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Water strategies for Swedish sustainable urban planning

A comparison between certification systems and urban water research

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Abstract

Water strategies for Swedish sustainable urban planning – a comparison between certification systems and urban water research

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Sustainable development is gaining more focus than ever, and sustainable urban water management is increasingly being incorporated in urban planning worldwide. Internationally, certification systems for sustainable urban planning have gained popularity, and a Swedish version of the British certification system BREEAM Communities is on its way. In this degree project the technical water related aspects of the certification system BREEAM Communities are analyzed and compared with the corresponding aspects of the American certification system LEED for Neighborhood Development. Water related aspects of both systems are discussed on basis of research in sustainable urban water management. Difficult questions raised in managing the urban water of the future are e.g. climate changes and new technical solutions for storm water management.

Keywords: Sustainable development, water management, green infrastructure, urban planning, climate change, BREEAM Communities, LEED for Neighborhood Development

Referat

Hållbara vattenstrategier - en jämförelse mellan tekniska vattenaspekter inom certifieringssystem och aktuell forskning

Pia Sjöholm

Hållbar utveckling är en term som används allt flitigare i olika sammanhang, så även inom byggsektorn. Ofta används termen för att sammanfatta utvecklingen av ekonomiskt, socialt och miljömässigt långsiktiga lösningar. Under de senaste decennierna har olika typer av certifieringssystem för hållbara byggnader utvecklats, och på senare tid även certifieringssystem för hela stadsdelar. I detta examensarbete analyseras vattenrelaterade aspekter inom två stora internationella certifieringssystem för hållbara stadsdelar; det brittiska systemet BREEAM Communities och det amerikanska systemet LEED for Neighborhood Development. Syftet är att jämföra dessa system med aktuell forskning inom hållbar urban vattenhantering och därmed kunna utvärdera huruvida systemen skulle kunna anpassas och implementeras för svenska förhållanden. Utmaningar inom urban vattenhantering som certifieringssystem för hållbara stadsdelar bör förhålla sig till är exempelvis klimatförändringar och nya tekniska lösningar för dagvattenhantering.

Nyckelord: Hållbar utveckling, grön infrastruktur, stadsplanering, VA-planering, dagvattenhantering, klimatförändringar

Preface

This degree project is the final part of the master programme in environmental and water engineering at Uppsala University, Sweden. The project was done at the Uppsala office of Vectura, a technical consultant company which is a part of the Sweco Group. Subject reviewer was Hans Lind from the Department of Real Estate and Construction Management at the Royal Institute of Technology, and supervisor was Josefine Kofoed-Schröder from Vectura. I thank you for your time and engagement in this project!

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Pia Sjöholm

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Populärvetenskaplig sammanfattning

Hållbar utveckling är en term som används allt flitigare i olika sammanhang, så även inom byggsektorn. Ofta används termen för att sammanfatta utvecklingen av ekonomiskt, socialt och miljömässigt långsiktiga lösningar. Under de senaste decennierna har olika typer av certifieringssystem för hållbara byggnader utvecklats, med målet att främja användningen av miljövänliga material och energisnåla hus. Med tiden har även certifieringssystem för hållbara stadsdelar tagits fram, och det finns flera internationella system som används. Syftet med dessa system är att främja hållbara lösningar när nya stadsdelar ska planeras eller när gamla stadsdelar ska göras om, så att man kan följa ett färdigt certifieringssystem och nå upp till olika certifieringsnivåer för en stadsdel beroende på hur väl planprocessen uppfyller systemkraven. I skrivande stund pågår ett projekt som går ut på att ta fram en svensk version av det brittiska certifieringssystemet BREEAM Communities, ett system skapat för planering av hållbara stadsdelar. Projektet med den svenska versionen drivs av Swedish Green Building Council (SGBC) och kallas HCS-projektet, en förkortning av *Hållbarhetscertifiering av stadsdelar*.

Detta examensarbete har som syfte att analysera vilka vattenrelaterade aspekter som ingår i BREEAM Communities, att analysera vilka vattenaspekter som ingår i den amerikanska motsvarigheten *LEED for Neighborhood Development*, samt att koppla vattenaspekterna från båda systemen till den senaste forskningen inom hållbar urban vattenhantering med fokus på Sverige och svenska förhållanden. Detta görs genom en litteraturstudie i kombination med en analys av resultaten av en workshop som HCS-projektet organiserat. Workshop:en samlade verksamma från flera svenska vattenorganisationer för att diskutera och sammanfatta vilka vattenrelaterade aspekter som är viktiga att uppmärksamma och ha med i ett framtida svenskt certifieringssystem. Dessutom genomförs en undersökning hos planavdelningarna på ett antal kommuner för att undersöka vilken uppfattning som finns hos personer som är aktiva inom planeringsverksamhet idag, angående idén med att implementera certifieringssystem för hållbar stadsplanering.

Resultaten från analysen av och jämförelsen mellan de två certifieringssystemen BREEAM Communities och LEED for Neighborhood Development visar på följande gemensamma vattenrelaterade aspekter:

- Främjandet av så kallad grön infrastruktur som renar dagvatten och fördröjer flödestoppar genom infiltreringslösningar, våtmarker och gröna tak

- Omhändertagande av dagvatten för olika typer av användningsområden, exempelvis bevattning

- Utvärdering av översvämningsrisker, enligt BREEAM Communities ska även framtida klimatförändringar vara inräknade i dessa

Vattenrelaterade aspekter som den behandlade forskningen tar upp men som saknas i de analyserade systemen är:

- Recirkulation av näringsämnen via slam

- Bristen på säker data och fungerande modeller för beräkningar av effekter av klimatförändringar

Vattenrelaterade aspekter som tas upp i systemen men som inte har funnits ha stöd i analyserad forskning vad gäller implementering för svenska förhållanden:

- Uppsamlande av regnvatten för konsumtion

- Återanvändning av avloppsvatten för konsumtion

Enkäten som undersökte vilken uppfattning som finns hos personer inom den kommunala planverksamheten idag, angående idén med att implementera denna typ av certifieringssystem, visade på en generellt positiv inställning. Respondenterna ansåg att dagvattenhantering och översvämningsrisker, vattenskydd samt lokal avloppsvattenhantering är viktiga aspekter att inkludera i ett certifieringssystem för hållbar stadsplanering. Till stor del är redan dessa frågor inkorporerade i planprocessen idag.

Content

1. Introduction

In 1987, the World Commission on Environment and Development defined the term "sustainable development" as "a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs" (Barnaby, 1987). By this report, the term "sustainable development" was spread internationally and today, 26 years later, it is still a very live issue.

In the spring of 2013, the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, Formas, announced annual funding of SEK 21 million for research in the area of the built environment (Formas, 2013). This funding is to be granted over a five year period with the intention to improve knowledge of sustainable building and urban planning. This is also part of developing a long-term research programme for sustainable spatial planning. The term "sustainable building and urban planning" is defined by Formas to include planning, construction and the administration and management of cities, urban areas, infrastructure, buildings and facilities in order to achieve improved social, ecological and economic sustainability. This funding can be considered as a confirmation by the government of the necessity to incorporate research when developing urban planning strategies for the future. Challenges behind research in the area of sustainable urban planning include according to Formas climate change, major stresses imposed on the environment, increased density in urban areas, infrastructural problems and increasing demands for resource efficiency. The need of collaboration between several disciplines and nations is pointed out.

Within the building sector, issues of sustainability are increasingly included in the production of buildings and in the planning of communities. As a result of this, several certification systems for sustainable planning and construction have developed all over the world. A goal for the close future is to develop a Swedish manual for a British certification system called BREEAM (Building Research Establishment Environmental Assessment Method) Communities (from here on BREEAM C), a project driven by Swedish Green Building Council (SGBC). SGBC started as cooperation between several consultant companies, municipalities and other organizations. The project of developing a Swedish system is called the HCS project, from the Swedish name *Hållbarhetscertifiering av stadsdelar*. The future certification system will be based on Swedish standards, methods and regulations instead of

British. After the work of the project has been published, the SGBC will decide whether a unique Swedish system is to be developed, or if SGBC will participate in influencing the development of BREEAM C. A specific request from the HCS project that the water issues were to be evaluated further, became a starting point for this degree project. In this degree project, water issues in BREEAM C will be analyzed and compared to water issues of another important international certification system for sustainable urban planning, the American LEED (Leadership in Energy and Environmental Design) for Neighborhood Development (from here on LEED N-D), which will also be evaluated in the HCS project.

Parallel to this degree project, a similar project with focus on water aspects was simultaneously in progress, coordinated by the HCS project (HCS, 2011a). Differences between this degree project and the HCS coordinated project is that this degree project is more detailed in analyzing the water related aspects of the systems, and compares the certification systems to research which the HCS project does not. There have been cooperation including exchange of ideas and information between this degree project and the HCS coordinated project, especially in connection to a workshop organized by the HCS coordinated project.

2. Purpose of study

The overall purpose of this study is to compare the certification systems of BREEAM Communities and LEED for Neighborhood Development to each other with focus on water related aspects, and to compare the certification systems to up-to-date research in urban water management. Up-to-date research includes research published in the last decade. Thereby the relevance of the certification systems' sustainability criteria for urban water management can be evaluated according to the latest research in the area.

Partial goals that this study is built upon are:

1. Analyzing the sustainable urban planning certification systems of BREEAM Communities and LEED for Neighborhood Development with respect to water related aspects

2. Comparing the analyzed certification systems to each other with a focus on water related aspects

3. Carrying out a literature study on up-to-date research in sustainable urban water management

4. Comparing the analyzed certification systems to up-to-date research in sustainable urban water management

3. Methods

The two certification systems were chosen based on the on-going HCS project (Hållbarhetscertifiering av stadsdelar). These certification systems are to be analyzed by SGBC (Swedish Green Building Council) to develop a Swedish framework for sustainable urban planning and they consist of two of the most used certification systems for sustainable urban planning world-wide. BREEAM C is a British system while LEED N-D is an American system. The analysis was done by identifying water related assessment issues from the latest editions of the technical manuals for both systems, and systemizing these issues under the following four technical urban water management main groups:

- Groundwater and surface water quality
- Flood control and storm water management
- Water supply
- Wastewater management

These four main groups were selected to compile all water related aspects in the analyzed certification systems systematically. The comparison between the two systems was done by comparing the corresponding water related assessment issues of both systems within the four categories mentioned above. The chosen categorization was inspired by the EU project *SWITCH Managing Water for the City of the Future*, in which the technical parts of urban water are structured into the following three research areas; "water supply", "storm water" and "wastewater" (SWITCH, 2013a). The reason for adding "groundwater and surface water quality" as an extra group to this degree project was to enlighten the value of clean water as a resource.

To locate relevant research and gather information on relevant urban water aspects, a literature study was done combined with attending a workshop organized by the HCS project. The literature used in the project is mainly scientific reports published during the years 2004-2013 from highly ranked field specific journals such as *Water Research* and *International Journal of Water Resources Development*. The Swedish national research programme *Sustainable Urban Water Management – Framtidens uthålliga VA-system* (1999-2006) was used as a major source of input, especially through a PhD thesis by Edgar L. Villarreal

(Villarreal, 2005) and through a scientific report by Justyna Czemiel Berndtsson (Czemiel Bendtsson, 2004).

Information on water aspects, considered relevant for an urban planning framework by leading professionals in Swedish urban water management, was gathered during a workshop organized by the HCS project. The purpose of the workshop was to investigate and discuss whether there are relevant water issues missing in BREEAM C that should be included in a future Swedish framework. The results of the workshop were compiled and functioned as a guideline to highlight water aspects relevant to focus on. The participants of the workshop were representing the following organizations and institutions: The Swedish Environmental Institute (IVL), The Swedish Water & Wastewater Association (Svenskt Vatten), Urban Water, VA Syd, Swedish Green Building Council (SGBC), Geological Survey of Sweden (SGU), Stockholm Environment Institute, Stockholms Stad, Stockholm Vatten, Luleå tekniska universitet, and the consultant companies Sweco, WSP, Tyréns, and OkiDoki!Arkitekter.

To further evaluate the idea of incorporating a Swedish urban planning certification system or framework in the municipal planning process, a survey on water related aspects in urban planning was sent out to urban planning departments in the following Swedish municipalities: Örebro, Gävle, Jönköping, Uppsala, Värmdö, Västerås, Linköping, and Sigtuna.

This degree project does not include other aspects of urban planning such as construction, landscaping, esthetics or social aspects, but focuses strictly on technical urban water management.

4. Background

4.1 The planning and design of urban water systems in Sweden

The first sewer systems were built in the major cities in the end of the 19th century, and by the beginning of the 20th century most of the larger communities had started to build sewer systems (Svenskt Vatten, 2007). Before app. 1950, wastewater, storm water and drained water were led through the same pipes in a combined system, but at this time the duplicate system was introduced for environmental reasons. The duplicate system separates wastewater from storm water, and drained water will go in any of the pipes. In the beginning of the 1990's, the separate system was introduced. With this system, storm water is not led to pipes but instead handled locally or led to ditches. This is an important part in creating sustainable storm water systems and for the last 10-20 years local handling of storm water has been enhanced. The reason is to avoid flood problems by peak flows during heavy rains. An example of locally handled storm water is seen in figure 1, where storm water is allowed to percolate and refill the groundwater. The following picture was taken during a rainfall with a 10 year return period.

Figure 1. Locally handled storm water during a heavy rain (Göran Lundgren 2007).

The reason to handle storm water locally is to minimize the amount of water through pipes, keep the groundwater level steady and create more resistance within communities towards heavy peak flows of storm water. In combination with placing buildings according to terrain level, floods in the community can be avoided. When the amount of storm water flowing through pipes is minimized, pollution loads on the recipients are lowered. Resistance towards possible effects of climate changes are lifted as special benefits of these kinds of storm water

management solutions, but the development of these systems demand that storm water and drain water questions are raised very early in the planning process.

The designing of urban water systems in Sweden are mainly the responsibility of municipalities (Svenskt Vatten, 2007). Politicians and planners share the major responsibility for developing master plans. The master plan directs how land, water and the build environment within the municipality are to be used, how environmental quality norms are to be fulfilled, and includes the coordination of the physical planning with national and regional goals (Boverket, 2013). The process is regulated by Sweden's Planning and Building Act (PBL). The exact planning process differs between different municipalities as many actors are involved, and whether people responsible for water and wastewater systems are involved in the designing of the master plan depends on the municipality. Detailed development plans are designed by the municipality on basis of the master plan when new urban areas are exploited or re-planned. The designing of a detailed development plan can be done either by municipal planners or by consultants (Uppsala kommun, 2012).

In the designing of master plans and of detailed development plans, urban water systems must be included (Uppsala kommun, 2012). The municipalities own the water management facilities and are responsible for running them. During the planning process many actors are involved and PBL must be followed (Svenskt Vatten, 2000). Drinking water quality is the responsibility of the Ministry of Agriculture with the National Food Administration as the central supervising agency. Water protection is the responsibility of the Swedish Agency for Marine and Water Management (HaV), supervised by the municipal committee for environment and health. Further, the EU Water Framework Directive must be followed.

4.2 International certification systems for sustainable urban planning

Certification systems for constructions have already been adapted by several companies worldwide for years. In Sweden, the most common systems are *Miljöbyggnad*, *EU GreenBuilding*, *BREEAM* and *LEED* (SGBC, 2013). Of these systems, the first one is adjusted for Swedish conditions while the later ones are an EU initiative, a British system and an American system. To extend the certification systems beyond buildings and towards entire communities, new versions of the construction certification systems have been developed. Internationally there are many systems, such as *Green Star – Communities* from Australia (GBCA, 2012), *CASBEE* (Comprehensive Assessment System for Built Environment

Efficiency) *for Cities* from Japan (JaGBC, 2013), *DGNB* (Deutsche Gesellschaft für Nachhaltiges Bauen) from Germany (SGBC, 2013c), and *Living Building Challenge* from Canada. The certification systems specifically designed for communities instead of single constructions and used in Europe, are mainly the British system *BREEAM Communities* (BREEAM C) and the American system *LEED for Neighborhood Development* (LEED N-D) (SGBC, 2013b).

4.3 Swedish development of certification systems for sustainable urban planning

In 2009, the Sweden Green Building Council (SGBC) was formed by thirteen Swedish companies and organizations. It is a non-profit association promoting and developing green and sustainable construction, according to the guidelines given by World Green Building Council (SGCB, 2012). A membership in SGBC is promoted as a way of making a council member's work for sustainability visible, as well as a way of connecting to other members through meetings, seminaries and courses. The obtained marketing opportunities, together with possibilities for networking, are raised as main reasons to apply for a membership. The annual fee is depending on the council member's annual profit.

To produce a certification system for sustainable urban planning in Sweden, the project HCS (Hållbarhetscertifiering av Stadsdelar) was introduced in 2010 by WSP, NCC, the Swedish Environmental Research Institute IVL, and the City of Stockholm (HCS, 2011b). The number of participating municipalities, universities and companies grew rapidly, and in 2011 ten workshops were held by HCS with more than 120 participants. During these workshops, BREEAM C was evaluated according to differences and similarities to Swedish conditions at the time. The topics of the workshops were based on the earlier version of the BREEAM C manual, *BREEAM Communities SD5065B Technical Guidance Manual*, and included a number of assessment issues such as management and operation, biodiversity action plan, water resource management, energy efficiency, and infrastructure services. The aim of these workshops was to give SGBC recommendations on how to implement BREEAM C into a Swedish framework for sustainable urban planning. In 2012 SGBC took over responsibility for the HCS project and the project had at this point involved more than 1500 participants (SGBC, 2013b).

4.5 An overview of BREEAM Communities rating system

In 1990, BREEAM was launched as an environmental assessment method and rating system for buildings (SGBC, 2013d). Today it is the most widely spread international environmental assessment system in Europe. To reach a more holistic approach including economic, social and environmental benefits, the rating system BREEAM Communities was launched in 2011. The manual to BREEAM C used in this project is *SD202 – 0.1:2012 BREEAM Communities Technical Manual*.

BREEAM C is promoted as a scheme for developers, master planning professionals, local authority planners, local politicians, communities and relevant statutory bodies (BRE Global Limited, 2012). The aim is according to the manual to "improve, measure, and certify the social, environmental and economic sustainability of large-scale development plans by integrating sustainable design into the master planning process".

The BREEAM C manual is divided into six impact categories; *Governance, social and economic wellbeing, resources and energy, land use and ecology, transport and movement,* and *innovation*. Under these categories a number of assessment issues are listed. The assessment issues are ordered within three chronological steps. The steps are designed to chronologically follow an urban planning process from outline planning to detailed planning. Step 1 is establishing the principle of development, step 2 is determining the layout of the development, and step 3 is designing the details. The more assessment issues that are fulfilled for a specific site, the more credits are given and the higher the final certification rank for the project or site will be.

4.6 An overview of LEED in Neighborhood Development rating system

In 1993, the U.S. Green Building Council (USGBC) started to research existing green building rating systems (CNU, NRDC and USGBC, 2009). The first LEED pilot project program was launched in 1998, followed by three updated versions the following seven years. During the years there have been many releases of different LEED rating systems such as LEED for Healthcare, LEED for Schools and LEED for Homes. LEED for Neighborhood Development (LEED-ND) is the latest system, launched in 2009. LEED-ND is the outcome of cooperation between the USGBC, the Congress for the New Urbanism (CNU), and the Natural Resources Defence Council (NRDC). In addition to the former systems, the LEED-ND manual describes a system that "puts a higher value in the site selection, design, and

construction elements that bring buildings and infrastructure together into a neighborhood and relate the neighborhood to its landscape as well as its local and regional context" (CNU, NRDC and USGBC, 2009).

The system checklist for certified projects contains three environmental categories: *Smart Location and Linkage (SLL)*, *Neighborhood Pattern and Design (NPD)*, and *Green Infrastructure and Buildings (GIB)*. In addition to the environmental categories are two further impact categories: *Innovation and Design Process (IDP)* and *Regional Priority Credit (RPC)*. Under the five categories follows a checklist of receivable points, based on how well the credits are fulfilled. The allocation of points is, according to the LEED-ND rating system, based on potential impacts and human benefits. The impacts are defined as the effect on environment or humans of the design, construction, operation, and maintenance of the building, such as greenhouse gas emissions, fossil fuel use, toxins and carcinogens, air and water pollutants, and indoor environmental conditions. Energy modeling, life-cycle assessment, and transportation analysis, are used to quantify each type of impact. The certification process is mainly done online as documents are submitted to USGBC for review and the project is registered at www.leedonline.com.

4.4 From theory to practice

According to the project leader of the HCS project, Ann-Kristin Karlsson, the main incitements for municipalities and other actors to adapt to a future Swedish framework for sustainable urban planning are time, money and sustainability (Karlsson, 2013). According to Karlsson, a common system makes sharing knowledge of sustainable planning easier and thereby time can be saved. The process can be reused, cooperation between municipalities can be eased, and routines established. An important part of the certification process is according to Karlsson involving a sustainability perspective early in the planning process. The vision includes earlier incorporation of research, cost-analyzes, local business and service opportunities, socio-economical benefits for the community, and earlier exchange with the contractor.

The creation of a certification system or framework for Swedish conditions is still in progress, and the next step is 22 different site projects evaluating BREEAM C as a certification system. After the evaluation, the question is whether a Swedish version of BREEAM C will follow, or if a Swedish framework will be created outside of the BREEAM system. How follow-ups of

certified sites are to be done is yet not decided, but it will most likely be done either by the Swedish Green Building Council or by the British BRE Group depending on if a Swedish framework or a modified version of BREEAM C is developed.

5. Results

5.1 Results from the HCS workshop and from the survey

To discuss the implementation of BREEAM Communities in a Swedish framework for sustainable urban planning, a workshop was arranged in May 2013 as part of the HCS project. The participants were Swedish professionals of water management, representing the following companies and institutions: Swedish Environmental Institute (IVL), Svenskt Vatten, Urban Water, VA Syd, Swedish Green Building Council, Geological Survey of Sweden (SGU), Stockholm Environment Institute, Stockholms Stad, Stockholm Vatten, Sweco, WSP, Tyréns, Luleå tekniska universitet, and OkiDoki!Arkitekter. Three groups of participants were formed and discussions were held on the topic of water issues in BREEAM Communities. The workshop lasted for a day with the goal of collecting ideas and thoughts of which assessment issues of the BREEAM Communities technical manual are relevant for a Swedish framework. Another goal was to identify assessment issues possibly missing in the manual. The results of the workshop are sorted under the four main groups designed for this degree project and are presented in table 1. Topics brought up during the workshop that are followed up in chapter 5.5 on research, are in black font. The topics followed up in chapter 5.5, are related to water technology rather than construction, landscaping, esthetics or social aspects, as this degree project does not include these topics. The Swedish planning process also affects which topics are further discussed in this degree project. A special focus is put on main group number 2 as these aspects are the ones that the Swedish spatial planning process affects the most.

Table 1. Results from the IVL workshop sorted under the four main groups used in this project, with aspects which are not further discussed in the chapter on research marked in grey font.

1. Groundwater and surface water quality	**2. Flood control and storm water management**	**3. Water supply**	**4. Waste water management**
- Swedish water quality norms	- Height/ initial placing of buildings	- Access to water difficult to estimate for a community as part of a city	- Recycling of nutrients/sludge
- Water quality status of the recipients	- Rising sea level		- Avoid end-of-pipe-solution
- Material choices on site	- Buffer zones for floods	- Production of drinking water often located outside the community in Sweden	- REVAK-certification
- Eutrophication	- Spring floods from melting snow		- Evaluate effects downstream
- Protection of water during construction	- Mapping flood risks	- Risk analyzes for water supply	- Hygiene
	- Rainwater harvesting		- Traces of medicine
	- Escape routes for residents		- Wetlands
	- Storm water retention such as green roofs		- Local treatment plants, new technology
	- Intensified hydrological cycle		
	- Map where in the watershed the community is located		
	- Blue and green solutions		

The results from the survey are presented in Appendix C and within chapter 5.4 as comments to the analyzed certification systems. The respondents are anonymous and a response cannot be connected to a specific municipality. The survey is available in appendix B and the results of the survey are compiled in appendix C.

The general view among Swedish municipal urban planners is, according to the survey, that urban water planning is important to incorporate in the spatial planning process. Several aspects of water management are considered important to include in urban planning, especially storm water management. About half of the respondents in the survey claim that storm water management and flood risks are not included in the spatial planning process in their municipality today, but all respondents agree that these issues should be included.

5.2 Water related aspects in BREEAM Communities technical manual 2012 version

This chapter is based on information from the BREEAM Communities technical manual 2012 (BRE Global Limited, 2012). The assessment issues of the manual are systemized in table 2.

Table 2. Assessment issues of BREEAM Communities Technical Manual 2012 version. Issues considered not to be water related marked in grey font.

STEP 1	**STEP 2**	**STEP 3**
GO 01 Consultation plan	GO 02Consultation and engagement	GO 04 Community management of facilities
SE 01 Economic Impact	GO 03 Design review	SE 14 Local vernacular
SE 02 Demographic needs and priorities	SE 05 Housing provision	SE 15 Inclusive design
SE 03 Flood risk assessment	SE 06 Delivery of services, facilities and amenities	SE 16 Light pollution
SE 04 Noise pollution	SE 07 Public realm	SE 17 Labour and skills
RE 01 Energy strategy	SE 08 Microclimate	RE 04 Sustainable buildings
RE 02 Existing buildings and infrastructure	SE 09 Utilities	RE 05 Low impact materials
RE 03 Water strategy	SE 10 Adapting to climate change	RE 06 Resource efficiency
LE 01 Ecology strategy	SE 11 Green infrastructure	RE 07 Transport carbon emissions
LE 02 Land use	SE 12 Local parking	LE 06 Rainwater harvesting
TM 01 Transport assessment	SE 13 Flood risk management	TM 05 Cycling facilities
	LE 03 Water pollution	TM 06 Public transport facilities
	LE 04 Enhancement of ecological value	
	LE 05 Landscape	
	TM 02 Safe and appealing streets	
	TM 03 Cycling network	
	TM 04 Access to public transport	

Step 1

There are all together 11 assessment issues in step 1 of the BREEAM C Technical Manual 2012 version, of which seven are interpreted in this project as being water related. Step 1 can chronologically be compared to the master planning process in Sweden.

First off is *SE 03 Flood Risk Assessment*. With the aim of reducing the flood risk of the development and surrounding areas, it is one of the major assessment issues of step 1. The mandatory parts, not rewarding any credits, include "risk analyzes of flooding both on the site and from the site to the surrounding area, changes in flood risks due to climate change, consultation with statutory bodies, and knowledge of possible flood risks within the local community". To receive the full amount of credits, which is two, the site has to be placed in an area considered a low risk flood zone. If the site lies in a medium or high risk zone, only one credit can be achieved and a list of issues needs to be fulfilled including strategic placing of infrastructure, and an emergency plan in case of flooding. A list of sources of flooding is presented, taking up e.g. infrastructure failure and high levels of rainfall in the catchment area causing the groundwater to rise or causing excess surface runoff. A list of defences is provided including railway embankments and motorways, and a rising sea level due to climate change is mentioned as an aspect with the need of extra allowance. To estimate the site-specific flood risk, the manual refers to information attained from National Planning Policy Framework technical guide document (March 2012).

Step 1 continues to *RE 01 Energy Strategy*. As this is only a water related issue when hydropower is present in the area, which is an un-common issue while planning communities, this assessment issue will be disregarded in this project. Another assessment issue, de-emphasized in this project, is *RE 02 Existing Buildings and Infrastructure*. This part is encouraging re-use of infrastructure, which refers to e.g. existing pipes and other water related utilities.

As one of the overall central water assessment issues, *RE 03 Water Strategy* follows. The aim of this issue is a minimized water demand, taking into account the availability of water in the area. Future demand is to be taken for consideration as well. As mandatory parts in this issue are mentioned cooperation with local water suppliers and authorities, and climate change is again lifted as an aspect to keep in mind together with growth. Further mandatory parts include creating a water strategy including maintenance of shared facilities, actions to minimize the predicted water use and maintain it in the future, and storage or collection

opportunities. To get extra credits, the water strategy must be adopted through commitments affecting the design of the landscape, planting and hard surfaces, and management of water supply or water collection. Climate change allowance to handle effects of impacts on precipitation levels, evaporative losses and changing use patterns must be taken into account.

One assessment issue not directly associated with water, but dependent on water, is *LE 01 Ecology Strategy*. Water supply is mentioned as a part of the process to sustain local ecological habitats, and the ecological strategy includes protection and enhancement of habitats.

The last water related issue in step 1 is *LE 02 Land Use*. Groundwater quality is mentioned when aiming for two credits, and does specifically refer to the UK Sustainability Remediation Forum's 'Framework for Assessing the Sustainability of Soil and Groundwater Remediation'. Water is not mentioned more specifically.

Step 2

Step 2 can chronologically be compared to the detailed development plan process in Sweden. The first water related assessment issue under step 2 is *SE 08 Microclimate*. Open water is mentioned as a way to reduce the urban heat island, and later in the manual as a possibility to provide a comfortable outdoor environment through controlling climatic conditions.

The following issue is *SE 09 Utilities*, reminding of RE 02 Existing Buildings and Infrastructure in step 1. It mainly states that services such as water and sewage should be provided, and that maintenance of the services should not cause unnecessary disruption in people's movement.

An issue mentioned in several other areas is *SE 10 Adapting to Climate Change*. The aim of this issue is to ensure that the development is resilient to impacts of climate change, both known and predicted. Among the listed impacts are flood risks, changes in ground conditions and impacts on water resources. Benefits in addition to climate change are also mentioned, e.g. using drainage techniques that may increase biodiversity or improve water quality.

Another lifted benefit is reducing more than one climate change impact, e.g. helping to reduce the urban heat island while simultaneously reducing flood risk. A list of methods for adapting to the heat island is provided, including open water and fountains. A list of techniques for adapting to increased flood risk is also given including flood resilient buildings and materials,

management of flood pathways, water storage within green space, hard flood defences and barriers, attenuation of runoff with green open space and green roofs, and use of sustainable drainage systems. There are three provided examples of methods for adapting to impacts on water resources; increased use of recycled water, reduction in water demand, and rainwater harvesting combined with drainage systems to collect and store water. This is followed up in the assessment issues *SE 11 Green infrastructure* and *SE 13 Flood risk management*. The first one has the aim of ensuring access to either natural environment or urban green infrastructure. The second one is one of the most emphasized assessment issues of the system.

The aim of SE 13 Flood risk assessment is “to avoid, reduce and delay the discharge of rainfall to public sewers and watercourses, thereby minimizing the risk of localized flooding on and off site, watercourse pollution and other environmental damage”. To achieve extra credits, the recommendations from SE 03 Flood risk assessment in step 1 have to be incorporated. Calculations on a surface water run-off draining system has to be done by a qualified professional, and the peak rate of surface water run-off including climate change effects cannot be higher than it was before the development of the site. Any additional run-off caused by the development for a 100 year event of 6 hour duration, including climate change effects, must be reduced. Infiltration is given as an example of a relevant technique. Three credits can be granted if local drainage system failure would cause no flooding of property. A component to manage surface water run-off must be added, and a list of examples is given including wet ponds, infiltration basins, detention basins, swales, reed beds, dry wells, green roofs and rainwater harvesting.

Another major assessment issue in step 2 is *LE 03 Water pollution*. There are no mandatory standards in this issue, with the aim to protect the local watercourse from pollution and damage. To receive extra credits, a drainage plan has to be made available to the authority maintaining the drainage infrastructure. Water pollution is to be avoided during construction, following specific guidelines of the UK Environment Agency. The run-off is to be treated following the guidelines in the SuDS Manual created by the British Construction Industry Research and Information Association, CIRIA. The natural watercourses must be protected from chemicals by fitting shut-off valves to the drainage system where there are chemical or liquid gas storage areas. Oil or petrol separators have to be used where there is a high risk of contamination by spillage. If a professional can confirm that there will be no discharge from the site for rainfall up to 5 mm, the full amount of credits can be received.

The last water related issue in step 2 is *LE 05 Landscape*. Water is mentioned when aiming for higher credits, if the irrigation system and the selection of tree, scrub and herbaceous planting are based on water efficiency.

Step 3

Two issues are related to water in step 3. The first one is *RE 04 Sustainable buildings*. To receive credits, the design of the buildings must comply with recognized industry best practice standards in sustainable design for, among other key issues, water.

The other water related issue in step 3 is *LE 06, Rainwater harvesting*. The aim of this issue is to ensure that "surface water run-off space is used effectively to minimize water demand". Credits can be received if rainwater is collected and used for toilet demand or washing machines, second for irrigation and planting.

5.3 Water related aspects in LEED for Neighborhood Development

This chapter is based on information from the LEED for Neighborhood Development Technical Manual 2009 version (updated 2012) (CNU, NRDC and USGBC 2009). The assessment issues of the manual are systemized in table 3.

Table 3. Assessment issues of LEED for Neighborhood Development Technical Manual 2009 version (updated 2012). Issues considered not to be water related are marked in grey font.

Smart Location and Linkage	**Neighborhood Pattern and Design**	**Green Infrastructure and Buildings**
Prerequisite 1 Smart Location	Prerequisite 1 and Credit 1 Walkable Streets	Prerequisite 1 and Credit 1 Certified Green Buildings
Prerequisite 2 Imperiled Species and Ecological Communities	Prerequisite 2 and Credit 2 Compact Development	Prerequisite 2 and Credit 2 Minimum Building Energy Efficiency
Prerequisite 3 Wetland and Water Body Conservation	Prerequisite 3 Connected and Open Community	Prerequisite 3 and Credit 3 Minimum Building Water Efficiency
Prerequisite 4 Agricultural Land Conservation	Credit 3 Mixed-Use Neighborhood Centers	Prerequisite 4 Construction Activity Pollution Prevention
Prerequisite 5 Floodplain Avoidance	Credit 4 Mixed-Income Diverse Communities	Credit 4 Water-Efficient Landscaping
Credit 1 Preferred Locations	Credit 5 Reduced Parking Footprint	Credit 5 Existing Building Reuse
Credit 2 Brownfield Redevelopment	Credit 6 Street Network	Credit 6 Historic Resource Preservation and Adaptive Use
Credit 3 Locations with Reduced Automobile Dependence	Credit 7 Transit Facilities	Credit 7 Minimized Site Disturbance in Design and Construction
Credit 4 Bicycle Network and Storage	Credit 8 Transportation Demand Management	Credit 8 Stormwater Management
Credit 5 Housing and Jobs Proximity	Credit 9 Access to Civic and Public Spaces	Credit 9 Heat Island Reduction

Credit 6 Steep Slope Protection	Credit 10 Access to Recreation Facilities	Credit 10 Solar Orientation
Credit 7 Site Design for Habitat or Wetland and Water Body Conservation	Credit 11 Visitability and Universal Design	Credit 11 On-Site Renewable Energy Sources
Credit 8 Restoration of Habitat or Wetlands and Water Bodies	Credit 12 Community Outreach and Involvement	Credit 12 District Heating and Cooling
Credit 9 Long-Term Conservation Management of Habitat or Wetlands and Water Bodies	Credit 13 Local Food Production	Credit 13 Infrastructure Energy Efficiency
	Credit 14 Tree-Lined and Shaded Streets	Credit 14 Wastewater Management
	Credit 15 Neighborhood Schools	Credit 15 Recycled Content in Infrastructure
		Credit 16 Solid Waste Management Infrastructure
		Credit 17 Light Pollution Reduction

Smart Location and Linkage

The first water related assessment issue in LEED for Neighborhood development is *Prerequisite 1 Smart Location*. This issue requires the project to be located on a site served by existing water and wastewater infrastructure, or located within a planned water and wastewater service area. New water and wastewater infrastructure for the project must be provided, but no specifications on the kind of infrastructure are given.

Prerequisite 3 Wetland and Water Body Conservation is focused on preserving water quality, natural hydrology, habitat, and biodiversity. Requirements are given to limit development effects on wetlands, water bodies, and surrounding buffer land. Credits are given depending on how the development is located in relation to objects mentioned above. A list of features that must not be protected is provided, including industrial mining pits, storm water retention ponds and man-made wetlands rated “poor”. A list of minor improvements to enhance local appreciation for the wetland or water body is also provided, including bicycle pathways and removal of hazardous trees.

The following issue under the headline of *Smart Location and Linkage,* is *Prerequisite 5 Floodplain Avoidance*. The intent is “to protect life and property, promote open space and

habitat conservation, and enhance water quality and natural hydrological systems". The manual refers to the mappings of the American National Flood Insurance Program, and it is with a few exceptions required to avoid land that lies within a 100-year-high-or-moderate-risk floodplain according to the manual.

The first water related non-prerequisite issue, is *Credit 6 Steep Slope Protection*. The intent is "to minimize erosion to protect habitat and reduce stress on natural water systems by preserving steep slopes in a natural, vegetated state". Different requirements for different slopes are given, such as no disturbance for slopes over 15 %. When previously developed land is in question, areas with slopes over 15 % must be restored with native plants or noninvasive adapted plants. A table is given of required restoration areas of slopes.

The intent of *Credit 7 Site Design for Habitat or Wetland and Water Body Conservation*, is to "conserve native plants, wildlife habitat, wetlands, and water bodies". This is to be done by choosing the location of the development with great respect to how wetlands or water bodies in the area perform functions such as water quality maintenance, wildlife habitat protection, and hydrologic function maintenance. A list of features not considered wetlands, water bodies, or buffer land is given.

The goal of *Credit 8 Restoration of Habitat or Wetlands and Water Bodies* is "to restore native plants, wildlife habitat, wetlands, and water bodies harmed by previous human activities". This is to be done by using only native plants and by recreating habitat characteristics, such as hydrology, that likely occurred in predevelopment conditions. Restored areas are to be maintained for a minimum of three years after the project is built and the land is to be protected from development by, for example, donating or selling the land to an accredited trust or public agency.

The last water related issue in the first part of LEED N-D is Credit 9 *Long-Term Conservation Management of Habitat or Wetlands and Water Bodies*, with the intent "to conserve native plants, wildlife habitat, wetlands, and water bodies". A long-term management plan is to be created, including procedures for maintaining the conservation areas, estimated costs, and threats from the development on habitat or water resources and measures to reduce the threats.

Green Infrastructure and Buildings

Prerequisite 2 Minimum Building Energy Efficiency and *Credit 2 Building Energy Efficiency* have the intent "to encourage the design and construction of energy-efficient buildings that

reduce air, water, and land pollution". This is to be done by following given standards but no details or examples are given on how it is to be done.

The issue is followed by *Prerequisite 3 Minimum Building Water Efficiency* with the intent to "reduce effects on natural water resources and reduce burdens on community water supply and wastewater systems". This is followed up later by *Credit 3 Building Water Efficiency*. Numbers on American efficiency baselines for water usage are given, as guidelines to reach an indoor water usage in the project buildings less than 40 % of the national baseline.

Prerequisite 4 Construction Activity Pollution Prevention has the intent "to reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, and airborne dust generation". A sedimentation control plan is to be created to limit negative effects by runoff from the project site during construction. As an example, sedimentation in any affected storm water conveyance system must be prevented. Again, the manual refers to external standards, this time to the Washington State Department of Ecology's *Stormwater Management Manual for Western Washington, Volume II, Construction Stormwater Pollution Prevention* (2005 edition).

Credit 4 Water-Efficient Landscaping has the intent to "limit or eliminate the use of potable water and other natural surface or subsurface water resources on project sites, for landscape irrigation". Outdoor landscape irrigation is to be reduced, and a list of examples on how to reduce it is given. The list includes, among other examples, using captured rainwater or recycled wastewater.

Credit 8 Stormwater Management is one of the largest water focused assessment issues with the intent to "to reduce pollution and hydrologic instability from stormwater, reduce flooding, promote aquifer recharge, and improve water quality by emulating natural hydrologic conditions". A storm water management plan is to be implemented, to retain water that falls on the site through infiltration, evapotranspiration, or reuse. Up to four credits can be received depending on the storm water retaining efficiency of the site. Again, the manual refers to the Washington State Department of Ecology's *Stormwater Management Manual for Western Washington* for guidelines.

Credit 11 On-Site Renewable Energy Sources suggests the use of, among other examples of renewable energy sources, micro hydroelectric energy. The production capacity should be at

least 5 % of the project's annual electrical and thermal energy cost. A larger percentage is rewarded with more credits.

Credit 14 Wastewater Management is the last water related assessment issue. The intent is "to reduce pollution from wastewater and encourage water reuse". At least 25 % of the annual wastewater is to be retained and reused as potable water. No further information on how this is to be done is given.

5.4 Comparison of analyzed certification systems

The comparison between LEED N-D and BREEM C has been done with respect to the urban water management main groups:

1. Groundwater and surface water quality
2. Flood control and storm water management
3. Water supply
4. Wastewater management

These groups have been selected depending on issues emphasized in the analyzed certification systems. The aim of the groups is to create a structure for the project and to keep a focus throughout the report. All aspects of water mentioned in the systems are sorted and discussed under these four main groups as in table 4.

Table 4: All water related aspects of BREEAM C and LEED N-D systemized under the four main groups

Main group	Water related issue	BREEAM C	LEED N-D
1	Groundwater and surface water quality	LE 02 Land use, LE 03 Water pollution	Wetland and Water Body Conservation, Minimum Building Energy Efficiency, Stormwater Management, Wastewater Management
2	Flood control and storm water management	SE 03 Flood risk assessment, SE 10 Adapting to climate change, SE 11 Green Infrastructure, SE 13 Flood risk management	Floodplain avoidance, Stormwater Management
3	Water supply	RE 03 Water strategy, SE 09 Utilities, SE 10 Adapting to climate change, SE 13 Flood risk management, LE 06 Rainwater harvesting	Smart location, Building Water Efficiency, Water-Efficient Landscaping, Stormwater Management, Wastewater Management
4	Wastewater Management	SE 09 Utilities, RE 02 Land use, RE 04 Sustainable buildings	Smart location, Wastewater Management, Minimum Building Water Efficiency

5.4.1 Comparison with focus on groundwater and surface water quality

In BREEAM C, groundwater and surface water quality is mentioned in connection to land use, to water pollution and to green infrastructure, but never as mandatory for the project to be certified. Soil and groundwater remediation is mentioned when aiming for extra credits within land use.

Water pollution must only be taken into account during site construction and lacks mandatory standard. Treating run-off is mentioned when heading for extra credits, together with shut-off valves to protect the drainage system from leakage of chemicals.

In LEED N-D, wetlands are promoted and dominate the technical solutions mentioned to protect groundwater and surface water quality. Wetlands are considered important enough to make an effort in raising the local inhabitant's appreciation for wetlands. Focus on preserving wetlands follows throughout several assessment issues; *Prerequisite 3 Wetland and Water Body Conservation, Credit 7 Site Design for Habitat or Wetland and Water Body Conservation, Credit 8 Restoration of Habitat or Wetlands and Water Bodies,* and *Credit 9 Long-Term Conservation Management of Habitat or Wetlands and Water Bodies.*

Except wetlands, it is encouraged to reduce water pollution in the design and construction of buildings, but it is not specified how to do this. Pollution from storm water is to be reduced and water quality is to be improved by emulating natural hydrological conditions.

Throughout both certification systems, the only mandatory part related to preserving groundwater and surface water quality is wetland and water body conservation by LEED N-D. The exact demand is to avoid development affecting water bodies, but it is not specified in what sense.

Protection of groundwater and surface water quality during the planning process is considered important by municipal planners and is already incorporated in the planning process of today, according to the survey done for this project. The EU project Natura 2000 is given as an example of how this is done, which indicates this question might have been understood in a different way than intended. Natura 2000 is a project aiming to protect areas from urban development, rather than protecting the environment in urban areas (European Commission 2013).

5.4.2. Comparison with focus on flood control and storm water management

As for flood risk, BREEAM C is more open to the possibility to develop new projects on medium or high risk zones than LEED N-D. For full credits, the BREEAM C project must be placed in a low risk flood zone, but the manual also opens up for the possibility to place projects in medium or high risk zones. To do this, there are issues to fulfill, such as taking measures to protect the development from flooding without increasing the flood risk in upstream and downstream areas. Other issues to fulfill for building in medium or high risk areas concern e.g. location of essential infrastructure.

LEED N-D is open only for developing projects on previously developed sites in flood risk areas, demanding critical facility to be protected and operable during a 500-year event.

To reduce the risk of flooding from storm water, BREEAM C demands that calculations on a surface water run-off draining system is done. The report should include e.g. areas of permeable and impermeable surfaces, peak rates of run-off for 1 year and 100 year events, and additional volume of run-off caused by the development. Reduction of run-off caused by the development is necessary for higher credits. A storm water management plan is also demanded by LEED N-D, which must include ways of retaining the water on the developed site by e.g. evapotranspiration or reuse.

Climate change is uplifted as crucial in BREEAM C for calculations on surface run-off over the development lifetime, while not mentioned in LEED N-D in association with flood risk or run-off.

According to the survey sent to Swedish municipal planners (Appendix C), this is an area incorporated in the planning process today. On the other hand, flood risks might not always be considered and sometimes surrounding areas are not included in risk calculations. Whether climate change is considered is not shown by the survey.

5.4.3. Comparison with focus on water supply

Both BREEAM C and LEED N-D demands that the project is served by water infrastructure, and that the water demand is minimized. BREEAM C demands for this to be done through a water strategy including actions to minimize the predicted water use together with storage or collection opportunities. Credits can be received if rainwater is collected and used for toilet demand, washing machines or irrigation. LEED N-D also mentions harvesting rainwater for irrigation purposes to limit the use of natural surface or subsurface water resources. In BREEAM C climate change and growth are lifted as aspects that are likely to affect a future water supply. Climate change allowance is to be taken into account when calculating impacts on water resources, precipitation levels, evaporative losses and changing use patterns. LEED N-D does not connect climate change or growth to future water demand.

LEED N-D opens for the possibility to reuse wastewater not only for landscape irrigation, but also as potable water, which BREEAM C does not. Aquifer recharge by storm water management is promoted.

5.4.4. Comparison with focus on wastewater management

Both certification systems state that wastewater infrastructure and services should be provided and that existing water infrastructure should be re-used. LEED N-D states that already when planning the location of the project, a site served by existing wastewater infrastructure should be chosen, or a site within a planned wastewater service area. According to LEED, at least 25 % of the annual wastewater is to be retained and reused as potable water, and pollution from wastewater is to be reduced. In connection to minimizing water demand, a reduced burden on wastewater systems is lifted as a goal.

Wastewater planning on a local scale, beyond pumping to centralized treatment plants, is not incorporated in the urban planning process of today according to the survey done for this

project. Still the municipal planners seem to find it reasonable to incorporate this issue in a certification system for sustainable urban planning.

5.5 Comparison between certification systems and research in sustainable urban water management

In this chapter, future challenges in urban water management subject to current research are compared to the assessment issues of the analyzed certification systems BREEAM Communities and LEED for Neighborhood Development. The aim is to find differences or similarities and thereby assess whether research and assessment issues of the certification systems support each other. Possible issues missing in the certification systems, found in research concerning a sustainable urban water management development, will be highlighted.

Between 1999 and 2006, the Swedish national research programme *Sustainable Urban Water Management* was carried out through collaboration between several Swedish universities. One of the results of the research programme is a set of doctoral theses. One of these doctoral theses, *Beneficial Use of Stormwater* by Edgar L. Villarreal (2005), is a major source of information to the following chapters. The focus of Villarreal's doctoral thesis is sustainable storm water management, direct use of storm water, and rainwater collection systems. As the thesis is written with respect to Swedish conditions, in combination with its recent publication date, it was chosen as a main source of information for this degree project.

Another result of the Sustainable Urban Water Management research programme is the report *Beneficial use of stormwater: a review of possibilities* by Justyna Czemiel Berndtsson (2004). This report is as well used as a major source of information to this degree project. In this report, as well as in the thesis by Villareal, peak flow potentially causing floods together with pollution loads are lifted as common problems of the traditional sewer systems and alternative solutions are lifted. In general, reports used for the following chapters, share a focus either on European conditions or on technical solutions suited for temperate climate zones.

The water infrastructure of Sweden is dependent on natural sources of water and consists of centralized drinking water production, wastewater treatment, storm water management and conveyance of all the mentioned types of water above through pipes (Hjerpe, 2005). Established in the end of the 19th century, the pipe system has been both extended and developed. As sustainable development is becoming an overall policy goal by the Swedish government through government bill 2001/02:172, there are many challenges to face when

planning the urban water management of the future. As urbanization increases, new problems rise, and some of these problems may become worse as climate changes (Chocat et al., 2007). Such problems are higher peak flows and depressed groundwater levels possibly leading to water shortages, stream bed erosion, and increased sedimentation.

Under the following main groups presented earlier in this degree project, the principles of sustainable water management above will be further connected to the analyzed certification systems.

5.5.1. Research concerning groundwater and surface water quality

According to the analyzed certification systems, it is during construction and during treatment of storm water that groundwater quality is to be protected. In addition, LEED N-D emphasizes wetlands as water quality preservers. In this chapter, different types of storm water treatment techniques that are shown to improve water quality will be lifted. As site construction is not part of the urban planning process, water quality protection during site construction will not be further discussed.

One of the water quality related problems following urbanization is dropping qualities of surface runoff. Urban storm water often contains trace organics such as toluene and acetone, heavy metals, nutrients such as phosphorus, complex organics and pathogens, and urban storm water is a significant source of pollution to receiving waters (Chocat et al., 2007) (Villarreal, 2005). The main sources of contaminants in storm water are release from hard surfaces, atmospheric disposition, animal activities, and human activities such as spreading pesticides and salting roads (Czemiel Berndtsson, 2004). Practical control measures that minimize water quality impacts are often referred to as BMPs or “best management practices”. The BMPs reduce pollution, peak flows and water volumes. In the UK the term “sustainable urban drainage systems”, SUDS, is used for the same purpose, and the trend in Europe has been to name these technical solutions “sustainable storm water management”. The BMPs chosen for case studies in the thesis by E. Villarreal are ponds and wetlands, green roofs, and open storm water drainage systems.

Wetlands for storm water treatment and detention ponds are similar to each other, as both solutions have the purpose to imitate natural ecosystems and are designed to remove pollutants from runoff. The natural pollutant removal processes are sedimentation of heavy metals, nutrient uptake by plants, and biodegradation by e.g. carbonaceous material (Czemiel Berndtsson, 2004). According to Villarreal the popularity of ponds and wetlands is due to

their ability to both improve the quality of storm water runoff and control runoff volume. Ponds and wetlands are reliable for removing pollutants and are climate adaptable. Examples of pollutants that ponds and wetlands can remove are phosphorus, nitrogen, and suspended solids, which is supported by Czemiel Berndtsson who present high removal rates up to 90%, 70% and 90% for suspended solids, phosphate and heavy metals in wet detention ponds receiving urban and highway runoff. Czemiel Berndtsson agrees on storm water treatment wetlands being adaptable, and suggests that they can be applied in several kinds of urban areas such as residential and commercial areas, sport areas and industrial areas. Both Villarreal and Czemiel Berndtsson seem to share a positive viewpoint towards ponds and wetlands, and lift beneficial aspects such as urban wildlife and recreational opportunities, aesthetic character and provision of sites for research and education.

Disadvantages of ponds and wetlands presented by Villarreal and Czemiel Berndtsson include retention of toxic chemicals, pathogens, potential groundwater contamination, potential of wildlife contamination, potential of noxious species invasion of wildlife and vegetation, biting insects, creation of unpleasant environments during dry periods, and the potential for drowning. During the cold season wetlands might remove pollutants less effectively, especially when the water is covered by ice.

Constructed wetlands became popular in Europe in the 1980s and have mostly been used for storm water and wastewater treatment. From an economical point of view, property value for houses built near well designed runoff controls tend to have a higher property value. On the other hand, there are risks mentioned above connected to wetlands not properly maintained. Therefor aesthetics and proper design is of great importance in urban water planning.

The drinking water production in Sweden is based on approximately 50 % groundwater and 50 % surface water. The main threats to groundwater quality in Sweden are exploitation of natural gravel, pollution, salt water pollution in coastal areas, and construction and traffic in sensitive areas (SGU, 2013). The surface water quality changes naturally throughout the year with a higher transportation of substances towards water courses during the spring. Climate scenarios show raised levels of precipitation during the autumn, winter, and spring, which will further lower the quality of surface water during spring concerning e.g. humus and nutrients. Raising temperatures might cause an increased growth of toxic algae. Heavier rains in combination with floods can cause mobilization of microbial and chemical contaminations such as oil or petrol, solvents, and microbes connected to sewage and manure.

5.5.2. Research concerning flood control and storm water management

In the analyzed certification systems, a lot of focus is put on flood risks and where to locate buildings and infrastructure based on flood risk calculations. Both LEED N-D and BREEAM C demands reduction of storm water flow and calculations on a storm water drainage system, but above this LEED N-D opens up for different ways of retaining storm water on the site by e.g. reusing it. BREEAM C connects climate change to changes in storm water flow, and demands that climate change is incorporated in the calculations on storm water flow. In this chapter, research on green infrastructure, storm water reuse, and climate changes affecting urban runoff, is lifted to connect the analyzed certification systems to relevant research.

According to Villarreal, there are challenges involved in sustainable urban water management and a scientific understanding of urban water is necessary. Recent changes in urban storm water management is that instead of merely draining storm water quickly, the focus is increasingly put on reducing the force of the flowing water as well as reducing the amount of pollutants carried by runoff. More and more is done to keep storm water on the surface instead of directing it as fast as possible to sewers hidden underground. Problems with the traditional sewage system are damaging of recipients, transport of pollutants and increased peak flows. There are operational problems as well, such as overflows of combined sewers, sediments in sewers, inflow of groundwater into sewers, and discharge of untreated storm water. Villarreal claims that a multi-disciplinary cooperation is needed. To keep storm water on the surface, cooperation between architects, engineers and city planners is of great importance. The design must be suited to both dry and wet periods, and as an example it is desired that unsanitary conditions are avoided during dry periods when water is shallow and still.

Alternative storm water runoff disposal techniques are, according to Czemiel Bendtsson, urban floodways and corridors, detention ponds, treatment wetlands, infiltration for groundwater recharge and peak flow reduction. There are possibilities to bring up the ecological potential of storm water management facilities through creating a landscape network of greenways. It is preferable to connect storm water corridors to parks, cemeteries and other urban patches, to optimize opportunities including both channel bioengineering and landscaping. An example of this is shoreline vegetation enhancing pollutant filtering and thereby offering both water quality preservation as well as peak flow reduction in the same kind of green infrastructure solution.

According to Czemiel Bendtsson, the possibilities of storm water infiltration have been almost forgotten during the Swedish industrialization and urbanization periods, though the techniques have been used for centuries before. By groundwater recharge, infiltration systems can bring back or sustain natural water balance by groundwater recharge.

There is a trend in Europe to develop green roofs, a kind of onsite storm water retention system (Czemiel Bendtsson, 2004). In figure 3 construction of a vegetated roof on a new building in Uppsala, Sweden, is shown.

Figure 2: A green roof is being rolled onto a curve-shaped building in Uppsala, Sweden. (Photo: P. Sjöholm 2013)

The purpose of green roofs is to reduce the total runoff and minimize the runoff peaks, by emulating natural processes of storage and gradual release (Turner et al., 2011). Sometimes the term “brown roof” is used, meaning a green roof created with soil or gravel from the specific site location to emulate natural conditions and thereby preserve the local biodiversity. Many studies have been done on the performance of green roof systems and the results are mixed. A study was done in the United States in 2006 (Carter and Jackson, 2006) on the effects that green roofs have on the hydrology of a watershed, using local green roof storm water retention data, to evaluate vegetated roofs as BMPs. Hydrologic modeling showed that peak runoff rates in a 237 ha watershed with 54 % impervious surface were reduced with up to 26 % during smaller storm events, if the use of green roofs is widespread. For larger storms the reductions is not as significant as for smaller storms, but results shows the same peak flow

of a 100-year-event, as a 50-year-event normally would result in without any green roofs. The study showed high potential in using existing rooftops to manage runoff as existing rooftops make up a large part of the urban land area. Other studies have shown that green roofs seem to delay runoff up to a certain precipitation rate, but when the field capacity of the green roof has been reached, the hydrograph for the green roof is similar to that of a standard roof (Hilten et al., 2008; Carter and Rasmussen, 2006).

To calculate the future impacts of climate changes on urban water, the Swedish Water & Wastewater Association (Svenskt Vatten) has gathered data from the Swedish Meteorological and Hydrological Institute's (SMHI) research institute, Rossby Centre. According to the report *Klimatförändringarnas inverkan på allmänna avloppssystem, Underlagsrapport till Klimat- och sårbarhetsutredningen* by the Swedish Water & Wastewater Association (Svenskt Vatten AB, 2007), climate changes will probably cause a raise of sea level, more intensive short rains, and changes in character and geographical spread of the rains. Consequences of the climatic changes are floods, increased amounts of storm water, and water saturated soil caused by long-term rains during periods of low transpiration. In Sweden the precipitation during June, July and August will decrease while the precipitation will increase during the winter months in combination with a rise in temperature.

To study the need of a Swedish urban water adaptation to future climate changes, a case study was done in the city of Arvika (Olsson et al., 2012). In the study, an increase in short-term rainfall intensities is assumed. Two main strategies are studied; replacing pipes with larger-diameter ones or constructing open waters such as ponds and channels. The later one was found to be the most cost-effective strategy, but to make the system meet today's standard a combination of both strategies is needed.

The list of infiltration techniques given in the assessment issue SE 13 Flood risk assessment in BREEAM C is supported by Czemiel Berndtsson, by the following list of the most commonly used installations for infiltration: Infiltration beds, open ditches and swales, infiltration ponds, percolation basins, and permeable pavements. Risks that local infiltration brings include risk for basement flooding and damages by rising groundwater levels, groundwater pollution, and contamination of soils at infiltration sites. Czemiel Berndtsson also brings up the need of maintenance of facilities which can be difficult in the case of many small scale infiltration systems. The vegetation included in the systems need maintenance, the surface top soil might become clogged and top soil layers might have to be removed and

replaced. It is also concluded that local infiltration is dependent on local conditions when it comes to runoff quality, soil properties, vegetation, and groundwater condition.

5.5.3. Research concerning water supply

In this chapter, water collection opportunities by green infrastructure and future climate changes affecting water supply will be discussed. Both BREEAM C and LEED N-D mentions storm water harvesting, though BREEAM C awards using rainwater especially for toilet demand, washing machines or irrigation. LEED N-D on the other hand opens up for using rainwater for drinking purposes.

In Sweden and Scandinavia, ideological grounds are part of the reasons to develop technologies for rainwater harvesting, as these technologies support the development of sustainable urban infrastructure in general (Czemiel Berndtsson, 2004). The Swedish Water & Wastewater Association agrees that in most parts of Sweden there is no need for saving water from a water resources perspective, and reasons for saving water might instead be minimizing pumping and minimizing the use of chemicals. Czemiel Berndtsson concludes that with the possible exception of islands with limited ground and surface water resources, there is probably no strong reason to practice storm water harvesting in households on a large scale in temperate climates. Whether this will change with climate is still to be seen. The interest in storm water harvesting is increasing though, especially on a local basis, due to reasons like security of water supply, economy and ideology.

Because of climate change, availability of water might change in the future (SMHI, 2012). If temperature and precipitation will change, the flow into the water courses will change as well. This affects both the amount of flow, and the flow distribution over the year. The hydrological rainfall-runoff model HBV has been used by SMHI to calculate the expected future flow during the period 2021 to 2050 as well as during the period 2069 to 2098 in Sweden, and to compare it to data on water flow during the period 1963 to 1992. The results of the modeling and comparison show that in the north and southwest of Sweden, the accessed amount of water will increase. For the south and southeast of Sweden, the accessed amount of water will decrease. The result is identical for all 16 different climate scenarios analyzed, and presented in figure 4.

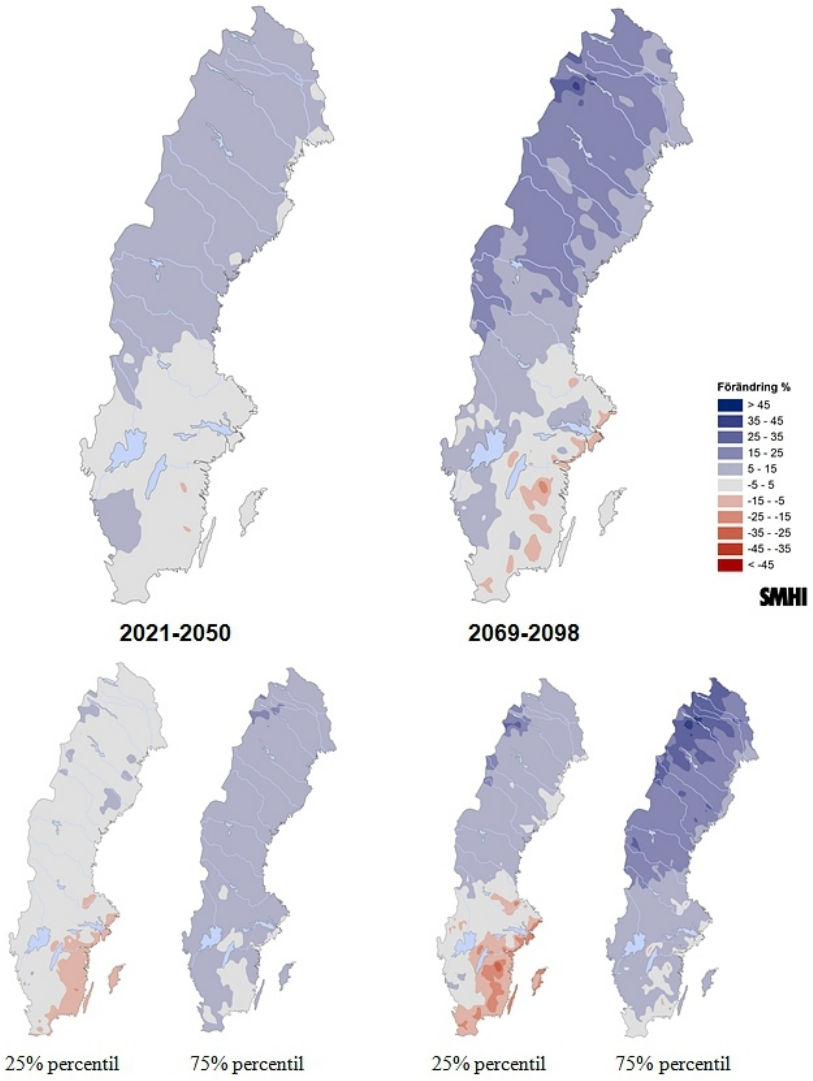

Figure 4. Expected future changes in flow in Swedish watercourses due to climate change (SMHI 2012).

5.5.4. Research concerning wastewater management

In addition to choosing a site served by wastewater infrastructure, which is demanded by both BREEAM C and LEED N-D, LEED N-D also demands that at least 25 % of the annual wastewater is reused as potable water and pollution from wastewater is to be reduced. There is a clear difference in focus between these certification systems and the discussion on wastewater in Sweden today. Major challenges in Sweden for a future sustainable urban water system is re-circulating nutrients from wastewater, and decreasing the environmental impact of the approximately 30 000 chemicals released from households (Hjerpe, 2005). In the report Strategies towards sustainable wastewater management the strategies for sustainable wastewater management are defined as follows (Kärrman, 2001):

1. Handle nutrient-rich flows separate from other flows

2. Recycle nutrients and use energy efficiently

3. Avoid contamination of wastewater flows

4. Put unavoidable pollution on a landfill

The reason nutrient-rich flows are to be separated, is to achieve recycling of nutrients to arable land. The nutrient-rich flows consist of urine, faeces, and solid organic household waste. As greywater and storm water are poor in nutrients, a mix between these and nutrient-rich flows should be avoided. The system at present mixes all the mentioned fractions in the same pipe. Depending on the distance from the community to agriculture, faeces and organic waste can be digested or composted and then used as fertilizer. Biogas or heat from digesting or composting processes, including faeces and organic waste, can be used for heating buildings. If sludge is to be used as a fertilizer, it is of great importance not to contaminate the wastewater flow. Pollution in the fertilizer will end up in the food production. Heavy metals are a problem as they are found in the nutrient-poor flows, and must me trapped during the treatment process to not end up in the food production.

A major discussion at the moment concerning the future Swedish water management is the risks and possibilities of using sludge as a fertilizer. As sludge contains essential nutrients, such as nitrogen and phosphorus, it has a great nutrient value. According to the report Cadmium in sewage sludge in a Swedish region: sources and reduction opportunities (Lindqvist Östblom and Eklund, 2001), the main source of cadmium in sludge is households. Because of the high levels of cadmium, large amounts of sludge are deposited in landfills every year in Sweden. A general decrease of cadmium in the society is lifted as the only long-term strategy to this problem.

An overview of future sustainable wastewater management possibilities connected to the Gothenburg region in Sweden is presented in the report Systemstudie Avlopp. The report is the result of cooperation between the city of Gothenburg, Gryaab, and the Swedish research programme Urban Water. In this report, several possibilities for wastewater management are presented and evaluated. The estimated time needed to implement the evaluated systems is 30-100 years. According to the results there is no reason to abandon the current system with central treatment plants and through good quality sludge, phosphorus can be re-circulated. Nitrogen is more difficult to re-circulate since a high energy input is demanded to extract

nitrogen from sludge. To re-circulate nitrogen, urine separation is assumed to be the best solution, but this technique was not evaluated during the project. The importance of degrading levels of metals in sludge is pointed out for a sustainable future re-circulation of nutrients to function.

Heavier rains in combination with floods can cause mobilization of microbial and chemical contaminations such as oil or petrol, solvents, and microbes connected to sewage and manure. The technology for the Swedish surface water supply is not, in contrast to the supply at the continent, designed to treat water heavily contaminated by chemicals or microbes (Swedish Government, 2007).

6. Discussion

Through the workshop organized in May and by analyzing the certification systems and overviewing the Swedish urban planning process, it becomes clear that some aspects of urban water planning are of greater importance to include in a future Swedish framework or certification system for sustainable urban planning than others. Aspects of urban water management lifted during the workshop such as rising sea levels, rainwater harvesting, storm water retention through green infrastructure, climate changes causing an intensified hydrological cycle, and recycling of nutrients through sludge, all have different relevance when it comes to raised sustainability or raised resilience of a Swedish neighborhood. Some of these aspects are already included in one or both of the analyzed certification systems, such as climate changes affecting urban water in different aspects, the use of green infrastructure, and rainwater harvesting. Some aspects are not mentioned at all in the certification systems, of which the most interesting ones are recycling of nutrients through sludge and water quality status of recipients including eutrophication. Some aspects mentioned in the certification systems were not thought of during the workshop, such as using wastewater or rainwater for drinking purposes.

The reason why it is interesting that recycling of nutrients through sludge is not mentioned in the certification systems is the live discussion in Sweden on this topic today. Researchers, water organizations and institutions such as the Swedish Water & Wastewater Association seem to agree that the question of nutrients in sludge is an important issue to further investigate for a future sustainable urban water management. The cycle of nutrients need to be closed for a sustainable development in the urban water sector.

Some aspects from the certification systems, such as rainwater harvesting, seem to have relevance depending on geographical circumstances. As an example, there seems to be a consensus among the Swedish Water & Wastewater Association and researchers that rainwater harvesting for domestic use besides irrigation is unnecessary in Sweden and mainly done on ideological bases.

Aspects in which one or both of the analyzed certification systems and research head in the same direction are the usage of wetlands and ponds for storm water treatment, green infrastructure such as green roofs and storm water infiltration, and adaption to climate change through flood risk assessment and drainage system dimensioning. There is not much to

discuss in the matter of green infrastructure relevance, the technical solutions are there and if they can be incorporated by urban planners for a sustainable handling of storm water, they offer great opportunities for future urban water management. The enthusiasm for wetlands as water quality preservers presented by LEED N-D, not quite shared by BREEAM C, might depend to some extent on climate zones. As wetlands perform better in higher temperatures, especially when not frozen, the southern swamps of the U.S. are likely to present greater opportunities for wetlands than Europe and especially northern Europe can present.

Another interesting difference between the two analyzed certification systems is the potential to develop communities within flood risk areas. BREEAM C is more open towards developing sites in flood risk areas if the right precautions are taken. This could have some grounds in great parts of the UK existing in flood risk areas, as goes for the neighboring country the Netherlands of which about one third of the urban areas would therefore not be classified as sustainable by LEED N-D.

Water aspects brought up during the workshop that could be useful to incorporate in a Swedish urban planning framework are Swedish water quality norms, how to avoid end-of-pipe-solutions, REVAK-certification of sludge, and whether local treatment plants for wastewater are beneficial in the long run.

The research on effects of climate change on the hydrological cycle and sea level still comes with large uncertainties; yet BREEAM C demands calculations on urban runoff to include climate changes. This makes it quite difficult to fulfill the certification system demands on dimensioning urban drainage systems for the future. The same applies for assessing changes in a future water supply, as both climate change and growth might have an effect yet unknown.

A notification discovered when analyzing the certification systems is that water quality protection is not demanded in either of the certification systems. Neither is the environmental status of water bodies in the area mentioned, except in LEED N-D when demanding avoidance of development affecting water bodies in general.

The research programme *Sustainable Urban Water Management* (Urban Water, 2013) has been a dominating source of information for this degree project together with documents by the Swedish Water & Wastewater Association. As a complimentary viewpoint, reports from the EU initiative *SWITCH Managing Water for the City of the Future* (SWITCH, 2013b) have

been presented. To extend the research area, a broader literature study could be done including other Scandinavian, European or worldwide research with a focus on technology functional for temperate climate zones. A broader literature study would open up for a more critical viewpoint on the results of the research programme *Sustainable Urban Water Management*, and comparisons between water management in Sweden and other Nordic countries could provide further technical solutions, experiences and viewpoints. The report by the Intergovernmental Panel on Climate Change IPCC released right after this report was written can most probably function as a great source of information for following studies in this area.

Interviews done, together with the workshop and the survey, have been given a leading role to connect this degree project to the existing planning process. Whether presented opinions on implementation of a Swedish certification system are general, cannot be assumed based on the 11 respondents. Generally the opinions on implementing a certification system for sustainable urban planning seem to be positive, and questions such as “what competence is behind creating the system” and “when in the planning process will the system be included” do not have specific answers yet.

As for the future of municipal urban planning, the upcoming Swedish certification system seems to be a practical organized way of working with multidisciplinary and broad questions. As sustainable urban water management is becoming increasingly dependent on the spatial planning because of technical solutions such as wetlands and infiltration techniques, it is natural to incorporate water management planning into the spatial planning process. If a future Swedish certification system will not be too expensive to use, regarding possible fees to BRE Group which owns the BREEAM systems, it seems to contribute valuable information on and systemization of the planning process. If the information and systemization can simplify the planning process and even create an economic benefit in the long run, it is reasonable to use the future system. As sustainable development is an investment in the future and as more resilient communities seem to be enhanced by these kinds of systems, the future system should for a start be evaluated by municipalities. If a demand for certified communities develops, consulting companies will gain on providing sustainable solutions, which will push further development and modification of the certification systems. These kinds of systems seem to be a good way to unify what sustainable

planning is and in which direction to head. If the systems can correspond to international systems for sustainable urban planning, cooperation over borders is enhanced.

I consider this to be a part of the future, but parts of the current British system need to be modified to Swedish conditions. Among these are rainwater harvesting and recirculation of nutrients through sludge. In general this coming system seem to represent a future way of adapting to a changing world, and it seems to be the next natural development of urban planning.

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Appendix A: English-Swedish wordlist

Blue-green solutions – tekniska lösningar som kombinerar VA-lösningar och grön infrastruktur, exempelvis gräs- och sedumtak, våtmarker, infiltrationsområden, dagvattenbassänger

Buffer land, buffer strip – mark med växtlighet för att främja vatten- och luftkvalitét i urban miljö

Contractor – byggherre

Detailed development plan – detaljplan

Detention pond, wet pond, detention basin – bassäng för fördröjning av dagvatten

Dry well, soakaway – underjordisk konstruktion för att leda ner dagvatten i marken och i förlängningen till grundvattnet

Green roof – gräs- och sedumtak

Infill site – nybyggnation inom ett bebyggt område, exempelvis en tomt mellan två hus

Infiltration basin – infiltrationsbädd för rening av dagvatten

Master plan – översiktsplan

Rainwater harvesting – uppsamling av regnvatten från exempelvis tak

Reed bed – vassbädd för rening av dagvatten

Spatial planning - stadsplanering

Sprawl development pattern – amerikansk term för utbredning av bebyggelse

Swales – kärrliknande mark för infiltrering av dagvatten

Appendix B: Survey

A copy of the survey in Swedish is shown on the following pages. Before the survey started, respontants received the following Swedish text explaining the background to the survey:

Tack för att du vill delta i min undersökning! Efter bakgrundsinformationen nedan följer åtta kortare påståenden på nästa sida som jag gärna vill att du tar ställning till. Eftersom mitt examensarbete har ett särskilt fokus på hur vattenfrågor hanteras inom stadsplanering finns det mer detaljerade frågor kring detta. Du förblir anonym och svaren kommer endast att användas inom examensarbetet.

Swedish Green Building Council håller på att anpassa ett svenskt ramverk för hållbar stadsplanering, så att en stadsdel i framtiden kan certifieras som "hållbar" utifrån vissa riktlinjer. De internationella certifieringssystemen BREEAM Communities och LEED for Neighborhood Development kommer att ligga som grund, framför allt BREEAM Communities. Systemen tar hänsyn till ekonomiska, tekniska och sociala aspekter och kan fungera som checklistor från översiktsplan till detaljplan vid nyexploateringar, samt vid revideringar av detaljplaner. Den första och enda BREEAM-certifierade stadsdelen i Sverige idag är Masthusen i Malmö.

1. Hur ser du på följande påstående: "Ett certifieringssystem som fungerar som en typ av checklista kan göra det enklare att konkretisera vad hållbar stadsplanering kan innebära för just vår kommun."

- [ ] Jag håller med.
- [ ] Jag håller delvis med.
- [ ] Jag håller inte med.

Kommentera gärna!

2. Hur är din inställning till att introducera ett certifieringssystem för hållbar stadsplanering i den verksamhet som du själv arbetar med? Kommentera gärna ditt svar.

- [ ] Det låter som en mycket bra idé!
- [ ] Jag är positivt inställd, med vissa förebehåll.
- [ ] Jag är negativt inställd, med vissa förebehåll.
- [ ] Jag är negativt inställd, det låter som en dålig idé.

Kommentera gärna!

Nedan följer påståenden kring vattenhatering uppdelade på tre olika områden: Dagvattenhantering och översvämningsrisker, avloppsvattenhantering och vattenskydd.

Dagvattenhantering och översvämningsrisker:

3. "Detta område behandlas ingående i vår detaljplanering av stadsdelar idag."

- [ ] Jag håller med.
- [ ] Jag håller delvis med.
- [ ] Jag håller inte med.

Kommentera gärna.

4. "Detta område vore viktigt att ha med i ett svenskt ramverk för hållbar planering av stadsdelar."

- [ ] Jag håller med.
- [ ] Jag håller delvis med.
- [ ] Jag håller inte med.

Kommentera gärna.

1. Hur ser du på följande påstående: "Ett certifieringssystem som fungerar som en typ av checklista kan göra det enklare att konkretisera vad hållbar stadsplanering kan innebära för just vår kommun."

- [ ] Jag håller med.
- [ ] Jag håller delvis med.
- [ ] Jag håller inte med.

Kommentera gärna!

2. Hur är din inställning till att introducera ett certifieringssystem för hållbar stadsplanering i den verksamhet som du själv arbetar med? Kommentera gärna ditt svar.

- [ ] Det låter som en mycket bra idé!
- [ ] Jag är positivt inställd, med vissa förebehåll.
- [ ] Jag är negativt inställd, med vissa förebehåll.
- [ ] Jag är negativt inställd, det låter som en dålig idé.

Kommentera gärna!

Nedan följer påståenden kring vattenhatering uppdelade på tre olika områden: Dagvattenhantering och översvämningsrisker, avloppsvattenhantering och vattenskydd.

Dagvattenhantering och översvämningsrisker:

3. "Detta område behandlas ingående i vår detaljplanering av stadsdelar idag."

- [ ] Jag håller med.
- [ ] Jag håller delvis med.
- [ ] Jag håller inte med.

Kommentera gärna.

4. "Detta område vore viktigt att ha med i ett svenskt ramverk för hållbar planering av stadsdelar."

- [ ] Jag håller med.
- [ ] Jag håller delvis med.
- [ ] Jag håller inte med.

Kommentera gärna.

Avloppsvattenhantering för en specifik stadsdel (lokala lösningar för hantering av avloppsvatten utöver transport i ledningar till ett centralt reningsverk):

5. "Detta område behandlas ingående i vår detaljplanering av stadsdelar idag."

- [ ] Jag håller med.
- [ ] Jag håller delvis med.
- [ ] Jag håller inte med.

Kommentera gärna.

6. "Detta område vore viktigt att ha med i ett svenskt ramverk för hållbar planering av stadsdelar."

- [ ] Jag håller med.
- [ ] Jag håller delvis med.
- [ ] Jag håller inte med.

Kommentera gärna.

Skydd av yt- och grundvattenkvalitét i den specifika stadsdelen:

7. "Detta område behandlas ingående i vår detaljplanering av stadsdelar idag."

- [ ] Jag håller med.
- [ ] Jag håller delvis med.
- [ ] Jag håller inte med.

Kommentera gärna.

8. "Detta område vore viktigt att ha med i ett svenskt ramverk för hållbar planering av stadsdelar."

- [ ] Jag håller med.
- [ ] Jag håller delvis med.
- [ ] Jag håller inte med.

Kommentera gärna.

Appendix C: Results of survey

The results of the survey are initially presented in Swedish. In the end of this appendix follows a translation of the results to English.

Fråga 1:

Hur ser du på följande påstående: "Ett certifieringssystem som fungerar som en typ av checklista kan göra det enklare att konkretisera vad hållbar stadsplanering kan innebära för just vår kommun."

Answer Options	Response Percent	Response Count
Jag håller med.	72,7%	8
Jag håller delvis med.	27,3%	3
Jag håller inte med.	0,0%	0
Kommentera gärna!		4
answered question		11
skipped question		0

Kommentarer:

Viktigt med habil upphovsperson, som inger förtroende!
2013/9/6 11:10 AM

Stadsplanering är extremt komplex och låter sig sällan kokas ner till en checklista. Det kan bara bli ett av många underlag. Normalt blir stadsplanering alltid "dåligt" eftersom listorna oftast utformas av ingenjörer utan förståelse för sociala och estetiska frågor, eller så är de utformade av biologer och då är nya hus och vägar alltid "onda".
2013/9/2 9:22 AM

Skulle underlätta arbetet och även säkerställa att alla jobbar lika och mot samma mål.
2013/8/29 4:35 PM

Förstår inte helt hur det ska fungera, i vilket skede systemet ska användas? Kommunen arbetar ju redan enligt målet att stadsplaneringen ska vara hållbar, även om mycket kan göras. Men ett förtydligande av vilka konsekvenser olika beslut ger är ju såklart bra.
2013/8/29 4:13 PM

Fråga 2:

Hur är din inställning till att introducera ett certifieringssystem för hållbar stadsplanering i den verksamhet som du själv arbetar med? Kommentera gärna ditt svar.		
Answer Options	**Response Percent**	**Response Count**
Det låter som en mycket bra idé!	27,3%	3
Jag är positivt inställd, med vissa förbehåll.	72,7%	8
Jag är negativt inställd, med vissa förbehåll.	0,0%	0
Jag är negativt inställd, det låter som en dålig idé.	0,0%	0
Kommentera gärna!		6
	answered question	11
	skipped question	0

Kommentarer:

Om systemet kan revideras efter en tids användning.
2013/9/9 9:50 AM

Något vi håller på att jobba med, men det är komplicerat. Vårt mål är eg att hitta något för hela kommunen - dvs hållbar utbyggnadsstruktur, men frågan som fortfarande inte är besvarad är om det går att hitta något verktyg som är så generellt att det funkar för en hel kommun - och ändå är till någon nytta.
2013/9/5 9:52 AM

Det blir mer konkret, alla är överens och arbetar mot samma mål.
2013/9/4 9:53 AM

Se fråga 1
2013/9/2 9:22 AM

Det beror på vad systemet kommer att innehålla, det måste vara lite flexibelt, eftersom det är väldigt olika frågor man arbetar med.
2013/8/30 8:43 AM

Det är jättebra att man kan jobba på det sättet, underlättar och minskar misstag, risk för bekvämlighet och att nya idéer utvecklas?
2013/8/29 4:35 PM

Fråga 3: (Dagvattenhantering och översvämningsrisker)

"Detta område behandlas ingående i vår detaljplanering av stadsdelar idag."		
Answer Options	**Response Percent**	**Response Count**
Jag håller med.	45,5%	5
Jag håller delvis med.	45,5%	5
Jag håller inte med.	9,1%	1
Kommentera gärna.		4
answered question		11
skipped question		0

Kommentarer:

Översvämningsrisker kan fördjupas.
2013/9/9 9:50 AM

Det hanteras, men i ganska liten skala och oftast enbart sett till själva detaljplaneområdet och inte omkringliggande.
2013/9/5 9:52 AM

Det kommunala VA-bolaget deltar alltid och ger bra underlag. Länsstyrelsen bevakar.
2013/9/2 9:22 AM

Tas alltid upp och undersöks under arbetets gång
2013/8/29 4:35 PM

Fråga 4: (Dagvattenhantering och översvämningsrisker)

"Detta område vore viktigt att ha med i ett svenskt ramverk för hållbar planering av stadsdelar."		
Answer Options	**Response Percent**	**Response Count**
Jag håller med.	100,0%	11
Jag håller delvis med.	0,0%	0
Jag håller inte med.	0,0%	0
Kommentera gärna.		1
answered question		**11**
skipped question		**0**

Kommentarer:

Viktigt ämne och betydande konsekvenser om det inte skulle fungera som det bör.
2013/8/29 4:35 PM

Fråga 5: (**Avloppsvattenhantering för en specifik stadsdel (lokala lösningar för hantering av avloppsvatten utöver transport i ledningar till ett centralt reningsverk))**

"Detta område behandlas ingående i vår detaljplanering av stadsdelar idag."		
Answer Options	**Response Percent**	**Response Count**
Jag håller med.	9,1%	1
Jag håller delvis med.	45,5%	5
Jag håller inte med.	45,5%	5
Kommentera gärna.		1
	answered question	11
	skipped question	0

Kommentarer:

Det finns ett sådant område i staden idag. De har efter några år valt att frångå systemet och koppla upp sig på kommunens nät.
2013/9/2 9:22 AM

Fråga 6: (Avloppsvattenhantering för en specifik stadsdel (lokala lösningar för hantering av avloppsvatten utöver transport i ledningar till ett centralt reningsverk))

"Detta område vore viktigt att ha med i ett svenskt ramverk för hållbar planering av stadsdelar."		
Answer Options	**Response Percent**	**Response Count**
Jag håller med.	36,4%	4
Jag håller delvis med.	63,6%	7
Jag håller inte med.	9,1%	1
Kommentera gärna.		2
	answered question	11
	skipped question	0

Kommentarer:

Se ovan
2013/9/9 9:50 AM

Målsättningen är all planering sker i eller nära tätorter som redan har kommunalt VA.
2013/9/2 9:22 AM

Fråga 7: (Skydd av yt- och grundvattenkvalitét i den specifika stadsdelen)

"Detta område behandlas ingående i vår detaljplanering av stadsdelar idag."		
Answer Options	**Response Percent**	**Response Count**
Jag håller med.	36,4%	4
Jag håller delvis med.	54,5%	6
Jag håller inte med.	9,1%	1
Kommentera gärna.		1
	answered question	11
	skipped question	0

Kommentarer:

Natura 2000 etc.
2013/9/2 9:22 AM

Fråga 8: (**Skydd av yt- och grundvattenkvalitét i den specifika stadsdelen)**

"Detta område vore viktigt att ha med i ett svenskt ramverk för hållbar planering av stadsdelar."		
Answer Options	**Response Percent**	**Response Count**
Jag håller med.	81,8%	9
Jag håller delvis med.	18,2%	2
Jag håller inte med.	0,0%	0
Kommentera gärna.		2
	answered question	11
	skipped question	0

Kommentarer:

Se ovan
2013/9/9 9:50 AM
Viktigt ämne även detta.
2013/8/29 4:35 PM

Translation of results to English

Question 1

How do you concider the following statement: ”A certification system with the function of a checklist can help to specify what sustainable urban planning can be for our municipality”		
Answer Options	**Response Percent**	**Response Count**
I agree.	72,7%	8
I partly agree.	27,3%	3
I disagree.	0,0%	0
Please comment!		4
answered question		11
skipped question		0

Summary of comments:
Important with a suited originator that creates confidence! Urban planning is extremely comlex and rearly boils down to a checklist. It would make it easier to work towards a common goal.

Question 2

What is your opinion on introducing a certification system for sustainable urban planning in your own daily work?		
Answer Options	**Response Percent**	**Response Count**
That sounds like a good idea!	27,3%	3
I am positive within some limitations.	72,7%	8
I am negative within some limitations.	0,0%	0
I am negative, it sounds like a bad idea.	0,0%	0
Please comment!		6
answered question		11
skipped question		0

Summary of comments:
The system must be revised after some time. Skeptical towards a tool common enough to suit a whole municipality and still be to any use. Good with a common goal. Flexibility is needed in the system. It could be a good way to collect new ideas.

Question 3 (Concerning storm water and flood risks)

"This technical area is carefully included in planning of communities today"		
Answer Options	**Response Percent**	**Response Count**
I agree.	45,5%	5
I partly agree.	45,5%	5
I disagree.	9,1%	1
Please comment!		4
answered question		11
skipped question		0

Summary of comments:
Flood risks could be further expanded. Usually surrounding areas are not included in flood risks. The local water association is always a part of the planning process.

Question 4 (Concerning storm water and flood risks)

"This technical area is relevant to include in a future Swedish certification system for sustainable urban planning."		
Answer Options	**Response Percent**	**Response Count**
I agree.	100,0%	11
I partly agree.	0,0%	0
I disagree.	0,0%	0
Please comment!		1
answered question		11
skipped question		0

Summary of comments:
Important area with great consequences if not functioning properly.

Question 5 (Concerning waste water for a specific community (local solutions for handling sewage beyond transportation in pipes to a centralized treatment plant))

"This technical area is carefully included in planning of communities today"		
Answer Options	Response Percent	Response Count
I agree.	9,1%	1
I partly agree.	45,5%	5
I disagree.	45,5%	5
Please comment!		1
answered question		11
skipped question		0

Summary of comments:
There is an area like that in our city today but they chose to abandon their system and use the municipal sewage system instead.

Question 6 (Concerning waste water for a specific community (local solutions for handling sewage beyond transportation in pipes to a centralized treatment plant))

"This technical area is relevant to include in a future Swedish certification system for sustainable urban planning."		
Answer Options	Response Percent	Response Count
I agree.	36,4%	4
I partly agree.	63,6%	7
I disagree.	9,1%	1
Please comment!		2
answered question		11
skipped question		0

Summary of comments:
The aim is that all planned areas are within or close to urban areas connected to the municipal pipe systems.

Question 7 (Concerning protection of surface water and groundwater in a community)

"This technical area is carefully included in planning of communities today"		
Answer Options	**Response Percent**	**Response Count**
I agree.	36,4%	4
I partly agree.	54,5%	6
I disagree.	9,1%	1
Please comment!		1
answered question		11
skipped question		0

Summary of comments:
Natura 2000 etc.

Question 8 (Concerning protection of surface water and groundwater in a community)

"This technical area is relevant to include in a future Swedish certification system for sustainable urban planning."		
Answer Options	**Response Percent**	**Response Count**
I agree.	81,8%	9
I partly agree.	18,2%	2
I disagree.	0,0%	0
Please comment!		2
answered question		11
skipped question		0

Summary of comments:
Important technical area.

Appendix D: Certification systems for sustainable urban planning – PM till Vectura

Inledning

Detta PM sammanfattar mitt examensarbete inom miljö- och vattenteknik vid Uppsala universitet, som skrivits för Vectura under perioden april-september 2013. Arbetet syftar till att redogöra för hur vattenfrågor behandlas i det brittiska respektive amerikanska certifieringssystemen *BREEAM Communities* och *LEED for Neighborhood Developent* samt att koppla dessa vattenfrågor till det aktuella forskningsläget inom vattenhantering i samband med hållbar samhällsplanering.

Bakgrund

Under de senaste decennierna har olika typer av certifieringssystem för hållbara byggnader utvecklats, med målet att främja användningen av miljövänliga material och energisnåla hus. Med tiden har även certifieringssystem för hållbara stadsdelar tagits fram, och det finns flera system i användning världen över som exempelvis Green Star – Communities från Australien, CASBEE (Comprehensive Assessment System for Built Environment Efficiency) for Cities från Japan, DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) från Tyskland, och Living Building Challenge från Kanada. Syftet med dessa system är att förenkla planprocessen när nya stadsplaner ska tas fram eller vid revidering av gamla stadsplaner, så att man kan följa ett färdigt certifieringssystem och genom olika poängsystem nå upp till en viss certifieringsnivå för ett projekt.

I skrivande stund pågår ett projekt för att ta fram en svensk version av det brittiska certifieringssystemet BREEAM Communities för hållbara stadsdelar. Projektet ägs av Swedish Green Building Council (SGBC) och kallas HCS-projektet, en förkorting av *Hållbarhetscertifiering av stadsdelar*. Detta projekt fungerade som inspirationskälla för detta examensarbete i och med att hållbar samhällsplanering är en så aktuell fråga just nu. Vid kontakt med projektledaren för HCS-projektet, Ann-Kristin Karlsson, lyftes en speciell önskan om att vattenfrågorna inom BREEAM Communities och LEED for Neighborhood Development skulle utvecklas ytterligare. Eftersom ett stort intresse fanns för att gå närmare in på vattenfrågor inom hållbar samhällsutveckling valdes denna inriktning på examensarbetet.

Syfte

Studien bygger på följande fyra mål:

1. Analysera certiferingssystemen BREEAM Communities och LEED för Neighborhood Development med fokus på vattenrelaterade frågor

2. Jämföra de analyserade systemen med varandra med avseende på vattenrelaterade frågor

3. Utföra en litteraturstudie på forskning inom hållbar vattenhantering för svenska förhållanden

4. Jämföra de analyserade systemen med aktuell forskning

Metoder

Analysen av certiferingssystemen görs genom att sortera ut vattenrelaterade frågor från de båda aktuella certifieringssystemen och sortera dem under följande fyra huvudgrupper som valdes för att täcka hela vattenteknikområdet:

- Grundvattenkvalité och ytvattenkvalité
- Översvämningar och dagvattenhantering
- Vattentillgångar
- Avloppshantering

En workshop som HCS-projektet anordnade i maj 2013 användes som underlag för att sortera ut vattenfrågor som anses aktuella inom VA-branschen. Deltagarna i workshopen representerade följande organisationer: Svenska Miljöinstitutet IVL, Svenskt Vatten, Urban Water, VA Syd, Swedish Green Building Council SGBC, Sveriges geologiska undersökning SGU, Stockholm Environment Institute, Stockholms Stad, Stockholm Vatten, Sweco, WSP, Tyréns, Luleå tekniska universitet, och OkiDoki!Arkitekter. Utöver workshopen genomfördes även en enkätundersökning vid ett antal plan- och byggavdelningar i följande kommuner: Örebro, Gävle, Jönköping, Uppsala, Värmdö, Västerås, Linköping och Sigtuna. Enkäten finns i sin helhet i bilaga 2 i examensarbetet.

Resultat

Analys av systemen

Av de vattenfrågor som diskuterades på workshopen följer i figur 1 en sammanfattning utgående från systematiken med fyra huvudgrupper som använts inom detta examensarbete:

1. Groundwater and surface water quality	2. Flood control and storm water management	3. Water supply	4. Waste water management
Swedish water quality norms	Height/ initial placing of buildings	Access to water difficult to estimate for a community as a part of a city	**Recycling of nutrients/sludge**
Water quality status of the recipients	**Rising sea level**	Production of drinking water often located outside the community in Sweden	Avoid end-of-pipe-solution
Eutrophication	Buffer zones for floods	**Risk analyzes for water supply**	REVAK-certification
Protection of water during construction	Spring floods from melting snow		Evaluate effects downstream
Material choices on site	**Mapping flood risks**		Hygiene
	Rainwater harvesting		Traces of medicine
	Escape routes for residents		**Wetlands**
	Storm water retention such as green roofs		Local treatment plants, new technology
	Intensified hydrological cycle		
	Map where in the watershed the community is located		
	Blue and green solutions		

Figur 3 Sammanfattning av vattenrelaterade aspekter som togs upp under workshopen. Aspekter som behandlas vidare i samband med aktuell forskning är fetmarkerade.

Vattenfrågor som lyfts i BREEAM Communities i samband med grundvattenkvalitét och ytvattenkvalitét är framför allt vattenföroreningar under byggskedet och har inget krav på sig för att ett projekt ska klassas som hållbart. Det samma gäller för LEED for Neighborhood Development, förutom att LEED N-D förespråkar våtmarker mycket mer än vad BREEAM C gör. Det är generellt ospecificerat i båda certifieringssystemen hur man bör göra för att bevara och skydda grundvattenkvalitén.

Vad gäller översvämningsrisker och dagvattenhantering finns det mer tydliga riktlinjer och exempel på tekniska lösningar för att uppfylla certifieringskraven ges. Dessa förslag är olika typer av infiltreringstekniker tillsammans med våtmarker och gröna tak, samt avledning av dagvatten till grundvattnet.

Båda certifieringssystemen är restriktiva vad gäller att bygga på områden med förhöjd översvämningsrisk men BREEAM C öppnar ändå upp för att sådana projekt kan anses hållbara så länge de rätta åtgärderna tas. Till dessa åtgärder hör olika typer av fördämningar. Dessutom kräver BREEAM C att framtida klimatförändringar tas med i beräkningar på dagvattenflöden, vilket inte LEED N-D kräver.

När det kommer till vattentillgångar är båda systemen främst fokuserade på att man bör kunna koppla upp det planerade området på ett fungerande dricksvattennät. Olika lokala lösningar

för uppsamling av regnvatten nämns främst i LEED N-D som lyfter möjligheten att använda regnvatten för konsumtion. BREEAM C sträcker sig till att regnvatten kan användas för toaletter och tvättmaskiner. Igen lyfter BREEAM C klimatförändringar, denna gång i samband med att vattentillgångar kan förändras i framtiden med avseende på nederbördsmängder, avdunstning samt förändrade användarvanor.

Avloppshantering behandlas relativt kort i båda systemen, huvudsaken är att man kan koppla upp området till ett fungerande system. Den enda stora skillnaden mellan systemen är att LEED N-D kräver att föroreningar av avloppsvatten bör minskas. Det finns dock inga specifikationer på hur det ska ske.

Analys av aktuell forskning samt samband mellan certifieringssystem och forskning

En stor del av forskningskapitlet i detta examensarbete är grundat på det nationella forskningsprogrammet *Sustainable Urban Water Management – Framtidens uthålliga VA-system* som pågick mellan 1999 och 2006. Forskningsprogrammet var ett samarbete mellan åtta svenska universitet och högskolor, fem kommuner samt ett antal forskningsinstitut och konsultbolag. Resultat från detta forskningsprogram har tillsammans med ett antal övriga rapporter använts för att koppla vattenaspekterna till vad aktuell forskning visar på. De största skillnaderna mellan forskning och certifieringssystem har visat sig finnas inom VA-hantering samt vad gäller uppsamling av regnvatten för konsumtion. Svensk forskning tillsammans med branchorganisationen Svenskt Vatten är överens om att näring i slam bör återföras till åkermark för att sluta kretsloppet, istället för att deponeras. Denna problematik nämns inte i något av certifieringssystemen, men är väldigt aktuell i Sverige och kommer med stor sannolikhet att behandlas i ett framtida svenskt certifieringssystem eller ramverk för hållbar stadsplanering. Vad gäller uppsamling av regnvatten för konsumtion är även här forskning och Svenskt Vatten överens om att detta inte är intressant i tempererade zoner samt att Sverige för nuvarande inte har någon brist på vattentillgångar.

Vad gäller dagvatten är certifieringssystemen och forskning överens om att grön infrastruktur som våtmarker, gröna tak och infiltrationsdammar är hållbara framtida lösningar för rening av dagvatten och minimering av flödestoppar.

Diskussion

Att se närmare på ett projekt som visualiserar framtiden, som HCS-projektet, kan ge en inblick i vilken typ av ny kompetens som kan behövas inom konsultbolagen för att följa utvecklingen framåt. Att ifrågasätta och analysera internationellt erkända certifieringssystem har gett en värdefull inblick i hur planeringsprocesser fungerar både i Sverige och internationellt, samt vilken typ av frågor som är aktuella och kan bli aktuella i framtiden. Eftersom det är värdefullt att veta hur framtida klimatförändringar kan komma att påverka utvecklingen inom exempelvis VA-teknik kan ett deltagande i utvecklingen av ett framtida certifieringssystem ge en tidig inblick i vilken kompetens som behövs inför framtiden. Samtidigt kan systemen innehålla brister och man bör se kritiskt på vad systemet innehåller för att som företag kunna stå för de lösningar man levererar. Med rätt kompetens inom företaget kan certifieringssystemen användas som hjälpmedel för att nå de mest hållbara lösningarna på marknaden.