STORAVATNET

- A POTENTIAL SPARE WATER SUPPLY AT HAUGALANDET

Could Storavatnet by Sandbekken be used as a spare water source for Haugalandet, and what environmental factors affects the quality of the water?

Written by:

Torjus Olai Erland Aartun, Evelina Nesse, Hans Christian Andersen, Lasse Stuvik, Andreas Aukland, Jonas Harboe, Maria Rønnevik, Adrian Låte Svendsbøe and Ann Rebekka Undheim

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Summary

The municipalities in the region of Haugalandet have looked at the possibility to create a communal source for a spare water supply for the entire region. Today, a large part of our municipality, Tysvær, get their drinking water from the lake Stakkestadvannet, but they also buy water from the neighbouring municipalities Haugesund and Karmøy. When the municipality are to discuss potential new spare water supplies, one possible solution is the lake Storavatnet near Sandbekken in Tysvær.

We reached out to the municipality to see if they had a suggestion to what our project could be, this is because we wanted our work to be useful. They were extremely positive about this and gave us the task to test the water for them, in order to figure out if the lake Storavatnet could be a potential source for drinking water in our region.

Storavatnet consists of five lakes in Tysvær, where Storavatnet near Sandbekken is the lake we have tested.

We have taken two water samples from four streams that are flowing out into Storavatnet, one simple sample and one extended sample, during the period from November to December 2018. We have compared the samples with the ones the municipality took themselves in July and August 2018. We got sample bottles from the Agency for Water and Sewerage Works, and the samples were sent to be analysed at Petrotech AS in Haugesund.

The water tests show that the especially the number of colour units exceeds the recommendations from the official drinking water regulations. The tests the municipality did last summer show a lower number of colour units, but these tests were taken in a period with irrigation restrictions due to extremely low rainfall. The tests also show that the number of coliform bacteria and E.coli exceed the recommendations. The problem with a high colour unit is that UV-radiation as a purifying technique is not sufficient to eliminate the bacteria from the water. We believe that Storavatnet near Sandbekken could be a spare water supply for our region, Haugalandet, in the future, given that some measures are taken. Since the waterworks in Tysvær only use UV-radiation as a purifying technique, either the water has to pass through another waterworks that offer a suitable form of filtration, or our own waterworks needs to be modified with modern technology. The sources of contamination need to be removed and some leisure activities probably need to be restricted in these areas.

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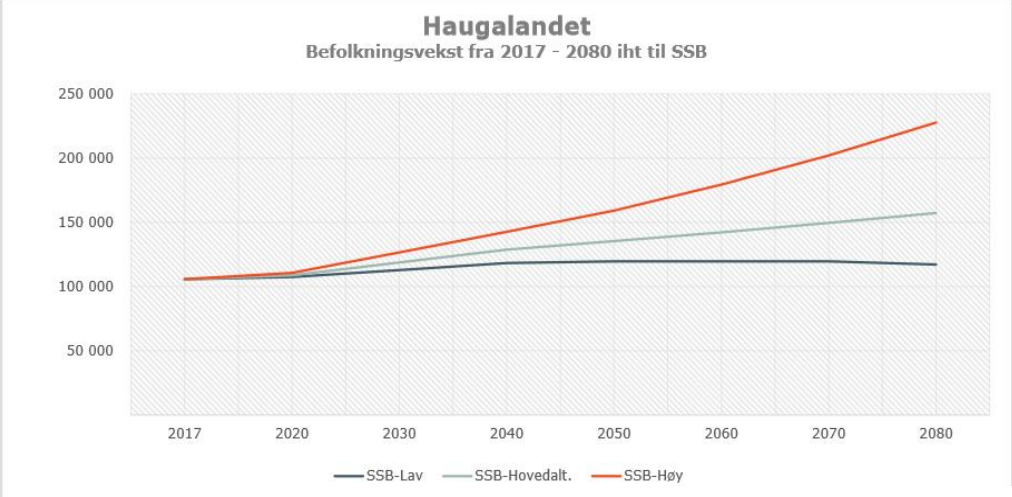
1.1 Introduction

1.1 Thesis statement

We are three girls and six boys from Frakkagjerd secondary school, who have the elective "Research in practice". We are in 8th to 10th grade. We contacted our municipality because we wanted a project that could be beneficial, and they were positive to give us a mission. Haugalandet, which includes the municipalities Tysvær, Haugesund, Vindafjord, Sveio, Karmøy and Bokn, have together investigated the possibility of creating a common reserve water source for the entire region. Today, large parts of Tysvær receive the drinking water from Stakkestadvannet, but water is also bought from both Haugesund and Karmøy. There are forecasts of population growth in Haugaland, and therefore a reserve water source is needed. Storavatnet in Tysvær is one of the possible sources that the municipality takes in the discussion, and together we came up with the following thesis statement; *could Storavatnet at Sandbekken be used as a reserve water source for Haugalandet, and what environmental factors affect water quality?*



Estimated population development Haugalandet in accordance with various options from Statistics Norway, obtained from COWI project note no. 1 "Reserve water supply Haugalandet" (from June 2018)

1.2 Hypothesis

We have shared opinions about if Storavatnet can become a future spare drinking water source for Haugalandet. There are many farms along the entire water and other sources of pollution that can contribute to the quality getting worse. In addition, there is a leisure facility by the water, which is frequently used during the summer months. We believe that the municipality must make some changes regarding agriculture and the campsite by the water.

1.3 Storavatnet

Storavatnet consists of five lakes in Tysvær municipality, Rogaland. It is Storavatnet (Falkeid in Tysvær), Storavatnet (Hetland in Tysvær), Storavatnet (forest in Tysvær), Storavatnet (Stakland in Tysvær) and Storavatnet (Sagbakken in Tysvær).
The water we have examined is the latter, Storavatnet at Sagbakken. The lake is 13 mamsl, the maximum depth is 42 m and has an area of 2.36 km^2. This is a lake with many fishing opportunities, with a leisure facility offering accommodation, canoeing and fishing. Close to the water is also the Cleng Peerson house, which has a lot of visitors, especially during the summer.

1.4 Drinking water requirements in Norway

In the Drinking Water Regulations, we have found the quality requirements for drinking water.

- Drinking water must be hygienic and without harmful bacteria, parasites and viruses.
- The water must be clear without smell, colour or taste.
- The water must not contain any physical, chemical or biological substances, which may present a hazard to health by normal use.
- The water must not contain E. coli, coliform bacteria, intestinal ether oxides or C perigens (bacteria found in animal and human faeces)
- There is no limit value for germ counts, but at values > 100 (number / ml of water) the cause must be investigated.2.0 Methods

2.0 Methodes

2.1 Collection of water samples

We took water samples from four different streams that runs out into Storavatnet (see map). At first sampling, we were assisted by an employee from the Agency for Water and Sewerage Works in the municipality, which showed us which streams were to be sampled and how the samples were to be taken. We were given sample bottles, took the samples with guidance, and the samples were sent to Petrotech AS for analysis. The water samples from Storavatnet are taken from just below the surface.

2.2 Water analysis

We have taken two water samples during November and December 2018. The first sample was a simple test, where it was tested for germ counts, coliform bacteria, intestinal enterococci, clostridium perfringens, turbidity, color unit number and pH. The second sample was an expanded sample, which tested for, among others, chloride, nitrate nitrogen, TOC, calcium, iron, manganese, silicon and bromide in addition to those on the single sample. In addition, the municipality has taken water samples in July and August 2018, a period of very little rainfall, which we can look back on.

3.0 Results

3.1 Results from former water samples

The municipality itself has taken samples of Storavatnet in July and August 2018, before the start of our project. This was a period of little rainfall, so little that the municipality had a watering ban for much of this period. The results are shown in the table below.

1. Storavatnet

Parameter	Enhet	Min.	Middel	Maks.	Ant. prøver	Ant. påvist
Koliforme bakterier	MPN/100ml	0	>140	>201	6	6
Escherichia coli	MPN/100ml	0	1,2	3	6	6
Clostridium perfringens	cfu/100ml	0	0,7	2	6	4
Konduktivitet	mS/m	4,4	4,6	4,7	2	2
Farge, filtrert	mgPt/l	27	30,0	33	2	2
Total fosfor	mg/l	0	0,012	0,023	2	1
Total nitrogen	mg/l	0,37	0,38	0,39	2	2
pH, surhetsgrad		6,3	6,3	6,3	1	1
Temperatur v/ pH-måling	°C	23	23,0	23	1	1
Turbiditet	FNU	0,36	0,4	0,4	2	2

Figure 1: Table taken from PP presentation "Reserve water Haugalandet - Discussion basis for meeting 12.09.2018»

3.2 Results from our samples

The result showed that the amount of E. coli, coliform bacteria and germ counts exceeds that recommended in the Drinking Water Regulations. E. coli, coliform bacteria and germ counts are relatively easy to clean out, but the problem in Storavatnet is the high color unit number (farge, filtrert). We have therefore chosen to focus on that in this report.

When we add the two analysis results from the samples we have taken on November 20 and December 11 from the four streams, this was the result:

Parameter	Unit	Min.	Average	Max
Colour units	mgPt/l	29	52,87	78

Tablel 1: Extracts of results, colour units.

The smallest colour unit number, which was 29 mgPt /l, was taken from stream 4 (same result both times). Based on what we could observe, there was least settlement around this stream, and the water came running down from a mountain, which may have had an impact on the result. Around the other 3 streams, especially around stream 3 which had the highest colour unit number, there was farming around the area.

We can highlight these results:

Parameter	Unit	Limit	Min.	Average	Max
E. Coli	Number/100 ml	0	0	13,125	38
coliform bacteria	Number/100 ml	0	45	121,25	>201
Intestinal enterococci	Number100 ml	0	0	1,375	5
Colony count 22°C	Number/100 ml	100 and no abnormal change	190	>300	>300

Table 2: Extracts of results. Limits after the Drinking Water Regulations.

4.0 Discussion

The colour unit number is due to organic matter in the water. Time series with colour measurements (colour units) in Norwegian drinking water sources show that the colour number is increasing. Factors that explain much of the observed colour increases can be climatic conditions, especially precipitation. Increased content of organic matter in the water makes the quality of the raw water worse, with regard to smell and colour and affects a number of conditions relating to the operation of a water treatment plant.

The organic substances, also called humus, are the brown compounds that leak out when water comes to the soil. The brown colour comes from complex carbon compounds from degrading plant and animal material. Separation products from microorganisms, animals and plants may also have something to say. Water with humus has no known direct health effects, but it reduces the efficiency of the various processes used for disinfection, and can cause radiation attenuation by UV radiation. Chlorine is inactivated by reducing it to chloride by oxidation of organic matter, and the side effect of this is that some chlorine is bound to

organic matter to form chlorinated organic compounds, which can be carcinogenic. Trihalomethanes (THM) are one of the by-products most commonly formed, and in the Drinking Water Regulations a limit value has been set for this.

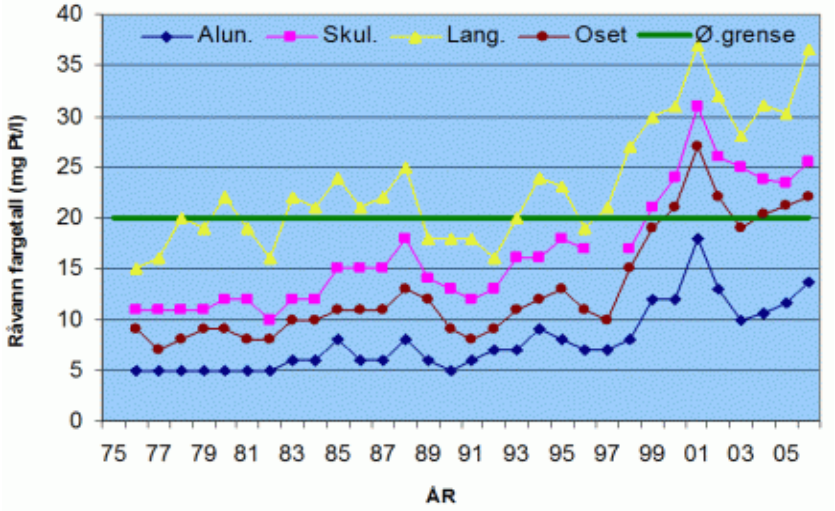


Figure 2: Colour units in raw water sources in the Oslo-region.Data from VAV in Oslo. The points represent the mean of monthly measurements. Alun = Alunsjøen, Skul = Skullerud waterworks with Elvåga as raw water source, Lang= Langlia, Oset waterworks with Mariadalsvannet as raw water source. Table obtained from klimakommune.no

Climate change influence the nature, by for example change in the amount of rain, flood frequencies and frequency. The climate changes may have something to do with increased occurrence of humus substances in raw water. Figure 3 shows the development of colour units in raw water in Oslo region from 1975 to 2005. The green line shows the highest allowed colour unit (20 mgPt/l) in drinking water (Drinking water regulations). We can also see a development of high colour units from the local waterworks in Tysvær municipality. Figure 4 shows the development from May 2016 until December 2017.

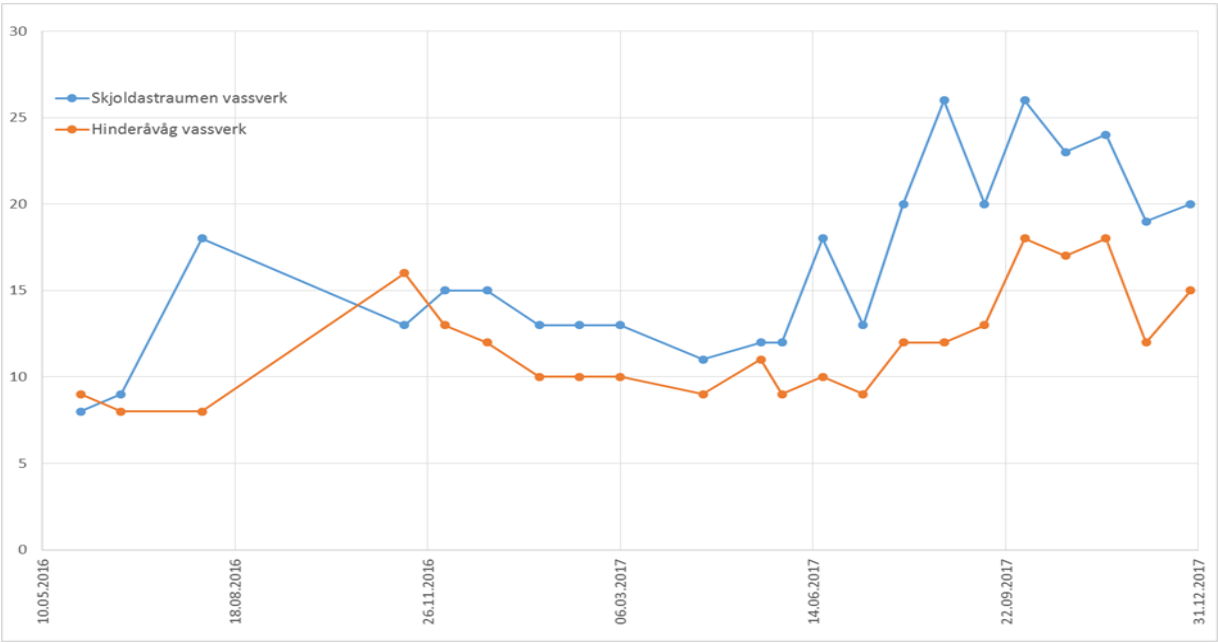


Figure 3: Colour units. Obtained from PP-presentation «Reservevann Haugalandet - Diskusjonsgrunnlag for møte 12.09.2018»

An article in NRK Rogaland from 2017, tells that huge amount of rainfall gave smaller waterworks big problems, resulting in people from six different areas having to boil their drinking water. In Skjoldastraumen in Tysvær, the drinking water was not drinkable for a week because of coliform bacteria. Then the head of water supply in Tysvær municipality, Erling Severinsen, told NRK that the problem was caused by surface water that got into the drinking water. The large amount of rainfall brought with it the pollution on the ground. The drinking water was cleaned using UV-radiation, but because of the high colour unit number, the coliform bacteria was let through. To get rid of the bacteria, the water had to have a shock treatment of chlorine and then washed out again. At the same time, there were problems with the waterworks at Risoy in Haugesund, Sveio og Høle in Sandnes.

5.0 Conclusion

Tysvær municipality buys water from Karmøy and Haugesund. This water is purified before it comes into our system. Tysvær also has its own water purification system, one in Skjoldastraumen and one in Nedstrand, where it is purified only with UV-rays. UV-radiation involves that the water is being radiated by light in the 254-nanometre spectre to kill what is of microbiological activities. Coloured water have no direct health consequences, but in chlorinated drinking water, the chlorine reacts with the organic material and creates connections that can damage our health. Raw water (that we have tested) with high contents of organic material must be cleaned to satisfy requirements in drinking water regulations. The increased colour number can have a connection with the climate change the last years.

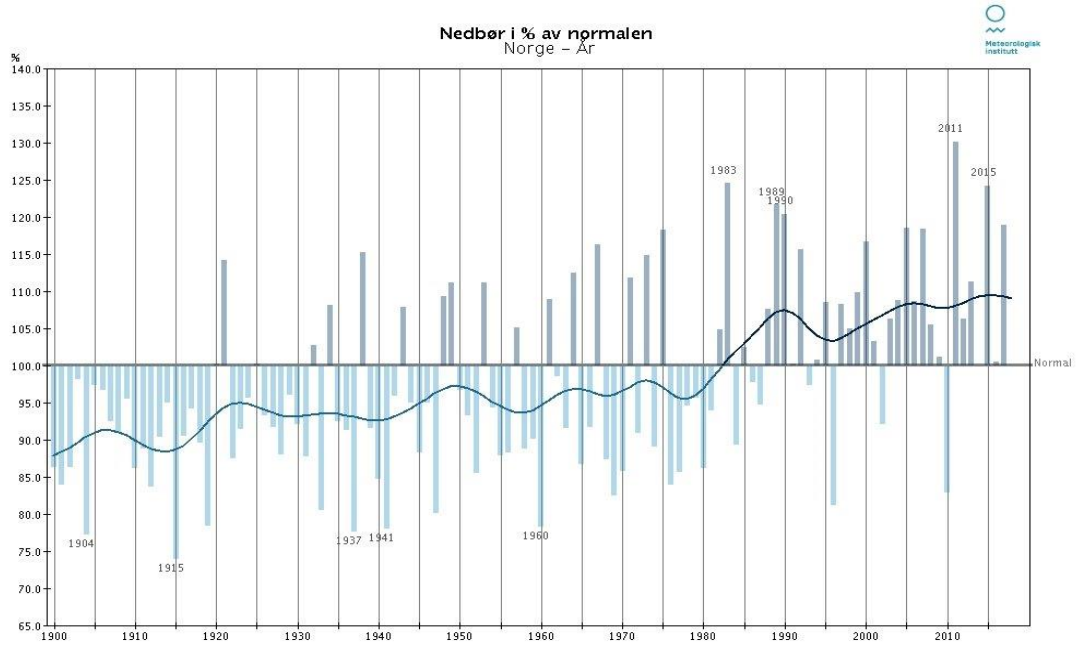


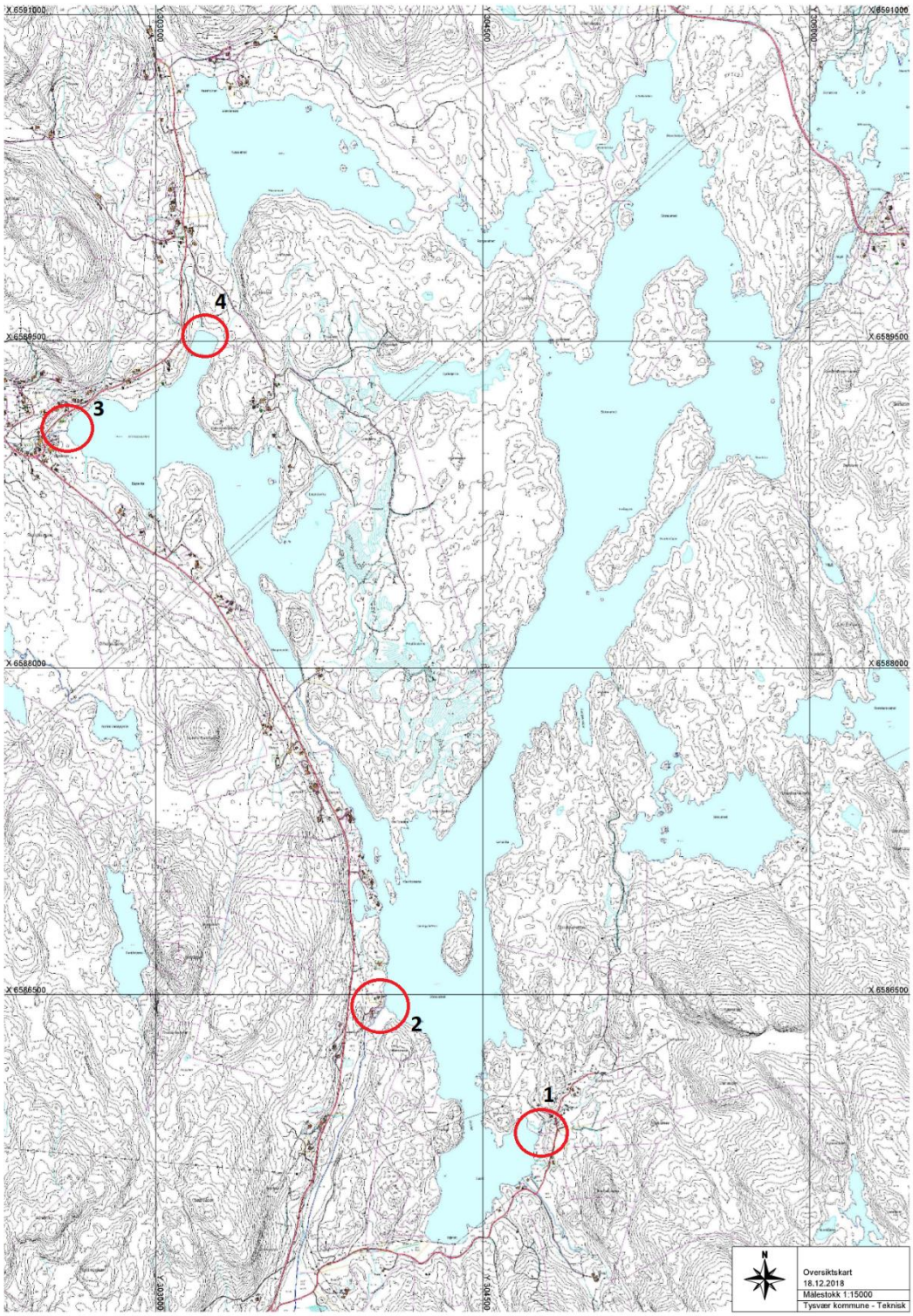
Figure 4: Precipitation development in Norway, year by year. Obtained from Metrologisk institutt (met.no), climate last 150 years.

Figure 5 shows the development of rainfall in Norway, and it shows that it has become wetter in the last 20 years. Much precipitation leads to large leaching of humus substances, which makes it important to do something about the colour unit number. UV radiation is often used as one of two barriers in water purification. When we have a high colour number, it will not be possible to have only UV radiation as a cleaning step, and the water must therefore have a different barrier. The wastewater treatment plants must be expanded with filtration, if Storavatnet is to become a reserve water source for Tysvær municipality and neighboring municipalities.

If Storavatnet was to become a source of drinking water, outdoor activities also had to be drawn. In §4 Pollution in the regulations on water supply and drinking water, states that it is forbidden to pollute drinking water. The ban covers all activities, from the water safety area to the tapping points, which entail the risk of the drinking water becoming contaminated. Activities also include outdoor life and other exercise of public rights.

6.0 Map

Map over Storavatnet, marked with circles around the streams.



7.0 Afterword

We would like to thank our municipality, Tysvær, for the assignment, for all their help during this project and for financial support of testing equiptments and analyses. We would like to give a special thanks to several people; Head of Technical Department, Solveig M. Myge, who has been available via e-mail and answered all our questions, and equally important, supplied us with maps and project plans. Leif Gunnar Søvik for his help during our first test taking, showing us, which water streams to test, given us a demonstration of how to do it, and also teaching us how to run a deep-water test. And last, but not least, our teacher who has taken us around, given us advice and guidance on how to write a report and which elements to include.

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