

7. Water resources and water supply

Water is of vital importance to life and health and to society as a whole. Providing good quality water and sufficient water at all times is therefore a primary objective in the supply of water. The authorities require all water works supplying more than 50 persons or 20 households or holiday homes, or supplying water to food manufacturers, health institutions, etc., to be approved by the authorities.

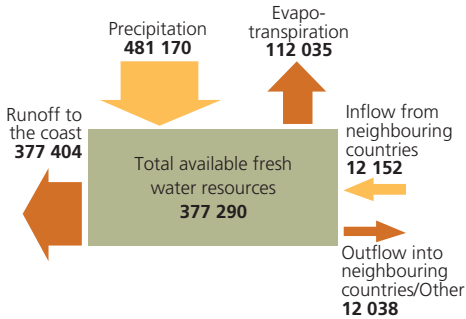
Figures from the Norwegian Institute of Public Health's water works register show that in 2006, a total of 1 570 water works (municipal and private) were subject to reporting requirements, and 284 of these recorded unsatisfactory results for pH. Furthermore, 163 water works recorded unsatisfactory results for water colour, and thermo-tolerant intestinal bacteria in the water were found at 93 water works (Norwegian Institute of Public Health 2008). Thus, the quality of drinking water supplied by a number of water works is still not satisfactory. There are many reasons for this, which vary from one water works to another.

Surface water is the main source of drinking water, and supplies about 90 per cent of the population in Norway (see Table 7.1). Even though the drinking water regulations (Ministry of Health 2001) require all water from surface water sources to be disinfected, many small water works still do not do this adequately. This means that the microbiological quality of drinking water may at times be unsatisfactory and may, at worst, cause illness. Warnings that water must be boiled before use must therefore sometimes be issued, as happened in Oslo in October 2007. Despite these problems, the quality of drinking water for most users in Norway is good (Norwegian Food Safety Authority 2006).

Norwegian lakes and rivers are vulnerable to acid rain, which for a long time has been regarded as one of the major environmental problems in Norway. However, a substantial reduction in sulphur and nitrogen releases in Europe has reduced the acidification load in Norwegian inland waters. Nonetheless, there is still a long way to go before the natural ecosystems in the most vulnerable areas have recovered, and new international agreements, such as the Gothenburg Protocol, have been concluded to reduce discharges of harmful substances even further.

7.1. Availability and consumption of freshwater resources

Figure 7.1. Annual available freshwater resources in Norway¹. Average for 1971-2000. Whole country. Million m³

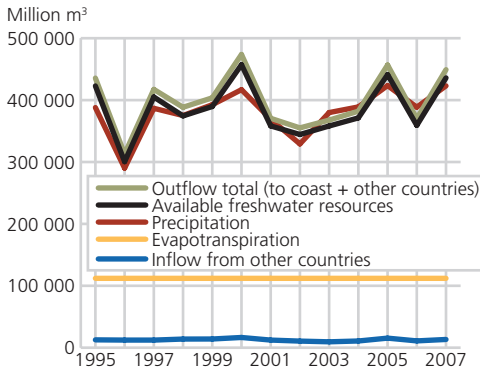


¹ Records of precipitation do not make it possible to calculate inputs with the same accuracy as runoff. As a result, there is a discrepancy between total inputs and total runoff in the figure. See also footnote to Figure 7.2. Based on normal values for precipitation and evapotranspiration in the period 1961-1990. Source: Norwegian Water Resources and Energy Directorate 2004 (methodology) and 2007 (data).

Available freshwater resources

- The water resources available in Norway in a normal year – runoff to the coast and outflow to neighbouring countries minus inflow from neighbouring countries – total about 377 billion m³.
- 98 per cent of the annual input of water resources is in the form of precipitation, while the remainder is in the form of incoming water flows via rivers from our three neighbouring countries.
- About 79 per cent of the annual input of water drains to the sea and to neighbouring countries through watercourses and runoff. The rest evaporates.

Figure 7.2. Trends in available freshwater resources, precipitation and runoff^{1,2} in Norway. 1995-2007



¹ This figure appears to show that runoff is higher than water input through precipitation. This is a well-known phenomenon in hydrology, and can partly be explained by the fact that not all precipitation is recorded at meteorological stations, particular in mountainous areas (but other factors may also be involved).
² Evapotranspiration is shown as the normal value for the period 1961-1990, as in Figure 7.1.

Source: Norwegian Water Resources and Energy Directorate 2007 and Norwegian Meteorological Institute 2008.

Box 7.1. The EU Water Framework Directive

As a party to the EEA Agreement, Norway is required to implement the Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000). The Directive, which entered into force in 2003, provides a framework for other EU directives of importance to water resource management, including the Urban Waste Water Treatment Directive (see Box 12.3). The main objective of the Directive is to protect and, if necessary, improve water quality in inland waters, estuaries, coastal waters and groundwater. Other objectives include promoting sustainable water resource use, and protecting terrestrial ecosystems that directly depend on water, such as wetlands.

The main principle in the framework directive is that inland waters, coastal waters and groundwater should have «good status» with regard to water quality. This means that by 2015, the volume and quality of bodies of water should not deviate substantially from the «natural» conditions that would have existed without the impact of human activity.

The key elements in the directive as regards water resource management are as follows:

- coordination of administrative arrangements
- specified environmental objectives for all water and a stronger focus on ecological conditions
- greater need for investigation and monitoring.

A management regime based on river basins means that all water within a river basin district and all activities that may affect the quality or amount of water are viewed as a whole, irrespective of administrative boundaries such as

municipal, county or national borders. A management plan is to be drawn up for each river basin district, and must include

- environmental objectives
- action plans (programmes of measures) for the bodies of water
- description of the river basin(s)
- impact of human activity
- protected areas (e.g. designated protected areas, recreation areas, areas defined as a result of other directives)
- the results of the monitoring of water bodies required by the directive.

Progress in Norway

The Ministry of the Environment has coordinating responsibility for the Directive, with the county governors responsible at the regional level. A steering group with representatives from the relevant directorates has been established to oversee the implementation of the directive in Norway.

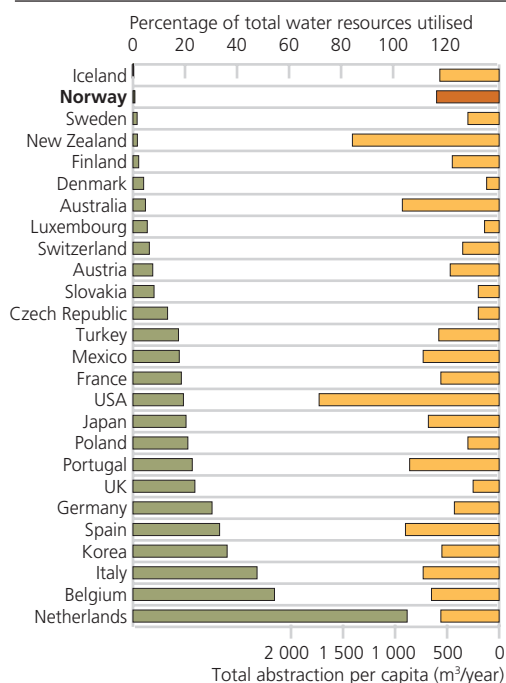
Management plans are to be drawn up for at least one river basin in each river basin district by 2009. Public consultations are being held on the proposed work programmes for this process.

The Ministry of the Environment is responsible for reporting to the EFTA Surveillance Authority on the progress of the various processes and developments in the status of water bodies.

See also the indicators for ecological status in aquatic ecosystems in the indicator set for sustainable development presented in Chapter 2.

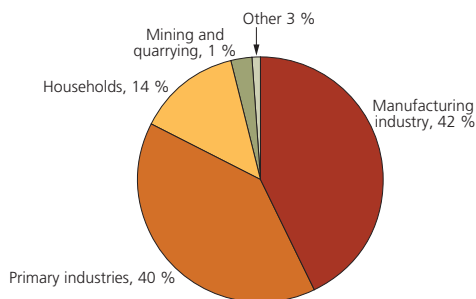
Source: Norwegian Institute for Water Research and Water Framework Directive (http://ec.europa.eu/environment/water/water-framework/index_en.html).

Figure 7.3. Percentage of total freshwater resources utilised and abstraction per inhabitant in OECD countries at the turn of the century



Source: OECD (2006). Figures for Norway have been updated on the basis of new calculations, see Statistics Norway (2008).

Figure 7.4. Freshwater consumption by sectors and households¹. 2005 or latest year for which figures are available. Per cent



¹ Leakages not included.

Source: Provisional figures from Statistics Norway.

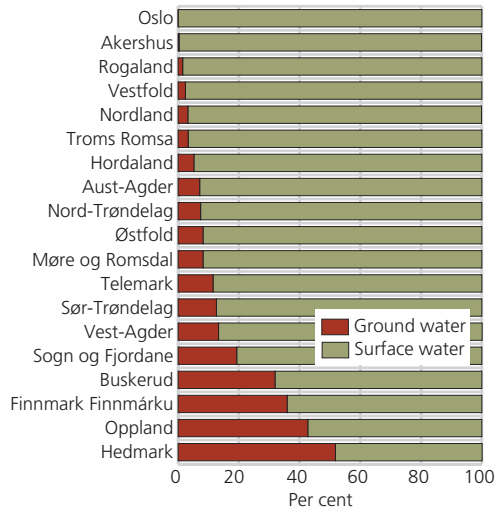
Water consumption

- Only 0.7 per cent of the freshwater resources available each year in Norway is utilised (water used in hydropower production is not included).
- The only OECD country that utilises a smaller percentage of its total available freshwater resources than Norway is Iceland (0.1 per cent).
- Per capita abstraction of freshwater in Norway is about 600 m³ per year. This is well below the average for the OECD countries (880 m³). The average in the US is 1 730 m³, and in Denmark 120 m³.

- A total of about 2.7 billion m³ of freshwater is used annually in Norway, and the manufacturing industries use about 1.3 billion m³ of this.
- The metal industry, the chemical industry, the pulp and paper industry and the food industry are the most important consumers of freshwater among the manufacturing industries. The primary industries use roughly the same amount of water as the manufacturing industries.
- Households use about 358 million m³ of freshwater. Manufacturing industries and the primary industries (agriculture, forestry and fish farming) largely meet their water needs from their own sources.

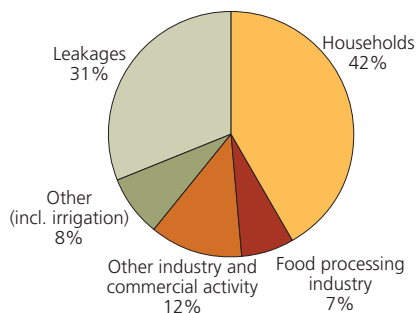
7.2. Public water supplies

Figure 7.5. **Percentage of population connected to municipal water works, split by type of water source. By county. 2006¹**



¹ Surface water includes four water works in Sør-Trøndelag and Nordland which supply 445 people using seawater as the water source. Source: National Institute of Public Health, water works register.

Figure 7.6. **Percentage of public water supplies used by various sectors¹. 2006**



¹ The figure is based on data for 1 570 water works in 2006. Source: National Institute of Public Health, water works register.

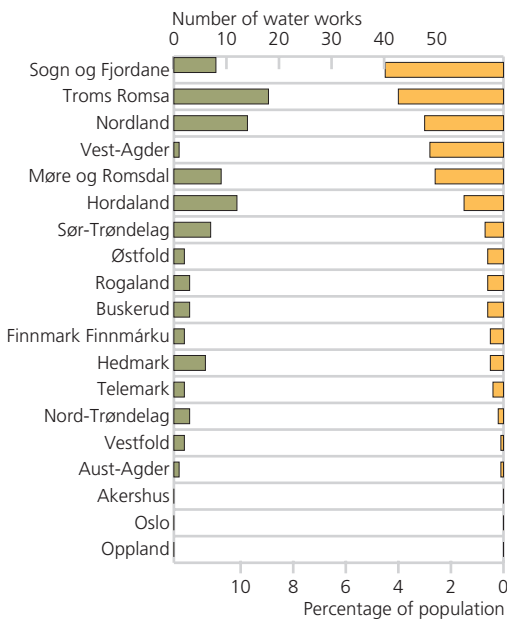
Water sources

- In 2006, about 90 per cent of Norway’s population was served by public water supplies from 1 570 water works. These water works, which include municipal, intermunicipal, state-owned and privately-owned water works, are subject to reporting requirements and registered in the water works register of the National Institute of Public Health. Water works that only supply holiday homes are not included. The remaining 10 per cent of the population was supplied by smaller water works or from their own water sources.
- In 2006, 38 per cent of Norway’s public water works used groundwater as their source of water, while the remainder used surface water. A limited number of people were supplied with desalinated seawater (see footnote to Figure 7.5).
- Only 10 per cent of the population was supplied with drinking water by water works using groundwater as their water source.
- The counties that in 2006 had the highest percentage of the population connected to water works using groundwater as their source were Hedmark, Oppland and Finnmark.

Production and consumption of water

- Water production at Norwegian water works in 2006 was calculated to be 743 million m³. Households used 42 per cent of this.
- About a third of the water produced was lost due to leakages from pipelines.
- Average household consumption was estimated at 197 litres per person per day in 2006.
- There is substantial uncertainty associated with these figures as they are largely based on estimates from the water works.

Figure 7.7. Number of water works where *E. coli* was registered, and percentage of the population who had to boil drinking water. By county. 2006¹

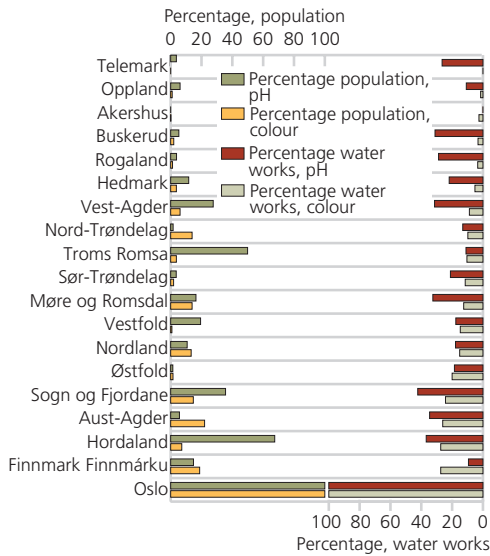


¹ Based on information from 1 301 water works that took samples to test for the presence of *E. coli*.
Source: National Institute of Public Health, water works register.

Water quality

- It is important to ensure that drinking water does not contain pathogenic bacteria, since their presence is an indication of faecal contamination of the water. The drinking water regulations therefore contain an absolute requirement for all water to be disinfected or treated to prevent the spread of infection. The treatment of drinking water involves adding chemicals (primarily chlorine), the use of UV radiation or membrane filtration.
- A number of water works using surface water as their source are finding it hard to comply with the requirements with respect to thermo-tolerant coliform bacteria in water. In 2006, the proportion of the population not receiving water of satisfactory quality was highest in the counties of Sogn og Fjordane, Troms and Nordland.
- Figures from 2006 for a sample of water works that supply 4.1 million people in Norway show that just under 1 per cent are supplied with drinking water that does not satisfy water quality with regard to *E. coli*. The *E. coli* bacterium is a common indicator of the presence of faecal contamination in water.

Figure 7.8. **Percentage of public water works that do not satisfy the requirements with respect to pH and colour, and percentage of population affected. By county. 2006¹**



¹ The figure is based on information from 1 223 water works that have made pH tests and 1 255 water works that have conducted colour tests. In Oslo, the information refers to one water works comprising several treatment plants. The main treatment plant is currently not satisfactory, but a new plant is under construction.
Source: National Institute of Public Health, water works register.

- A number of water works are finding it difficult to meet the pH and colour requirements. Figures from 1 223 water works that have taken samples to test pH values show that 23.2 per cent of them did not have satisfactory results. For colour, the proportion of unsatisfactory results is somewhat lower, 13.0 per cent of 1 255 water works.
- The proportion of people connected to water works with unsatisfactory results for water colour was highest in Oslo, Aust-Agder and Finnmark: for pH, the counties with the highest proportion of unsatisfactory results were Oslo, Hordaland and Troms.
- Acidic water (with a low pH) corrodes pipelines and can result in a high metal content in drinking water. High humus content colours the water brown and may cause sludge and unwanted bacterial growth in water pipeline systems. Chlorination of water containing humus may result in the formation of organo-chlorine compounds, with potential effects on odour, taste and health

Table 7.1. **Water sources, number of water works and number of people supplied. By county. 2006**

	Total		Lakes ¹		Rivers/streams		Groundwater	
	No. of water works ³	No. of people supplied ⁴	No. of water works	No. of people supplied	No. of water works	No. of people supplied	No. of water works	No. of people supplied
Whole country ³	1 487	4 228 554	576	3 466 562	352	349 088	560	412 904
Østfold	27	230 571	15	153 502	4	58 061	8	19 008
Akershus	28	477 541	19	353 576	1	122 385	8	1 580
Oslo	1	548 000	1	548 000	0	0	0	0
Hedmark	97	153 528	11	73 332	3	732	83	79 464
Oppland	74	127 612	19	69 751	7	3 358	48	54 503
Buskerud	62	237 188	16	161 622	0	0	46	75 566
Vestfold	29	219 663	9	214 488	0	0	20	5 175
Telemark	54	141 932	18	113 846	3	11 714	33	16 372
Aust-Agder	33	88 528	19	79 736	5	2 516	9	6 276
Vest-Agder	36	146 365	12	125 833	4	1 111	20	19 421
Rogaland	50	379 741	33	371 043	4	2 992	13	5 706
Hordaland	146	396 432	76	350 745	32	25 021	38	20 666
Sogn og Fjordane	104	79 067	42	48 159	35	15 649	27	15 259
Møre og Romsdal	152	225 119	54	183 040	52	23 575	46	18 504
Sør-Trøndelag	107	258 237	44	223 584	11	2 126	52	32 527
Nord-Trøndelag	72	106 148	36	97 070	7	1 227	29	7 851
Nordland	210	211 509	91	169 599	80	35 232	39	6 678
Troms Romsa	128	132 838	29	101 920	78	26 533	21	4 385
Finnmark Finnmarku	76	66 785	31	26 603	25	16 219	20	23 963
Svalbard ²	1	1 750	1	1 113	1	637	-	-

¹ Includes four water works in Sør-Trøndelag and Nordland which supply 445 people using seawater as the water source.

² One water works in Svalbard has two main sources of different types.

³ The table is based on information from 1461 water works that have supplied information on their water sources. Since some water works have several sources of different types, the figures in the column for total number of water works add up to more than the number of water works in the sample.

⁴ There are 174 people who are supplied by water works that have not provided information about their water source or that they receive water from other water works.

Source: National Institute of Public Health, water works register.

Box 7.2. Waterborne communicable diseases

Norwegian drinking water is generally considered to be of high quality. Nevertheless, outbreaks of disease caused by waterborne pathogens are reported every year. In the period 1988–2002, 72 outbreaks of waterborne disease were reported, involving a total of 10 616 registered cases (Nygård et al. 2003). In the period 2003–2007, 15 outbreaks of disease were registered (Nygård pers. comm.). The real number of outbreaks is probably higher. Short-term contamination of drinking water can result in sporadic cases of gastro-intestinal infection, and it is often difficult to identify the cause of such problems. People who experience short-term problems rarely seek medical attention, and several people in the same area may therefore be ill at the same time without this being registered as a disease outbreak (Nygård et al. 2003).

Outbreaks of waterborne disease can be acute and involve large numbers of people, since the inhabitants in a particular area generally receive drinking water from the same source, and are therefore likely to be infected at about the same time. It is therefore important to identify the source of an infection quickly. Under Norwegian legislation, the municipal medical officer is required to report outbreaks of disease to the Norwegian Institute of Public Health if food or drinking water is suspected to be the source.

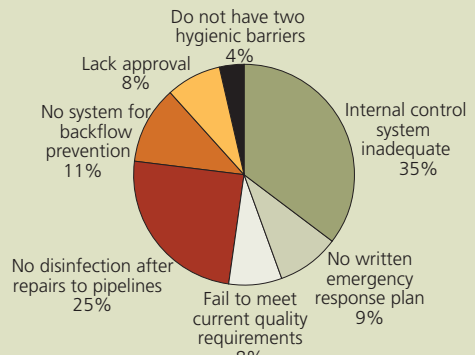
Outbreaks of waterborne diseases are generally caused by animal or human faecal contamination. Cholera, bacillary dysentery, salmonellosis, typhoid fever and hepatitis A are examples of waterborne diseases that used to be common in Norway. Today, diseases (mainly gastro-intestinal) are more often caused by bacteria such as *Yersinia enterocolitica* and *Campylobacter jejuni* and viruses such as Norovirus (Norwegian Institute of Public Health 2007). Parasites such as *Giardia intestinalis* and *Cryptosporidium parvum* are a common cause of outbreaks of waterborne disease in other developed countries (Nygård pers. comm.). An outbreak of *Giardia* in Bergen in 2004 was the first involving such parasites to be registered in Norway.

In a study of disease outbreaks in Norway in the period 1988–2002, *Campylobacter* and Norovirus were most frequently identified as the cause, but in many cases the cause was unknown. Contamination of raw water and inadequate disinfection were the most frequent reasons for disease outbreaks (Nygård et al. 2003).

In 2006 and 2007, the Norwegian Food Safety Authority carried out a nationwide inspection campaign for drinking water. This was done in response to the failure of some Norwegian water works to obtain approval and draw up emergency plans, and because drinking water is still linked

to disease outbreaks in Norway. The campaign focused on approval of water works and on compliance with the legislation in general, and looked particularly at distribution systems and emergency planning. The campaign covered 357 water works, which were chosen on the basis of a risk assessment. This corresponds to 26 per cent of all the separate water works listed in the Authority's drinking water register in March 2007. The water works in the sample supply 2.8 million people. No breaches of the rules were found at 43.5 per cent of the water works. In all, 943 breaches of the rules were found at 202 water works (see the figure). However, few of these were so serious that there was a health risk associated with drinking the water. Most of the water works were found to supply consumers with drinking water of satisfactory quality, but serious breaches of the rules at a small number were considered to represent a substantial health risk for consumers (Norwegian Food Safety Authority 2007).

The most serious breaches of the rules at water works. Per cent



Source: Norwegian Food Safety Authority.

Sources:

Norwegian Institute of Public Health: Smittsomme sykdommer i vann (Communicable waterborne diseases). http://www.fhi.no/eway/default.aspx?pid=233&trg=MainArea_5661&MainArea_5661=5631:0:15,3310:1:0:0:::0.

Norwegian Food Safety Authority: Nasjonal tilsynskampanje på drikkevann 2006. (Nationwide inspection campaign for drinking water 2006) http://www.mattilsynet.no/mattilsynet/multimedia/archive/00029/Sluttrapport_-_Matti_29907a.pdf

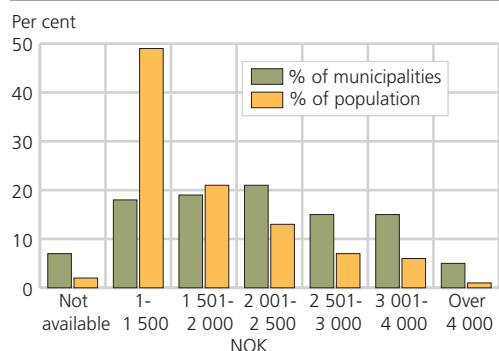
Nygård, K., B. Gondrosen and V. Lund: Sykdomsutbrudd forårsaket av drikkevann i Norge (Outbreaks of disease in Norway caused by drinking water). *Tidsskr Nor Lægeforen* 2003; 123: 3410–3.

Nygård, K.: Giardiasis - et undervurdert problem i Norge? (Giardiasis – is the extent of the problem in Norway underestimated?). *Tidsskr Nor Lægeforen* 2007; 127:155.

7.3. Fees in the municipal water sector

Norwegian legislation lays down that municipal water and waste water fees may not exceed the necessary costs incurred by the municipalities in these sectors. The fees must follow the principle of full costing, and must be based on estimates of the direct and indirect operating, maintenance and capital costs of water supply services. The annual fees must be calculated on the basis of measured or stipulated water consumption, or in two parts, one fixed and one variable. For properties where no water meter is installed, water consumption is as a general rule stipulated on the basis of the size of the buildings.

Figure 7.9. Variation in annual water supply fees shown as proportion of municipalities and population in different price classes. 2008



Source: KOSTRA, Statistics Norway.

Water supply fees

- The average water supply fee for the county as a whole rose by 7 per cent from 2007 to 2008.
- The fees vary significantly between municipalities, from NOK 659 to NOK 5 720.
- The reasons for the large variations in water supply fees have not been systematically surveyed, but in general, local conditions such as the size of the water works (economies of scale), the state of the water source, topography and population density will be important for the costs of providing water supplies and thus for the fees.
- The average fee is less than NOK 2 000 in 37 per cent of all municipalities. In all 71 per cent of the country's population lives in these municipalities, which illustrates the fact that annual fees are lower in the larger municipalities.

More information: Kari B. Mellem (kbm@ssb.no) (financial data) and Jørn Kristian Undelstvedt (jku@ssb.no).

Useful websites

Statistics Norway – Water and waste water statistics: <http://www.ssb.no/english/subjects/01/04/20/>

Statistics Norway – Environmental protection expenditure statistics: <http://www.ssb.no/english/subjects/01/06/20/>

Norwegian Institute of Public Health: <http://www.fhi.no/eway/?pid=238>

State of the Environment Norway: <http://www.environment.no/>

Norwegian Pollution Control Authority: http://www.sft.no/aktuelt____29292.aspx

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