

## **Groundwater bodies in Estonia and their Compliance with River Basin Districts**

### **Criteria for identification of Groundwater bodies in Estonia.**

Hydrogeologically Estonian area is a typical artesian basin with 5 main aquifers divided into a greater or lesser extent by impervious beds: Devonian (D) in Southern Estonia and Silur-Ordovician (S–O), Ordovician-Cambrian (O–C) and Cambrian-Vendian (C–V) in Central and Northern Estonia. The uppermost aquifer is the Quaternarian, that feeds the deeper aquifers by 62 m<sup>3</sup>/s. Available resource of groundwater is 1.5 million m<sup>3</sup> per day.

The total amount of groundwater is about 2000 km<sup>3</sup>, being fed on precipitation about 70 mm (3.2 km<sup>3</sup>) annually. The most intensive infiltration areas are uplands, which form only 16% of Estonian territory, at the same time when 40% of infiltration takes place there.

The guidance of EUROWATERNET “The European Environment Agency's Monitoring and Information Network for Inland Water Resources. Technical Guidelines for Implementation” has been taken as the basis for the criteria for identifying the groundwater bodies in Estonia.

According to this, groundwater bodies can be defined when at least one of the following three requirements is met:

1. > 300 km<sup>2</sup>;
2. regional, socio-economic or environmental importance in terms of quantity and quality;
3. exposed to severe or major impacts.

### **Number and explanation of groundwater bodies in Estonia**

Estonian Ministry of the Environment and Geological Survey of Estonia have two totally different opinions when it comes to the issue of the number of Groundwater bodies in Estonia.

1. According to the brought out criteria in Estonia, Geological Survey of Estonia has defined 30 groundwater bodies and it has been mentioned that according to the

EUROWATERNET criteria it would be possible to bring out even more groundwater bodies. The later Water Framework Directive (WFD) implementation guidance documents have added additional demands about water conductivity and quality to the three criteria that are set up by EUROWATERNET, but it is advised to keep account about possibly big number of groundwater bodies. (See the figure 1 and table 1)

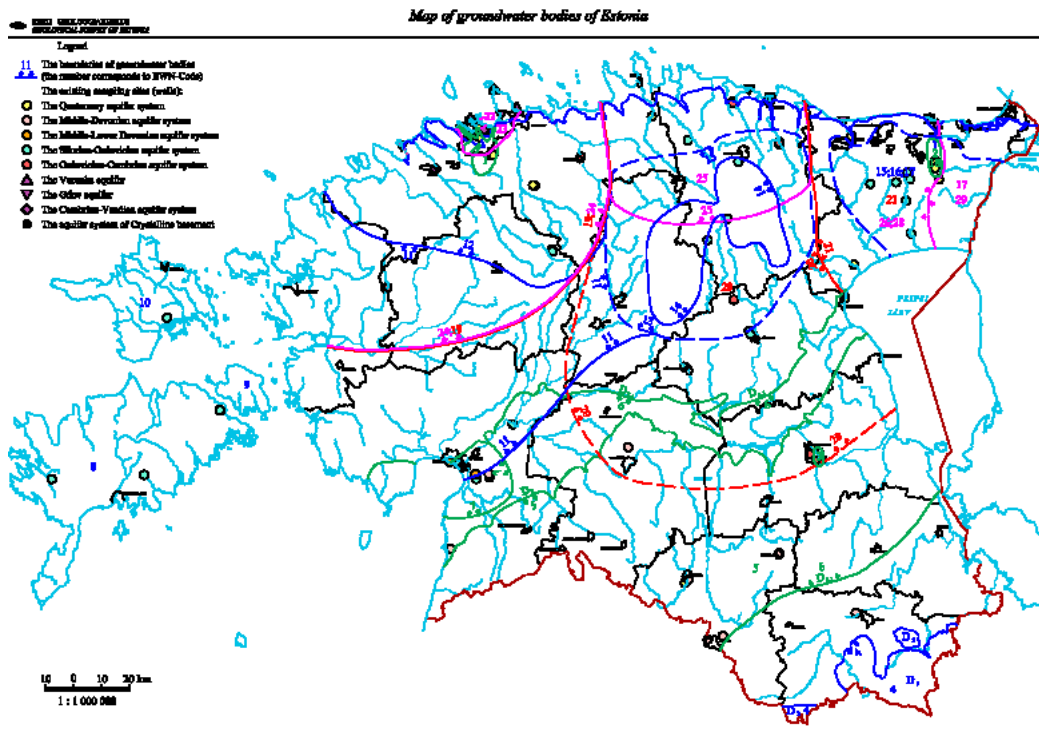


Figure 1. Groundwater bodies of Estonia

Table 1. The list of Estonian Groundwater subbodies

Name	Location	Area	Aquifer type
of the groundwater subbody	(province etc.)	(in km <sup>2</sup> )	(porous, fractured or karst)
Männiku - Pelgurand	Tallinn	120	porous - Q
Vasavere - Q	East - Viru	60	porous - Q
Meltsiveski	Tartu	15	porous - Q
Upper - Devonian	Võru	725	karst - D3
Middle - Devonian	South Estonia	12,8	porous - D2
Pärnu	South Estonia	11500	porous - D2-1
Reiu - Vaskrääma	Pärnu	500	porous - D2+1
Saaremaa	Saare	2,716	karst - S2
Muhumaa	Saare	206	karst - S2
Hiiumaa	Hiiu	1,023	karst - S+O
West Estonia	West Estonia	7,760	karst - S+O
North Estonia	North Estonia	4,020	karst - S+O
Pandivere springs	Pandivere Uppland	3,530	karst - S+O
Vault of Pandivere	Pandivere Uppland	1,280	karst - S+O
top of oil - shale	East - Viru	1,840	karst - S+O
oil - shale	East - Viru	1,940	karst O
underlayer of oil - shale	East - Viru	1,940	karst O
Vasavere - O	East - Viru	60	karst O
North - West Estonia	North - West Estonia	9,690	porous - O - C
Middle - Estonia	Middle Estonia	14,000	porous - O - C
East - Viru - O-C	East Viru	3,310	porous - O - C
Kopli	Tallinn	10	porous - C - V2
Tallinn - Viimsi	Harju	220	porous - C - V2
North - West Estonia	North - West Estonia	9,690	porous - C - V2
Lahemaa	Harju - W - Viru	3,550	porous - C - V2
East - Viru - V2vr	East - Viru	2,315	porous - V2vr
Border area - V2vr	East - Viru	995	porous - V2vr
East Viru - V2gd	East - Viru	2,315	porous - V2gd
Border area - V2gd	East - Viru	995	porous - V2gd
Crystalline basement	Estonia	45,215	fractured - PR1

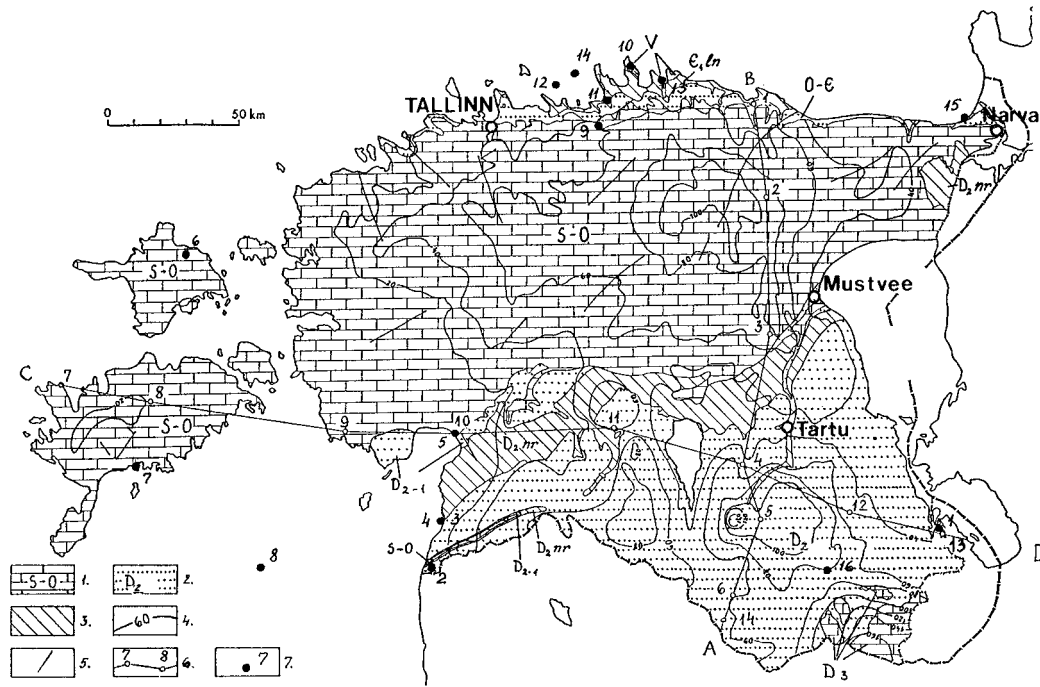
2. According to the widespread opinion in the environmental ministry of Estonia and among the members of The Estonian Groundwater commission it is advised to consider all the main 5 aquifers that were brought out above as Estonian groundwater bodies :

Devonian (D) in Southern Estonia

Silur-Ordovician (S-O), Ordovician-Cambrian (O-C) and Cambrian-Vendian (C-V) in Central and Northern Estonia.

And present them in the international level. There has been proposal to consider the other 30 groundwater bodies that are brought out by Geological Survey of Estonia as groundwater subbodies which have importance on the local level when it comes to completing and fulfilling the water management plans. And there is no sense to form

groundwater body without representative number of monitoring wells. (See the figure 2)



(1. -carbonaceous water-bearing rocks; 2. - terrigenous water-bearing rocks; 3. sporadically water-bearing and impermeable rocks; 4. - groundwater table, potentiometric surface (a s1, m); 5. - tectonic fault; 6. - cross-section; 7. - mineral water resource)

Figure 2. Hydrogeological sketch-map of Estonian aquifers and aquitard

### **Compliance of groundwater bodies with river basin districts (RBD)**

In compliance of Water Framework Directive (WFD) in the future all the environmental activity in Estonia is planned to take place on the bases of the river basin district (RBD)

According to the governmental regulation of the Republic of Estonia the territory of Estonia belongs to the Baltic Sea Drainage area and is divided into 8 +1 (Pandivere) river basin districts. (See the figure 3)

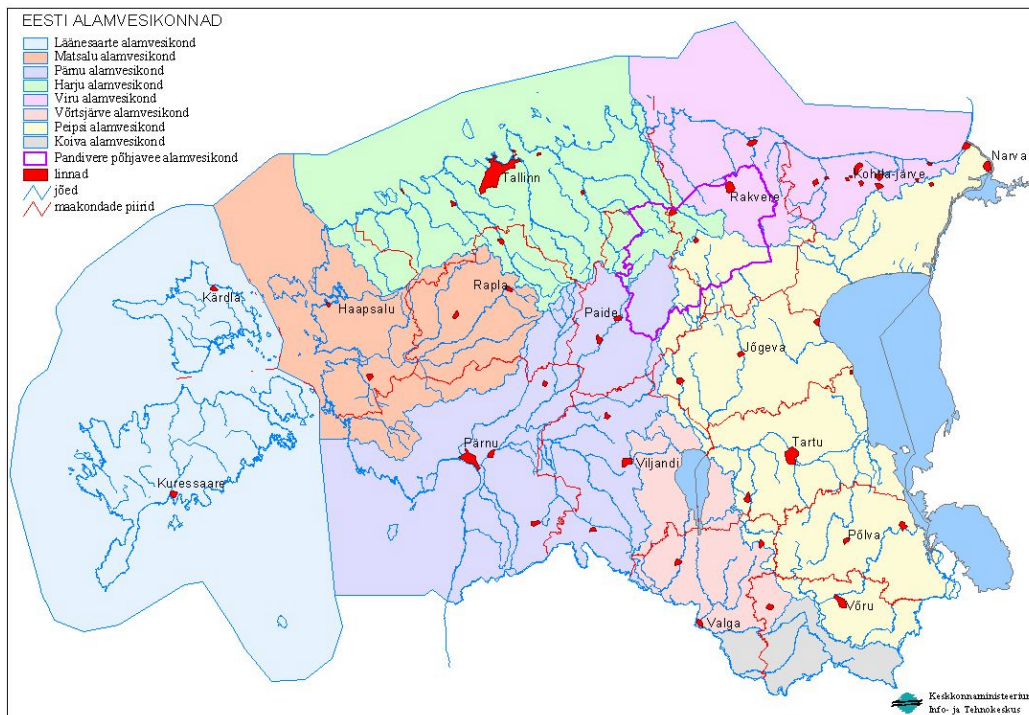


Figure 3. River Basin Districts in Estonia

Pandivere RBD has brought out separately due to the fact that this is where most of the rivers in Estonia are starting and because of the vulnerability to the antropogenic influence. Pandivere RBD has more Karst area in Estonia than any other RBD.

To arrange better groundwater protection it has considered necessary to chart/map groundwater bodies in the river basin district that correspond to the certain criteria.

As the identification of Estonian groundwater bodies was carried out in the framework of the project “ Support to the implementation of the EUROWATERNET in the Baltic Countries” in the year 2000 and that time Estonian territory was not yet divided into different river basin districts the assimilation/unifying of the borders of the groundwater bodies and the river basin districts afterwards is quite complicated.

Taking into account the needs of the water management through the river basin districts and the similarity of forming the close surface groundwater with the surface water the close surface groundwater should form independent groundwater body in the borders of each river basin district.

The close surface groundwater body is the first bedrock waterbody on which the main

part of the water supply of the population is based.

Although the movement of groundwater is not always corresponding to the river basin district borders it is principally possible, especially by defining the close surface groundwater bodies, to take into account the borders of different RBDs.

It assumes the necessity to unify the groundwater databases in the future in addition to the hydrostratigraphic and administration-territorial jointing also with RBDs and important groundwater bodies.

The given RBD distribution doesn't accept at all the borders of the distribution of the groundwater subbodies neither the utilisation intensity of the groundwater. Enormously big Peipsi RBD covers practically all the groundwater layers of Estonia.

In the deeper groundwater layers, where the borders of the groundwater sources do not correspond to the RBD borders it is advisably to (taking into account the formation and utilisation of groundwater) identify different groundwater subbodies and to get an agreement in accordance to their management.

#### Different groundwater subbodies in the RBD

##### \* West islands RBD

The following three groundwater subbodies are represented in West islands RBD:

- 1) Saaremaa groundwater subbody;
- 2) Hiiumaa groundwater subbody;
- 3) Muhumaa groundwater subbody.

In the named groundwater subbodies we can find groundwater of Silur-Ordovician (S-O).

Taking into account the principle of the drainage area in the water management it would be useful to count all the silur-ordovician groundwater complex as one west islands groundwater subbody. The biggest problems for the quality of groundwater are due to the tight restraint with the sea.

##### \* Matsalu RBD

Matsalu RBD holds in itself Kasari river that lies on the ordovician sedimentation rocks. It is an area with thickest surface layer in Northern and Central Estonia. The surface layer thickness is accordingly 2-10 m. In the point of view of the groundwater protection level the most important sediments are limnoglacial and they are also most

commonly distributed sediment type around the river Kasari. The common discharge area allows to treat close surface silur-ordovician water complexes as Matsalu groundwater subbody. The groundwater of deeper layers in that area belongs into:

- 1) NW-Estonian (ordovician-cambrian);
- 2) Voosi-Kroodi (cambrian-vendian) groundwater subbodies which management should be organized by Harju RBD because they do not follow the borders of Matsalu RBD.

#### \* Pärnu RBD

The RBD Pärnu is extremely heterogeneous by its geological structure. When to take into account Estonian hydrostratigraphical distribution it enholds in itself silurian middle-devonian outcrops of the groundwater complex. According to this the surface groundwater has divided between different subbodies:

- 1) Pärnu -Järva porous middle-devonian groundwater subbody;
- 2) Reiu-Vaskrääma groundwater subbody;
- 3) SW-Estonian middle-devonian groundwater subbody.

#### \* Harju RBD

In this RBD karst is widely spread. In the karst area groundwater is unprotected even with thick surface layer because during the period of flood surface water absorbs into groundwater within very short time period. Because of the heterogeneous hydrogeological structure it is possible to distinguish 4 groundwater subbodies in Harju RBD. They situate completely in the borders of Harju RBD or their borders coincide with the borders of RBD.

- 1) Männiku-Pelguranna quaternarian groundwater subbody;
- 2) Harju ordovician groundwater subbody;
- 3) NW-Estonian ordovician-cambrian groundwater subbody;
- 4) NW-Estonian cambrian-vendian groundwater subbody.

#### \* Viru RBD

It was rather unsuccessful to bring out Viru RBD according to the groundwater subbodies. Some of the groundwater is in the Viru RBD and some of it in Peipsi RBD. Even the water of deeper layers divides between two named RBD-s. Taking into account the principle of RBD, close surface groundwater subbodies of ordovician water

complex are divided not according to hydrostratigraphical jointing but by following the borders of Viru and Peipsi RBDs. The groundwater subbodies in the area are:

- 1) Vasavere quaternarian groundwater subbody. The importance of the groundwater body is very big because in the borders of the groundwater subbody is situated water supply unit which groundwater source is evaluated to 10 000 m<sup>3</sup>/d;
- 2) Viru ordovician groundwater subbody;
- 3) NE-Estonian ordovician-cambrian groundwater subbody;
- 4) East-Viru cambrian-vednian groundwater subbody.

\* RBD of Võrtsjärv

Geologically RBD of Võrtsjärv is quite homogeneous. One groundwater subbody has defined in the area and it is called middle-devonian groundwater subbody of Võrtsjärv.

\* Peipsi RBD

On the geological map practically all the stratigraphical units in the territory of Estonia are represented here- starting from upper-devonian and ending with ordovician and cambrian sandstones. The only unifying hydrogeological element is the fact that also the movement of close surface groundwater is taking place in the direction of lake Peipsi and river Narva. The groundwater subbodies represented in the area are following:

- 1) Meltsiveski quaternarian groundwater subbody;
- 2) Tartu middle-devonian groundwater subbody;
- 3) Pärnu middle- and lower-devonian groundwater subbody;
- 4) Peipsi silur-ordovician groundwater subbodies. In the borders of the groundwater subbodies in the northern part are occurring many problems. The northern part is situated East -Virumaa (NE-Estonia) where mining "Estonia" and Sirgala, Viivikonna and Narva oilshale open pits are situated.

\* Koiva RBD

The geological structure of the bedrock here can be divided almost two equal parts - in the western part of Koiva RBD are mainly middle-devonian sandstones and in the eastern part mainly upper-devonian.

According to this two groundwater subbodies are represented:

- 1) Koiva middle-devonian groundwater subbody;
- 2) Upper-devonian groundwater subbody.

\* Pandivere RBD

When taking into account surface water riverbasin districts Pandivere can almost equally be divided between Harju, Viru, Pärnu and Peipsi RBDs. Pandivere upland is the place where many rivers of Estonia are beginning and where forms the pressure of groundwater and it has been for a long time already in the middle of attention. Pandivere upland is the most karsteous area in Estonia and this explains the attention that it has got. Two groundwater subbodies have been brought out:

- 1) The groundwater subbody of Pandivere springs - To this groundwater subbody belong close surface groundwater layers till the depth of 30 m;
- 2) Groundwater subbody of Pandivere vault where belong waters of the deeper layers.