LAB University of Applied Sciences

Incorporating practical applications of storm water control into vocational education

– case study the Joint Authority of Education in the Espoo region Omnia – Landscape gardening studies.

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Master of Engineering, Urban Sustainability
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Andrew Atkinson

Abstract

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– case study the Joint Authority of Education in the Espoo region Omnia – Landscape gardening studies.

Degree and field of study

Master of Engineering, Urban Sustainability

Abstract

Climate change has brought about increased awareness of the issue of stormwater control methods and created a need for landscape garden professionals to be ever more skilled and knowledgeable about stormwater control.

The Finnish national study plan for landscape gardening was renewed in 2021. The study plan calls for the incorporation of stormwater control methods into the curriculum of vocational education institutions but does not lay down how this should be carried out, with the decision for actual teaching methods being left to individual schools to decide.

This thesis is a case study, which aims to clarify how vocational educational institutes in Finland have been going about this, and, using similar educational institutes in the United Kingdom as a benchmark, aims to come up with recommendations for future methods.

The desired outcome is a working model to teach stormwater control methods at Omnia, which could be adapted to other vocational schools as well.

Keywords

Stormwater, Runoff water, Stormwater control, Landscape gardening education

Tiivistelmä

Tekijä	Publication type	Julkaisuvuosi
Atkinson, Andrew	Thesis, UAS	2022
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Hulevesien hallinnan käytännön sovellusten sisällyttäminen ammatilliseen koulutukseen

– case Espoon Seudun Koulutuskuntayhtymä Omnia – Viheralan opinnot.

Degree and field of study

Insinööri (YAMK), Kestävä kaupunkiympäristö

Tiivistelmä

Ilmastonmuutos on lisännyt tietoisuutta hulevesien hallintamenetelmistä ja luonut maisemapuutarha-alan ammattilaisille tarpeen olla entistä kyvykkäämpiä ja tietoisempia hulevesien hallinnassa.

Suomen kansallinen viheralan opintosuunnitelma uudistettiin vuonna 2021.

Opintosuunnitelmassa vaaditaan hulevesien hallintamenetelmien sisällyttämistä opetussuunnitelmaan, mutta siinä ei määritellä, miten se tulisi toteuttaa, vaan varsinaisista opetusmenetelmistä päättäminen jätetään yksittäisten koulujen päätettäväksi.

Tämä opinnäytetyö on tapaustutkimus, jonka tavoitteena on selvittää, miten Suomen ammatilliset oppilaitokset ovat toteuttaneet hulevesien hallintamenetelmien opetusta. Työssä käytetään vertailukohtana vastaavia oppilaitoksia Iso-Britanniassa, ja tavoitteena on laatia suosituksia tulevaisuuden opetusmenetelmille.

Tavoitteena on kehittää Omniassa sellainen hulevesien hallintamenetelmien opetusmalli, jota voitaisiin soveltaa myös muissa ammatillisissa oppilaitoksissa.

Keywords

Hulevesi, Valunta, Hulevesien hallinta, Viherrakentamisen koulutus

Contents

Appendices:

1 Introduction

Climate change has brought an increased amount of extreme weather. This has resulted in a growing demand for sustainable stormwater control methods, especially as regulations in most urban areas within Finland require that most of this stormwater is dealt with onsite. Accordingly, new urban stormwater control networks are not being built unless necessary.

The runoff water created by snow melting in spring is an issue which is outside of the realms of this thesis, which will concentrate on stormwater control methods.

The vocational level teaching plan for landscape gardening in Finland has been rewritten with stormwater control becoming an integral part of studies. In theory, this is positive progress, as those who are now studying in vocational training centres are in fact the very people who in future will be installing many of the stormwater control systems. These are the ones who will have to pay attention while working in landscape construction and maintenance to take careful note of how stormwater and runoff water is treated and what sort of infiltration systems, ditches, drains, are required. Also, they will have to consider surface shaping and which surface materials can be used.

A major problem, is that vocational training, by its very definition is practical based, thus meaning that schools and training centres must come up with teaching methods which can be duplicated in such a way that all students acquire the skills and knowledge they need in order to be true experts in stormwater management.

This Master's thesis aims to use Omnia in Espoo as a case study to develop teaching methods which can be implemented by most vocational training centres.

Methods used will include, an examination of the current situation, a written questionnaire answered by a selection of representatives of landscape gardening training centers in Finland and the United Kingdom, with the United Kingdom schools being used as for benchmarking purposes on the assumption that the United Kingdom is ahead of Finland on the topic being studied, and referral to the national teaching plan as laid out by the Finnish National Board of Education (NBA).

Consideration is made into how much the construction of stormwater control systems falls into the realm of landscape gardening, and how much of it comes under the realm of the construction industry.

Focusing more on the practical instalment of stormwater control methods, this thesis does not intend to develop any necessary theoretical based teaching methods, nor does it consider how the teaching of maintenance of stormwater control systems should be conducted other than to make a few minor recommendations.

Finnish vocational education institutions are self-governing, and decide for themselves where they make investments, if those investments remain within the budget allocated to them by the ministry of education. Other than to make some general references to funding, there is no breakdown of costs given. Nor are there any recommendations given for how much time should be allocated to the teaching of stormwater as that is something which each school decides for themselves.

The author of this thesis is himself responsible for teaching stormwater control methods at Omnia, and as such will be incorporating the findings into his own personal work life.

2 Methodology

This thesis uses qualitative research methods. Being a case study dealing with education, it was deemed that qualitative rather than quantitative research would be more appropriate. Qualitative research in this case means making use of structured interviews with the aim of gathering information on a specific theme (Metsämuuronen 2006). The theme in this case being teaching stormwater control methods, and the interviewees being teachers of landscape gardening.

It was decided to make a case study comparing the United Kingdom and Finland under the pre-assumption that the United Kingdom, being a country with a higher level of precipitation and a much longer history of gardening practices, as well as a reputation for being advanced in the science of horticulture is ahead of Finland when it comes to teaching stormwater control, and that consequently, Finnish education institutes would be able to use the knowledge and experiences of those in the United Kingdom to assist in developing their own methods.

This thesis has made use of interviews of landscape gardening teachers at schools in Finland and the United Kingdom. The Finnish schools chosen are those which teach landscape gardening as a specific subject, while the British ones were chosen at random from a larger available selection with the same criteria in mind. A similar number of vocational education institutes was chosen in each country, with the addition of the Finnish Viherympäristöliitto as a further check point. One teacher from each school was interviewed. These interviews were conducted both by phone, in person, and, in the case of the British schools, via e-mail. The interview questions are attached in the appendix section, as are selected transcripts of the interviews. These interviews were used to give background into how different educational institutes have approached the issue at hand, as well as to give indications into how the issue of training students in stormwater control methods is intended to be developed in the future.

It was decided to limit the number of questions being asked in order to keep to the specific topic being studied, as well as to minimize the time that responders would have to devote to taking part. A total of seven questions was decided upon, this being deemed an adequate amount to discover both the current situation in the schools and their plans for future developments (Metsämuuronen 2006). Careful consideration was made of what to ask in order to lead to the required answers without leading the responders on.

The questions that were asked are as follows:

1. How does your school approach teaching storm water control?

2. Do you have more theory based or more practical based teaching methods?

3. How well is storm water control integrated into the study plan?

4. Is storm water control integrated into other topics, or is it a stand-alone topic?

5. Is there more emphasis on teaching storm water control methods in the school, or is it considered something which is best left to the practical training periods?

6. How aware are students made of the issues of climate change and storm water?

7. What are the plans in your school for future teaching of storm water issues and control methods?

Interviews conducted with the Finnish organisations, which were conducted in person or via phone were transcribed in such a way that only the relevant information was recorded. Interviews with the British organisations, which were conducted via e-mail, involved sending the responder the list of questions with instructions about how to answer them. In those cases, the answers given were used in their entirety.

An effort was made to try and ensure that each organisation was allotted an equal space in the transcriptions. A table showing full selected transcriptions can be found in the appendix section of this thesis.

As well as the interviews, this thesis has also made use of the Finnish national study plan for landscape gardening as laid down by the Finnish National Board of Education which dictates what topics must be taught in the schools, as well as with the grading criteria (Opetushallitus 2022). The national study plan does not describe what methods should be used for teaching and training, nor if the subjects must be taught within the schools or if they can be taught during practical training periods.

The schools which agreed to the interviews in the United Kingdom were Threave School of Heritage Gardening in Castle Douglas, The Barony in Dumfries, Askham Bryan College in York, and Sparsholt College in Winchester. The Finnish schools were, the Joint Authority of Education in the Espoo region Omnia in Espoo, Keuda Group, Vocational Education and Training in Mäntsälä, Savo Vocational College Sakky in Kuopio, Häme Vocational Institute Hami in Lepaa and Educational consortium OSAO in Oulu. For additional information, a representative from The Finnish Association of Landscape Industries (Viherympäristöliitto ry) was also interviewed. In all cases, one representative of each organisation was interviewed. To ensure fairness, and to encourage critical answers, interviewees anonymity was

guaranteed, with the organisations being labelled A to J, with organisations from the United Kingdom being placed alphabetically first.

Being a very specific subject, there were limited options of who was qualified to take part in the interviews, and unfortunately, not everybody who was asked was willing to take part, thus resulting in a limited number of answers. There were however enough answers received to be able to draw legitimate conclusions. (Valli 2018.)

Interviews with representatives of schools in the United Kingdom were conducted in English, while interviews in Finland were conducted in Finnish and translated into English by the author of this thesis, any mistakes made in translation are purely the fault of the author himself.

Results are analysed in two ways, with the first being a clear analysis of what the current situation regarding teaching of stormwater control methods in vocational education establishments is, with a comparison being made between the situation in the United Kingdom and Finland. The second analysis deals with how interviewees consider that stormwater control methods should be taught. Using the results of this analysis as a guideline, recommendations have then been drawn up for how practical based stormwater control methods could be taught in vocational schools. Emphasis is placed on Omnia, and recommendations are made with consideration to facilities already available there, although the suggestions should also be easily adaptable to other schools as well. In Images 1 and 2 below can be seen the Kirkkokatu garden hall, where students can be taught green construction methods all year round, even when the ground outside is frozen during winter.

3 Omnia

3.1 Espoo Consortium for Education

Omnia is one of the largest vocational training centres in Finland, with about 35 000 active students, over 1000 members of staff, and an annual budget of 85 million Euros. (Omnia 2022.)

3.1.1 Omnia's department of Landscape gardening.

The Landscape gardening course at Omnia takes between two and three years, with each student moving forward at their own pace. (Anttila-Koskinen 2020.) The programme is essentially practical based, although it does contain enough theoretical studies for students to understand why things are how they are, and to enable students to advance to bachelor level studies upon graduation should they wish to do so. The department has at any given time about 250 – 300 active students and 9 members of staff, making it one of the largest educators of Landscape Gardeners in Finland. (Omnia 2022.)

Being based in Espoo, the school caters mainly for students from the Greater Helsinki region. Intake occurs two to three times a year, with each intake of new students numbering between twenty-five and fifty, meaning that at any given time, there can be as many as two hundred students participating in the course of studies. Students are grouped according to intake, with mature and young students being mixed in the same groups. (Helander 2009.) Students age vary from 16 to 60 approx. with prior experience within the landscape gardening sector ranging from zero to anywhere as much as twenty years.

Approximately one third of studies take place within the school itself, with emphasis being placed on students developing the skills required to go out into practical training places where they will hone their skills and become proud professionals. (Kotila 2008.)

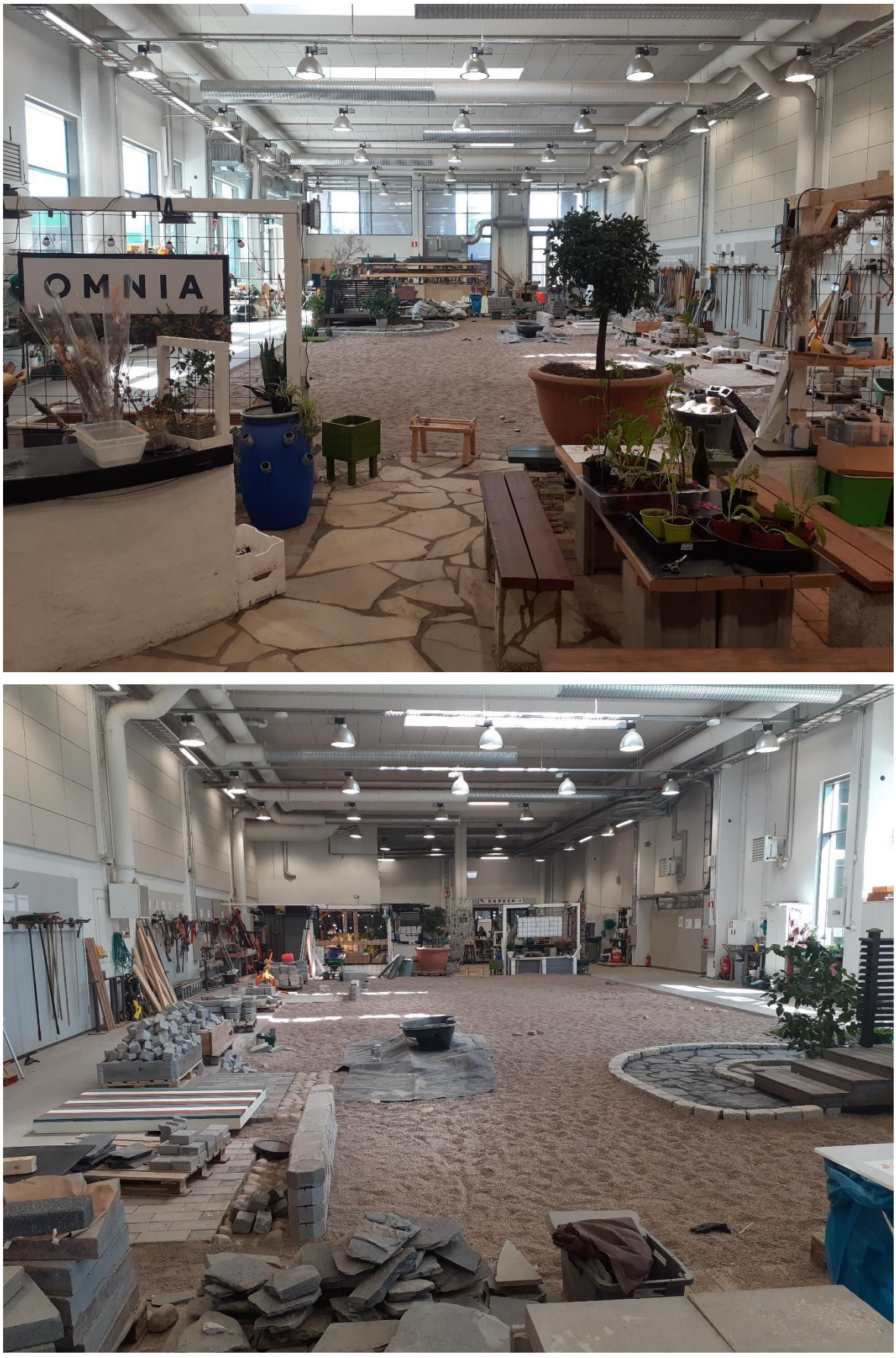
This emphasis on developing practical skills includes maintaining planted areas at several of Omnia's campuses, taking part in practical building training sessions in the Kirkkokatu campuses Garden Hall, and, getting actual physical experience at Omnia's building site in Pellas, which is as near to a real working life experience as can be created while still being a teaching facility. Sustainability is a theme which cuts across almost all vocational courses (Santalahti 2004.) within the landscape gardening department, with the aim that upon graduation, students will take their knowledge of sustainable gardening into working life. (Houstonen & Åhlberg, 2005) Sustainability is also considered to be of such importance that heavy emphasis is placed upon it in the national study plan. (Opetushallitus 2022.)

3.1.2 The Kirkkokatu Garden Hall

Containing the largest indoor sandpit in Finland, the garden hall at Omnia's Kirkkokatu campus is a purpose-built landscape gardening training facility. At this site, students train and hone their stone and wood construction skills readying them for their entrance into working life, which usually happens during their practical training periods. Emphasis is placed on the student's abilities to use concrete paving and prefabricated concrete walling products, including, basic surveying skills, and the ability to construct level surfaces as well as laying the paving according to pre-assigned gradients and height differences. Some students, especially those who choose to participate in the optional stone construction studies also get the opportunity to become familiar with natural stone construction methods.

The garden hall is mostly used during the winter, when weather conditions make it impossible to practice construction work outside. The sand in the sandpit, which measures 6 m by 26m, is of grade 0.2 – 0.6mm and has a depth of no more than 60 cm. This can at times have a limiting effect on what can be practiced there.

Images 3 and 4 below show students at work in the garden hall. Images 5 and 6 show some results of students practical training in the garden hall. Image 5 was a temporary larger scale project, which was later dismantled, while the construction shown in image 6 was considered to be of such a high standard that it has been kept in place, and is used to demonstrate to new students the sort of work they will be practicing.



Images 1 and 2. Omnia's Garden Hall, indicating the size of the sandpit. (Andrew Atkinson 2022)

Images 3 and 4. Student projects in Omnia's Garden Hall (Andrew Atkinson 2022)

Images 5 and 6. Student projects in Omnia's Garden Hall. (Andrew Atkinson 2022)

3.2 Pellas

Pellas is a real-world building site, where students from several departments get to hone their skills while still being supervised by their teachers. A total of eight houses are being built, with, at the time of writing, two being completed and for sale on the open market, and two more under construction. The entirety of the construction is expected to take as many as ten years to complete, mainly due to the emphasis placed on education rather than professional speed construction. This maximises the number of students who will have a chance to improve their skills at the school construction site prior to entering their actual working life based practical training placements.

Students of the landscape gardening department have the task of conducting the final landscape gardening once actual construction of the houses is complete. This is conducted on a house by house basis, with gardening students being able to start work once the main house construction is complete. Subsurface construction has been outsourced due to a lack of resources in the gardening department, however, gardening students do have the opportunity to visit the site and practice their surveying skills there prior to subsurface construction work proceeding, and, some fortunate students also get to be present to see for themselves what is involved in the subsurface construction process.

Available resources, work safety, and the need to teach other topics as well has resulted in a limit to how many students can be at the worksite at any given time. This can have some effect on how many students have the chance to practice each part of the landscape construction process, as work progresses according to a logical format, with hard landscaping being completed before soft landscaping. Timetabling issues can also have a negative effect on which students get to spend time on the site. These various issues have resulted in approximately half of Omnia gardening students having an opportunity to spend time on the worksite, although it has also been incorporated into theory teaching, with for example ordering of plants, calculations of materials, and timetabling being taught at a theoretical level using the Pellas worksite as an example.

Finnish climatic restrictions result in the landscaping side of the construction closing from October until April, while the summer holiday season means that the whole construction site closes from midsummer until early august. This is quite different from working life, when the summer months are a time of often quite intense construction.

The Pellas worksite, which is on naturally sloping ground with a total height difference of over three meters across the entire site, and as much as two meters height differential on the individual properties, has incorporated the use of basic stormwater control methods,

including sloping the ground and paving to focus stormwater onto planted areas, where it will naturally soak away, as well as having permeable paving materials to aid the infiltration of stormwater.

Being primarily a teaching facility, with the actual construction process being of secondary importance, progress on the worksite is much slower than it would be on a site staffed purely by capable professionals. Every time a new batch of students comes in, they have to first go through the process of becoming familiar with the rules of being on a worksite in a way that professionals would not need, not taking into account the legally binding requirement for worksite familiarisation, which every worker has to undergo. A further difference between Pellas and a professional worksite, is that often the students who come there are at the beginning of their studies, and, must undergo a process of becoming familiar with the techniques, tools and materials being used. This can take quite a lot of time in some cases, and often involves redoing the same work several times, in a way that should never happen on a real-life worksite.

Pellas is also very resource intensive for the school, with a minimum of one teacher and one teaching assistant present always, and, sometimes as many as three or four teachers required to be present. Sometimes the students can advance to a point where their skills and knowledge stops, and then must wait for the teacher or teaching assistant to finish explaining something to other students before they can continue. This occasionally leads to students sitting around on the worksite in a way that a professional cannot do.

Teachers who are working at the Pellas worksite have a multiple number of roles on top of their traditional one of teaching. They are responsible for work safety on the site, and, must always keep a close watch on all students to ensure that work safety is taken seriously, this is especially crucial when students are using machines to cut stones. Any exceptions to the work safety rules must be reported, and teachers must then stop work and hold a safety talk with all students. Teachers are also responsible for ensuring that the work is done according to current standards, that the material used is up to standard, and are responsible for ensuring that the work passes its final inspection prior to the houses being sold. A further role of the teachers is that of organising schedules and making sure that the necessary materials arrive onsite at the right time. All of this must take place during the teachers normal working hours, which means that students rarely spend a full workday on site. Often, the site can sit empty for several days due to teachers having responsibilities which take them elsewhere.

All these issues taken together add up to the slow speed at which work is progressing, with construction of the first house having begun in the year 2017, and the garden of the final

house not expected to be complete until the year 2025 at the earliest. In a real world, professional environment, construction work on a project such as this should last for a maximum of two year from start to finish.

The houses built there are also designed to have minimum environmental impact, being exceptionally well insulated, fitted with low energy LED lighting, and heated using ground heat obtained from pipes buried in the gardens during the construction phase. These pipes can be seen in image 7, which also demonstrates the height differential in one of the gardens at Pellas.

In terms of stormwater control, the main issue on the Pellas site is the gradients and height differentials involved, which if not taken into consideration properly could lead to potential future problems with damp and mould in the buildings, or stormwater running into the neighbouring property, which is strictly forbidden under Finnish law.

Images 8 to 11 below show some of the work being conducted at the Pellas worksite.

Image 7. Landscape garden teacher Harald Jansson demonstrates the height differential at Pellas. (Andrew Atkinson 2021)

Image 8. Students working at Pellas, installing ‘Hulekivi’ (Andrew Atkinson 2021)

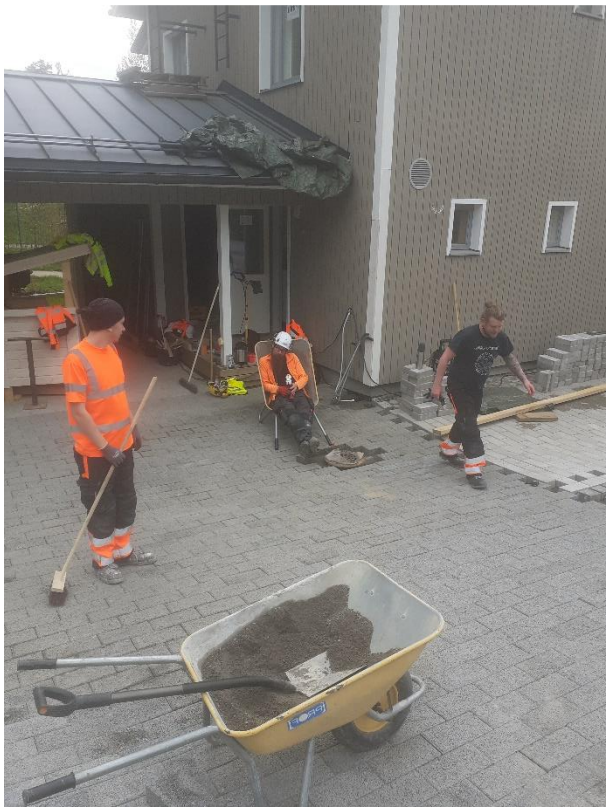


Image 9. HB-Betoni’s pervious concrete ‘Hulekivi’ installed at Pellas. (Andrew Atkinson 2021)

Image 10. Pellas ready for planting. (Andrew Atkinson 2021)

Image 11. Louhikivi and Hulekivi as installed at Pellas. (Andrew Atkinson 2021)

4 Stormwater defined

4.1 Definition

Stormwater is quite simply the water which is not soaked into the ground as a result of rainfall or snowmelt.

4.1.1 Why storm water is considered a problem

Traditionally, stormwater has been considered a problem to be dealt with by removing it from urban areas as fast as possible. This has involved the use of drainage systems, ditches, gullies, and diversion of surface water to predetermined low lying areas. Stormwater has been blamed for causing problems with dampness and even and rot in buildings, and is largely to blame for urban flooding, especially the flooding of basements and other underground structures such as carparks and metro tunnels. Of concern has always been the effect of flash flooding, which usually occurs when precipitation levels momentarily overcome the capacity of stormwater control systems. (Griffin 2018.)

In the Finnish climate, a major issue is the runoff water which occurs during the spring when snow melts, but the ground is still frozen from winter. This can have quite marked effects on how stormwater control systems are planned and constructed, and in places can cause spring floods to occur.

4.1.2 Precipitation and infiltration rate

Precipitation, which can be measured both in millimetres per hour (mm/h) and millimetres per year (mm/annum), refers to the amount of water which comes from the sky. There is a slight difference between the terms rainfall and precipitation, in that rainfall refers to the water which comes down in a liquid state, while precipitation also includes that which comes in solid state, more commonly referred to as snow (USGS 2022.) Normally, it is more common to discuss the amount of rainfall, but in a scientific concept, precipitation is the correct term. Which measure is required depends almost entirely on the purpose for which it is required. When planning stormwater control systems, the most important factor is how much precipitation occurs at any given time, so the measurement used is millimetres per hour.

Differing rates of precipitation are referred to using differing terms. The range of terms used is from fog, with a precipitation level of 0,13 mm/h through to a cloudburst, with a precipitation level of 102 mm/h. For the most part, when considering stormwater, the levels referred to are 3,8 mm/h and above. Most higher levels of precipitation usually only last for short

periods of time, although it is not unknown for longer periods to occur. These longer periods of heavy precipitation can sometimes be over the capacity of even the most advanced stormwater control systems (Spence 2019).

	Intensity inches/hour (cm/hour)	Median diameter (millimeters)	Velocity of fall feet/second (meters/second)	Drops per second per square foot (square meter)
Fog	0.005 (0.013)	0.01	0.01 (0.003)	6,264,000 (67,425,000)
Mist	.002 (0.005)	.1	.7 (.21)	2,510 (27,000)
Drizzle	.01 (0.025)	.96	13.5 (4.1)	14 (151)
Light rain	.04 (0.10)	1.24	15.7 (4.8)	26 (280)
Moderate rain	.15 (0.38)	1.60	18.7 (5.7)	46 (495)
Heavy rain	.60 (1.52)	2.05	22.0 (6.7)	46 (495)
Excessive rain	1.60 (4.06)	2.40	24.0 (7.3)	76 (818)
Cloudburst	4.00 (10.2)	2.85	25.9 (7.9)	113 (1,220)

Figure 1. Definitions of levels of precipitation. (USGS 2022)

On average, Finland and the United Kingdom have quite different annual amounts of precipitation, with the average total for the United Kingdom being 1200 mm (Jenkins 2008) while Finland's average is 660 mm (FMI 2022). This, as well as the United Kingdom having a reputation for being advanced when it comes to the field of horticulture has led to the pre-assumption being considered in this thesis that the United Kingdom is ahead of Finland when it comes to the teaching of stormwater control systems.

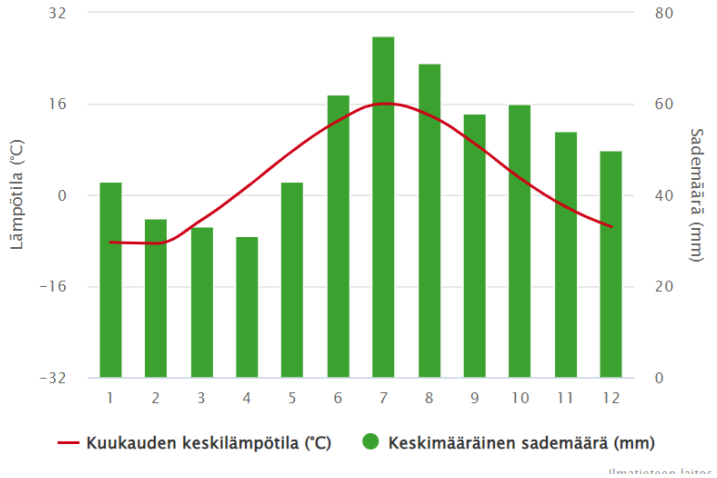


Figure 2. Average monthly rainfall for Finland 1961 – 2021 (FMI 2022)

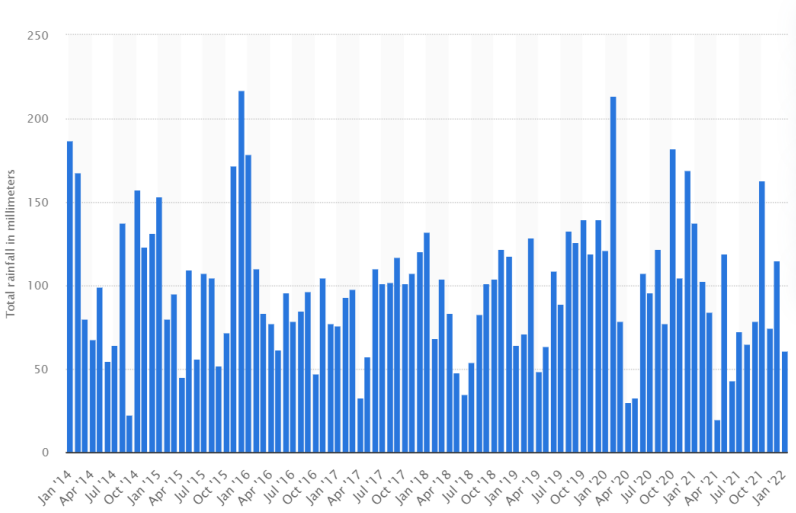


Figure 3. Average monthly rainfall for the United Kingdom 2014 – 2022 (Statista 2022)

The infiltration rate means the volume of water being absorbed by the ground at any given time (Zoca 2017). When planning stormwater control systems, it is important to consider the what the average rainfall is, both annually and during a storm, as well as the infiltration rate of surface and subsurface materials in the specific area. Longer and more extreme levels of precipitation have a direct negative effect on infiltration rates. This is something which must always be considered during the planning process, with an estimate made during planning stage of what the potential maximum water flow in any area is.

Precipitation rates are affected by climate change, while infiltration rates are affected by construction work and the increasing use of hard surface material in urban areas (Spence 2019). When considering how to teach stormwater control, it is important that students are made aware of these facts and terms, especially how the work that they do has a direct effect on the need for stormwater control.

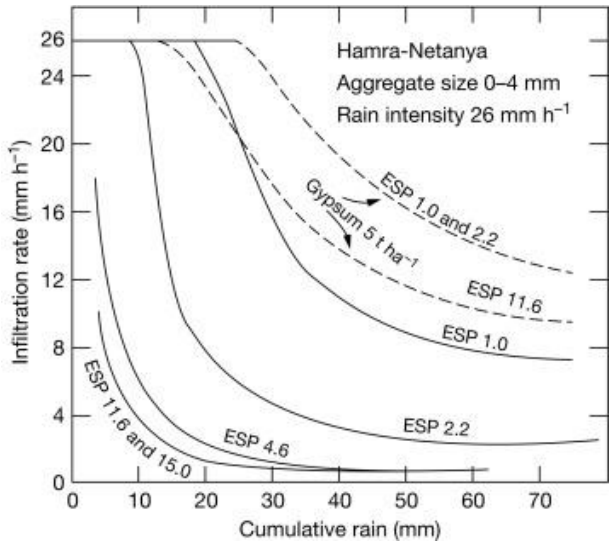


Figure 4. An indication of how cumulative rainfall diminishes infiltration rates. (Kazman 1983)

4.1.3 What Finnish law says

Finnish law is quite clear on the matter of stormwater. Local municipalities have the right to decide how stormwater is controlled locally (Vesihuoltolaki 2022), and, can require landowners to either connect to traditional stormwater drains or to otherwise deal with stormwater on their own property (Maankäyttö -ja Rakennuslaki 2022), or if they so choose, a combination of both methods. Municipalities are these days requiring landowners to deal with a percentage of stormwater on their own properties (Hulevesiopas 2012), with the remainder being directed into the drainage systems. The law is also very clear on where stormwater can be directed to, with a specific stipulation that stormwater cannot be directed onto a neighbouring property without the express written consent of the landowner (Maankäyttö -ja Rakennuslaki 2022).

Most Finnish municipalities have specific stormwater control programs, which specify how stormwater is to be dealt with in that region. Espoo is no exception, with the Espoo Stormwater control program having been implemented in 2020.

These are tools, which planners and constructors can and should use when they are deciding how stormwater is going to dealt with in any development.

The main clearly defined aims of the Espoo stormwater control program are:

1. To prevent flooding and flood damage
2. To aid in replenishing ground water reserves
3. To protect delicate waterways and prevent pollutants from entering the water system

4. To help provide a healthy and pleasant environment for human inhabitants

(Espoo 2020.)

The Espoo stormwater control programme gives detailed accounts of the responsibilities of individual parties, as well as giving recommendations for how all parties should work together towards achieving the goals laid down in the plan. It also considers the fact that at present, we do not know what the full impacts of climate change are going to be, and so sets goals that account for worst cast scenarios. The intentions are that the program will be updated regularly, so that it always remains current and is able to make use of new developments and methods as they become available.

4.1.4 How storm water is controlled

Traditionally, and to a large extent, still the most commonly used method of controlling stormwater is to drain the area concerned as quickly as possible. (Griffin 2018.) This is achieved using a combination of channels, drains and pipes. A major downside of this is that it causes peaks, during which time the system is over worked and is incapable of dealing with the amount of water involved. Another drawback is that this system essentially just moves the water from one place to another, where there is still the problem of what to do with it. (Debo & Reese 2003.)

A more modern approach, and one which is being applied in increasing amounts, is Integrated Urban Water Management (IUWM) which rather than considering stormwater to be a problem, actually turns the traditional way of thinking around, and considers stormwater to be a valued resource which can to a large part be dealt with onsite. (Meilvang 2021.)

There are six most commonly used modern methods of stormwater control, all of which can be used separately or together with other methods as part of an integrated system. The main common factor of all six methods is that they aim to reduce runoff, and to one extent or another increase infiltration. (SSWM 2022.)

1. **Detention and retention pond**s. Usually constructed in areas where there is a large amount of space available, such as municipal parklands, the idea is to retain water on the surface thus creating pond areas. These are usually also created to include marshland planting areas and wildflower meadows.
2. **Onsite detention (detention tanks).** Water storage tanks connected to traditional style drainage systems are buried underground. Depending on the situation where they are installed, they can either be fully sealed or pervious. Pervious

tanks allow the water to slowly infiltrate into the surrounding ground, while fully sealed tanks require pumps or drainage systems to remove the water in a controlled method. In some cases, water pumped from the storage tanks can be used for watering planted areas in dry weather.

3. **Rainwater harvesting.** A more modern version of the very particularly British tradition of having a water collection barrel at the corner of a garden shed, which is filled by rainwater collected from the roof of the shed, Rainwater harvesting relies on there being some sort of onsite water storage system. The harvested rainwater is then used for watering planted areas, or in some cases even for such things as flushing toilets.
4. **Constructed wetlands.** These work in a very similar way to detention and retention ponds, with the exception that the water collected is held within the surface soil for as long as possible, thus creating wetlands where naturally occurring plants and animals can thrive.
5. **Infiltration trenches.** Used particularly in grassed areas, infiltration trenches are a modern horticultural take on the traditional underground drainage systems used by farmers to control water levels in their fields. Often, instead of using a drainage pipe, these trenches are simply backfilled with pervious gravel before being topped off with topsoil and sown with grass. The trenches are usually placed at the lowest lying point of a grass area.
6. **Pervious paving.** Usually made of concrete produced using sand which has had the fine dust removed, pervious paving can be used in almost any area where traditional paving can be used. It is slowly becoming more readily available, and more affordable as demand for it is increasing. Requiring a slightly different construction method than traditional paving, pervious paving must be placed on pervious foundations. (University of Michigan 2022.)

An example of pervious paving as installed in the town of Tuusula can be seen in image 12 below, while the Louhikivi pervious paving stones as used at Pellas can be seen in image 13.

While in many cases, it is possible to only install one of these systems, recent research has tended to conclude that the best results come from using a combination of two or more of them. More and more research is being conducted into integrated stormwater management systems, and only time will tell how they will develop. (Jalonen 2020.) Planners and landscapers can only make use of the best available methods at the time, and it will be for future generations to judge the success or failure of such methods.

It is only ever possible to make use of the best available practices and methods as well as the best available materials at the time of constructing anything. This holds true for storm-water control systems as well. Technology, materials and knowledge develop, and it is quite possible that future generations will look at what is being done today and wonder why that was done. In much the same way, we today, look at what our ancestors have done and wonder why, and what were they thinking. Perhaps one of the most relevant cases here is the use of underground drainpipes which conducted stormwater directly into waterways, taking all sorts of pollutants and impurities with it, and contributing in many cases to an increase in the growth of algae as well as the contamination of fish. (Spence 2019.)

Image 12. Pervious paving installed in Tuusula. (Andrew Atkinson 2020)

Image 13. Louhikivi, indicating the way the stones are designed with spaces to allow water to pass through them. (Andrew Atkinson 2021)

Some companies have been developing element based underground stormwater infiltration systems. These are versatile systems, which are easily adapted for different situations. In the last few years, more and more sites have been integrating these systems during the construction stage, but it is also possible to retrofit existing gardens. These systems, which usually come in modular form, can be made larger or smaller depending on the requirements of any given site. Many of them can be placed either underneath green areas, or even if so desired underneath car parks and asphalt. The idea behind them is that stormwater is directed into the underground pervious storage tank, where it is slowly infiltrated into the surrounding ground. One version of this is the Q-Bic system developed by the company Wavin, which can be seen in images 14 and 15 below.

Being a modern and versatile system, there is still not much practical based experience at installing them, nor is there much more than anecdotal experience, beyond the manufacturers own research, into how they hold up under Finnish winter conditions.

These systems, however, could be taught in landscape gardening schools.

Image 14. Installing the Q-Bic system. (Wavin 2022)

Figure 5. Example of the Q-Bic system in use. (Wavin 2022)

Despite the ongoing development of modern stormwater control systems, in many cases, there is still a need for a traditional system of ditches. These ditches can also include ponds, wetland, and other retention systems. Taken as part of a whole system of stormwater control methods, the traditional ditch is a very useful tool. See images 16 and 17 below.

Images 15 and 16. Combined ditch and retention ponds in Lahti. (Andrew Atkinson 2022)

Image 17. Retention tanks being installed in Helsinki. (Andrew Atkinson 2022)

There is a quite big difference between the field of landscape gardening and landscape construction. The landscape gardening industry generally deals with construction of the ground surface including construction to a depth of about 50 cm. Most construction which involves digging down to a depth below 50 cm come under the realm of the landscape construction industry, which counts as part of the general construction industry. In the case of installation stormwater control systems, this means that retention and detention tanks will be installed by the landscape constructors, as will the digging of ditches. Installation of surface drains, pervious paving, and the final surface levelling, as well as planting all come under the realm of the landscape gardening industry. Image 18 shows installation of underground retention tanks. This kind of installation work is usually carried out by landscape construction professionals, although landscape gardeners should also be aware of how it is done.

The boundaries between these two industries are however often a grey area, with many independent landscaping companies doing both tasks. The two professions must also work closely together to ensure that the outcome is exactly as planned, including ground levels being correct to the allowed tolerance, which in Finland is generally within a range of plus/minus 2 cm. (InfraRYL 2020.)

4.1.5 Pervious paving stones

The range of pervious paving stones available is quite large and growing, with each manufacturer developing their own trademark stones. Which stones are best depends entirely on the unique situation of whatever site they are being placed into, this can also include such issues as aesthetics, is the paved area intended for light transport such as walking and cycling, or is it intended for large heavy vehicles? There are standards about how thick stones must be, with for example, a rescue road, which is required by law to be built at all larger residential building and most offices etc. has to withstand the weight of large heavy fire-engines, and usually requires the concrete stones used to have a thickness of 10 cm, whereas a paved area which is intended for walking and cycling purposes, or a terrace area intended for relaxation purposes only requires concrete stones of 4 cm (Soini 2009). Of course, when constructing a pathway for light pedestrian traffic, it is important to consider the type of machines which will be used for snow-clearing, and other maintenance procedures, which can sometimes require thicker and stronger stones.

Making us of pervious paving stones instead of traditional non-absorbent paving is potentially the one adaptation that the landscaping industry can make easily, it is perhaps also the one with the greatest potential impact on stormwater control (Charlesworth 2014).

Images 19 and 20 below show two types of pervious stones, ‘Nurmi’, and ‘Hulekivi’, both of which are used to a large extent at the Pellas construction site. Hulekivi, developed by HB-Betoni is one of the more unusual types of pervious paving stones, in that water will pass through the concrete. Most pervious paving is designed with gaps between the stones, or holes in the stones to allow water to infiltrate between them.

Images 18 and 19. Nurmikivi and Hulekivi as used at Pellas. (Atkinson Andrew 2022)

5 Results of the interviews

As stated earlier, one representative from the landscape gardening department of each vocational school was interviewed. In the United Kingdom, interviewees were from Threave School of Heritage Gardening in Castle Douglas, The Barony in Dumfries, Askham Bryan College in York, and Sparsholt College in Winchester. In Finland, interviewees were from, the Joint Authority of Education in the Espoo region Omnia in Espoo, Keuda Group, Vocational Education and Training in Mäntsälä, Savo Vocational College Sakky in Kuopio, Häme Vocational Institute Hami in Lepaa and Educational consortium OSAO in Oulu. For additional information, a representative from The Finnish Association of Landscape Industries (Viherympäristöliitto ry) was also interviewed.

Interviewees were guaranteed anonymity, and were randomly assigned a code letter from A to J. No records were made of which code letter was assigned to which institution.

A full summary from the interviews is included as in attachment 1 at the end of this thesis, however, the answers to perhaps the most important question asked are as follows:

Question: How should schools approach teaching stormwater control?

Organisation A: As part of horticulture classes, science classes - ecology. General awareness of human impact on nature

Organisation B: By incorporating information about the issues relating to stormwater into teaching as much as is possible

Organisation C: As something that all students must be aware of

Organisation D: As an essential and integral part of a gardener's basic knowledge.

Organisation E: Stormwater control is an integral part of the Landscape construction course

Organisation F: From the perspective that students need to have basic knowledge in the issue before they enter working life.

Organisation G: For most students, it is a new topic which they must be made familiar with.

Organisation H: As in integral part of larger courses.

Organisation I: According to the directions laid down by the national study plan, with some added emphasis on how important it is to control water in a landscapes area.

Organisation J: Schools should approach the issue as one which will be of increasing importance and should ensure enough resources to fully educate students in stormwater management.

5.1 How vocational education institutions are planning future teaching

One question which was asked was if the school currently has plans for future teaching of stormwater control. The answers received were quite varied and indicate that there is a need for a unified approach to future planning. Some of the answers given pointed to a lack of resources. This is something which must be considered as part of a bigger picture, as schools have limited funding available and must ensure that where investment is made, it has the maximum possible impact on quality of teaching.

Question: Are there any plans for future teaching of storm water issues and control methods?

Organisation A: The Programme we teach is starting to focus more on issues of sustainability and climate change, but I don't think it will be taught in any great depth.

Organisation B: Not right now, although there should be

Organisation C: Not right now.

Organisation D: At the current point in time, we are aware of the need for increased teaching, however, at present, there are no available resources to achieve this.

Organisation E: Stormwater will remain an integral part of teaching.

Organisation F: If resources are made available, then we hope to increase practical teaching.

Organisation G: Currently there are no plans to change anything.

Organisation H: No.

Organisation I: Currently there are no plans to make any changes.

Organisation J: Stormwater control is going to become increasingly important in the future. Currently, work is being done on creating a new manual about the maintenance of integrated stormwater control systems, which it is hoped will be used a tool by schools and working life. In the future, there will probably be much more emphasis placed on the construction of integrated stormwater control systems as well.

5.2 How stormwater control methods are taught in gardening schools

In most vocational schools, stormwater is treated as an integral part of a larger whole. Particularly in Finnish schools, it is an integrated part of a larger course on landscape construction. Emphasis within the schools can and in fact does seem to vary, although they all seem

to concentrate on mainly giving students the basic skills and knowledge they need in order to advance to their practical training placements, where it is hoped they will receive more in depth practical training. Schools in the United Kingdom seem to favour integrating storm-water control into other larger topics as well.

Some emphasis is given to basic stone guttering installation and surface formations, including the degrees of slope that must be applied to lawns and stone covered areas to ensure that water flows away from buildings and doesn't stand for long on lawns. These degrees of slope are in Finland, always according to the accepted norms. In most cases, this means students learn to ensure that within three meters of a building there is a five percent slope, and beyond that, a minimum of a one percent slope depending on the situation (Soini 2009). The United Kingdom does not appear to have any similar standards, instead students are mainly taught to ensure that most water will flow away from walls.

Methods vary between schools, but, overall, the approach seems to be that students are taught how to ensure that proper preparations and subsurface construction is completed before continuing to surface level construction. Due to restriction of resources, this can often be at a purely theoretical level.

In Omnia, all students are required to spend time practicing their stone construction skills in the sandpit, including learning how to use surveying equipment and methods to ensure that levels and height differentials are precise. They are also taught the basics about practical instalment of surface drains, as well as basic sealed and perforated drainage pipe installation. Omnia has a wide range of stones available for students to practice with, including traditional concrete as well as modern pervious paving stones.

An important part of the student's education in both the United Kingdom and Finland is to learn how to read and interpret garden designs as well as written construction instructions where applicable. This is seen as an important integral part of a professional gardener's skill set, almost as important as being able to identify plants.

In Omnia, the plans for Pellas have been used for several years as a tool for teaching real working life skills to the students. Using these plans, students learn exactly how to understand the markings on them, how to interpret gradients, how to transfer the two-dimensional picture into a three-dimensional garden, as well as how the construction methods and various subsurface structures are calculated and created. They also learn which laws, bylaws, regulations and norms apply to the work they are learning how to do and how to apply them to their real-world working experience.

In general, schools in both countries consider that the teaching of stormwater control is something which should be treated as an integral part of a larger teaching segment, with only organisation H saying that it should be treated as stand-alone course. All organisations were of the opinion that teaching needs to mainly focus on the practical side of the issue, with organisation A stating that they were more likely to arrange theoretical teaching, while organisation E stated that while they try to have as much practical based teaching as possible, often resources are too few to be able to achieve that.

All organisations were of the opinion that it is important for students to have at least a grasp of the basics of stormwater control prior to entering practical training placements, with organisation I stating that schools should focus on the theoretical side and leave the practical side for training periods, while organisation J emphasised that schools and working life need to work together to ensure that students entering working life have all the skills and knowledge required.

There was cross organisational agreement on the need for emphasis on the teaching of climate change issues, with stormwater and stormwater control seen as an integral part of the larger climate change issue. The only organisation which was of a different opinion to this was organisation F, which stated simply that these days very few students are not aware of climate change issues.

About half of the organisations are planning on increasing their teaching of stormwater issues, or, are at least of the opinion that it should be increased, with several claiming that to do so would require allocation of more resources. No mention was made of whether this means more teaching resources, or more investment in the equipment required for teaching practical methods. Given that allocation of resources within schools is something which is decided at a higher level than individual teachers, it was decided not to investigate this issue further, although it is something which could be recommended for further research in the future.

6 Recommendations for future teaching methods

As previously mentioned, vocational education institutes are focused mostly on teaching students how to do the job they are training for. With this as a goal, gardening schools invest most of their time and resources into teaching practical skills.

The Finnish vocational education method requires that between thirty and fifty percent of the training takes place in work placement periods where the students are placed in a real-world working life situation and gain the actual skills required to call themselves professionals. These work placement periods mostly take place in private companies or municipal organisations, which have limited time and resources available to train the students.

Schools must therefore ensure that students have all the necessary skills and knowledge prior to entering practical training periods. This must apply to both the theory and practical implications of stormwater control systems.

All gardening schools in Finland either have, or, are in the process of acquiring inside sandpits like the one that Omnia already has. This is a facility which can easily be used as a place to train the students in many methods of stormwater control.

Omnia has already made a start in this, in the teaching of gradients, installation of hard surfaces including pervious paving and drainage pipes. With relatively little investment, this training can and should be expanded to include the installation of detention and retention systems. In fact, if schools and working life really work together on this, it is possible that companies could sponsor the training by for example supplying them with the materials and equipment needed to teach the installation of stormwater retention tanks. These tanks are of course produced by several companies, and come in different models, but if students were to learn how to install one model of tanks which come in element form, and one model which comes as a prefabricated whole, then it would be fairly easy for them to transfer those skills to the installation of other models as needed.

Pellas, or other similar worksites should be continued, and if possible both their number and their use during studies should be increased, or at least arranged in such a way that most if not all students get to experience some real-world landscape construction prior to entering their practical training placements.

Most teachers of landscaping gardening are also highly experienced professionals themselves and in fact, many of them already have experience in installing stormwater control systems. This means that any training of staff would be quite minimalistic, teachers are

besides required to keep current on their own fields of specialisation and are provided with a certain amount of resources for further training every year.

During the interviews, organisation J touched on the issue of upcoming publications about stormwater. The first one which is due to be published in autumn 2022 by Viherympäristöliitto, is focused on the maintenance of natural based stormwater control systems. Schools can and indeed should make use of these publications, as they already do with other publications.

As well as teaching the construction and installation of stormwater control systems, schools should also give some time to maintenance. Of course, each system requires different methods of maintenance, but students should at least be made aware of the fact that it is required.

The recommendations made here are that Omnia (and other vocational education schools) work closely with working life to discover which types of stormwater control methods are used the most, and then to invest in the equipment required by those systems either as a one-off investment, or through sponsorship agreements with companies that produce or install the systems. Methods should then be created where groups of students would spend time in the indoor sandpits learning how to install those stormwater control systems. Thought must be given on which systems are used, as it must then be easy to dismantle them ready for the next group of students. By using this method, students would be given the opportunity to learn basic installation methods in in a way which is repeatable and sustainable.

On a theoretical side, schools should stress the importance of the Integrated Urban Water Management (IUWM) approach to stormwater control, especially in the way it can be used to ensure that stormwater is cleaned before being released into the natural water system. How this would be accomplished is something which is best left to the individual teachers to decide for themselves, using the facilities available to them in each school, as long as they follow the requirements set by the national study plan.

Vocational schools are required to co-operate closely with working life, mainly due to their principle task of training future workers. This close co-operation should be developed further, especially when it comes to keeping current with the latest developments in such a fast-developing field as stormwater control. This co-operation could take the form of representatives of companies which build and install the systems. There are two potential ways to do this, either representatives of the companies go the school and hold workshops there, or the school transports students to worksites where the systems are being installed. Both methods have their own pros and cons.

The benefits of the companies going into the school is that it does not require very much use of the school's resources, and, can be usually be quite easily arranged around the companies' own schedule. If the school has the use of an auditorium, then the companies can make a presentation to large groups of students at the same time. The downside of this is that unless this takes place during the winter when companies are not doing the actual installation of stormwater control systems, then the amount of time that a company can delegate to the procedure can be quite limited.

The benefits of schools taking students to see for themselves in real time the installation process is that this does not involve companies investing their own time and resources into it, also, this give the students the chance to gain actual knowledge of how the installation takes place. If possible, the students could even have the opportunity to take part in the stormwater control system installation process. The downsides of this method are that often due to safety reasons, only a limited number of students can visit a worksite at any given time, and, for the school, it can involve some extra expense in transportation. A further downside is that overall, in Finland the installation of stormwater control systems takes place in the summer, when most students are out in practical work training placements.

There is of course, also the possibility that a combination of these two methods could be used to the benefit of all involved.

7 Conclusions and discussion

Given the very narrow and specific topic of this thesis, there is a rather narrow number of people available who could answer the questions being asked. It was considered that some representatives of working life could have been questioned as well, but that idea was ruled out as the focus here is on educational institutions. The decision to include Viherympäristöliitto was made because it an umbrella organisation which works closely with both schools and working life and has up to date information on what is happening at a national level within Finland. This has resulted in a narrow range of answers, but it is seen that there are enough to be able to draw conclusions from.

There is a clear need to increase teaching of stormwater issues and especially stormwater control systems in vocational education institutes both in Finland and the United Kingdom. The author of this thesis is unaware of facilities available in the United Kingdom, but in Finland at least, practically all gardening schools have or are in the process of building some sort of indoor sandpit where it is easy to teach stormwater control system installation methods.

One thing which was clear from conducting the interviews of schools was that despite prior assumptions that the United Kingdom was ahead of Finland in the issue of stormwater, the fact is that to a large extent the opposite is true, and Finland is in many ways actually more advanced than the United Kingdom. Maybe expertise in stormwater control methods could be a future export for Finland? Time will tell.

It is of course up to individual schools to decide how they teach the subjects laid down in the national study plan, and in fact, they have some leeway to choose which subjects they choose to teach, and which ones are outsourced to working life. This means that any suggestions made here are applicable only to Omnia, although they are easily adapted to any other school.

In order to ensure that graduating students are true professionals with the knowledge and skills required by working life, Omnia must increase use of the available sandpit, and with quite minimal investment can obtain the equipment required to teach students the basic skills needed to install stormwater control systems.

There is a possibility that staff teaching in the schools are not up to date in their knowledge of stormwater control systems, or that they have no personal experience of installing the systems. This could result in a requirement for some extra training of teaching staff. Such training will have to be planned on a case by case basis, with each school deciding for itself what its requirements are, and, making training investments accordingly. This should not in

itself be a major problem, as, at least in Finland, all schools are required to set aside a sum of money each year for teacher training purposes, and most vocational schools have programs in place where teachers can spend some time in working life. However, being a potential expensive investment, maybe this could somehow be co-ordinated across multiple schools in such a way that a teacher from one or two schools specialises in stormwater, and then that teacher is provided with enough resources that they can go and visit other schools where they conduct workshops to train students in the stormwater control system installation. This system could also perhaps be implemented for other topics as well. This is something which will require co-ordinating across several schools, and, is left here as a purely theoretical suggestion. Further study, including perhaps a pilot trail would be required.

There is a common unit sustainable development course, which is obligatory for all students in Finnish vocational schools. How it is taught is at present left very much for each individual teacher to decide as long as they meet certain requirements as laid down in the Finnish national teaching plan. This existing course could possibly be integrated, at least partly, into the landscaping course as part of the sustainable stormwater control topic. Some schools have already piloted the integration of obligatory common unit courses into the vocational courses, however, yet it is not something which schools are generally doing, nor have the full results of this integration been published. This is something else which would require further studying.

Most stormwater control systems require some sort of regular or irregular maintenance. How this will be taught, if it will be taught, and when it will be taught is something which will need further studying. The teaching of stormwater system maintenance was outside the realm of this thesis; however, it is possible that it will have to go hand in hand with the teaching of construction of stormwater control systems.

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Appendix 1. Selected transcripts of interviews

	How should schools approach teaching stormwater control?	Should there be a more theory based or more practical based teaching methods?	How well can stormwater control be integrated into a study plan?	Should stormwater control be integrated into other topics, or should it be treated as a stand-alone topic?	Should there be more emphasis on teaching storm water control methods in schools, or is it something which is best left to students practical training periods?	How can students be made aware of the issues of climate change and storm water?	Are there any plans for future teaching of storm water issues and control methods?
Organisation A	As part of horticulture classes, science classes - ecology. General awareness of human impact on nature	A mix. Theory more likely but systems could be demonstrated using models to show flow of water	I'm sure it could be if discussing weather, climate change, construction topics	Incorporated to relevant topics like the above.	Yes, it would help people to be more aware of the methods even if they are not involved practically with a subject. Might make them consider landscaping options in the future.	Class discussions, visual resources - David Attenborough documentaries	The Programme we teach is starting to focus more on issues of sustainability and climate change, but I don't think it will be taught in any great depth.
Organisation B	By incorporating information about the issues relating to stormwater into teaching as much as is possible	A mixture, depending on the level of study	Theoretically quite easily, but in practice maybe not so	As much as possible integrated, but with some stand-alone parts	Students should at least be aware of the issue before they enter working life	Using group work, research projects, examples etc.	Not right now, although there should be

Organisation C	As something that all students must be aware of	Generally, a mixture, but at a vocational school level, more emphasis should be placed on the practical side.	This very much varies depending on available time and resources.	A stand-alone topic to begin with, later integrated once students are acquainted with the topic.	Basics in schools, deeper and realistic installation methods are best left to working life.	By being encouraged to take awareness of the world around them.	Not right now.
Organisation D	As an essential and integral part of a gardener's basic knowledge.	At a vocational education level, the emphasis should be on the practical side of things.	Overall quite well, although there is room for improvement	Definitely integrated into other topics, it is an issue which cuts across many other topics and therefor to gain a full understanding of it, it must be integrated.	Students should receive basic training in storm water issues before they enter practical training periods, but they should then hone their knowledge and skills out in the field.	Climate change is something that everybody should be aware of, stormwater is something which should be integrated into the relevant areas of education	At the current point in time, we are aware of the need for increased teaching, however, at present, there are no available resources to achieve this.
Organisation E	Stormwater control is an integral part of the Landscape construction course	We attempt to arrange practical lessons, but resources are often too few. In future, more resources will be allocated, so it should	It is a small part of a larger whole	Integrated	The basics should be taught in schools. So simple gutter and surface shaping in school, with infiltration and	By focusing on strategies relating to sustainable development.	Stormwater will remain an integral part of teaching.

		be possible to increase the amount of practical lessons.			stalling being focused more in training periods.		
Organisation F	From the perspective that students need to have basic knowledge in the issue before they enter working life.	In vocational schools, the emphasis should be placed on practical based knowledge.	On the whole quite well.	A combination of both, very much depending on the student's own needs.	Schools should provide basic knowledge, which is then supplemented during practical training.	Very few students these days are not aware of issues relating to sustainability.	If resources are made available, then we hope to increase practical teaching.
Organisation G	For most students, it is a new topic which they must be made familiar with.	Practical	A lot depends on the resources available at any given time, but usually quite well.	Integrated.	Certain aspects are more suited to in school teaching, while on the whole, practical implementation is usually best arranged during training periods.	It could be better integrated into the sustainable development YTO course.	Currently there are no plans to change anything.
Organisation H	As in integral part of larger courses.	As much as possible practical, although students must also have some grasp of the theories.	On the whole pretty well.	Ideally as a stand-alone course.	Theory and basic practical should be taught within schools, but most implementation is best done in training periods.	By placing more emphasis on the issues when teaching other courses.	No.

Organisation I	According to the directions laid down by the national study plan, with some added emphasis on how important it is to control water in a landscapes area.	Practical.	Taken as part of a larger course in landscape construction, stormwater can be quite easily integrated. As a stand-alone course integration becomes much more difficult dur to restriction of resources.	Integrated.	Schools could focus more on teaching the theoretical side, with just a touch of practical.	By increasing integration of the topics into other courses.	Currently there are no plans to make any changes.
Organisation J	Schools should approach the issue as one which will be of increasing importance and should ensure enough resources to fully educate students in stormwater management.	Ideally a combination of both methods should be used.	It is up to individual schools to decide where they focus their resources and emphasis, but it should be easy to integrate it.	A combination would be ideal, first a stand-alone topic to ensure students are fully aware of the issue, followed by increasing integration across all courses.	Schools and working life should work closely together to ensure that the skills students have are those required when they enter their training periods.	Climate change is such a huge issue that it must be integrated into all aspects of education, right from kindergarten and going all the way the highest levels.	Stormwater control is going to become increasingly important in the future. Currently, work is being done on creating a new manual about the maintenance of integrated stormwater control systems, which it is hoped will be used a tool by schools and working life. In the future, there will probably be much more emphasis placed on the construction of integrated stormwater control systems as well.

Appendix 2. Relevant section from the Finnish National Study Plan

Construction of green areas, 30 credits Professional skills requirements

General landscaping works

Student

• plans their own work

• complies with construction related documents

• calculates the amount of materials needed

• performs the necessary measuring work at the site using measuring instruments suitable for the situation

• process the materials used safely and economically, considering the material's processing characteristics

• identify landscaping plants, knowing their Finnish names, scientific genera and species, and habitat characteristics

• use tools and machines necessary for the job, considering emissions and energy efficiency

• performs daily maintenance and minor repairs on the machines and tools he uses according to instructions

• complies with the occupational safety instructions and regulations of the construction site and takes care of his own occupational safety, considering the necessary permits and qualifications for the tasks

• follow the invasive species list and acts in the eradication of harmful non-native species according to the instructions

• takes care of ergonomic working

• minimizes the generation of waste and sorts and recycles waste material, promoting a circular economy

• cleans the work area and finishes the job.

Construction of pavements, walls and edging structures in green areas

Student

• find out the properties of the soil

• builds unbound and bound pavements

• takes care of storm water structures according to the plan

• makes the necessary support structures.

Makes the growing medium and mulching for green areas

Student

• conducts basic improvement of the soil to suit the purpose of use

• shapes the surface of the subsoil to the level of the bottom surface of the growing medium layer

• builds growth platforms that are suitable for different vegetation areas in terms of thickness, structure and nutrient status

• spreads and shapes the growing media into the right shape, compactness and height

• uses different growing media according to the plants' requirements

• uses different cover materials in vegetated areas.

Conducting vegetation work

Student

• protect according to the instructions of the vegetation to be preserved

• ensures the quality of seedlings in accordance with the quality requirements for seedlings

• protects and takes care of the vitality of seedlings at the work site during interim storage and construction

• performs the different work phases of plant planting work

• build a vegetation area to be increased by sowing

• does finishing work on the surface of the vegetation area.

Grading

Student

Satisfactory 1 • carries out the work according to the instructions

• works cooperatively

• needs additional instructions in some situations

• utilizes the basic knowledge needed at work

• changes their operations according to the feedback they receive

Satisfactory 2 • carries out work on their own initiative and in accordance with instructions

• works cooperatively and interactively

• only needs additional instructions in rare situations

• uses the information needed at work appropriately

• changes their activities in accordance with the feedback they receive and their own observations

Good 3 • carry out the work independently

• works cooperatively and proactively in interaction situations

• copes with usual problem-solving situations

• make versatile use of the information needed at work

• evaluates their performance realistically

Good 4 • plans and implements the work package independently

• works cooperatively and constructively in interaction situations

• copes with problem solving situations by utilizing versatile solution methods

• applies the knowledge needed at work in a versatile and justified manner

• evaluates their performance realistically and identifies their strengths and targets for development

Commendable 5 • plans and implements the work package independently, considering other actors

• works cooperatively and constructively even in challenging interaction situations

• applies the knowledge needed at work in problem-solving situations in a versatile and critical manner

• presents justified development proposals related to the work and operating environment

• evaluates their performance realistically and presents justified solutions for developing his skills

• understand the meaning of their own work as part of a larger whole

Ways of demonstrating professionalism

The student demonstrates his skills on the screen in practical work tasks by doing green building work tasks. The work tasks include making unbound or bound pavement or other similar green area structure made of stone material and building a vegetation area with trees and grass-stemmed plants. To the extent that the professional skills required in part of the degree cannot be evaluated based on evidence, the demonstration of professional skills is individually supplemented in other ways.

Appendix 3. Pellas Plan

TONTTIKOHTAISET SUUNNITELMAT
DIAKONISSANTIE 6, 8 ja 10
02940 ESPOO, KATSO PIIRUSTUSLUETTELO

MERKINNÄT:

ISTUTETTAVA LEHTIPUU

LEHTIPENSASISTUTUS / YKSITTÄISPENSAS / KÖYNNÖS

HAVUPENSASISTUTUS / YKSITTÄISHAVU

PERENNAISTUTUS

NU — SIIRTONURMI, kasvualusta 200 mm

HK — HULEKIVEYS. Hule-kartanokivi, harmaa, 278x138x80 mm, Rudus Oy
siililadonta, jätetään saumaamatta, ladontasuunta rasteroinnin mukaan

B I JH — BETONIKIVEYS, Kartanokivi 80, harmaa, 278x138x80 mm, Rudus Oy, tiililadonta, ladontasuunta rasteroinnin mukaan
BETONIKIVIRIAITA, Kartanokivi 80, rajaus yhden kiven raitana, sisäänkäynnin betonikiveyksen reunoissa

NK — NURMIKIVEYS, Golfkivi, harmaa, 140x140x80 mm, esim. Rudus Oy
saumataan multahiekkaseoksella johon nurmen siemenet on sekoitettu

LO — LOUHIKIVEYS, Louhikivi, harmaa, 400x400:200x80 mm, Rudus Oy
kalannuotoladonta valmistajan ladontaohjeen mukaan

LI — LIUSKEKIVEYS, Liuskekivi, Oriveden musta
saumataan esim. Grepur 294UV sauma-aineella, väri basaltti

NO — NOPPAKIVEYS, Noppakivi, harmaa graniitti, lohkottu 90x90x90 mm,
oleskelualue ympyrätiladontana, portaat tiililadontana
saumataan esim. Grepur 294UV sauma-aineella, väri harmaa

SEULANPÄÄKIVEYS, Seulanpääkivi, halk. 100-150 mm, asennus kivituhkaan

PUUTERASSI, Lämpöpuu, esim. Luna Deck 2 profix 2, 26x117 mm
tai Lehtikuusi, 26x145 mm.

gkr GRL — GRANIITTIKIVIREUNUS, Nupukivi, harmaa graniitti, lohkottu 140x140x220 mm
GRANIITTIREUNALISTA, Suoareunakivi R80, harmaa graniitti, 80x1000x250 mm
asennus maakosteaan betoniin

kr — LANKKUREUNUS, kestopuuta, 28x120 mm, tai rajausreunalistalla, kork, 125 mm, suunnitelmassa esitetyssä laajuudessa

TM yp — TUKIMUURI, HB-Vallikivi, harmaa, 630x215x100 mm, kulmissa käytetään HB-Vallikulmakiviä, harmaa, 314x215x100 mm, HB-Betoniteollisuus Oy. Yli 700 mm korkeat muurit tulee raudoittaa ja valaa

ASKELKIVET, Liuskekivi, Oriveden musta, porrastaen maaston mukaan

PERGOLA-AITA, Lämpöpuu tai ruskea kestopuu, tolpat ja yläpalkki 90x90 mm, rimoitus vinorima. Korkeus 2400mm, tolppien väli 1200-1500 mm. Tiheä rimoitus 1000 mm korkeuteen, siitä ylemmäs harventaen. Perusteiaan betonilla tai suoraan terassin runkoon.

valo_pl yl/ul — VALAISIN, valpu pollari, Lacuna Duo, Winled 150x50x900 mm, väri RAL7030 Stone grey.
valaisin upotettava, Velma, Winled. sis sähkötolppa, esim. Bega pistorasiapylväs.

SVK +31.25 — SADEVESIKAIVON KANSI ja KANNEN KORKEUS (asemapiirroe)
SADEVESIKAIVON KANNEN YMPÄRYSKIVEYS, seulanpääkivi, halk. 100-150 mm.
asennus maakosteaan betoniin

+31.60 — SUUNNITELTU MAANPINNAN KORKO / KORKO TASAUSVIIVOIN

+30.89 — MITATTU, OLEVA MAANPINNAN KORKOASEMA

Tasokoordinaattijärjestelmä: ETRS-GK25Korkeusjärjestelmä: N2000

UUDISRAKENTAMINEN

DIAKONISSANTIE 6, 8 ja 10

TYÖPIIRUSTUS

YLEISSUUNNITELM

1:20

VIREO

VIH 2019-

Appendix 4. Relevant Pellas construction specifications

3.12 Hulekivi

The driveway area of the yard will be covered with grey Hulekivi, 278x138x80 mm. The paving is laid like brick laying.
The storm stones are installed in such a way that they rest evenly on their base. Hulekivi's base structure must be water permeable. In the installation layer, ø 2-5 mm crushed stone is used. The stone is left unsealed. Check the manufacturer's installation instructions.
The paving must form a uniform and stepless surface. Seams must be straight. The surfaces of the finished stones must be intact. Fittings and cuts are made by sawing. Gaps larger than 20 mm are not allowed when connecting to another building part. The edge of the paving is supported when it borders the loose pavement with concrete or a plank border, unless another border is specified.

3.13 Nurmikivi

Next to the concrete paving of the entrance, grass paving will be established to the extent shown in the plan.
A mixture of growing medium and sand is used to fill and seal the holes in the grass stones. The proportion of sand is about 50%. The soil-sand mixture is brushed into the holes and seams and then compacted with a vibrating plate. Mulch is added until the holes are full.
Finally, the lawn seed is sown in the holes and the seeding is carefully watered. Drought-resistant Festuca ovina is used as lawn seed.
Lawn stones are installed in such a way that they rest evenly on their base. Sand for installation is ø 0-4 mm sand.
The paving must form a uniform and stepless surface. Seams must be straight. The surfaces of the finished stones must be intact. Fittings and cuts are made by sawing. Gaps larger than 20 mm are not allowed when connecting to another building part. The edge of the paving is supported when it borders the loose pavement with concrete or a plank border, unless another border is specified.

3.14 Louhikivi

The maintenance area and corridor at the ends of the building will be covered with grey quarry stone, 400x400/200x80. Quarry stone is laid as a herringbone laying, according to the manufacturer's instructions.
Quarry stones are installed in such a way that they rest evenly on their base. Sand for installation is used ø 0-4 mm sand.
The paving must form a uniform and stepless surface. Seams must be straight. The surfaces of the finished stones must be intact. Fittings and cuts are made by sawing. Gaps larger than 20 mm are not allowed when connecting to another building part. The edge of the paving is supported when it borders the loose pavement with concrete or a plank border, unless another border is specified.