

Decree on the emission of substances and heat in the discharge of wastewater into waters and public sewage system (Ur.l. RS, No. 47/2005)

http://www.uradni-list.si/1/objava.jsp?urlid=200547&stevilka=1902

Thermal wastewater belong in the category of industrial wastewater, for which this decree regulate threshold emission proportion of the emitted heat (article 8) and threshold values of parameters of industrial wastewater (article 9), which are with this decree classified as a hazardous substance (e.g. temperature as °C and concentration of e.g. B, Al, As, Cu, Ba, Zn, Cd, Co, Cr, Fe, Cl (free), TOC, AOX, Phenols as mg/l) as well as threshold values of annual quantity of hazardous substance in the wastewater (e.g. B, Al, As, Cu, Ba, Zn, Cd, Co, Cr, Fe, Cl (free), TOC, AOX, Phenols as g/year). Temperature of the wastewater should not exceed 30 °C, concentration of e.g. B shouldn't be higher than 1 mg/l and quantity of B in emitted wastewater should not exceeds 1000 g/year.

Decree furthermore define methodology for the estimation of excessive burden (article 14) and determined the content of an environmental permit for operation of a facility for industrial wastewater disposal into surface waters (article 15), the method of implementation of the first emission measurements (article 26) and defines the operational monitoring of wastewater (article 27).

4.4 Legal background on groundwater monitoring

The *Water Framework Directive 2000/60/EC* represents the basis for the groundwater monitoring in Slovenia.

The Government provides groundwater monitoring (state monitoring of groundwater status of groundwater bodies, based on the provisions of the *Water Framework Directive*) to determine the chemical and quantitative status of groundwaters (*Decree on groundwater status, Official Gazette of RS, no. 25/2009*). The groundwater monitoring, in accordance with the aforementioned Decree, is carried out by the Hydrology and State of Environment Office of the Slovenian Environmental Agency (ARSO).

Methods of implementation of the groundwater monitoring, the content of the program and the forms of reporting the results of groundwater monitoring are regulated under the provisions for groundwater monitoring (*Rules on groundwater monitoring, Official Gazette of*

RS, no. 31/2009). Monitoring is further divided into quality (control and operational) and quantitative monitoring.

In addition to the state monitoring of groundwater status (VTpoV), an operational monitoring is also mandatory and must be carried out by the holders of water rights in accordance with the *Water Act (ZV-1)*. The implementation of the operational monitoring is controlled by the Water Management Office (ARSO). In accordance with the special requirements of the Article 50 (ZV-1) the water rights are conditioned on certain obligations such as the holder of water rights is obliged to install measuring devices to determine the actual amount of abstracted water in such a way that the yield and the total amount of abstracted water can be checked any time. The holder of water rights must also provide the monitoring of groundwater levels. All measurements must be carried out at least once a week. The exact date and time must be recorded during each measurement. In the case of intermitted pumping regime the holder of water rights is obliged to measure the groundwater level before the next pumping cycle and during it. All acquired data must be presented on the annual chart and sent to the Ministry of the Environment and Spatial Planning, Slovenian Environmental Agency, until the end of January for the previous year. The annual chart must be sent in appropriate scale on A4 or A3 sheet and also in digital format Excel (*.xcl).

Reports of the operational monitoring are part of Water Cadastre set by the Article 155 of the *Water Act*:

(1) The Water Cadastre consists of the inventory of waters and the inventory of water facilities and equipment.

(2) The inventory includes data on surface and groundwaters, water and waterside land, river and marine national assets, protected areas in accordance with this Act and protected areas under other acts.

(3) The inventory of water facilities and equipment consists of water infrastructure data, aimed at implementing the water rights.

The requirements for the operational monitoring and the methods of implementation are not regulated by executive acts. The obligations and methods of implementation for the operational monitoring are defined in the water permit itself or attached as an annex to the concession contract.

5. National legislation in Hungary

5.1 Introduction

The regulation framework of geothermal energy utilization is rather complicated in Hungary; regulations are connected with mining, energetics, environmental protection and water management (Table 1). Despite the continuous efforts to legal harmonization, a number of contradictions exist among them which, together with the complicated licensing processes, make the job of users and potential investors difficult. The harmonization of the demands of these sectors, the clearing up of the roles of the different authorities would greatly help to enhance the utilization of geothermal energy in Hungary.

Numerous overall legal surveys, proposals have been prepared in the past few years by Hungarian professional organizations, workshops and the Hungarian Office for Mining and Geology, as well as surveys concentrating on certain regulation groups, to sift out legal discrepancies (Table 2). This study intends to give a general picture about the legal framework of the geothermal energy utilization in Hungary partly based on these previous overviews, but mostly on the basis of the itemized review of the relevant and current regulations concerning the 2011 first half-yearly state.

Table 1. National regulations related to geothermal energy

Regulations related to mining

Act XVI of 1991 on concession

Act XLVIII of 1993 on mining

Governmental Decree 203/1998 (XII.19.) on the execution of Act XLVIII of 1993 on mining

Governmental Decree 267/2006 (XII.20.) on the Hungarian Office for Mining and Geology

Governmental Decree 54/2008 (III.20) on the determination of the specific value of mineral resources and geothermal energy and the method of value calculation

Governmental Decree 103/2011 (VI.29.) on the complex vulnerability and impact assessment of the natural occurrences of mineral resources and geothermal energy

Regulations related to energetics

Act LXXXVIII of 2003 on energy tax

Act XVIII of 2005 on district heating

Governmental Decree 157/2005 (VIII.15.) on the execution of Act XVIII of 2005 on district heating

Act LXXXVI of 2007 on electric energy

Governmental Decree 273/2007 (X.19.) on the execution of certain regulations of Act LXXXVI of 2007 on electric energy

Governmental Decree 389/2007 (XII.23.) on the compulsory acceptance system and feed-in tariffs of electricity produced by energy gained from renewable energy resources and waste, as well as the co-generated electricity

GKM/Ministerial Decree 110/2007 (XII.23.) on the calculation method to determine the quantity of the useful heat and the co-generated electricity

Regulations related to environmental protection

Act LIII of 1995 on the general rules of environmental protection

Act XLIII of 2000 on waste management

Governmental Decree 219/2004 (VII.21.) on the protection of groundwaters

Governmental Decree 220/2004 (VII. 21.) on the protection of surface waters

Governmental Decree 221/2004 (VII.21.) on certain rules of river basin management

KvVM /Ministerial Decree 30/2004 (XII.30.) on certain rules of examination of groundwaters

KvVM /Ministerial Decree 33/2005 (XII.27.) on the administrative service fees of environment, nature protection and water authorities

Governmental Decree 314/2005 (XII.25.) on the licensing process of environmental impact assessment

Regulations related to water management

Act LVII of 1995 on water management

KHVM / Ministerial Decree 18/1996 (VI.13) on the contents of the application form and its annexes to be submitted for granting the water permits

Governmental Decree 72/1996 (V.22.) on the implementation of authority powers in water management

Governmental Decree 121/1996 (VII.24.) on the establishment and utilization of public baths

KHVM /Ministerial Decree 12/1997 (VIII.29.) on the degassing of the produced and supplied waters

Governmental Decree 123/1997 (VII.8.) on the protection of water resources, potential water resources and water establishments supplying drinking water

KHVM /Ministerial Decree 23/1998 (XI.6.) on the water management register of the water inspectorates

KHVM /Ministerial Decree 43/1999 (XII.26.) on the calculation of the water resource fee

EüM/ Ministerial Decree 74/1999 (XII.25.) on the natural medicinal factors

KvVM /Ministerial Decree 24/2007 ((VII.3.) on the Water Safety Regulations

KvVM /Ministerial Decree 101/2007 (XII.23.) on the professional requirements about the intervention into the groundwater reserves and water well drilling

KvVM /Ministerial Decree 30/2008 (XII.31.) on the technical regulations related to the activities and establishments serving the utilization, protection and mitigation of damages of waters

Governmental Decree 147/2010 (IV.29.) on the general regulations related to the activities and establishments serving the utilization, protection and mitigation of damages of waters

Special regulations related to heat pumps:

Governmental Decree 264/2004 (IX.23.) on the taking back of waste deriving from electric and electronic gadgets

KTM /Ministerial Decree 10/1995 (IX.28.) on the environmental protection product fee and the execution of Act LVI of 1995 on the environmental protection product fee of certain products

GKM /Ministerial Decree 96/2005 (XI.4.) on the regulations of certain building processes concerning special buildings falling within the competence of the mining inspectorates

TNM /Ministerial Decree 7/2006 (V.24.) on the determination of energetic features of buildings

Table 2. Some major reviews concerning Hungarian legislation related to geothermal energy

Hámor T. 2007: Legal barriers of geothermal energy use in Hungary, a country profile – Final report of the GeoThermal Regulation – Heat (GTRH) project. – manuscript

KHEM, 2008: National Action Plan for utilization of renewable energy in Hungary 2010 – 2020 – Manuscript (in Hungarian language)

Mádlné Szőnyi J., Rybach L., Lenkey L., Hámor T., Zsemle F. 2008: Overview of national and international utilization of geothermal energy and its future possibilities in Hungary: Recommendations for the government – Manuscript (in Hungarian language)

Rezessy G., Szanyi J., Hámor T. 2005: Preparation for national geothermal resource assessment l – MGSZ, Manuscript (in Hungarian language)

Besides the legal regulation a number of economic processes (method of price formation, tax system, lack of investment support — favorable loans and risk guarantee/insurance —, 'non-competitiveness' against gas prices, lack of harmonization with the carbon-dioxide quote system, etc.) hinders the spread of the renewables, including geothermal energy. An incentive scheme should be worked out on the basis of economic analyses to encourage geothermal utilization methods and technologies that show the best cost/social benefit ratio. It would be necessary to work out a more favorable, realistic price formation which considers also the external costs (compensation for environmental damages and their prevention) of energy production. The discussion of all these economic questions, however, is not part of this study.

5.2 General overview of the legislation framework

In Hungary the basic legislative, judicial and executive constitutional powers are distributed among different state bodies. The democratically elected National Assembly (The Parliament) is the highest legislative and political body that makes acts. The Constitution stands on top of the legislation hierarchy, the form of which is an act. The Civil Code is also above other acts in the hierarchy.

The Government and its members, the ministers present an overlap between the legislative and executive power, because they are authorized to issue Governmental Decrees and Ministerial Decrees, which are in accordance with acts. The local governments have the right to issue local governmental decrees, the territorial scope of which is limited to the administrative land of the settlement, that represent the lowermost level of legislation. All other quasi-legal forms, such as orders, guidelines of governmental agencies, and technical standards of national and international organizations have no binding force but have an important role in practice.

According to Article 57 of the Constitution, every citizen has the right to turn to the court for a jurisdiction concerning his/her rights, or obligations. The juridical system in Hungary has three levels. Local municipal, district and thematic (e.g. labor affairs) courts constitute the first level. The nineteen county courts and the Budapest Municipal Court form the second level. The Supreme Court is on top of the juridical system, its resolutions are obligatory for all juries. The Constitutional Court is not part of the juridical system in a strict sense, but it has a special role and power in the legislation, and indirectly in the public administration as well.

The public administration legal procedure (licensing processes) is defined by the *Act CXL of 2004 on the general rules of state administration*. In addition to defining the administration processes and the competence of different authorities, this act recognizes the importance of professional task-oriented authorities, ensuring their participation and option of appeal in the licensing process. The co-authority system means, that in a thematic licensing process (e.g. environmental license) the final resolution is issued by the main professional authority (e.g. local environmental inspectorate), which collects and incorporates the conditions and prescriptions of other interested authorities (e.g. water authorities, local municipality, etc.).

5.3 Mining legislation

Due to strategic reasons, mineral resource management has not been put into the community law yet; decision-making has remained in the own sovereign competence of the member states. Nevertheless, this tendency seems to change slowly. The *Mining Act XLVIII of 1993* came into force on 14th June, 1993. It was amended several times; its latest amendment came into force on June 25, 2011. *Government Decree 203/1998 (XII.19)* is responsible for the enforcement of the Mining Act.

Among others, the scope of the Mining Act (1§) is to control the mining of raw materials, the research, exploitation and utilization of geothermal energy (in case if it is not connected with the abstraction of thermal groundwater), and all the activities in relation to the aforementioned topics. Survey and exploitation of thermal groundwaters yielding geothermal energy is not under the force of the Mining Act, but it is regulated by the environmental and water management legislation.

The amendment of the Mining Act at the beginning of 2010 (after a long-time debate) attempted the partial relief of the former incompatibility between the water management and the mining legislation, according to which — considering geothermal energy — the territory of the entire country is considered as a closed area below a depth of 2500 m from the surface (49§). Thus, its exploration can take place in a concessional system (see below). This means that the license of the prospection, exploitation and utilization of geothermal energy in this depth interval is issued by the mining inspectorate, in case it is not connection with water abstraction. (According to the *Government Decree 267/2006* it is the duty of the Hungarian Office for Mining and Geology to be within the competence of a mining inspectorate and operate according to the rules fixed in the Mining Act 44 §).

The area above a depth of -2500 m from the surface is considered as an open area; where concession is unnecessary, therefore the planning, establishment and operation of geothermal energy utilization combined with thermal groundwater abstraction is licensed by environmental and water management inspectorates. However, according to 22/B § of the Mining Act, the license for the utilization of thermal groundwater in an open area shall be considered as a license for prospection, exploitation and utilization of geothermal energy, simultaneously, i.e. the mining inspectorate participates as a co-authority in the licensing procedure.

According to 3§ of the Mining Act, mineral resources and geothermal energy are, at their natural place of occurrence, in state property. As (minerals and) geothermal energy are exploited for energetic use, they are transferred into the property of the mining entrepreneurs, who pays royalty (20§). The State delegates licensing to mining inspectorates (at first level) or to the responsible Minister (in case of concession contract).

The Mining Act acknowledges three types of exploration and mining activity. The first type is a preliminary surface survey (4§) which does not require a permit. In order to carry out this activity the company needs to have an agreement with the caretaker/user of the land and report the commencement of prospection to the mining authorities 30 days in advance. The report has to contain the exploration plan (text and map showing locations). This type of survey does not pose any exclusive rights for the operator concerning mineral exploitation. Geoscientific data gained during the preliminary survey has to be sent to the Hungarian Office for Mining and Geology.

Mining activities performed on the basis of authority permission are defined by articles 5–7 of the Mining Act. In open areas the mining inspectorate grants exploration licenses. This license gives an exclusive right to the entrepreneur to explore for the given mineral on the defined area and to initiate the establishment of a mining plot within a certain timeframe. According to article 5 of the Mining Act the mining inspectorate shall license the exploitation and utilization of geothermal energy including the construction and putting to use of the underground and surface facilities required for this purpose unless the activity does not require a water license (i.e. does not abstract thermal groundwater). Water license is required for the utilization of geothermal energy, combined with the abstraction of thermal groundwater, even if it is below -2500 m. After the Mining Act's amendment (February 2010) geothermal energy users already possessing water licenses (for construction, or operation) may continue their activities for a determined period under conditions established in their permits. However, ongoing licensing processes (being under judgment) for prospection, exploitation and utilization of geothermal energy should be abolished, if they are carried out in territories declared to be closed areas (>2500 m) after the Act's entry into force (see below).

The third type of exploration/exploitation is based on concession, which general rules are described in the *Act XVI of 1991 on Concession*, specific regulations related to mineral resources and geothermal energy in the Mining Act Sections in articles 8−19. Closed areas − below a depth of 2500 m from the surface − can be assigned for exploration, exploitation and utilization by the Minister for domestic or foreign, legal or natural persons, and their companies without legal entities after concluding a concession contract (8§). Contents and the evaluation of the open tender are regulated by articles 10–11.

According to Mining Act article 9 − and taking into consideration regulations set in the *Governmental Decree 103/2011 (VI.29.) on the complex vulnerability and impact assessment of the natural occurrences of mineral resources and geothermal energy* − the Minister shall take into account the closed areas to be designated for concession, in which the mining of the given raw material, or the exploitation of the geothermal energy seems to be favorable.

According to the *Governmental Decree 103/2011 (VI.29.)* the aim of the complex vulnerability and impact assessment is to determine those areas, where mining activity cannot be performed due to environmental- and nature protection, water management and protection of water resources, protection of cultural heritage, - agriculture, public health, national defense, land-use, transportation issues, as well as mineral resource management. Furthermore the aim of the study is to set up the rules of the mining activity to be performed in the frame of the concessional contract.

According to article 2, the investigation and the study is done by the Hungarian Office for Mining and Geology (MBFH) together with the Eötvös Loránd Geophysical Institute, the Geological Institute of Hungary and the Water and Environment Protection Directorate, also involving public authorities listed in Appendix 1. Study is performed for those closed areas, where mining of a certain raw material, or exploitation of geothermal energy can be potentially favorable taking into account available geological data as well as initiatives from entrepreneurs. The detailed content of the study is listed in Appendix 2 of the decree. It includes the geographical location of the area, description of land-use, geological, hydrogeological, tectonic characterization and status of previous exploration, protected areas related to the water management plans, status of the surface- and subsurface (ground)water bodies, their monitoring, rate of subsurface groundwater abstraction, other valid licenses for exploration and exploitation. The study also summarizes data related to the geological

environment of geothermal energy, expected amount to be exploited, foreseen exploration and exploitation methods, introduction of the energy concept, duration of activity and forecast of environmental impacts with a special regard to surface and subsurface (ground)water bodies, drinking water resources, areas of natural protection (Natura 2000), and possible transboundary effects.

According to article 4, MBFH sends out the study to the public authorities listed in Appendix 1 for comments and supplement with further specific data. These authorities determine those areas where mining activity cannot be performed, or only with certain restrictions. According to articles 5-6, MBFH collects and incorporates all these additional information and puts together the report, which is checked by the contributing authorities whether their comments were properly incorporated. After a public consultancy MBFH finalizes the report

According to article 10 of the Mining Act, the Minister calls a public tender for concession, in which – in addition to the general contents set up in the *Act XVI of 1991 on Concession* – the location of the concessional area with the indication of other already existing bids owned by a third party, activities to be performed in the frame of the concession, a work programme and the regulations set up in the complex vulnerability and impact assessment, as well as securities serving its performance are determined. The call also has to inform about the tendering conditions, payment duties, regulations about remediation and guidelines of evaluation. The public call has to be published in the official journal of the European Union.

According to article 12 of the Mining Act, the Minister shall conclude a concessional contract with the winner of the public competition, in which the duration of the concession, the work programme and the securities serving its performance are determined. The holder of the concession should establish a concessional enterprise for carrying out the mining activity within 90 days of the signature of the contract (13§).

The contract may be concluded for a period of not more than 35 years, which may be extended on one more occasion, by not more than half of the term of the concession contract. According to article 14 of the Mining Act, the planned period of prospection for geothermal energy cannot be longer than 4 years within the period of the concession. This may be extended on not more than two occasions, by half of the original period of prospection per occasion. Within the period of 1 year of the completion of the prospection, the mining entrepreneur may initiate the designation of a geothermal protection zone (’equivalent’ of the mining plot). In case the concessional activity is due to an environmental impact assessment (see *Governmental Decree 314/2005 (XII.25.)*), than the period of this procedure does not fall within the 1 year.

Concession license (22§) gives an exclusive right to the entrepreneur to submit a technical operation plan, and —in case of its approval — the commencement of geological exploration (instrumental measurements, analyses, drillings), and the initiation for the designation of the geothermal protection zone based on the accepted closing report of prospection. The special rules of exploration, exploitation and utilization of geothermal energy are summarized by Mining Act Section 22/B. According to this, in closed areas (> -2500 m) geothermal energy can be exploited solely from the geothermal protection zone, which is designated by the mining inspectorate. According to article 15 of the Mining Act utilization for energetic purposes should be commenced within 3 years after the designation of the geothermal protection zone, otherwise refund must be paid, in default whereof the concession shall be discontinued. It should be noted here, that the mining legislation still lacks the regulation of the geothermal protection zone.

According to article 20 of the Mining Act the rate of the mining royalty shall be 2 per cent of the value of the exploited geothermal energy. No mining royalty needs to be paid for geothermal energy exploited from an energy carrier of a temperature not higher than 30 °C or for the quantity of geothermal energy which utilization rate exceeds 50% (such supporting efficient utilization).

According to article 4 of the *Government Decree 203/1998. (XII.19.) on the execution of the Mining Act* royalty shall be defined in a self-assessment and shall be paid to the account of the central budget separated for this purpose. Section 34 defines the utilized quantity of geothermal energy as the part utilized for the purposes of energy generation of the quantity exploited from the energy carrier with a temperature exceeding 30 °C. In this respect the person using geothermal energy for medical, balneological, or water supply purposes on the basis of a water license, shall not qualify as a mining entrepreneur, even if the exploited thermal water is used also for the purposes of a secondary energetic utilization.

Governmental Decree 54/2008 (III.20.) determines the specific value of geothermal energy and its calculation methodology. According to article 3, the value derived from the geothermal energy − exploited for the purposes of the generation of energy − can be determined as the multiplication of the amount of the exploited energy (E) (from a carrier of a temperature at least 30°C) and the specific value.

According to the Annex 1/b of the Governmental Decree, the specific value − in case of its direct exploitation together with the geothermal carrier (‘thermal groundwater’) is 1650 Ft/GJ, whereas in case of the heat transfer material being recirculated in the Earth’s crust, the specific value is 325 Ft/GJ. The amount of geothermal energy exploited for the purposes of the generation of energy must be measured by the entrepreneur: temperature and amount at the well-heads and the temperature of the energy carrier (‘thermal water’) at the heat exchanger outflow point. Based on this the exploitation of geothermal energy coupled with water extraction:

E = V • (Twh-The) / 2 • 0,004186, where

E = the amount of exploited energy in GJ

V = volume of exploited water (m3)

Twh = temperature at wellhead (°C)

The = temperature at heat exchanger outflow (°C)

Mining royalty in thousand Forints: E • 1650 / 1000

In case of the exploitation of the geothermal energy via the circulation of secondary heat-exchanger fluids:

E = V • (Twh-The)/2 • Tf, where

E = the amount of exploited energy in GJ

V = volume of exploited energy carrier at the well-head (m3)

Twh = temperature at wellhead (°C)

The = temperature at heat exchanger outflow (°C)

Tf = specific heat of the circulated fluid GJ/m3 • °C

Mining royalty in thousand Forints: E • 325 / 1000

According to article 25 of the Mining Act on geological data supply and handling of the data, the mining entrepreneur has to send annually the geological data obtained in the course of the mining activity to the organization responsible for geological tasks. The *Governmental Decree 267/2006 (XII.20.) on the Hungarian Office for Mining and Geology* nominates this organization as responsible for performing state geological tasks, including handling the National Archive of Geological, Geophysical and Mining Data. Initial data concerning the geological conditions of geothermal energy should be sent in a closing report of exploration, whereas a report on the calculation of exploited and utilized quantities should be sent to the Hungarian Office for Mining and Geology annually.

Concerning the publicity of data, information for the site of prospection, the amount and of the annual production and the holder of the exploration right are public. Data concerning technologies, exploration and exploitation methods, logistics, know-how supplied in the closing report and resource assessment are confidential during the period of the license and until the approval of the plan of closure of the mine, or in the absence of the designation of a geothermal protection zone − for 1 year after the acceptance of the closing report of prospection.

Mining activity can be only carried out on the basis of an approved technological-operation plan (Mining Act 27§), which should be prepared by taking the following aspects into consideration: the rules related to technical safety, health protection and fire-protection, the requirements of mineral resource management, water management as well as environmental protection, nature conservation and landscape protection. The content of the technological-operation plan is regulated by article 13 of the *Government Decree 203/1998. (XII.19.) on the execution of the Mining Act*, and it is approved by the mining inspectorate.

According to *Governmental Decree 203/1998 (XII. 19)* − among others − the followings belong directly to the competence of Hungarian Office for Mining and Geology on first level (3§): the register of royalties, the control of royalty income, preparation of decisions of the minister in connection with mineral resource management and with concession contracts, the operation of the Hungarian State Geological, Geophysical and Mining Archive, the State Mineral Resource Register, and the Geological and Mining Informational System, as well as the register of the national mineral and geothermal resources.

According to article 22/B of the Mining Act, licensing of exploitation and utilization of geothermal energy on open areas without water license (i.e. ground-source heat-pumps) fall in the competence of the mining inspectorates, based on the *GKM /Ministerial Decree 96/2005 (XI.4.) on the regulations of certain building* processes concerning special buildings. Exploitation and utilization of geothermal energy from the Earth's crust above a depth of 20 m from the natural surface requires no licenses, however this does not free the entrepreneur from obtaining other necessary permits.

5.4 Energetic legislation

The domestic regulation of energetics, especially its electric energy part renewed completely according to the common market liberalization obligations in 2007. The major aims of *Act LXXXVI of 2007 on electric energy* (1§) are to promote the competitiveness of the economy through the development of an effectively operating electric energy market, the enforcement of the principles of energy efficiency, energy economy and security supply in line with the principles of sustainable development. In addition, it also aims to assist/help the production of electricity produced by energy gained from renewable energy sources and waste, as well as the co-produced electricity. The provisions of law on electricity co-generated with thermal energy have to be applied in accordance with the regulations of *Act XVIII of 2005 for district heating* (2§).

Articles 9–13 discuss separately how to promote the production of electricity produced by energy gained from renewable energy sources and waste, as well as the co-generated electricity for the sake of protection of the environment and nature, as well as saving the usage of primary energy sources. For this purpose it creates a differentiated, compulsory acceptance system considering the energy sources, the production processes, the nominal efficiency of the power plant, the efficiency of energy transformation and the time of establishment of the power plant. The main considerations are as follows:

- the necessary long-term security and consistency in accord with energy policy principles has to be guaranteed
- while maintaining competition among generators, the competitive disadvantage in the course of the sale of the generated electricity has to be alleviated
- the acceptance price, quantity and duration of the electric energy has to be established in view of the average time of return of the production process, the effectiveness of the use of the energy source in line with the natural conditions of Hungary, the carrying capacity of the users and the development in the effectiveness of the technologies, as well as the effect of the technology on the operation of the electricity system
- the compulsory acceptance of co-generated electricity has to aim at helping the co-generated energy production based on the useful heat demand, has to be founded on savings in the use of primary energy sources, and it must not hinder the controllability of the electricity network.

Neither the co-generated electricity production beyond the useful heat demand, nor heat production from renewable energy sources can be facilitated through the compulsory acceptance network considering these viewpoints.

The producer is obliged to make a balance circle contract according to the commercial code of the acceptance system operator. The compulsory acceptance can happen on market price (11§), or on an acceptance price established in a regulation [*Governmental Decree 389/2007 (XII.23.)*]. Based on the demand of the producer, the Hungarian Energy Office verifies the quantity of electricity and useful heat produced by energy gained from renewable energy sources or waste, as well as the primary energy source used for the production of co-generated energy (12§).

In accordance with *Act LXXXVIII of 2003 on energy taxes* no energy tax has to be paid on self-used electricity generated from renewable energy sources (3 §).

Governmental Decree 389/2007 (XII.23.) on the compulsory acceptance system and feed-in tariffs of electricity produced by energy gained from renewable energy resources and waste, as well as the co-generated electricity is especially important considering geothermal energy utilization. The decree discusses in details the general rules of feed-in obligations of electricity produced by energy gained from renewable energy sources and waste (3§), the cases of acceptance (4§), the administrative licensing procedures (6§) and the rules how to practice it (7§), the certificate of origin (8§) and the steps of control (9§). Annex 1 of the decree contains the compulsory acceptance base prices of the electricity produced from renewable energy sources in a geothermal power plants yielding less than 20 MW.

	Ft/kWh
peak period	29.56
normal period	26.46
low peak period	10.80

GKM/Ministerial Decree 110/2007 (XII.23.) disposes on the calculation method to determine the quantity of the useful heat and the co-generated electricity.

The scope of *Act XVIII of 2005 on district heating* covers all legal relationships that affect the production, supply and utilization of district heating. The provisions of the law concerning the exploitation and establishment of geothermal energy for district heat purposes have to be applied in accordance with *Act XLVIII of 1993 on mining*, as well as the regulations of *Act LVII of 1995 on water management*. The rules how to establish the highest administrative price of district heating are contained in *Act LXXXVII of 1990 on the establishment of prices* (57§). The environmental and financial benefits of energy produced and co-generated from renewable energy sources have to be taken into account in the course of the establishment of prices.

According to article 1 of *Governmental Decree 157/2005 (VIII.15.) on the execution of the act on district heating*, the utilization possibilities of renewable energy sources, their technical and economic conditions have to be surveyed by the license applicant in the course of the establishment, reconstruction, enlargement of the district heat production facilities. The result of the survey aiming at the utilization of renewable energy carriers has to be attached to the application in all cases. The establishment and the operation license for district heat production has to be issued by the licensing authorities for the utilization of renewable energy carriers if the economic conditions are similar or better, than other options.

5.5 Environmental legislation

The *Act LIII of 1995 on the general rules of environmental protection* is to set up rules related to the protection and maintenance of natural resources, their sustainable utilization and management. According to article 2, the scope of the act covers the inanimate components of the environment (including earth and water), their natural and man-made environment, the activities that utilize, load, pose hazard or pollute the environment.

Protection of earth is regulated in articles 14-17. According to article 14, the protection of earth encompasses the surface and subsurface, the soil, rocks and minerals as well as their processes. According to article 15 only those processes can operate on the surface or in the subsurface, and only those materials can be disposed, which do not effect or pollute them.

Basic principles regarding the protection of waters are given in articles 18-21. According to article 18, the protection of water encompasses the protection of surface and groundwaters, their reserves, quality (including temperature conditions) and quantity. The load and utilization of the environment has to be planned and carried out in a way that the environmental targets regarding the status of the waters should be achieved, i.e. the status of the surface and groundwaters should not deteriorate. The actions to achieve the good status have to be determined in the river basin management plans, which details are regulated in the *Governmental Decree 221/2004 (VII.21.)* (see there).

According to article 19, during the utilization of the environment, it has to be ensured that groundwater dependant terrestrial ecosystems should be sustained, and the quality and quantity of waters ensuring their utilization should not deteriorate.

According to article 20, the water reserves supplying mineral water and medicinal purposes has to be protected in line with the Governmental Decree 123/1997 (VII.18.) on the protection of water resources.

According to article 21 the utilization of water, their load, the input of used and wastewaters into water bodies − after a necessary treatment − can happen only in a way that does not threat the natural processes and the quality and quantity renewal of the water reserves. This is especially relevant regarding the re-injection of thermal groundwaters, which is regulated among others in Governmental Decrees 147/2010 (IV.29.) and 219/2004 (VII.21.) (see there).

According to article 68, those activities which are supposed to have a significant load on the environment, have to be preceded by the performance of an environmental impact assessment, which details are given in the Governmental Decree 314/2005 (XII.25.) (see there).

The aim of the *Governmental Decree 219/2004 (VII.21.) on the protection of groundwaters* is to regulate tasks, rights and obligations associated with ensuring and maintaining the good status of groundwater, progressive reduction and prevention of their pollution, a sustainable water use based on the long-term protection of available groundwater resources and the remediation of the geological medium.

According to article 4, as a fundamental principle, the status of groundwater bodies should meet the objectives of good quality and quantity status by the deadline referred to in the Act on the general rules of environmental protection (December 22, 2015). To meet these objectives it has to be ensured that no deterioration of status of surface and groundwaters takes place, all significant man-related adverse trends in groundwater status reverse, the status

of poor water bodies and those at risk progressively improve, and on the areas where the geological medium or the groundwater is damaged should be registered and controlled and their status should improve by remediation. The status of groundwater is determined by the poorer out of the qualitative and quantitative status.

The outline of water bodies and the details of characterization of their status is regulated in the *KvVM / Ministerial Decree 30/2004 (XII.30.) on certain rules of examination of groundwaters* (see there).

A groundwater body is in good quantitative status if the long-term (min. 6 years) annual abstraction rate does not exceed the available groundwater resource determined in the *Governmental Decree 221/2004 (VII.21.)*, abstraction does not cause a permanent decrease in groundwater level or hydraulic head, ecological or chemical status of associated surface waters are not threatened by any deterioration in the coupled groundwaters which could hold back the achievement of their environmental objectives. Furthermore criteria are that no alterations in the subsurface flow directions take place which could cause significant changes in the chemical or physical status of the groundwater body and no terrestrial ecosystems depending on groundwaters are damaged.

A groundwater body is in good chemical status if its monitoring proves no contamination, measured values do not exceed the thresholds, do not hinder to achieve the environmental objectives of associated surface waters as a consequence of poor water quality, and no terrestrial ecosystems depending on groundwaters are damaged.

A groundwater body is in good qualitative status if it has good chemical status and its temperature does not decrease to such extent which may cause changes in its chemical or qualitative status, or flow paths and does not disturb utilization.

According to article 4/B, during river basin management those areas have to be outlined in groundwater bodies at risk − in accordance with the regulations of the *KvVM /Ministerial Decree 30/2004 (XII.30.)* − where there is a permanent decrease in groundwater level, or hydraulic head, or there is a constant increase of contamination.

According to article 5, the outline of groundwater bodies is based on the boundaries of the aquifers, water temperature, subsurface water divides, hydrodynamic and quality status of groundwaters. Details are given in the Governmental Decree 221/2004 (VII.21.) on certain rules of river basin management. Groundwater bodies have to be monitored according to the provisions of the *KvVM/Ministerial Decree 30/2004 (XII.30.) on certain rules of examination of groundwaters* and to regulations related to the river basin management. Based on the results, the status of the groundwater body has to be evaluated regularly, but at least in each 6 years related to river basin management plans.

According to article 6, the survey of the status of water bodies, their monitoring and if necessary actions are the task of the environmental- and nature protection and water management inspectorates.

According to article 7, groundwaters have to be classified according to their status and level of protection, considering their recharge, transmissivity of the aquifer and the protected areas. Guidelines of classifications are listed in Appendix 2. According to this, the hydrogeological protection zones of the water abstractions for mineral and medicinal waters are considered as outstandingly vulnerable areas to be protected.

According to article 9, in order to achieve the good quality status, water abstraction cannot exceed the abstraction limit value (Mi) and cannot cause the physical or chemical deterioration of the groundwater body. According to the *Governmental Decree 221/2004 (VII.21.) on certain rules of river basin management*, the abstraction limit value (Mi) should be determined for the different parts of the groundwater body ensuring that abstractions do not endanger to achieve the environmental objectives, do not cause permanent drop in the groundwater table / hydraulic head and do not result the mixture of other surface or subsurface waters causing unfavorable changes in quality. Articles 4−5 list those activities, which cannot be carried out (or only with restrictions) on the areas being vulnerable regarding groundwaters.

Permission for water abstraction is regulated in article 12. According to this a water license for abstraction can be issued only in those cases, when exploitation − taking into account all existing water abstractions in the given region − does not threaten the achievement of environmental targets and the performance of those measures determined in the *Governmental Decree 221/2004 (VII.21.) on certain rules of river basin management*.

Quality protection of groundwaters is regulated by article 10. The main aspects are to prevent re-injection of contaminating materials into groundwaters and to limit those activities which would cause the deterioration of the good chemical status of the water body, or would permanently increase the concentration of contaminating materials.

Disposal of waste materials into groundwaters is regulated in article 13. According to its provisions, abstracted groundwater can be re-injected to the same aquifer ensuring that the re-injected water does not contain any materials different from the originally abstracted water (e.g. in geothermal utilization a closed-loop technology), and thus does not cause the deterioration of water quality.

The environmental register of groundwaters and geological medium (FAVI) is regulated under articles 34-35.

Governmental Decree 220/2004 (VII. 21.) on the protection of surface waters is relevant when discussing of releasing used thermal water (without re-injection) into surface waters, which may contaminate them, as thermal waters may contain natural components (e.g. remnants of hydrocarbons, some metal compounds) listed as ‘hazardous materials’ for surface waters in the Appendix 1. The degree gives detailed provisions about releasing sewage waters, their cleaning, emission limit values, etc.

KvVM /Ministerial Decree 30/2004 (XII.30.) on certain rules of examination of groundwaters applies to the rights and obligations established for the designation of groundwater bodies, characterization and assessment of their status, their monitoring, , the review of the aforementioned tasks, as well as the collection, processing and reporting of data necessary for the execution of these tasks.

Rules of designation of groundwater bodies are discussed in articles 2-3. Article 2 determines the rules of spatial delineation (identification, GIS database presentation). In case of transboundary aquifers, designation should be harmonized with the relevant country, involving the Geological Institute of Hungary. According to article 3, water bodies should be designated on the type and occurrence of the aquifer, such as karstic formations, non-karstic and porous formations of basin areas, and formations of non-karstic mountainous areas. Based on the outflow temperature, the 2 main categories are cold waters with a temperature below

30 °C, and thermal groundwaters with temperature exceeding 30 °C. Groundwater bodies should be delineated considering the subsurface catchment areas, flow patterns, geological build-up of the aquifer, natural hydrogeochemical conditions and vulnerability. During the designation it has to be considered that all aquifers of sufficient porosity and permeability to allow abstraction of more than 100 m3/day should be assigned to a groundwater body.

Characterization of groundwater bodies are discussed under articles 4-7. According to article 4, ware bodies should be characterized with a special regard to registered protected areas, water bodies at risk, and those parts of transboundary aquifers which may be affected by transboundary impacts, as well as those parts of a groundwater body, which supply surface water bodies or terrestrial ecosystems.

According to article 5, the first country report (assessment) has to be done for all water bodies based on the available geological, hydrogeological, land-use, monitoring, etc. data and water bodies at risk have to be identified. The assessment consists of a 1:500 000 scale digital map series (database) and related texts, which represent the natural geological conditions (geological and hydrogeological properties of the aquifers and aquicludes, flow paths), the natural quantity conditions of the water body (recharge and discharge areas, spatial and temporal changes in hydraulic heads), the natural quality conditions of the water body (chemical composition, temperature), surface water bodies and terrestrial ecosystems that are depending on the quality and chemical status of groundwater bodies, and activities influencing the quality and quantity status of groundwater bodies (water abstractions, contaminations, etc.). Appendix 1 provides a list about data and information that has to be collected continuously for further characterization, such as location of water abstractions, utilization aspects, chemistry and temperature of exploited groundwater, depression areas related to water abstraction, quality and quantity of re-injected waters, potential contaminations on the recharge areas.

According to article 9, the status of groundwater bodies has to be evaluated and assessed according to Appendix 2. During the quality status assessment the relationship of the Contents of the application form and its annexes to be submitted for granting the water permits − determined in the *Governmental Decree 221/2004 (VII.21.) on certain rules of river basin management* − and real load (amount of exploited water) has to be investigated by the followings tests: water budget test (ratio of recharge and abstraction), surface water test (effects on related surface water body), ecosystem test (effects on related terrestrial ecosystems), flow pattern test (admixture of saline, or other chemical types of waters).

During quality status assessment the following tests have to be performed: general water quality test (to determine spatial distribution of contamination), surface water test (contamination effects on related surface water body), ecosystem test (contamination effects on related terrestrial ecosystems), drinking water test (contamination effects on drinking water reserves), temperature test.

For the chemical status assessment the background concentration of natural components has to be determined.

According to article 11, all groundwater body assessment data have to be stored and represented in a GIS system in 1:500.000 scale. The report on the actual status (with justification) has to be presented in the river basin management plans.

According to article 12 changes in the quality and quantity status of the groundwaters have to be monitored, which consists of the quantitative monitoring.

The regional monitoring system comprises the qualitative monitoring (observation of water levels and hydraulic heads and springs), quality and quantity monitoring of surface water bodies related to groundwater bodies, regular observations related to water quality, special regional monitoring, groundwater monitoring system operated by the Geological Institute of Hungary, the Soil Information and Monitoring System, quality and quantity monitoring operated by the local governments, as well as especial surveys of expeditions, scientific research.

The environmental monitoring comprises of observation systems related to waterworks, waste disposals, monitoring related to the protection of drinking-, mineral and medicinal water resources, remediation monitoring systems in contaminated sites.

According to article 14, these systems have to be developed in an adequate way to provide monitoring sites for the water body monitoring system, which has to be defined in the river basin management plans. The water body monitoring consists of a quantitative and a qualitative monitoring. The quality monitoring provides information about long-term changes in groundwater level and hydraulic heads, as well as changes in the spring discharges. The quality monitoring gives an overview about the quality status of groundwaters and their effects on drinking water reserves and terrestrial ecosystems. In the case of transboundary aquifers, the density of the monitoring points and the frequency of observation have to be determined in a way that they are appropriate for the inventory and control of the impacts of abstractions in the neighboring countries, as well as for the determination of cross-border groundwater flow paths and discharges.

According to article 16, the characterization and status assessment of groundwater bodies, based on the results of the above mentioned monitoring systems have to be carried out in the frame of the river basin management plans. Data necessary are maintained and stored by the environmental and nature protection and water management inspectorates.

The aim of the *Governmental Decree 221/2004 (VII.21.) on certain rules of river basin management* is to integrate all actions that are necessary to achieve targets of good status of waters determined in the *Water Framework Directive*, to determine the content of the river basin management plans.

According to article 3, the river basin management plans contain all those activities, which may have a potential effect on the quality and quantity, as well as ecological status of waters, their analyses, actions to be done to achieve the good status together with their monitoring program. The river basin management plans for the 42 local catchment areas, for the 4 regional catchments (Danube, Tisza, Dráva and Balaton) are compiled based on a uniform methodology by the environmental and water management directorates, while the national plan encompassing the territory of the entire country by the Water and Environmental Protection Directorate (VKKI).

The river basin management plans contain − among others − the protection zones (in line with the Governmental Decree 123/1997 (VII.8.)), registers, economic analyses related to water use, different threshold values determined according to the Governmental Decree 219/2004 (VII.21.) on the protection of groundwaters, identification and actions to reverse permanently deteriorating tendencies, chemical assessment of groundwaters.

According to article 4, in the case of transboundary aquifers, river basin management plans have to be prepared in co-operation with the neighboring countries.

Article 12 summarizes the content of the river basin management plans, such as the geographical location of the groundwater bodies, their characterization, especially their loads and water abstractions (diffuse and point-source contaminations, water abstraction and re-injection), identify those groundwater bodies which supply surface waters or terrestrial ecosystems. After the first assessment, further evaluations have to be prepared for the water bodies at risk and for the transboundary aquifers to define measures in order to achieve environmental targets (good status). These evaluations have to be done latest till December 22, 2013, then re-evaluated in each six years, and make modifications, if necessary.

KvVM /Ministerial Decree 33/2005 (XII.27.) on the administrative service fees of environment, nature protection and water authorities determine the fees to be paid for the different water permits (preliminary, construction, operation) depending on the amount of thermal water to be exploited and re-injected (in m3/day).

According to *Governmental Decree 314/2005 (XII.25.) on environmental impact assessment* has to be prepared for activities that include thermal groundwater abstraction exceeding 5 million m3/year, or re-injection of 3 million m3/year for the generation of electricity or direct heat, or in all cases where thermal groundwater exploitation from karstic aquifers exceeds 500 m3/day, or 2000 m3/day from porous aquifers. Furthermore, an environmental impact assessment has to be prepared for geothermal power plants of 20 MW, or more, and for all power plants without output restrictions which are established within the protection zone of mineral-, medicinal-, or drinking water resources, or on nature protection areas.

The environmental impact assessments are licensed by the environmental-, nature protection and water management inspectorates.

During the drilling of thermal water wells, the produced waste (e.g. drilling mud, drilling devices) has to be handled according to the provisions of the *Act XLIII of 2000 on waste management*.

5.6 Water management legislation

The scope of the *Act LVII of 1995 on water management* is related to the surface and groundwaters, their natural aquifers (such including thermal waters and their reservoirs), all activities which influence these reservoirs, the utilization and management of water resources, as well as collection, processing, supply and utilization of all those data which are necessary for the evaluation of (ground)waters and their survey. In the following text we talk only about groundwater.

According to article 6, (ground)waters and their natural aquifers are in state property.

Water management is regulated in articles 14-15. According to article 14, mineral and medicinal waters have to be protected by determining their protection zones, which is regulated under Governmental Decree 123/1997 (VII.8.) on the protection of water resources (see there).

According to article 15 groundwater resources can be utilized only to that extent that the dynamic equilibrium of recharge and abstraction is maintained without quality deterioration, and targets related to the good status of waters phrased in the *Water Framework Directive* are achieved. During the utilization of mineral-, medicinal, and thermal waters balneological utilization should be prioritized. Thermal water abstracted solely for geothermal energy utilization has to be re-injected according to *Governmental Decree 147/2010 (IV.29.) on the general regulations related to the activities and establishments serving the utilization, protection and mitigation of damages of waters* (see there).

The act defines priority to satisfy water demands as the following (15§):

- water uses aimed at substantial drinking water supply, public health and emergency responses to disasters
- medicinal purposes, as well as direct services of the population
- livestock watering, fish-farming
- nature conservation
- economic
- other activities (such as sport, recreation, tourism, balneology)

This means that thermal water abstraction for energy production, as economic activity is placed at a low level of the hierarchy.

Article 15/A regulates water resource fee, which the user is obliged to pay to the state after the amount of water used, or reserved in the water permits for construction and operation. The amount of the fee is defined in article 15/B as 4,5 HUF/m3, as a base. In case the amount of exploited water exceeds by 10% the amount granted in the permit, the fee is 9 HUF/m3 for the extra amount. If water abstraction is carried out without any permit, than the base fee is 28,9 HUF/m3. Details of calculation are in KHVM / Ministerial Decree 43/1999 (XII.26.) (see there). According to article 15/C no water resource fee has to be paid after the amount of groundwater re-injected into the same aquifer. Water-resource fee to be paid for the thermal groundwater abstracted solely for energetic purposes can be reduced (max. to the extent of the water resource fee) by the amount to be spent for construction of a re-injection well in the given year.

Articles 28-29 standardize the water permits. The inspectorates can issue a water permit only in case the water use does not threaten the safety of the water resources and it is in line with other regulations related to the protection of water budget, groundwater resources management and water quality. A new water permit can be issued only if the required amount of water is available.

Contents of the application form and its annexes to be submitted for granting the water permits are standardized in *KHVM / Ministerial Decree 18/1996 (VI.13.)*. Applications for the planning (preliminary)-, construction- and operation permits have to be submitted to the regional Environmental and Nature Protection and Water Management Inspectorates. The Decree discusses in great details the different permits, in the following only the most important items related to a thermal well are summarized.

Water permits have different types. The planning (preliminary) permit describes the general water management objectives and basic technical parameters of the planned activity and determines the amount of water to be used in the future (which is registered as reserved water resource by the inspectorates and is considered during new applications), but it does not authorize for drilling of a well, or any kind of water utilization. The construction permit is necessary for drilling, reconstruction, or abandonment of a well, while only the operation permit authorizes for the execution of water use within the given period.

According to article 1 and Appendix 1, the application for a planning (preliminary) permit should contain the aim of the planned water use, the quality and quantity of the water to be abstracted, time schedule, planned methods for water treatment, technology of the acquisition, results of preliminary investigations (if there were any), location map, area to be effected by the well, other water uses, etc.

Article 2 and Appendix 2 gives provisions on the content of the application for a construction water permit which has to contain the documentation of the property rights. The application has to give information on the category of water use (private, public), utilization purpose (agriculture, balneology, energy), the type of the targeted water resource/aquifer (fissured, karstic, porous), groundwater temperature, exact location of the drilling (settlement, coordinates, etc.). Furthermore information has to be provided on the detailed use of the groundwater (quality, quantity, mean- and maximum values), technical parameters for operation (periodical, continuous), detailed technical parameters of the well (depth, diameter, screened intervals, etc.), yields (l/sec, m3/day), the type of the well (free outflow, or pumped, in the latter case the technical parameters of the pumping), other technical devices associated with the well, water sampling facilities, protection of the water resources (protection zones). The application for the permit has to contain also a geological description (lithological chart of the well) as well a hydrogeological model including hydrogeological parameters of the units, recharge and discharge conditions of the groundwater resources according both to the natural state (before water abstraction) and to the operation of the well. The hydrogeological model has to assess the effects all other water abstractions on the targeted area, too, including water resources reserved in already issued preliminary permits, as well as to the description of water quality. The application for the permit should describe the potential contamination sources according to Appendix 3 (communal, industrial, agricultural, transport, mining, other) and actions for protection (e.g. establishment of a monitoring system, different restrictions, etc.). The documentation has to provide an action plan to prevent environmental havarias, too.

The content of an operational water permit is regulated in article 6. It's most important parts are the name of the operator, in case of any deviations from the construction permit the detailed technical documentation of the real status, results of testing, the conditions, rights and obligations of operation and a hydrogeological report.

Governmental Decree 72/1996 (V.22.) on the implementation of authority powers in water management regulates the powers of the organizations in water administration. According to article 1, these tasks are performed by the Environment and Nature Protection and Water Management Inspectorates. One of their most important task is the issue of the different water permits (see in details in the *KHVM / Ministerial Decree 18/1996 (VI.13.)*).

the water permits can be modified both by the applicant and by the inspectorate. According to article 11, the water permit can be modified on the request of the license holder in case of the reconstruction of the well, different type of utilization as defined in the water permit, different amount of water to be exploited, or the owner/operator has changed. For the amendment all

documentation has to be attached, which are relevant for the evaluation of the required modification. According to article 12, the permit can be modified by the authority in case conditions − on the basis of which the permit was issued − have changed, especially regarding the amount, the abstraction limit value (Mi), or contamination limit values of the available water resources.

According to article 14, the water permit can be withdrawn, if the license holder does not fulfill his obligations, or the conditions − on the basis of which the permit was issued − have been fundamentally changed. Articles 15-16 give provisions on the wells constructed/operated without permission. Under special circumstances a special remaining permit can be applied for. Article 18 regulated different fines.

In addition to water permits, the other major task of the Environment and Nature Protection and Water Management Inspectorates is the delineation of protection zones of water resources (9§). The details are regulated in the Governmental Decree 123/1997 (VII.18.) on the protection of water resources.

Governmental Decree 123/1997 (VII.18.) on the protection of water resources summarizes the major tasks of safeguarding waters designated for drinking water supply and for utilization as mineral- and medicinal water, in relation with article 14 of the *Act LVII of 1995 on water management*. The scope of the decree covers the actual and perspective sources of the above mentioned types water resources (such including thermal groundwaters), as well as to the serving their treatment, storage and distribution.

According to article 2, the protection of such groundwater resources means the delineation and maintenance of protection blocks and zones, which have to be divided into inner-, outer- and hydrogeological protection zones. The boundaries of these zones have to be outlined on the basis of hydrogeological conditions, the actual or potential water exploitation of the water resource, and details provided in Appendix 2.

According to article 3, the task of the inner protection zone is the technical protection of the well itself and the protection of the water resource from direct contamination. The outer protection zone should safeguard the water resources from other degrading and bacterial contaminations, while the hydrogeological protection zone should protect the resources from non-degrading contamination which has to be outlined for parts, or for the entire recharge area.

According to article 4, the dimensioning of the protection zones is based on the travel times, calculated from permanent groundwater flow velocity (i.e. the time necessary for a pollutant, or water particle to reach the abstraction site).

Article 8 summarizes the main aspects of delineation of the different protection zones, such as the targeted depth interval, the amounts of water with abstraction permits, brief geological, characterization of the aquifers of the protected water resources, restrictions in land-use, necessary measures and monitoring and their assessment.

According to article 10, only those activities can be performed in the different protection zones, which do not endanger the quality or quantity of the water to be abstracted. Article 11 regulates and gives restrictions for activities to be performed in the inner protection zone, article 12 for the outer protection zone and article 13 for the hydrogeological protection zones.

Such activities are potential pollutions from agriculture, animal farming, industry, etc. The detailed list of the prohibited activities in the different zones is listed in Appendix 5.

The scope of the *Governmental Decree 121/1996 (VII.24.) on the establishment and utilization of public baths* also encompasses thermal spas, which are entitled to perform medicinal activities (1§). According to article 5 water resources providing water for public baths have to be protected and protection zones have to be delineated and maintained according to Governmental Decree 123/1997 (VII.18.).

According to the *KHVM / Ministerial Decree 23/1998 (XI.6.) on the water management register of the water inspectorates* groundwaters and their reservoirs, as well as related water reserves, their quality and quantity data are part of the national water registration system. The registration has to contain all associated hydrogeological, hydrological, technical data as well as relevant economic and legal facts and figures. The basis of the register is the water permit which details are given in the KHVM / Ministerial Decree 18/1996 (VI.13.)

According to article 8, the preparation and maintenance of the water registers is the task of the regional water directorates. Water reserves have to be updated and re-assessed at 5 years, while changes in the water budgets related to the water use have to be evaluated continuously, but at least once a year.

Users have to pay a water resource fee after the abstracted water, such as thermal groundwater. Its calculation method is regulated in the *KHVM / Ministerial Decree 43/1999 (XII.26.)*. According to Appendix 1, in the case of thermal waters the calculation is the following:

VKJ = V (m3) * A (Ft/m3) * m * g

V: amount of used water

A: basic fee (defined in the *Act on the State budget*, yearly)

m: modification number (non-measured water use: 2, measured water use: 1)

g: modification number according to the type of utilization and water resource. In case of thermal groundwaters the ‘g’ values are the following:

	medicinal	public	drinking water	bath	other
medicinal water	1	5	5	5	10
thermal water (>30 °C)	1	1	3	3	7,5

According to article 5, the amount of used water, on the basis of which the water resource fee is paid, has to be measured by a continuously measuring, certified water clock which has to be equipped at the well-head.

KvVM / Ministerial Decree 24/2007 (VII.3.) on water safety regulations discusses in details all technical and safety issues related to activities associated with waterworks, such as drilling

of wells, water treatment, establishment and operation of baths, etc. including their planning, construction, operation, reconstruction, abandonment, etc.

The scope of the *KvVM / Ministerial Decree 101/2007 (XII.23.) on the rules of intervention to groundwater resources and guidelines to the drilling of wells* covers all activities related to the planning, execution and operation of production-, reinjection- and monitoring wells, as well as the rights and obligations of their technical designer, constructor and supervisor.

During planning (3§) a water permit has to be applied for in line with the Governmental Decree 72/1996 (V.22.) on the implementation of authority powers in water management. It has to be considered that the well does not make a hydrodynamic connection between different groundwater bodies.

According to article 5, all wells deeper than 30 m can be drilled only on the basis of a water permit. During drilling a wide range of geophysical, technical, and hydrodynamic measurements have to be performed, which are listed in Appendix 1. These are the following:

Geophysical logging: SP, gamma, resistivity, as additional measurements: neutron-porosity, micro-resistivity, bottom-hole temperature, acoustic, thermal logging, mud-resistivity, magnetic susceptibility, etc.

Technical measurements, e.g. checking of inner diameter and bottom, position of screens, etc.

Hydrodynamic measurements: flow and thermal logging at max. yield (below 100 m – bottom-hole temperature, below 500 m – continuous thermal logging), well capacity (at 80, 60 and 40 % yield), pressure gradients, etc.

The Inspectorates can skip these measurements if the constructor can prove that there are enough information and logs form already existing wells are available on the area, so new measurements are not necessary to determine the technical parameters of the well.

According to article 5, the gas content of the well has to be measured according to the KHVM Ministerial Decree 12/1997 (VIII.29.) on de-gassing and gas sampling of groundwaters.

A separate article (5/A) discusses thermal wells. According to this, a thermal well has to be equipped with a special well-head that makes possible the differential water abstraction following the actual water demand, thus the economical an sustainable utilization of thermal groundwater bodies. Thermal wells have to be outfitted with devices that are resistant to changes in temperature and aggressive waters. It also has to be considered to hinder scale precipitations and make it possible to remove them.

Documentation and data supply obligations of completed wells are discussed under article 8. A hydrogeological report has to be prepared in case the abstracted water is from porous, karstic or fissured aquifer, and the amount of exploitation/reinjection exceeds 1,5 m3/day, as well as for monitoring wells, if the well is representative for a given groundwater body and is part of the regional monitoring system. The hydrogeological report has to be prepared by the constructor of the well, its content is defined in Appendix 2. It should contain the basic data (cadastral number, coordinates, locality, etc.), drilling technology, geological log, casing and screening depths, operational data, flow curve, etc. The Inspectorate sends a copy of the hydrogeological report to the regional Environmental Protection and Water Management Directorate, as well as to the Geological Institute of Hungary.

Articles 10-11 concern well related to the exploitation of thermal groundwater. Special requirements include measurements and their frequency of temperature, yield, water-level and well-head pressure both on the production and the reinjection wells.

Thermal springs have the same regulations as thermal wells (12§), as appropriate, furthermore, the discharge has to be given, even if water is flowing away without any utilization.

According to article 5 of the *KvVM Ministerial Decree 30/2008 (XII.31.) on the technical regulations related to the activities and establishments serving the utilization, protection and mitigation of damages of waters*, during the planning of a well, the conceptual hydrogeological model of the targeted groundwater body has to be considered, as well as data related to the groundwater reserves, abstraction value limit (Mi), the water demand of the groundwater dependent ecosystems, and the water quality of the aquifer. In case of thermal wells, it has to be ensured, that the water levels can be detected, the amount of abstracted water can be measured continuously, changes in the quality and quantity in the groundwater reserves can be observed, as well as access for sampling.

The distance between the wells has to be established in a way, that even co-production of wells abstracting water from the same aquifer, the drop in yield would not overcome 10% of the original amount to be produced by a single well. During determining the distance, the local conditions, decreases in yield, groundwater-level, pressure, quality and temperature have to be taken into account.

KHVM Ministerial Decree 12/1997 (VIII.29.) on the degassing of the produced and supplied waters is relevant, because thermal groundwaters often have a high gas content. According to article1, the scope of the decree covers all waterworks that are related to the production, treatment, storage, transport and supply of these waters. A groundwater is classified as gas-contented, which has dissolved hydrocarbon content determined at a pressure of 1013 millibar and 20 °C temperature in the following three categories: class A: below 0,8 l/m3, class B: between 0,8-10 l/m3, class C: above 10 l/m3.

According to article 2, during the water permitting procedure, the license holder is obliged to measure the gas content of the abstracted groundwater during the probe-tests, and if necessary, to modify the water permits accordingly.

Article 3 summarizes the different de-gassing procedures for the categories B and C. De-gassing has to be performed in away, that it does not cause the deterioration of water quality.

As thermal waters are utilized for balneological purposes in many cases, provisions of *EüM / Ministerial Decree 74/1999 (XII.25.) on natural medicinal factors* have to be considered, too. According to article 15 the terminology of natural mineral water, or medicinal water can be only used, if the water quality meets the requirements defined in Appendix 2, i.e. a natural mineral water is derived from a protected aquifer, it is clean by its origin, it is harmless to human health from a microbiological and chemical point of view, its dissolved content is permanent and it is at least as high as 1000 mg/l, or it is between 500 and 1000 mg/l and contains one of the active biological components give in the appendix. According to Appendix 2, medicinal water is a natural mineral water that has a proven healing effect. The operator of the water supply is obliged to make quality check measurements at his own costs in each 5 years in case these waters are used externally, and in each 2 years if they are also used internally.

According to article 22 the National Health Office maintains the register of the mineral and medicinal waters, as well as balneological centers.

Governmental Decree 147/2010 (IV.29.) on the general regulations related to the activities and establishments serving the utilization, protection and mitigation of damages of waters comprises the most important regulations concerned reinjection of thermal groundwater.

According to article 10, waterworks (wells) aiming water production solely for energetic purposes have to be planned in away, that their operation does not affect unfavorably the discharge and temperature of thermal karstic springs. The thermal groundwater abstracted for energetic purposes has to be reinjected to the same aquifer after utilization.

According to article 11, thermal groundwater can be utilized for medicinal and other health purposes, as drinking – and mineral water, for balneology, warm water supply in households, heat production and generation of electricity. During the planning of utilization, a multi-purpose (cascade system) operation and economic water use should be targeted. The utilization of accompanying gases should be also considered. During the construction of a waterworks using thermal groundwater, the safe disposal of utilized water, especially their reinjection has to be taken care of. Throughout the selection of a potential surface reservoir, environmental aspects and natural recharge processes have to be considered. Thermal water for household warm water supply can be delivered to the pipeline system only if the water meets the quality requirements of drinking water. If the thermal water is a certified mineral-, or medicinal water, than water treatment has to be designed on the basis of individual analyses. Medicinal waters can be treated only by a technology that does not weaken its healing effect.

In relation to reinjection, the provisions of this decree have to applied in licensing procedures starting after the decree comes into force, except for those activities, which preliminary water permit was already issued before (78§). Operational water permits applied for after December 22, 2012 and their prolongation are under the scope of this decree. An exemption can be applied for those users, who abstract thermal water solely for energetic purposes from groundwater bodies of poor, or declining quantity status (according to the assessment in the river basin management plans) till December 22, 2014, and till December 22, 2020 in case thermal water is exploited from groundwater bodies of good quality status.

5.7 Legal background for monitoring of groundwater

Water Framework Directive sets the standardized regulations at EU level for groundwater monitoring of in Hungary. Basic national legislation is related to the acts on environment protection and water management.

During river basin management planning the significant and permanently declining hydraulic head / groundwater level, and the significant and steadily rising pollutant concentration have to be identified in the groundwater body at risk according to the *Governmental decree 219/2004. (VII. 21.) on the protection of groundwater*. In order to identify these threats, the groundwater has to be monitored. Based on the monitoring results the status of the groundwater body has to be assessed regularly, but at least in every 6 years related to the river basin management planning.

Monitoring has to be performed according to the provisions of the *Governmental decree 221/2004. (VII. 21.) on certain rules of river basin management*. The aim of the decree is to integrate the measures and action programmes in order to achieve and maintain the good status of waters determined by special laws and to determine the content of river basin management plan and rules of planning.

The Decree also states that "it has to be ensured that the status of water does not change disadvantageously at the state borders and to ensure a good status of waters as a result of mutual measures".

Concerning the monitoring of surface- and groundwaters and protected areas, it states that a monitoring programme has to be elaborated and implemented which contents are determined by separate legislation. The monitoring programme has to be planned, elaborated and operated in a way that is compatible with the technical specifications and standardized methods and procedures determined in article 21 of WFD in order to perform river basin management planning effectively and reliably.

KvVM /Ministerial Decree 30/2004 (XII.30.) on certain rules of examination of groundwaters applies to the rights and obligations established for the designation of groundwater bodies, characterization and assessment of their status, their monitoring, the review of the aforementioned tasks, as well as the collection, processing and reporting of data necessary for the execution of these tasks. According to the decree changes in the quantitative and qualitative status of groundwaters have to be traced by monitoring that includes an observational network that detects the quality and quantity status of groundwaters influenced by natural processes and diffuse human effects (aerial monitoring). In addition it also includes a monitoring that supports the knowledge on the effects of point-like human activities influencing the quantity and quality of groundwater (environmental impact monitoring).

The detection and monitoring stations of groundwater body monitoring have to be recorded in the river basin management plan. Parts of groundwater body monitoring are: quantitative monitoring, qualitative monitoring including chemical surveillance and chemical operational monitoring.

The quantitative monitoring aims at observing changes in the hydraulic head / groundwater level, and long-term changes that happen in spring water discharges. The qualitative monitoring outlines a coherent and comprehensive picture on the qualitative status of ground waters and their impacts on the ecosystems and drinking water resources.

Annex no. 3. of the decree gives details about aspects on the establishment of the different groundwater body monitorings. According to this, the spatial density and frequency of observation of transboundary groundwater bodies has to be determined in the way that it should be suitable for a reliable review and control on changes in the hydraulic head due to water extraction and / or inlet as well as for the determination of the zone-budgets and groundwater flow direction crossing the border.

KHVM Ministerial Decree 22/1998. (XI. 6.) includes the institutional background and the detailed tasks of monitoring and hydrographic activity. These activities include the recognition, evaluation and forecast of quantitative and qualitative features of groundwaters, their status assessment by a coherent system approach

In connection with basic data related to water management, *Government decree 178/1998 (XI. 6.)* states that a water management information system has to be set up and operated in order to gather, process and serve data for the water management tasks performed by the state and local governments. *KHVM / Ministerial Decree 23/1998 (XI.6.) on the water management register of the water inspectorates* regulates its way and details.

Based on the *Act XLVI. of 1993 on Statistics*, data supply of the operators complements the regular monitoring measurements. In the frame of the National Statistics Data Collecting Programme - according to the *Government decree 288/2009. (XII. 15.)* - statistical data supply for water management purposes, survey and analysis is obligatory for regional and municipal waterworks, cities or locations having individual waterworks and other enterprises, institutions and organizations who provide water supply or sewage-disposal and treatment for the public. In the frame of the obligatory statistical data supply, user have to measure parameters as listed in Annex 3 of the KöViM *Ministerial decree 21/2002 (IV.25)*.

Regular control measurements should be performed in the mineral and medicinal water wells in addition to the obligatory operation data supply.

KvVM / Ministerial decree 101/2007. (XII. 23.) on the rules of intervention to groundwater resources and guidelines to the drilling of wells contains the types and frequency of measurements to be performed which are scheduled in the operational water permits issued by the water authority. There are separate details on the examinations to be performed regarding mineral and medicinal wells. In production and re-injection wells yield, well-head pressure, or operational water level and temperature has to be measured and registered according to the operational rules but at least every day, preferably with a digital data acquisition system. Temperature, water level and well-head pressure have to be measured and recorded in the inactive wells serving water level and water pressure observation at least once a week. More frequent measurement and registration may be required in the operation regulation. In the frame of the monthly control of active, continuously operating thermal wells, operators have to determine well-head pressure, operation water level and outflow temperature of the operation time. In addition to these regular tests, periodical examinations have to be performed before and after maintenance and transformations, but at least in every four year. Some tests e.g. gas test have to be performed in a frequency prescribed by a special measure. *KHVM /Ministerial Decree 12/1997 (VIII.29.) on the degassing of the produced and supplied waters* determines that gas content of the water has to be regularly controlled by the license-holder (in every five years in category “A”, in every three years in category “B”, in every two years in category” C”).

According to the *EüM/ Ministerial Decree 74/1999 (XII.25.) on the natural medicinal factors* the operator of the water supply is obliged to make quality check measurements at his own costs in each 5 years in case these waters are used externally, and in each 2 years if they are also used internally.

Regulations regarding thermal water wells have to be adapted for the thermal springs appropriately.

APPENDIX 1: Summary of the guidelines on monitoring and assessment of transboundary waters

The guideline is intended to assist governments and joint bodies in developing harmonized rules for the setting up and operation of systems for transboundary groundwater monitoring and assessment. The target group comprises decision makers and planners in ministries, organizations and institutions responsible for environmental, water or hydrogeological issues and all those who are also responsible for managing transboundary groundwaters.

According to the definitions used in the Guidelines:

• monitoring

Monitoring is the process of repetitive observing, for defined purposes of one or more elements of the environment according to pre-arranged schedules in space and time and using comparable methodologies for environmental sensing and data collection. It provides information concerning the present state and past trends in environmental behavior.

• assessment

The evaluation of the hydrological, chemical state of groundwaters in relation to the background conditions, human effects, and the actual or intended uses, which may adversely affect human health or the environment.

• survey

A finite duration, intensive programme to measure, evaluate and report the state of the groundwater system for a specific purpose.

Because the borders between countries do not necessarily coincide with the natural boundaries of groundwater aquifers, groundwater may flow from one state to another. Moreover, abstractions or other activities on one side of the border may adversely affect groundwater functions on the other side. To be able to distinguish natural characteristics from anthropogenic effects, information will be required about the aquifer and flow conditions on both sides of the border. Based on the information originating from neighboring countries, the pictures might show abrupt and unrealistic changes in geology and groundwater characteristics at the border crossings.

Furthermore, the possible existing monitoring networks may have been set up with different objectives, the measurement locations, times and frequencies might not match and the assessment and presentation may be different. Moreover, it is often very difficult to obtain the required data because of logistical difficulties. Consequently, without proper establishment of cross-border groundwater monitoring and assessment, errors may occur in aquifer characterization and in the prediction and evaluation of changes in groundwater flow and quality.

To develop and evaluate strategic policies for groundwater management it is a prerequisite that the monitoring and assessment of groundwater in the neighboring countries is performed in a comparable way. This means, for example that sampling procedures and chemical and numerical analysis should be comparable on both sides of the border.

When implementing transboundary monitoring and assessment programmes, it is essential to present the hydrogeology in conceptual models and/or in graphic schemes. This should comprise a characterization of the transboundary aquifer (geometry), the flow conditions, including recharge and discharge areas, and the evolution of the groundwater quality. Knowledge of the groundwater flow system means in particular the locations of groundwater recharge and discharge zones, and the way groundwater flows through aquifers from zone to zone. Activities in the recharge areas on one side of the border might adversely affect the quality of quantity of groundwater on the other side. To determine recharge and discharge conditions in some areas, the interaction between surface and groundwaters need to be understood. So, to characterize groundwater occurrence, information on geology, geophysics and hydrogeology in the transboundary area is needed. Also, the dynamics of the groundwater flow system, such as seasonal or longer-term responses and variations and changes in flow rate or direction caused by human activities, particularly groundwater abstraction, must be understood. Groundwater quality is infinitely variable in space and time, but on different spatial and temporal scales to surface waters.

Groundwater should be assessed in an integrated manner, based on criteria that cover water quality and quantity for different human uses as well as requirements of ecosystems. Relevant issues and the cause-effect relations between issues and uses have to be understood. When the information needs have been determined, the type of monitoring and assessment strategies can be chosen. The general approach of the monitoring cycle, offers a valuable approach when drawing up programmes for the monitoring and assessment of transboundary groundwaters.

Integrated water management comprises water quality and quantity aspects. Assessment linked to this purpose involves integrated monitoring that provides information on a wide variety of subjects/aspects (uses, functions, hydrogeology, flow regimes, progress towards policy goals). Analyzing, planning and managing water resources in a comprehensive transboundary way involve many disciplines, factors and actors. For transboundary aquifers with their dynamics and interrelated flow systems, this approach is and will become increasingly important, since water is one of the key factors for sustainable development in Europe.

Information on transboundary groundwaters can be obtained from primary sources, such as monitoring programmes, predictions with models, and other sources (e.g. databases) containing statistical or administrative information. Using these information sources, in combination with each other, offers optimal conditions for cost-effectiveness. In a transboundary context it should be emphasized that no combination or integration of these sources is possible, if the harmonization of data(bases) has not taken place or been foreseen prior to the actual assessment or joint modelling activities.

A prerequisite for monitoring and assessment of groundwater resources in general and for transboundary groundwater bodies in particular is the preliminary characterization of the relevant aquifer systems and the actual condition of groundwater flows. At the border between two countries, different flow systems might be superimposed and even opposite flow directions might occur. Recharge- and discharge areas should be identified including the interaction between surface water and groundwater. Transboundary aquifers might have recharge areas on one side of the border and discharge areas on the other side. Activities within the recharge areas at one side of the border might adversely affect the groundwater quality on the other side of the border. Furthermore, transboundary water transmitting layers, zones or structures have to be characterized in order to be able to produce a consistent picture of the geometry of these layers, zones or structures. This will be needed for a proper

assessment of possible transboundary phenomena. Therefore, an integrated interpretation of transboundary information on geology, geophysics and geo-hydrology will be necessary. Information on the extent of the different layers is also needed for a proper design and selection of representative locations for a transboundary monitoring network for groundwater and moreover for the assessment of the data on groundwater levels and groundwater quality.

After a preliminary characterization of the groundwater systems, further monitoring should provide information about the aquifer dynamics such as seasonal variations and changes of the groundwater flow system and about the effects of measures and other anthropogenic influences. Therefore, groundwater quality, groundwater levels and groundwater abstractions have to be monitored as well as the surface water systems which form the boundaries of the groundwater flow systems. Hence, an integrated evaluation of the results of groundwater and surface water monitoring is needed and in certain cases integration of the monitoring activities of groundwater and surface water is recommended. The application of groundwater flow modelling may be very useful to provide three dimensional pictures of the flow systems and to get indications of the groundwater fluxes.

A three-dimensional picture of the transboundary aquifers and the actual groundwater flow from recharge- to discharge areas should be obtained. Recharge sources might be infiltration from precipitation or from surface water bodies and discharge is generally represented by surface water and abstraction points. Besides the geometry of the groundwater flow system, additional information about the different quantity and quality aspects e.g. precipitation, evapo-transpiration, abstractions, base flows of streams, water balances etc., should be collected and presented.

The results of the preliminary assessment should include: the identification of the possibly dynamic boundaries of the transboundary groundwater flow systems, the characterization of the transboundary aquifers, aquitards and aquicludes, a description of the relevant groundwater quantity and quality characteristics and the identification of the respective water management authorities involved.

1. Identification of groundwater management issues

1.1 Functions, pressures and targets

Groundwater management is part of integrated water resources management and protection. The core elements in (ground)water management are the functions and uses of the groundwater bodies (aquifers), the problems and pressures (threats), and the impact of measures on the overall functioning of the water body.

1.2 Functions/uses

After the characterization of the aquifer, one of the first issues to be addressed by the management authorities involved will be the assessment of the actual and possible future functions and uses, which is based on the quantity and quality features of the groundwater system concerned.

Possible functions and uses of groundwater are: drinking water supply, agriculture use, industrial use, geothermal use. Further, the maintenance of certain groundwater levels and/or groundwater quality may sustain ecological values, base flow of streams, well abstractions, etc.

1.3 Threats/problems

A threat is an activity or situation which might cause groundwater quality or quantity problems. In particular, when the threat and the connected problem are separated by a national boundary, a transboundary approach to groundwater management is required. Threats may include potential pollution sources. Besides threats which may cause adverse quality effects, undesired quantity effects may also occur due to abstractions, etc.

Groundwater problems are defined as undesired situations with respect to man and the environment which are related to groundwater use and/or functions. For example, abstractions may result in increasing salinization, over-abstraction may result falling groundwater levels may give rise to problems like desiccation, land subsidence and foundation problems. Groundwater budgeting and determination of trends will be needed to identify over-abstraction.

1.4 Measures

After identification of the functions, uses, problems and threats of the groundwater resources, often alternative measures will be defined from the side of the water managers and water policy makers to protect and/or re-establish and/or guarantee the functions and uses of the groundwater. The final selection of measures should be the result of an evaluation of the different measures and their environmental, economical and social impact, in the framework of an integrated and comprehensive approach of environmental management.

1.5 Priority setting

The issues and targets of groundwater management should be prioritized – taking into account relevant agreements – at different levels/scales (i.e. region wide, regional and local transboundary level, aquifer level). These prioritized issues determine to a large extent the information needs that will form the basis for monitoring.

2. Information needs

2.1 Specification of information needs

The information required for the monitoring and assessment of transboundary groundwaters should be structured on the basis of issues in the policy life cycle.

n the first stage, the question is whether there is a true environmental problem. When admission of the issue grows, a policy will be formulated. In this second stage, the focus of the public on the problem-solving capacity of decision makers is high, which is reflected by

the political weight. In the third stage, the policy is being implemented and measures are taken to solve the problem. The fourth stage is focused on the nearly solved environmental problem. The first and the second stages require rough data and research to recognize the problem and causal coherence. The third and fourth stages require more precise data to select most effective measures and to quantify their effect.

The proper identification of information needs requires that the concerns and decision-making processes are defined in advance. From the structured specification of information needs monitoring objectives will evolve. Specification of information needs includes:

- the establishment of assessment criteria. These criteria should lead to the development of an assessment strategy. The assessment criteria, defined for each use, determine the choice of assessment methodology;
- the quantification of information needs, making clear what degree of detail is relevant for decision-making. This will affect frequencies, accuracy of measurement etc.;
- the specification of requirements for reporting and presentation of the information product

3. Transboundary groundwater monitoring and assessment

When establishing transboundary groundwater monitoring strategies, the following need to be identified and jointly agreed:

a) the transboundary aquifer and relations to surface water and associated ecosystems;

b) specific human uses of transboundary groundwaters;

c) ecological function of transboundary groundwater resources;

d) pressures which have an impact on the above-mentioned human uses

e) quantified, or otherwise clearly defined, management targets which should enable the establishment of restrictions and which can be implemented within a specified time period.

3.1 Monitoring objectives and types

Within a national context, monitoring networks generally have two fairly broad categories of objectives. These are basic or reference monitoring networks and specific purpose monitoring networks. Their objectives are threefold: (1) providing data for characterizing the groundwater regime, (2) providing data for detecting long-term trends in groundwater levels (quantity) or groundwater quality, and (3) serving as a reference network for the specific purpose networks.

For transboundary groundwaters, statutory monitoring will primarily be linked to agreements, which evolve from the Helsinki Convention or from other international agreements and directives which apply to the specific area.

The specification of a monitoring objective should principally make clear why the information is needed (e.g. for what decision-making process). It should also show the intended use of the information (purpose) and the management concern of the countries for the transboundary area.

The main monitoring types are the following:

a. Basic/reference monitoring

Basic/reference monitoring includes monitoring for state assessment. This type of monitoring establishes a background (reference) situation to enable the determination of trends caused by anthropogenic and natural impacts. For state assessment, long-term records are needed to determine the possible impacts through statistical analysis. The frequency of monitoring is about one to four times a year, depending on the characteristics of the aquifer. In an unconfined aquifer the measuring and sampling frequency will be higher than in a confined aquifer. It is often performed on very different scales (national, regional, local), but the density of this type of network is generally moderate. The parameters to be sampled are normally the field parameters and major ions. In a transboundary context, monitoring networks on both sides of the border could be used, but the statistical analysis requires central guidance from a joint body. This body should also provide guidance on critical items to be monitored and the statistical organization and interpretation of the raw data.

b. Monitoring linked to functions and uses (compliance)

This type of monitoring serves as a protection of functions and uses. The monitoring should answer the question, of whether the groundwater use complies with regulations and standards deriving from laws and directives related to the use of groundwater. The density of the networks and the sampling frequency depend on the functions and uses of the groundwater. For transboundary groundwaters, this means that countries have to establish and agree upon the groundwater uses and functions in the transboundary aquifer. Since monitoring results may be used as a basis for further action or measures, it is recommended that a transboundary quality assurance programme should be established.

c. Monitoring for specific purposes

Some groundwater resource management activities require special types of investigation and monitoring. For instance:

- the development and evaluation of special protection areas;
- the implementation and evaluation of remediation and restoration measures;
- the investigation of interconnection of surface water and groundwaters;
- modeling to predict migration of contaminants;

The density of the network and the frequency of measuring and sampling will often be higher than of the previously mentioned monitoring networks and are closely related to the type of aquifer. In a transboundary context, this type of monitoring requires close cooperation between parties.

d. Early-warning and surveillance

This strategy aims at collecting information on whether and where accidental spills may affect the drinking water supply, to determine public health hazards of "abandoned or illegal" land disposal sites, or to determine actual sources of groundwater quality deterioration. This type of monitoring is not relevant for thermal groundwater management; therefore it will not be discussed in the following.

3.2 Key aspects of monitoring and assessment

a. Existing information and monitoring systems

Firstly, information should be gathered on the relevant parts of the transboundary aquifer. Is relevant information already available from other sources (e.g. existing monitoring systems, specific surveys, models, other data suppliers)? Can existing monitoring and information systems provide the information needed by adjusting their operation? Is it possible to use the existing database information system? What does this require from a new monitoring system?

Such inventories and other preliminary activities should be carried prior to a monitoring effort in transboundary aquifers. The extent of these activities depends on the objectives of the programme, the complexity of the hydrogeology and the number and nature of issues to be addressed. Surveys provide the basic information needed to set up the monitoring as effectively and efficiently as possible. Inventories include a general screening of all available information relevant to the aspect under consideration, an evaluation of aquifer characteristics, the hydrogeologic setting, etc. Moreover, the need – if any – for other data will become more clear as a result of these inventories. Surveys should be undertaken where the inventory shows that data are lacking. Surveys are also helpful in determining the variability of monitoring parameters in time and space.

b. Type of monitoring

If monitoring is needed, what type of monitoring will be required? Will a single survey be sufficient or is more extended monitoring necessary?

c. Monitoring techniques

What are the available and suitable monitoring techniques (e.g. remote sensing techniques, continuous recording monitoring system)?

d. Stepwise approach

Is a stepwise approach to develop a monitoring network system, leading from coarse to fine assessments, worthwhile? As monitoring serves different aims and as the information needs vary from broad indications to fine-tuned diagnostic features, the choice of parameters and methods also depends on them. Especially for groundwater quality monitoring, step-wise approaches, which will lead from general to more detailed assessments, are recommended. Each step should be concluded with an evaluation of whether or not the information obtained is sufficient. In general, an approach going from simple to advanced is advisable for reasons of cost-effectiveness.

e. Aquifer vulnerability assessment

In general, more vulnerable aquifers or parts of aquifers will require greater monitoring efforts and therefore aquifer vulnerability assessment can provide means for prioritizing monitoring efforts. The monitoring intensity is related to those parts of an aquifer, where an impact is most likely to occur. Aquifer vulnerability should also be taken into account when interpreting and reporting monitoring results to assess whether groundwater resources are adequately protected or whether measures taken as a part of groundwater action plans are sufficient.

f. Risk assessment

Risk assessment can help considerably in prioritizing the monitoring activities. For example, a relatively small transboundary aquifer in a sparsely populated area is hardly affected by threats. If there is plenty of surface water and therefore no use of groundwater, there are almost no functions linked to this aquifer. Through a very simple risk assessment the authorities may decide that monitoring elsewhere has higher priorities. Risk assessment can also be used to determine whether the chosen monitoring strategy will cover most of the information need. The optimization of a network design will also include an element of risk assessment; if the number of wells is decreased, will the resulting information still cover most of the information needs?

g. Models

Models, especially mathematical models, play several roles in the monitoring and assessment of transboundary groundwaters. They can assist in the integrated modeling of the transboundary area (large-scale groundwater flow system analysis), in screening alternative policies, in optimizing monitoring network design, and in assessing operative actions, such as: the effectiveness of implemented measures, the determination of the impact on groundwater systems. Integrated modeling of transboundary areas should be preceded by a large-scale regional groundwater flow system analysis. The objective of this modeling should be to establish a conceptual (or identification) model, which requires a rather simplified modeling approach. Models can be used in addition to monitoring, but also as part of monitoring optimization programmes. Successful mathematical modeling is possible only if the methodology is properly integrated with data collection, data processing and other techniques/approaches for the evaluation of groundwater system characteristics. It is important to note that the accessibility of data (interfaces to databases and to GIS) are of the utmost importance in modeling of transboundary aquifers, than the standardization of software.

h. Indicators

Monitoring and assessment should be designed to increase the capacity to tailor monitoring objectives to the information needs of for responsible water management. Indicators will help this integrated assessment. Finding the right indicators requires a balanced approach between information needs of decision makers and the costs and constraints of obtaining the appropriate data. A stepwise approach to select and develop indicators is emphasized. It can be based on the core elements of groundwater management; problems, pressures (threats) and the impact of measures on the overall functioning of the groundwater system.

i. Responsibilities

Who will be responsible for the organization of the monitoring system (for the design, implementation, operation and evaluation)?

j. Financial and human resources

What is the available budget, human resources? The responsible authorities should realize that groundwater monitoring has to be guaranteed for a long time.

- The cost-effectiveness of monitoring could be improved further by:
- agreeing to specify information needs and monitoring objectives;
- setting up accountable monitoring programmes which are closely linked to the above-mentioned information needs;
- using models, which can assist in the integrated modeling assessment of the transboundary area;
- using springs as observation wells, since no well drilling has to take place and they reflect an undisturbed, representative groundwater sample. Furthermore, spring-related data usually reflect aggregated information, whereas a monitoring well delivers only point (wellrelated) data;

k. Integration

The integration of monitoring activities for reasons of cost-effectiveness in an early stage of the monitoring cycle may cause an over- or under sizing of monitoring networks. Therefore, it is recommended that an information strategy should be developed per monitoring objective or information need. Integration of monitoring efforts may be considered in the implementation phase. The outcome of the development of the monitoring strategy should be the specification of one or more monitoring options for which a system should be designed.

4. Implementation of monitoring programmes

The design of monitoring networks includes the determination of:

- the network density and location of measuring points;
- monitoring parameters;
- types of monitoring points;
- the measuring and sampling frequency.

The design is a function of the selection of sampling-point type, density and location, sampling method and frequency and the choice of parameters. The hydrogeological characteristics of the transboundary aquifers, water use, and the availability of funds are

among the basic factors to be considered when constructing a monitoring network. The technical aspects of monitoring programmes are discussed below.

4.1 Network density

The desirable, or target density of a network is basically determined by the hydrogeological and the hydrochemical complexity of the aquifer. Hydrogeological units with a high degree of heterogeneity will require a denser network of monitoring sites. In aquifers affected by intensive exploitation and/or other anthropogenical impacts the network density should be also higher.

4.2 Selection of sites

The sites or observation points of a network should be representative of:

- the delineation of the relevant groundwater flow systems;
- the extent of aquifers, aquitards and aquicludes

Monitoring sites for groundwater level observation can be wells or boreholes, provided that they are not substantially affected by groundwater abstraction in the neighboring areas. It should be noted that springs can also be used as monitoring sites. With regard to representative data, one spring can replace a number of monitoring wells.

4.3 Parameters

The choice of the monitoring parameters can be linked to the core elements of (ground)water management and will depend on:

- the requirements of the defined functions and uses of the groundwater system;
- the threats to which the groundwater system is exposed;
- the problems which are already occurring.

4.4 Quantity measurement and sampling procedures

Groundwater levels have to be measured in relation to a fixed reference point. Consideration needs to be given to the degree to which the measured water level is representative of the actual hydraulic head conditions. For example, where groundwater abstraction occurs, the influence of this pumping on groundwater levels should be taken into account. In confined or multi-layered transboundary aquifers, the construction of clusters of monitoring points at different depths should be envisaged. This may also apply to quality networks.

Sampling procedures vary, depending on which parameter or group of parameters is to be measured. Some parameters, like temperature, pH, Dissolved Oxygen (DO) and Electrical Conductivity (EC), can be measured directly on the spot. Other parameters have to be analyzed in the laboratory. In this case samples have to be taken and must be transported,

sometimes under special conditions. When a large suite is required, several samples may be necessary, each stored in a different type of container and using a different preservation technique. Water samples can be drawn from wells, abstraction boreholes and/or from observation boreholes. Samples of raw water from boreholes or springs operating more or less continuously at relatively high discharges can provide reasonable aggregate samples of water quality, especially if the boreholes more or less fully penetrate the aquifer and are screened through a significant proportion of its thickness.

These samples are less representative if there are vertical variations in groundwater chemistry. A water sample drawn from an abstraction borehole can also be a variable mixture of the groundwater which has entered the screened or open section of the borehole, which can be quite long. In this case water is drawn from a considerable thickness of the aquifer or perhaps more aquifers. Discharge samples from this type of borehole may be an insensitive indicator of possible deterioration in groundwater quality arising from activities on the land surface.

Another problem of sample representativeness is related to the borehole itself when it is situated in groundwater recharge or discharge areas with significant vertical components of groundwater flow. Sampling from observation boreholes has similar limitations with respect to hydrogeological representativeness and sample modification.

An appropriate method for sampling observation boreholes is the use of a small, portable electric submersible pump. The collection of groundwater samples in monitoring wells must be taken in two steps. The first step is to remove standing water from the well and the second is to take the sample itself. For removing the standing water a powerful electrical pump can be used, but the pumping capacity has to be adapted to the hydrogeological conditions. In general, the lowering of the groundwater level may not exceed 2 meters or more than 10% of the thickness of the saturated zone of the aquifer. For the sample itself a small pumping rate is usual to prevent air getting in. The pump is lowered into the well down to the screen, but still above it (to avoid damage to the pump with sand input but also due to well hydraulics). The removal of standing water must be controlled by measuring pH value, groundwater temperature and/or electrical conductivity. Samples should be taken when these parameters have stabilized. Samples for inorganic analysis should usually be filtered before preservation to remove suspended particulate matter, which could dissolve when acid preservatives are added, causing distorted values of solution concentration.

Parties should agree on standard methods of sampling. Sampling should be carried out by trained staff. The chemical analyses should be performed by licensed laboratories.

4.5 Frequency of sampling and quantity measurements

Sampling frequencies in groundwater quality monitoring programmes are usually based on budgetary and resource considerations, as well as on strategies. However, there are also scientific and technical considerations.

Observation frequencies for groundwater levels depend largely on groundwater fluctuation, which is determined by the hydrogeological situation (type and depth of the aquifer), hydrological circumstances (meteorology) and human impact (e.g. groundwater abstractions).

4.6 Statistical methods

For network design, there are several approaches and statistical methods. Two general areas can be identified:

- representativeness: to optimize the network to ensure the hydrogeological complexity and quality variables are adequately represented;

- reliable assessment: to give guidance on the required sampling frequency to detect changes in the mean concentration of any parameter over time.

An example of a statistical method is the so-called Kriging technique, which is often applied to optimize quantitative groundwater networks. This technique is usually applied to reduce the number of monitoring wells.

4.7 Costs

Existing monitoring sites or production wells located in the transboundary aquifer should always be considered at the initial stage of the monitoring programme, in particular for groundwater sampling purposes. Where possible, publicly owned wells should be selected to ensure continuity of access. Considering the financial aspects of network design, a distinction can be made between capital, sampling and analytical components. For groundwater quantity networks in general the capital costs and also the sampling (observation) costs will be somewhat lower than for groundwater quality networks.

Improving groundwater quantity monitoring has major observation costs implication if a higher density of measuring points and a higher measuring frequency are needed. The extra data management costs are relatively modest in comparison with measurement costs.

Improving groundwater quality monitoring has major capital cost implications only if significant numbers of newly constructed sampling points are required to replace unsuitable points, or to provide additional coverage. In comparison, capital cost requirements for additional sampling pumps or field equipment are relatively modest. There always needs to be some long-term capital cost provision to keep up with developments in instrumentation and to meet ever-lower detection limit requirements.

4.8 Summary: basic rules for a successful monitoring programme

The objectives must be defined first and the programme adapted to them, and not vice versa (as is often the case with multi-purpose monitoring). Adequate financial support must then be obtained.

1. The type and nature of the aquifer must be fully understood (most frequently through preliminary surveys), including the spatial and temporal variability within the aquifer. Very helpful information sources are maps of an appropriate scale (e.g. : 1:200,000) of the transboundary aquifer concerned:

2. hydrogeological and vulnerability map of the area (if it exists);

    - isoline maps of the aquifers' underlying and overlying geologic formations;

- maps of changes in groundwater levels;
- maps and lists of the hydrogeological boreholes (characteristic profiles and hydrogeological parameters), monitoring wells (with their basic data), significant groundwater abstractions (wells or well fields), location and abstraction data, and wells of regular water quality sampling (list of parameters);
- all isotope data concerning the age and origin of the groundwater.

3. The appropriate well type (or spring) must be chosen.
4. The parameters, type and frequency of measurements and sampling, and the locations must be chosen with respect to the objectives.
5. The analytical field equipment and the laboratory and data analysis facilities (e.g. models) must be selected in relation to the objectives and not vice versa.
6. A complete and operational data treatment scheme (DAP) must be established.
7. Groundwater monitoring should be coupled with surface water monitoring when applicable.
8. The quality of the collected data must be regularly checked through internal and external control. The data should be given to decision makers, not merely as a list of variables and their concentrations or levels, but interpreted and assessed by experts with relevant recommendations for management action.
9. The programme must be evaluated periodically, especially if the general situation or any particular influence on the groundwater flow system has changed, either naturally or by measures taken.

5. Data management

Data produced by groundwater monitoring programmes should be validated, stored and made accessible. The goal of data management is to convert data into information that meets the specified information needs.

5.1 Data management steps

Collecting and processing data is expensive. To safeguard the future use of the collected data, several data management steps are required before the information can be properly used:

- data should be analyzed, interpreted and converted into defined forms;
- collected data should be validated or approved before they are made accessible to any user or entered into a data archive;

- information should be reported to those who need to use it for decision-making, model validation, management evaluation. The information should also be presented in tailor-made formats for different target groups (e.g. GIS maps are easily accessible);

- data and information necessary for future use should be stored, and the data exchange should be facilitated not only at the level of the monitoring body itself, but also at all other appropriate levels (international, ECE regionwide, aquifer, etc.).

5.2 Data dictionary

The first archiving of monitoring data generally takes place at the monitoring agencies in each country. Transboundary cooperation will involve the exchange of data, especially when modeling is used in joint assessments. Then databases should be harmonized to the necessary extent. To facilitate the comparability of data, strict and clear agreements should be made on the coding of both data and meta-information. If data are to be stored, attention should be given to standardized software packages for data management, and to data storage formats to improve the possibilities for data exchange. Furthermore, agreements regarding the availability and distribution of data may facilitate the data exchange. A data dictionary containing this information and agreements on the definitions of terms used for the exchange of information or data should be agreed and jointly drawn up.

5.3 Data validation

Notwithstanding the quality control of separate procedures (well drilling, sampling, analysis), data validation should be an intrinsic part of data handling. The regular control of newly produced data should include the detection of outliers, missing values and other obvious mistakes (e.g. mg/l versus µ/l). Computer software can help to perform the various control functions, such as correlation analysis and application of limit pairs. However, expert judgment and thorough knowledge of the groundwater systems are indispensable for this validation. Where the data have been thoroughly checked and the necessary corrections and additions made, the data can be approved and made accessible.

5.4 Data storage and meta-information

To be available for future use, data should be stored in such a manner that they are accessible and complete with respect to all the conditions and qualifiers (e.g. detection limits) pertaining to data collection and analysis. Information on the dimensions and units should be stored. Furthermore, a sufficient amount of extra data (‘meta-information’), which is necessary for interpretation, has to be stored. Characteristics regarding place and depth of sampling, type of observation point, preconditioning and analytical techniques are commonly stored. For modeling purposes of transboundary aquifers, the standardization of the accessibility of data (interfaces to databases and GIS) is more important than the standardization of the software used.

The huge amounts of data collected from groundwater monitoring networks are preferably stored in relational databases, which should be the cornerstone of an integrated Geographical Information System (GIS). Although stored in a well designed database, an information system is needed to manage, retrieve and visualize the stored data in such formats as maps,

graphs, diagrams, and reports. Graphical interfaces will make the information management system more user-friendly as knowledge of the physical structure of the database is no longer necessary. It is essential that any database system is safeguarded against the entering of data without proper meta-information.

5.5 Data analysis and data interpretation

The conversion of data into information involves data analysis and interpretation. The data analysis should be embedded in a Data Analysis Protocol (DAP) which clearly defines a data analysis strategy and takes into account the specific characteristics of the data concerned, such as missing data, detection limits, censored data, data outliers, non-normality and serial correlation. In general, data will be stored on computers and the data analysis, mostly a statistical operation, can make use of generic software packages and/or GIS. To achieve standard automated data analysis, the use of tailor-made software is recommended.

5.6 Data exchange

There is a need for a standard (or format) for the purpose of exchanging digital data. The data dictionary should be the basis for the definition of such a standard or format. Data storage systems of neighboring countries should be able to handle the agreed data exchange format and ideally allow data to be imported into modeling, or analysis packages.

5.7 Reporting

The DAP may be extended to reporting formats for the resulting information (e.g. GIS maps). A reporting protocol can help to define the different characteristics for each use, or audience and should include certain guidelines regarding frequency of production, information content/detail and presentation format. Monitoring objectives should always be presented as part of the reported information.

Reporting information is the final step in the data management programme and links the gathering of information to the information users. To distribute the information, reports should be prepared on a regular basis. The frequency and the level of detail depend on the use of the information It is recommended that (annual) state reports should be provided for each transboundary groundwater system to focus on the link between policy measures (societal response) and the state of the groundwaters concerned.

6. Joint or coordinated action and institutional arrangements

The successful drawing-up and implementation of policies, strategies and methodologies on groundwater management crucially depends on institutional aspects. These include the organization, structures, arrangements for cooperation and the responsibilities of institutions and organizations involved.

6.1 Concerted action plans and programmes

Parties should agree on quantified management targets. These targets should become part of a concerted action plan or programme. This plan or programme should also cover other measures aimed at achieving rational groundwater management, conserving groundwater resources and protecting the environment. This action plan or programme should include provisions for mutual assistance, where necessary. It should be subject to approval at ministerial or senior official level. The action plan or programme can either be derived from existing national plans or programmes or set the preconditions for the establishment of such national plans or programmes.

The concerted action plan should at least include such items as:

a. Groundwater uses, taking into account that restrictions.

b. Protection zones, taking into account that these should help to prevent pollution of groundwaters in current and future groundwater abstraction areas for supplying drinking water.

c. Economic activities, whereby particular attention should be paid to the transboundary impact of economic activities on groundwater quality and quantity. An exchange of necessary information and bilateral and multilateral cooperation are needed to this end.

d. Groundwater abstractions, taking into account that groundwater abstractions for economic needs should be agreed upon to ensure the sustainability of groundwater use.

6.2 Joint bodies and their activities

Governments should set up joint bodies, where these do not yet exist, and include monitoring and assessment of transboundary groundwaters in the activities of these joint bodies. It is of less importance whether countries set up separate joint bodies responsible for either transboundary groundwaters, or whether they entrust one body with activities both linked with surface waters and groundwaters. However, it is of the utmost importance that, where two or more joint bodies have been set up by countries in the same catchment area, these countries agree on ways and means to coordinate the activities of these joint bodies.

Countries should, where appropriate, entrust the joint body with the drawing-up and supervision of the concerted action plan, or establish a technical working group under the joint body which is responsible for ongoing investigations under the action plan related to monitoring and assessment as well as for defining and implementing the monitoring and assessment strategy, including its technical, financial and organizational aspects.

Countries should, through their respective joint bodies, establish close cooperation ‘across the border’ between administrative authorities dealing with land-use planning and development, the rational use and the protection of groundwater and groundwater monitoring at the early stages of the planning process and at all levels of administration. This will help to overcome conflicting interests in sectorial planning both in the national and in the transboundary contexts. Because of differences in the organization of licensing procedures, countries should

jointly agree on a harmonized system of licensing procedures which does not conflict with the existing national legislation systems or adapt the national systems accordingly.

Through their joint bodies, countries should give each other access to relevant information on groundwater quality mand quantity. Through their joint bodies, countries should make arrangements so that the public has access to relevant information. To be effective, arrangements for the exchange of information should be governed by rules jointly agreed by the countries. These arrangements should specify the format and frequency of reporting. The creation and maintenance of a joint database could also be useful. In drawing-up these arrangements, account should be taken of obligations under other international agreements and supranational law, such as European Community directives.

Countries should, where appropriate, assign to their joint bodies responsibilities related to quality systems. Particular attention should be paid to the harmonization of sampling and data-processing methodologies, as well as laboratory accreditation. Cooperation on the local level for carrying out monitoring practices should be encouraged and promoted including direct contacts between laboratories and institutions involved.

6.3 Other arrangements at the national and/or local levels

The lack of proper institutional, legal or administrative arrangements at the national and local levels may considerably hamper international cooperation. Such arrangements include the cooperation between local governments, the responsibility for and ownership of groundwater, legislation and regulations (e.g. abstraction permits, protection areas), the coordination of quality and quantity monitoring by various national institutes and the appointment of a national reference laboratory.

Parties should provide sufficient funding for the execution of monitoring and assessment activities and joint research. This funding could be part of the regular budget. Each country should take care of its own requirements. Funding can, for example, be based on pollution charges or fees. The establishment of an environmental fund, from which companies can take loans for investments, may accelerate improvements.

APPENDIX 2: Licensing framework in Hungary

Exploitation of geothermal energy in Hungary is under a dual regulation of mining and environmental protection – water management. Utilization of geothermal energy falls within the scope of the *Mining Act XLVIII of 1993*, except for cases when it happens with production of groundwater (1§). In this latter case the provisions of the environmental and water management legislation have to be considered. In view of that, the licensing procedure is also two-folded and depends on two basic facts: whether the geothermal utilization happens with or without the abstraction of thermal water, and on the depth (below or above -2500 m, i.e. whether it is obliged to concession or not, according to the Mining Act). Accordingly, the licensing procedure can be initiated at the 'green authorities' (above -2500 m, with water production), or at the mining authorities (below -2500 m, without water production). However in all cases the partner authority takes part in the licensing procedure as consulting co-authority (Table 1).

In mining and geology affairs the competent designated authority is the Hungarian Office for Mining and Geology, which has 5 regional offices (Mining Inspectorates, as first-instance authorities). The Hungarian Office for Mining and Geology, as a governmental agency is supervised by the Ministry of National Development. Its main task in the licensing procedure is related to the concessional procedure (below -2500 m,), and the technical-safety licensing of deep drillings (for details see the Mining Act in the legislation overview).

In environment and water management-related affairs, the competent designated authority is the National Inspectorate for Environment, Nature and Water under the supervision of the Ministry of Rural Development. It has 10 regional inspectorates and 2 sub-offices ('green authorities') at first instance. In the licensing procedure they are responsible for issuing the different water- and environmental permits, outline protection zones (see details in the legislation overview).

Table 1 Flow chart of licensing procedures

Depth below surface (m)			Licensing Authority	Consulting co-authority
0-20				
20-2500	Open area	Closed loop, no water produced (GSHP)	Regional Mining Inspectorate	
		Abstraction of thermal water	Regional Inspectorates for Environment, Nature and Water	Regional Mining Inspectorates (technical-safety licensing of deep drilling)
Below 2500	Closed area (concession procedure)	Abstraction of thermal water	Regional Mining Inspectorates	Inspectorate for Environment, Nature and Water (water permits)
		without production of	Regional Mining Inspectorates	Inspectorate for Environment, Nature

		thermal water (EGS)		and Water (environmental impact assessment)

None of the above listed regional first-instance authorities' territorial shape of competence fits with the official EU NUTS regions in Hungary.

Furthermore, local municipalities also have a decisive role in licensing affairs. The Hungarian Bureau of Energy has got a prime role in power plants, electricity, gas network issues and setting the trade-in prices. It has no regional authorities.

The licensing/permission procedure is always conducted by the responsible authority (see 'licensing authority' in Table 1) that has to collect and incorporate the opinion of the participating co-authority, so this is not the task of the applicant (however the applicant has to provide all necessary documentations). (Principle of 'concentration' or 'one-stop shop' according to *Act CXL of 2004 on the general rules of administrative official procedures and services*).

1. Steps of licensing

1. To carry out a preliminary surface survey, the company needs to have an agreement with the caretaker/user of the land and report the commencement of prospection to the mining authorities 30 days in advance (surface survey itself does not require a permit from the mining inspectorate). The report has to contain the exploration plan (text and map showing locations) (Mining Act, 4§).

2. Exploitation of geothermal energy in Hungary down to a depth of -2500 m is happening all the time with the abstraction of thermal water (except for GSHP-s), so they licensing falls in the competence of the responsible Regional Inspectorates for Environment, Nature and Water, where the application has to be submitted. The procedure of licensing (applications for the planning (preliminary)-, construction- and operation permits) are regulated in KHVM / Ministerial Decree 18/1996 (VI.13.), and in Governmental Decree 72/1996 (V.22.) (see details in the legislation overview).

   The licensing procedure of the production and reinjection wells has to be handled separately, however the procedure is rather the same for both drillings.

   The technical-safety licensing of the drilling is issued by the Mining Inspectorates.

   In case of activities fall within the scope of an environmental impact assessment study, the user must obtain a valid environmental permit (also issued by the green authority) before starting activities. Details are given in the *Governmental Decree 314/2005 (XII.25.)* (see legislation overview).

3. Below -2500 m geothermal energy (with, or without thermal water abstraction) falls under concession, whose steps are given in the Mining Act articles 8-19 as well as in *Governmental Decree 103/2011 (VI.29.)* (for details see legislation overview). Environmental permit, and (if necessary water permits) are issued by the green authority (see above).

2. District heating

In the field of district heating, two authorities are empowered: the Hungarian Energy Commission and the local government. According to *Act XVIII of 2005 on district heating* (articles 4-8) the Hungarian Bureau of Energy is the responsible authority in case that heat energy and electrical energy are produced in a construction , either separately, or combined and heat energy is produced partly, or completely for district heating. For this reason a permit for the installation and a permit for the operation of a heat producing construction are granted by the Hungarian Bureau of Energy. In all other cases, (i.e. producing only heat energy for district heating, but no electrical energy), the local government is the responsible authority.

3. Heat pumps

The licensing of closed-circuit vertical heat-pump doublets is performed by the mining inspectorates, according to *GKM /Ministerial Decree 96/2005 (XI.4.)*. The application for open groundwater doublets has to be submitted to the regional green authority.