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Water Services in Espoo, Finland, from the 1930s to the 2000s - positive challenge or burden of history?

Riikka P. Rajala[1] & Petri S. Juuti[2]

Abstract

Organised public water supply in Espoo started in 1934. In the Finnish context the City of Espoo is young, modern, and large in terms of its area, being the second largest city in Finland, with a population exceeding 230,000. Espoo is located next to Helsinki, the capital city of Finland. Espoo has grown very rapidly; in the early 1950s, the city had less than 30,000 people. There are numerous challenges for the future; the growth and population estimate by 2040 is 85,000.

In 2007 about 70 percent of the distributed water was purchased from the city of Helsinki. The purification plant, Suomenoja, was completed in 1969 and it was operating in 2007 but there was a new wastewater treatment plant under preparation because the capacity of old plant was filling up. Wastewaters from neighbour municipalities were also purified there.

This paper aims at discussing colorful periods of water services in Espoo. There are nine different episodes in water services, which can be recognized. First episode was in 1934 when organised water services both by the municipality and the private sector were started. Last, the ninth one was in 1994 when Waterworks become a public enterprise.

Key words: Finland, Espoo, environmental history, history of technology, water supply, sanitation, sewerage, water services

[1] University of Tampere, Department of History, FI-33014 University of Tampere, FINLAND & Tampere University of Technology, P.O. Box 541, FI-33101 Tampere, FINLAND.
[2] University of Tampere, Department of History, FI-33014 University of Tampere, FINLAND.

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TIIVISTELMÄ

Espoon kaupunki on nuori, moderni ja suomalaisittain suuri. Se on maamme toiseksi suurin kaupunki, jonka asukasluku on yli 230 000. Kaupunki on kasvanut hyvin nopeasti, sillä 1950-luvun alussa espoolaisia oli vielä alle 30 000. Noin 50 vuodessa väestö on kasvanut lähes kymmenenkertaiseksi. Vuonna 2005 Espoon Veden verkostoon pumpatusta vedestä noin 70 prosenttia ostettiin Helsingistä. Loput eli noin 30 prosenttia oli peräisin omalta Dämmanin pintavesilaitokselta, jossa käsiteltiin Nuuksion Pitkäjärven vettä. Jätevesien puhdistus oli keskittynyt Suomenojan jätevedenpuhdistamolle, jossa vuonna 1997 laajennuksen jälkeen otettiin käyttöön Suomen ensimmäinen kokonaistypenpoistoon tähtäävä laitos.

Vielä pitkälle 1900-luvun puolelle vesihuolto oli Espoossa hoidettu kaivojen ja kuivakäymälöiden avulla. Järjestäytyneen vesihuollon kehitys alkoi Espoossa vuonna 1934, jolloin työllisyystöinä toteutettiin sairaalan kaivo sekä silta ja vesijohto Stensvikiin eli Kivenlahteen Jorvaksentielle, nykyiselle Vanhalle Jorvaksentielle. Vaikka nämä vuoden 1934 vesihuoltoon liittyvät työt eivät olleet erityisen suuria, erottuvat ne kuitenkin selkeästi aikaisemmista vuosista. Samoihin aikoihin tohtori Arne Grahn suunnitteli Westendin aluetta. Hän halusi tarjota kaikille tontinostajille liittymän vesi- ja viemäriverkostoon. Muualla Espoossa vesihuoltolinjoja ryhdyttiin rakentamaan laajemmin 1950-luvulla, kun Otaniemen ja Tapiolan rakentaminen edellytti yleisen vesihuollon toteutumista. Helsingin kaupunki aloitti vedenjakelun Otaniemessä vuonna 1951 ja Tapiolassa vuonna 1953. Olosuhteet ja väestön kasvu aktivoi espoolaisia: Espoon Vesihuolto Oy perustettiin vuonna 1957. Bodomin pintavesilaitos aloitti Espoon oman vedentuotannon maaliskuussa 1961. Keskustelu Vesihuolto Oy:n kunnallistamisesta alkoi jo vuonna 1959 ja lopullinen päätös tehtiin syksyllä 1964.

Taival nykyiseen asiakkaan ja ympäristön kannalta hyvään tilanteeseen vesihuollossa on ollut pitkä ja välillä myös vaikea. Haasteita riittää myös tulevaisuuteen, sillä virallisten ennusteiden mukaan Espoon väkiluku kasvaa Suomen kunnista eniten vuoteen 2040 mennessä, peräti noin 54 000 hengellä.

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Introduction

Organised public water supply in Espoo started in 1934 . The path to today's situation in water services, which is good from the viewpoint of clients and the environment alike, has been long and at times rocky. The City of Espoo is young, modern, and relatively large in Finnish terms. It is the second largest city in Finland, with a population exceeding 230,000 inhabitants. Espoo has grown very rapidly; in the early 1950s, there were still fewer than 30,000 people living there. (Table 1)

In 2007 about 70 percent of the water pumped into the pipes of Espoon Water was purchased from Helsinki, i.e., the water came from Lake Päijänne via the 120 km rock tunnel and the Pitkäkoski water treatment plant. The remaining 30 percent was taken from the City's own Dämman surface water plant, which treats water from Lake Pitkäjärvi in Nuuksio, northern part of Espoo. Espoo Water takes also care of wastewaters.

Wastewater purification was concentrated in the Suomenoja wastewater treatment plant, where the first process expansion based on total nitrogen removal was completed in 1997. There are numerous challenges for the future as well; according to official estimates, by the year 2040 the population of Espoo will increase more than in any other Finnish municipality, by a total of as many as 54,000 people.

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Table 1. Espoo in a nutshell. (www.espoo.fi)

* Espoo received its town charter in 1972
* Population 227,472 (2005)
* Area of Espoo 528 sq.km (land territory 312 sq.km, water 216 sq.km)
* Nearest airport: Helsinki-Vantaa Airport 25 km,
* Neighbouring municipalities: Helsinki, Nurmijärvi, Vihti, Kirkkonummi, Kauniainen (within Espoo)
* Mean temperature (2004) 6.2 degrees Celsius (Warmest month August, mean temperature 17.2 degrees Celsius, Coldest month January, mean temperature -5.7 degrees Celsius)
* Population by language: Finnish-speaking 85.6%, Swedish-speaking 8.8%, other languages 5.6%
* Main employers by number of staff on 1 January 2005: The City of Espoo, Nokia, University of Technology, Jorvi Hospital.

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BACKGROUND, SOURCES AND METHODS

The paper is based on a study by the authors on the evolution of water and sanitation services (Juuti & Rajala, 2007). The study was carried out from January 2006 to March 2007. A systematic analysis of the city and waterworks archives and the literature was made. Open-ended theme interview of 17, present or past, staff members of the waterworks were conducted, representing all levels of the utility. Visits to the facilities of the utility were an essential component of the project. Articles in local newspapers, and the available histories of the city were also reviewed. [1]

Espoo is part of the Helsinki Metropolitan Area (Figure 1). Espoo shares its eastern border with Helsinki, the capital city of Finland, and Vantaa, while enclosing Kauniainen. Other bordering municipalities are Nurmijärvi and Vihti in the north and Kirkkonummi in the west (Figure 2).

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Figure 1. Location of Espoo, which is part of the Helsinki Metropolitan.

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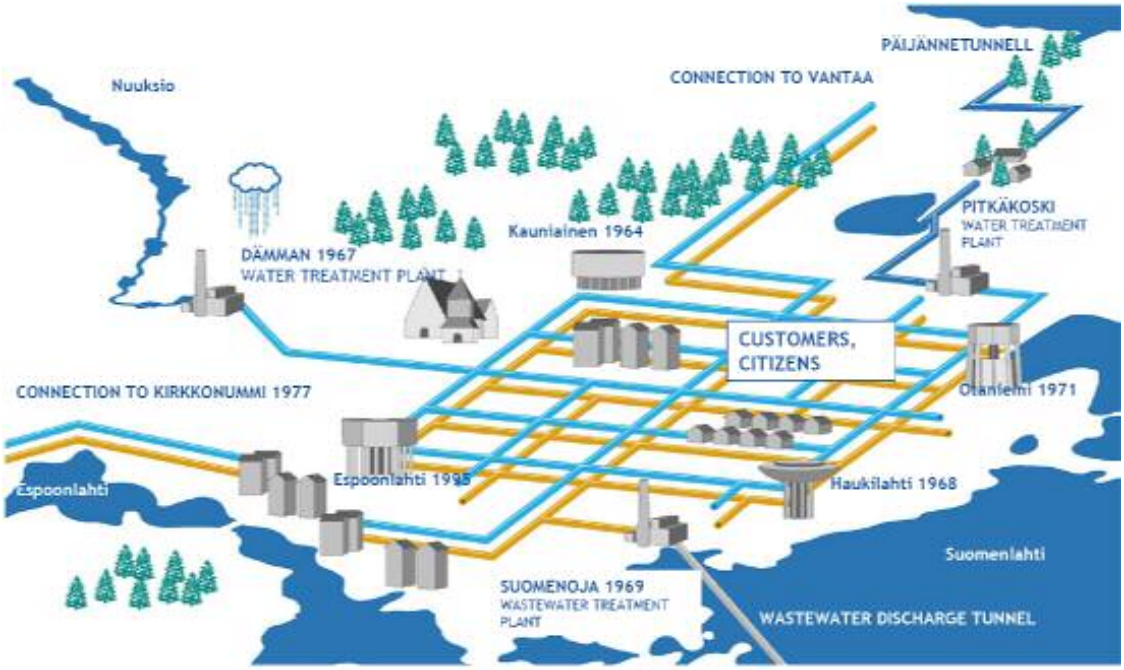

Figure 2. Distribution system of Espoo Water. (Espoo Water 2007)

FIRST STAGES OF THE EMERGING WATER SERVICES

Well into the 20th century, water supply in Espoo was based on wells. Public water supply started to develop in the early 1930s. In the spirit of the times, many unemployed people found a job on a number of construction projects. At the beginning of the decade, these public employment programmes were used to improve and construct roads, to implement agricultural and forestry projects, and to dig wells and firewells in Espoo. In 1934, a well on hospital premises, a bridge and a water main to Jorvaksentie in Stenvik, nowadays known as Vanha Jorvaksentie, or the Old Jorvas road, were built as public works projects. As of 1934, nearly all construction matters were overseen by Mr. Albin Andersson, Construction Site Supervisor of the municipality. The period between 1934 and the 1950s was known as the Albin Andersson era within the construction sector in Espoo.[2] Although the 1934 projects related to water services were not particularly extensive, they did differ significantly from earlier years.

Around that time, the Westend area was being designed by Dr. Arne Grahn. He wanted to offer access to water and sewers for all those buying a lot in the area. The detailed plan of Westend was completed in 1934. Dr. Grahn commissioned ground water

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surveys and water supply contracting from Yleinen Insinööritoimisto Oy (YIT). The large well and pump room along Pihlajatie Road functioned as Westend's waterworks while wastewater was led untreated into the Gulf of Finland. Water main lines were constructed simultaneously with roads in the area. [3]

ESTABLISHMENT OF A LIMITED COMPANY TO IMPROVE WATER SERVICES

Building of water mains began on a larger scale in other parts of Espoo in the 1950s, when the construction projects in Otaniemi and Tapiola suburbs called for implementation of general water services. The City of Helsinki began the distribution of water in Otaniemi in 1951 and in Tapiola in 1953. In 2008 Otaniemi is the home of and also synonymous for the Helsinki University of Technology (HUT). Tapiola is known as garden city and a cultural centre of Espoo. One of the reasons given by the then Helsinki City Board for construction of the water main network from Munkkiniemi to Otaniemi and further on to Tapiola was that the areas would sooner or later be annexed with Helsinki anyway. The people of Espoo were spurred by circumstances and population growth: Espoon Vesihuolto Oy was founded in 1957, and the actual construction of the water supply network was launched by the company in December 1957. [4]

During the first five years of its operation, Espoon Vesihuolto Ltd built 47 kilometres of water pipes, most of it water mains. Thirty-six kilometres of sewers were also constructed. In addition, the first phase of the Bodom water treatment plant was completed. The Municipality of Espoo had a strong role in the company from the start, and in 1959 it gained the majority of the shares in Vesihuolto Oy.[5]

In 1961 the Bodom surface water treatment plant marked the beginning of Espoo's own water production. In fact, the history of the Bodom plant can be traced back to 1954, when the Municipality of Espoo appointed a committee to make preparations for general water services in Espoo. The committee finished its work in November 1955. The key content of its report was the general plan drawn up by Mr. Eino Kajaste, Senior Engineer, which included Lake Bodom as one of the water supply lakes during the first stage. The biggest problem was the growth of algae in the lake. As late as the 1990s, the Bodom water treatment plant provided one fourth of the water needed in Espoo. The Bodom plant was closed down in 1998. [6]

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Discussion on turning Vesihuolto Oy into a municipally owned company began as early as in 1959, and the final decision on this was made in 1964. The municipality bought all the equipment and facilities owned by the company. Unfortunately, the final stages of Vesihuolto Oy were associated with widespread economic irregularities.[7]

MUNICIPAL WATERWORKS

After the waterworks became a municipal utility, the operation of water services was managed by municipal waterworks. The majority of the staff of Espoon Vesihuolto Oy stayed on in the employment of the municipal water utility, some moved on to the Technical Department and some to the private sector. Right from the start, the municipal waterworks commissioned a large number of planning and construction projects from private enterprises. [8]

In the 1960s, drastic forecasts of ever increasing water use were made in Espoo, as in other parts of the country. At that time, it was believed that Espoo's own water reserves would not suffice to cover water needs in the 1970s. The Municipality of Espoo and the Helsinki rural municipality – since 1974 the city of Vantaa - joined the raw water programme of the City of Helsinki. In the summer of 1965, the so-called three-party agreement was signed. It was believed that it would guarantee sufficient water supplies for Espoo well into the 1980s. In addition, a contract was made with the City of Helsinki on buying tap water from Helsinki.[9]

The municipal waterworks showed a loss in the 1965 balance sheet. Net loss was a typical feature of the water utility of a growing community. There were lots of capital expenses, but little income compared to construction capacity. In Espoo, the long distance between the service areas where the water was consumed and the water treatment plants also played a role in this; this meant longer feeding lines and higher energy costs. However, it was expected that the problems would be solved as the area of water distribution expanded and once the water treatment plants operated with full capacity. [10]

Espoo's second water intake, i.e., the Dämman surface water treatment plant, was completed in June 1967. Even though the plant marked a clear improvement, problems still abounded. The majority of inhabitants still had to do with traditional wells. There

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were also problems with water quality, especially due to algae. The need for even greater decisions was already evident. In addition to its own surface water treatment plants, some small surface water intake facilities have operated in Espoo, serving their immediate vicinity. [11]

In 1964 the first water tower in Espoo was built in Kauniainen. The Haukilahti water tower, intended to improve the distribution on water in south-eastern Espoo, was completed in 1968. The construction of the Otaniemi water tower, designed by Alvar Aalto, was delayed by difficulties caused by demanding foundation work. It was finally completed in 1971. The Espoonlahti tower (Figure 3) is the most recent built in Espoo. It was taken into use in 1995.[12]

Figure 3. The Espoonlahti water tower taken into use in 1995. (Juuti 2006)

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As of the beginning of March 1966, the Espoo municipal waterworks took over the water network in Tapiola. This meant that the amount of water purchased from Helsinki increased. In 1966, a dramatic rise was seen in water consumption compared to the previous year – over 1 615 000 cubic meters (m^3) of water was used in the area served by Espoo waterworks. It was about 74 percent more water than used in 1965. Pumping of water from Lake Bodom increased by as much as 53 percent. [13]

Because of the city's rapid growth, Espoo's water services required greater reliability and more water. An agreement on cooperation was signed by the three cities of Helsinki, Vantaa and Espoo in January 1970. At the time, the agreement was probably the most comprehensive cooperation contract in the field of Finnish water services. It included features such as the construction of the 120 km Päijänne rock tunnel, a joint treatment plant and joint feeding line, as well as joint use of local water supplies, so that the water needs of each of the three cities could be met in the 1970s as well as later, if needed. [14]

The organisation of the Päijänne project was decided on in 1972, when the councils of the cities taking part in the project approved a limited company solution. On 20 October 1972, the Ministry of Trade and Industry gave its approval to the by-laws of the limited company called "Pääkaupunkiseudun Vesi Oy – Huvudstadsregionens Vatten Ab". Espoo's share of the water flowing via the Päijänne tunnel was 1.9 m^3/s, and that of the company's shares and water reservations about 16.3 percent. The construction of the Päijänne tunnel commenced in December 1973, and was finally completed in 1982. It was world´s longest rock tunnel for raw water transmission of that time.[15] The tunnel starts at Asikkalanselkä in Lake Päijänne, which is the second largest lake in Finland. The tunnel ends at the artificial lake of Silvola in Vantaa. Water is pumped to water treatment plants in Helsinki.

CONCRETE ENVIRONMENTAL PROTECTION MEASURES

As late as in the early 1960s, the wastewater from Tapiola and its environment was purified in a treatment plant in Tapiola. In addition, Espoon Vesihuolto Oy also had purification plants in Iso Huopalahti, Lähderanta, Niittylä and Viherlaakso. In the 1960s, the focus of wastewater purification began to shift to Suomenoja. The first purification

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plant there was a modest 840-metre ring channel built in the early 1960s, which was linked to a pond purification plant in 1963. That same year, a discharge pipe to the sea was built from the pond, and another 4-kilometre parallel pipe was taken into use in 1967. Wastewater collection was further concentrated to Suomenoja wastewater purification plant, while construction of a mechanical purification plant was being planned. The purification plant that was completed in the autumn of 1969 was the largest single construction project undertaken in the municipality until then. [16]

A new wastewater discharge tunnel was completed in spring 1974. After that, wastewater could be led via a 7.5 km rock tunnel to the sea outside the island of Gåsgrundet, where the conditions for dilution were superior to the earlier discharge location, the open sea area of Bodö. After its completion, the Suomenoja purification plant has continuously been developed and renovated. In 1975, chemical precipitation was introduced. Five years later, the use of biological process was also adopted, while in 1997, nitrogen removal was taken into use. In 1988, the expansion of nitrogen elimination was awarded the first price by the Association of Finnish Civil Engineers in their engineering construction competition. Espoo's own sewer network grew rapidly from the 1960s onwards. On average, more than 20 kilometres of sewers were built each year. In addition to Espoo's own sewage, wastewater from the eastern parts of Vantaa, Kauniainen and Kirkkonummi gradually began to be directed to Suomenoja. (Figure 4) [17]

Figure 4. Suomenoja wastewater purification plant has continuously been developed and renovated. (Rajala 2008)

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In 1974, the waterworks and the sewage works were fused in connection with the reorganisation of the Technical Department. This was a significant change, because from the point of view of efficient water services it is beneficial if the same organisation manages the operation throughout the process, from one end of the cycle to the other. The next major administrative change took place in 1994, when the waterworks became a municipal enterprise with net budgeting. The public utility based on business accounting began its operation on 1 January 1995. [18]

BOLDLY TOWARDS THE FUTURE – DEVELOPMENT PLANS AND CONSTANT VIGILANCE

The Espoo Water Supply Development Plan, drawn up in accordance with the 2001 Water Services Act, was completed at the beginning of 2004. The measures described in the development plan mostly focus on the area of operation of Espoon Vesi (Espoo Water), where about 99.8 percent of the inhabitants using the service of the water utility in Espoo live. The area of operation of Espoon Vesi will expand considerably during the period covered by the plan, 2004 – 2010. The expansion targets the key areas in the vicinity of the current area of operation that are not yet covered by planning, as well as new areas to be planned. The development plan makes it possible to remove eight local water utilities from use and to link them to the water service system of Espoon Vesi.[19]

The share of the total population of Espoo who use the services of the water utilities will increase from the current 97.5 percent to an impressive 99.0 percent. At the end of 2004, some 6,200 local residents lived outside the operational area of the water utilities; at the end of the period, this number is expected to be down to 2,100. [20] In the near future, new decisions on wastewater purification must also be made: in 2006, a survey was underway concerning the transfer of the entire Suomenoja purification plant into a rock cave.

Provision of water services calls for continuous maintenance and development. In 2007 the water supply system in Espoo is operating very smoothly. The establishment of this comprehensive system has called for major investments and innumerable man years of labour. There has been a desire to solve the problems that arise in the best

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possible manner. The maintenance and development of the system also calls for continuous upkeep, well-motivated and skilful staff as well as new investments.

In Espoo, particular challenges have been posed by the long distance between water utilities and consumers as well as rapid population growth. Over the years, huge steps have been taken also in wastewater purification.

The sad end of Vesihuolto Oy with its economic irregularities shows that water services should be properly supervised and municipally owned. When people's well-being and lives are at stake, there is no room for the slightest irregularities.

Espoo has not lacked the courage to look well into the future. Major investments have been made in the past decades, and when needed, there has also been the courage to discard less fortunate solutions. The nine main phases of the development of Espoo water services are shown in Table 2. Even very successful solutions cannot be relied on exclusively, since constant vigilance is called for when dealing with systems interacting directly with the environment. For example, the Päijänne tunnel cannot be the only option in future scenarios, simply for reasons of safety. The City's own water supply plants and water supplies must be kept in good condition. Customers must also be kept satisfied. All this can only be achieved through good team spirit, which is based on a positive operating environment, an independent and strong organisation, and well-motivated and highly competent employees in particular.

Table 2. The nine main episodes of the water services in Espoo and the driving forces behind them.

NAME OF PHASE	YEAR	HISTORICAL PHASE	DRIVING FORCES
I	1934-	Beginning of organised water services both by the municipality and the private sector	Providing employment, investments in water services of municipal institutions, housing comfort
II	1951-	Helsinki builds water services	Helsinki built water services because

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	1953	in Otaniemi and Tapiola	it was thought that the areas would later be annexed with Helsinki
III	1957-1964	Espoon Vesihuolto Oy	Private company, mostly owned by the municipality Limited company to manage water services
IV	1961-1967	Espoo's own water production begins	Raising the level of self-sufficiency, safety 1961-1998 Bodom and 1967- Dämman surface water plant
V	1965	Water services becomes a municipal service	Irregularities at the Limited company and rapid population growth, among others
VI	1969-	The era of centralised wastewater purification begins	Environmental protection, health and hygiene
VII	1970-	Three-party agreement (among others, the Päijänne tunnel)	Cooperation with neighbouring municipalities, greater reliability and more water needed due to the rapid growth of the city. Päijänne tunnel completed in 1982.
VIII	1974	Waterworks and sewage works fuse	Reorganisation of the Technical Department, the same organisation manages the water over the entire cycle
IX	1994	Waterworks becomes a public enterprise	Other alternatives: fusion with electricity company and incorporation. Municipal enterprise =

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			the City retains ownership and decision-making power. Costs were cut at the same time. One of the reasons behind the move was the recession.

Conclusions

The major findings on the evolution of water and sewage services in Espoo, from the 1930s to the 2000s are as follows:

i) The sad end of Vesihuolto Oy with its economic irregularities shows that water services should be properly supervised and municipally owned. When people's well-being and lives are at stake, there is no room for the slightest irregularities.

ii) The long distance between water utilities and consumers as well as rapid population growth has been challenge to offer proper water services to everyone.

iii) Over the years, giant steps have been taken in wastewater purification, and Espoo has always been in the forefront of development.

iv) Most of the used water comes trough Päijänne tunnel and it is bought from Helsinki. For reasons of safety Espoo has kept it's own water supply plants and water supplies in good condition.

v) Espoo has not lacked the courage to look well into the future. Massive investments have been made in the past decades, and when needed, there has also been the courage to discard less fortunate solutions.

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REFERENCES

[1] The initial case study was Juuti P. & Rajala R. 2007. Veden Vuosisata [History of Espoo Water Works] (original in Finnish) Vantaa.
[2] Espoo city record office, Annual municipal report 1931-34; Virtanen T. 1999. (original in Finnish) Rakentamassa Espoota. Espoon kunnallinen rakennustoimi 1949-1999. Helsinki, 28.
[3] Westend, Espoon kaupunginmuseon kotiseutusarja 1. 1990. (original in Finnish) Espoo, 12-14, 22, 32-34, 39; Ahlsrtöm Al. & Westman I. 1951. (original in Finnish) Oy Yleinen insinööritoimisto 1912-1952. Tammisaari, 3, 51-53.
[4] Valtakari. 1991. (original in Finnish) Bodom 30 vuotta vesilaitostoimintaa. Memorandum 6.3.1991; Nykänen Panu, Teknillisen korkeakoulun historia, Opetusta ja tutkimusta Teknillisessä korkeakoulussa vuodesta 1849, (original in Finnish) http://www.tkk.fi/Yleista/history/historia.html, read 16.5.2006; Lehtonen K. & Virtanen T. (Eds.) 1999. (original in Finnish) Veikko Rantala. Monessa Mukana. Teviisi.10.2.1999. Kunnallinen rakennustoimi 50 vuotta. Muisteluksia ja muistikuvia. Espoon kaupungin Teknisen keskuksen, Espoon Veden ja Varikon tiedotus- ja henkilöstölehti, 8.
[5] Espoon Sanomat 16.3.1962; Annual municipal report 1959.
[6] Juuti & Rajala 2007, 122, 142;Valtakari 1991.
[7] Espoo city record office, Espoon Vesihuolto Oy, annual report 1965; Juuti & Rajala 2007, 77-80.
[8] Espoo city record office, Espoon Vesihuolto Oy, annual report 1965.
[9] Water Works, annual report 1965; Herranen T. 2001. (original in Finnish) Vettä ja elämää. Helsingin vesihuollon historia 1876-2001. Helsingin Vesi , 171; Annual municipal report 1965.
[10] Water Works, annual report 1965.
[11] Juuti & Rajala. 2007, 144; Water Works, annual report 1967.
[12] Espoon Sanomat 16.2.1968, 26.3.1968; Water Works, annual report 1966 – 1968, 1970 – 1971; Länsiväylä 10.10.1993; Asola. 2003. (original in Finnish) Vesitorni – yhdyskunnan maamerkki, Water Tower – Landmark of the Community. Suomen Rakennusinsinöörien Liitto RIL, 156.
[13] Water Works, annual report 1965-1966.
[14] Water Works, annual report 1970.
[15] Water Works, annual report 1966, 1972-1973; Pääkaupunkiseudun Vesi Oy. 2006. (original in Finnish) Päijänne-tunneli. http://www.psv-hrv.fi/paijanne.phtml?lang=fi, read 6.2.2006.
[16] Juuti & Rajala. 2007, 186.
[17] Juuti & Rajala. 2007, 187.
[18] Water Works, annual report 1974; Räty T. 1994. (original in Finnish) Vesi- ja viemärilaitos – liikelaitos. Memorandum. Water Works archive.
[19] Juuti & Rajala. 2007, 422; Maa ja Vesi Oy. 2004. (original in Finnish) Espoon kaupungin vesihuollon kehittämissuunnitelma. 30.1.2004.
[20] Juuti & Rajala. 2007, 422; Maa ja Vesi Oy. 2004. (original in Finnish) Espoon kaupungin vesihuollon kehittämissuunnitelma. 30.1.2004.