HELSINKI GREEN AREA FACTOR TOOL

User manual for the Excel-based tool

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European Regional Development Fund
EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP

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1 BACKGROUND

1.1. Origins

As a part of the EU-funded “Climate-proof city – tools for planning” (ILKKA) project a tool for calculating the ratio between scored green area and total area for a lot was developed. The first version of the Excel-based Helsinki Green Factor Tool was released in 2014. Based on the experiences with the tool’s usage and due to the increasing importance of stormwater management, which starts with the planning of lot-wise measures, an updated version of this tool was to be developed within the iWater (Integrated Storm Water Management) project.

1.2. Objectives and updates

Main objectives were the removal of the minimum level, revision and densification of the overall selectable elements (primarily bonus elements) and the implementation of stormwater as an additional scoring category. Additionally, information about the estimated amount of stormwater originating from the lot, as well as necessary detention volume, were to be provided within the results. Examples and descriptions of selectable stormwater management structures were provided by the iWater research group from Aalto University and added as a new info sheet.

2 DESCRIPTION OF THE UPDATED GREEN FACTOR TOOL

2.1. Introduction

The tool is Excel based and contains macros (xlsm file), which are essential for using the tool. Therefore, depending on the Microsoft Office version, a question or warning is shown when opening the file. The user must press “Enable Content” to use the file properly (Figure 1). Additionally, the workbook contains protected cells and areas. Their modification is denied when trying to access or change the contents. These cells are usually slightly greyed and any attempted change will cause an automatic message (Figure 2).

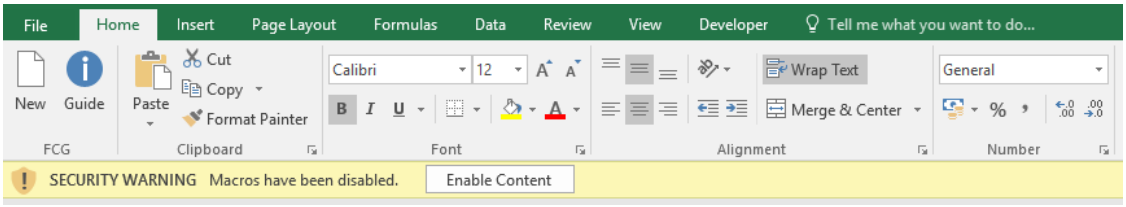


Figure 1. For activating macros, enable contents.

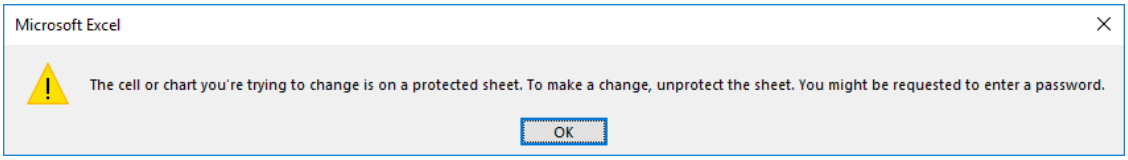


Figure 2. Certain cells are locked / read-only and their contents (formulas or default values) cannot be changed without unlocking the workbook. The necessary password can be requested from Jari Viinanen (mailto:jari.viinanen@hel.fi).

2.2. Using the tool

The tool contains five different sheets “Instructions”, “Limitations”, “Green Factor”, “Results” and “iWater Toolsheet” – the first four of which guide the user step-by-step through the calculation. The user can freely select the sheets using the mouse. However, it is recommended to use the buttons within the sheets to move forward and backward through the tool, since this enables internal checks

when switching between the steps. A new fifth sheet contains examples for stormwater management structures collected and summarised during the iWater project by Aalto University.

The "Instructions" sheet contains valuable information about the usage and the contents of the tool, as well as a description of the terminology. Especially, first-time users are therefore encouraged to start from here and read the instructions carefully.

2.3. Calculating the Green Factor in three steps

2.3.1. Step 1: Limitations

The calculation starts with filling in basic information and boundary conditions for the planned lot (Figure 3). The structure and amount of elements have changed compared to the previous version, particularly based on the removal of the minimum level.

The user should start with filling in basic data about the lot within the small table on the right border (a), such as Block and Lot ID. The site's area, building footprint and floor area are essential for the calculation and should be entered as accurately as possible.

Additionally, some boundary conditions have to be specified within the left table (b):

1. **Land use:** This choice will directly influence the basic value for the Target Level. The Target Level of the updated version varies between 0,9 for Residential and 0,5 for Industrial/Logistic lots.

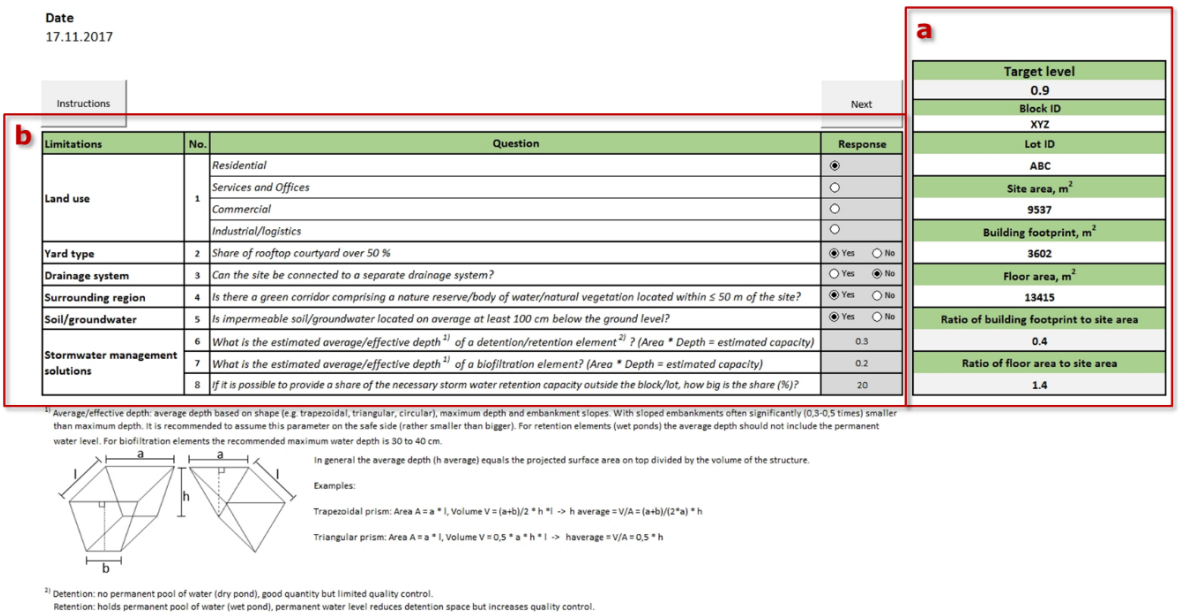
2. **Type of yard:** Depending on the share of rooftop courtyard on the site, this will influence the selection of green roof elements. If the share is larger than 50%, the user will be reminded to add a significant amount of green roof elements.

3. **Drainage system:** In case the site has to be connected to a combined sewer system instead of a separate stormwater drainage system, the user will be reminded to add at least one significant stormwater detention element.

4. **Surrounding region:** This has mainly informative/reminding character. If there is a green corridor comprising a nature reserve/body of water/natural vegetation located within ≤ 50 m of the site, this has to be taken in to account during the planning phase. An example would be to provide a proper green/natural axes for traveling of the flying squirrel.

5. **Soil/groundwater:** This will affect the final Target Level. If high groundwater level or impermeable soil levels like rock or clay exist close to the surface, especially infiltration and detention capacities of the remaining soil level limit options for on-site stormwater control. Therefore, the Target Level will be reduced by the factor of 0,2.

6. **Stormwater management solutions:** These options will influence directly the calculation of potential and necessary detention volumes on the site. The user has to estimate an average depth for two types of stormwater elements. The average depth in combination with the planned area will define the available volume. Pure detention/retention elements are limited in their possible depths only by necessary elevation differences (slopes) to connect the outflow of the element on the lot either to a surrounding stormwater sewer or an open ditch. For biofiltration elements it is usually recommended to limit the maximum water depth to 30–40cm. Further instructions can be found below the table.



Date
17.11.2017

a

Target level
0.9
Block ID
XYZ
Lot ID
ABC
Site area, m²
9537
Building footprint, m²
3602
Floor area, m²
13415
Ratio of building footprint to site area
0.4
Ratio of floor area to site area
1.4

Instructions | Next

b

Limitations	No.	Question	Response
Land use	1	Residential	◉
		Services and Offices	○
		Commercial	○
		Industrial/logistics	○
Yard type	2	Share of rooftop courtyard over 50 %	◉ Yes ○ No
Drainage system	3	Can the site be connected to a separate drainage system?	○ Yes ◉ No
Surrounding region	4	Is there a green corridor comprising a nature reserve/body of water/natural vegetation located within ≤ 50 m of the site?	◉ Yes ○ No
Soil/groundwater	5	Is impermeable soil/groundwater located on average at least 100 cm below the ground level?	◉ Yes ○ No
Stormwater management solutions	6	What is the estimated average/effective depth [1] of a detention/retention element [2] ? (Area * Depth = estimated capacity)	0.3
	7	What is the estimated average/effective depth [1] of a biofiltration element? (Area * Depth = estimated capacity)	0.2
	8	If it is possible to provide a share of the necessary storm water retention capacity outside the block/lot, how big is the share (%)?	20

[1] Average/effective depth: average depth based on shape (e.g. trapezoidal, triangular, circular), maximum depth and embankment slopes. With sloped embankments often significantly (0,3-0,5 times) smaller than maximum depth. It is recommended to assume this parameter on the safe side (rather smaller than bigger). For retention elements (wet ponds) the average depth should not include the permanent water level. For biofiltration elements the recommended maximum water depth is 30 to 40 cm.

In general the average depth (h average) equals the projected surface area on top divided by the volume of the structure.

Examples:

Trapezoidal prism: Area A = a * l, Volume V = (a+b)/2 * h *l -> h average = V/A = (a+b)/(2*a) * h

Triangular prism: Area A = a * l, Volume V = 0,5 * a * h * l -> haverage = V/A = 0,5 * h

[2] Detention: no permanent pool of water (dry pond), good quantity but limited quality control.
Retention: holds permanent pool of water (wet pond), permanent water level reduces detention space but increases quality control.

Figure 3. Limitations sheet. Section (a) contains basic lot information, section (b) specifies the necessary limitations.

NB. Having filled in all necessary options and boundary conditions, the user may switch to the second step to fill in the different elements on the site.

2.3.2. Step 2: Green Factor calculation

2.3.2.1. Filling in the Green Factor sheet

The “Green Factor” sheet (Figure 4) contains a table for filling in elements according to five basic groups: “Preserved vegetation and soil”, “Planted and/or new vegetation”, “Pavements”, “Stormwater elements” and “Bonus elements” (a). Compared to the previous version, this table has been restructured, some elements have been added, removed or grouped. For instance, the green roof elements – although not providing any specific detention volume – have been moved to the “Stormwater elements” group. Despite not providing a separate detention volume, they decrease the amount of stormwater originating from the lot by reducing the size of sealed roof surface and the total runoff-coefficient.

If possible, the user should choose at least one element from each group with exception of the “Bonus elements” which are not obligatory. When filling in elements, it is recommended to pay attention to the units: some elements come in numbers with a pre-set surface area per element, while others come in m^2. Because its underground location does not occupy any exterior surface area, the “Retention/Detention pit” element’s unit is the only one given in m^3.

Based on the user’s choice of elements, the tool automatically calculates the weighted areas based on the built-in weighting system, their total sum and the derived Green Factor. Both values in comparison to the Target Level are shown on the left side of the element table (b).

Additionally, compared to the previous version the tool now calculates an average runoff-coefficient of the lot based on built-in element-specific coefficients for each type providing a surface (c). Based on the chosen elements’ sizes the remaining area will be set automatically as impermeable with a runoff-coefficient of 1.

The runoff-coefficients are based on various sources. For most general land-use types a wide variety of published tables exist with different ranges of coefficients. For some elements, several different land-use types had to be merged and averaged (e.g. semi-permeable pavements). The coefficients for the green roofs are taken from published guidelines of the Building Information Group (Finnish: Rakennustieto or RT-kortisto), in particular guideline RT 85-11203 for green roofs and rooftop courtyards.

Due to the variety and large amount of sources, as well as the partially different land-use types combined in one element, the runoff-coefficients should be seen as an estimation, and not as an exact definition. Additionally, runoff-coefficients are time-dependent and therefore vary with rainfall amount and intensity, and usually also depend on the type of soil and its saturation. Using a single set of coefficients for all conditions thus holds risks of over- or underestimation. Since the overall task of this tool is NOT to replace a proper stormwater assessment and management plan by experts on this matter, but rather to give the lot planner the opportunity of a rough estimation on the potential need for detention, a certain degree of uncertainty has to be accepted.

Based on the average runoff-coefficient and an amount of precipitation (d) set by the user, the approximate amount of stormwater originating from the lot is calculated automatically (e). The amount of precipitation or rainfall should be set according to the rules for designing stormwater management systems applying to the location of the lot. The lot's estimated stormwater volume is calculated as follows: lot area * lot's average runoff-coefficient * precipitation.

A common approach for estimating the recommended lot-wise detention of stormwater is to use a rain intensity of 150 l/(s*ha) corresponding to a 10-minute rain event occurring every five years. According to statistical examinations, the amount of rainfall of about 85–90% of all occurring rain events in Finland is 10mm or less. However, in some cases, particularly in heavily built-up areas with a high percentage of sealed surfaces, this amount can be hard or impossible to achieve and the user is free to reduce the rain amount to a smaller value (e.g. 5mm).

As a new feature, the updated version includes links for selected stormwater elements with brief descriptions provided by the iWater research group from Aalto University, which are collected in the “iWater Toolsheet”. By clicking an element within the table, a hyperlink will directly switch to the corresponding example.

The only adjustable cells within this sheet are the “Areas or quantity” (with the exception of the impermeable surface) and the precipitation, all other cells are locked and cannot be changed. Areas and quantities can be freely set and cleared or cleared completely by pressing the “Clear Values” button at the bottom of the table. The latter will result in a pop-up security query.

After filling in the table by trying to reach or exceed the Target Level, the user should press the “Next” button to automatically run a couple of internal checks, which might result in adjusting the previously chosen design. If the checks result in no further necessary adjustments, the tool will switch to the “Results” sheet.

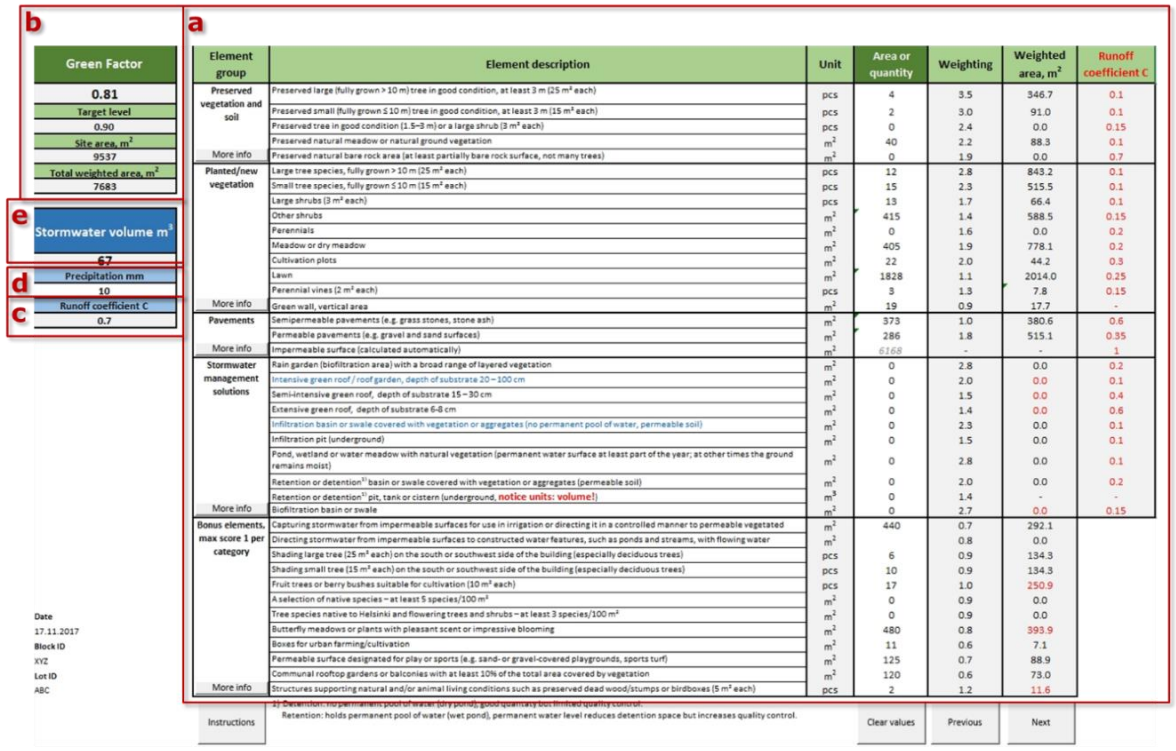


Figure 4. Green Factor calculation sheet.

2.3.2.2. Weighting system

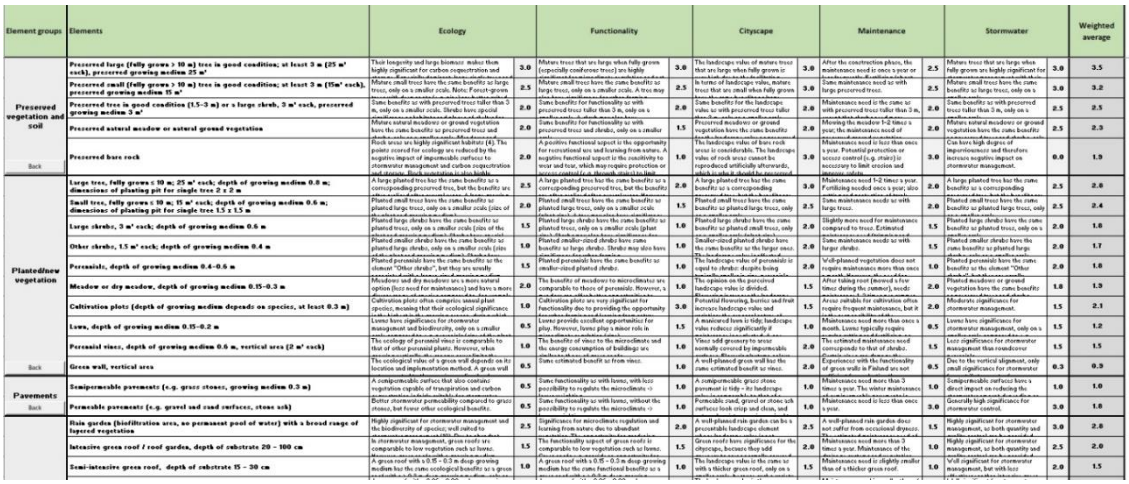
Pressing the "More Info" button will temporarily open a new sheet "More information" (Figure 5) containing a brief explanation for all the different elements concerning their significance for each of the categories. It also shows the weightings for each element under each group, as well as global weighting derived from specialist interviews.

The global category weightings for Ecology, Functionality, Cityscape and Maintenance were originally derived by interviewing experts from different relevant groups such as land-use planners, landscape architects, developers, and environmental specialists regarding their views on the importance and value of the different categories. For the updated version, these weightings were preserved (for more information, please check the report for the previous Green Factor version).

Assessing the weighting of the new stormwater category was difficult, because its importance was previously covered by, and included in, the weightings of the original four categories (focusing mainly on Ecology). It was therefore based on the average weightings of the original categories by its assumed importance for stormwater management and then adjusted by testing and comparing the resulting Green Factors on model sites. Thus, the final score of 1,25 was derived.

The element-specific weightings of the previous four categories were kept unchanged, while Stormwater elements were set by assessing the importance of each individual element concerning stormwater management. Also, the individual weightings were tested and calibrated based on the model sites.

Both category- and element-specific stormwater weightings underwent several test phases during various workshops for verification.



Element groups	Elements	Ecology		Functionality		Cityscape		Maintenance		Stormwater		Weighted average
Preserved vegetation and soil	Preserved large (fully grown > 10 m) tree in good condition; at least 3 m (25 m² each), preserved growing medium 25 m²	Their longevity and large biomass makes them highly significant for carbon sequestration and	3.0	Mature trees that are large when fully grown (especially coniferous trees) are highly	3.0	The landscape value of mature trees that are large when fully grown is	3.0	After the construction phase, the maintenance need is once a year or	2.5	Mature trees that are large when fully grown are highly significant for	3.0	3.5
	Preserved small (fully grown > 10 m) tree in good condition; at least 3 m (15m² each), preserved growing medium 15 m²	Mature small trees have the same benefits as large trees, only on a smaller scale. Note: Forest-grown	2.5	Mature small trees have the same benefits as large trees, only on a smaller scale. A tree may	2.5	Same benefits for the landscape value as with preserved trees taller than 3 m, only on a	3.0	Same maintenance need as with preserved trees.	2.5	Same benefits as large trees, only on a	3.0	3.2
	Preserved tree in good condition (1.5–3 m) or a large shrub, 3 m² each, preserved growing medium 3 m²	Same benefits as with preserved trees taller than 3 m, only on a smaller scale. Shrubs have special	2.0	Same benefits for functionality as with preserved trees taller than 3 m, only on a	2.0	Same benefits for the landscape value as with preserved trees taller than 3 m, only on a	2.0	Maintenance need is the same as with preserved trees taller than 3 m, only on a	2.0	Same benefits as with preserved trees taller than 3 m, only on a	2.5	2.5
	Preserved natural meadow or natural ground vegetation	Mature natural meadows or ground vegetation have the same benefits as preserved trees and	2.0	Same benefits for functionality as with preserved trees and shrubs, only on a smaller	1.5	Preserved meadows or ground vegetation have the same benefits	2.0	Mowing the meadow 1–2 times a year; the maintenance need of	2.0	Mature natural meadows or ground vegetation have the same benefits	2.5	2.3
	Preserved bare rock	Rock areas are highly significant habitats (4). The points scored for ecology are reduced by the negative impact of impermeable surfaces to	2.0	A positive functional aspect is the opportunity for recreational use and learning from nature. A negative functional aspect is the sensitivity to wear and tear, which may require protection or	1.0	The landscape value of bare rock areas is considerable. The landscape value of rock areas cannot be reproduced artificially afterwards,	3.0	Maintenance need is less than once a year. Potential protection of access control (e.g. stairs) is necessary to limit erosion and	3.0	Can have high degree of imperviousness and therefore increases negative impact on stormwater management.	0.0	1.9
Planted/new vegetation	Large tree, fully grown ≥ 10 m; 25 m² each; depth of growing medium 0.8 m; dimensions of planting pit for single tree 2 x 2 m	A large planted tree has the same benefits as a corresponding preserved tree, but the benefits are	2.5	A large planted tree has the same benefits as a corresponding preserved tree, but the benefits	2.0	A large planted tree has the same benefits as a corresponding	3.0	Maintenance need 1–2 times a year. Fertilizing needed once a year; also	2.0	A large planted tree has the same benefits as a corresponding	2.5	2.8
	Small tree, fully grown ≤ 10 m; 15 m² each; depth of growing medium 0.6 m; dimensions of planting pit for single tree 1.5 x 1.5 m	Planted small trees have the same benefits as planted large trees, only on a smaller scale (also	2.0	Planted small trees have the same benefits as planted large trees, only on a smaller scale	1.5	Planted small trees have the same benefits as planted large trees, only	2.5	Same maintenance needs as with large trees.	2.0	Planted small trees have the same benefits as planted large trees, only	2.5	2.4
	Large shrubs, 3 m² each; depth of growing medium 0.6 m	Planted large shrubs have the same benefits as planted trees, only on a smaller scale (size of the	1.5	Planted large shrubs have the same benefits as planted trees, only on a smaller scale (plant	1.0	Planted large shrubs have the same benefits as planted small trees, only	2.0	Slightly more need for maintenance compared to trees. Estimated	1.5	Planted large shrubs have the same benefits as planted trees, only on a	2.0	1.8
	Other shrubs, 1.5 m² each; depth of growing medium 0.4 m	Planted smaller shrubs have the same benefits as planted large shrubs, only on a smaller scale (size	1.0	Planted smaller-sized shrubs have same benefits as large shrubs. Shrubs may also have	1.0	Smaller-sized planted shrubs have the same benefits as the larger ones.	2.0	Same maintenance needs as with large shrubs.	1.5	Planted smaller shrubs have the same benefits as planted large	2.0	1.7
	Perennials, depth of growing medium 0.4–0.6 m	Planted perennials have the same benefits as the element "Other shrubs", but they are usually	1.5	Planted perennials have the same benefits as smaller-sized planted shrubs.	1.0	The landscape value of perennials is equal to shrubs despite being	2.0	Well-planned vegetation does not require maintenance more than once	1.0	Planted perennials have the same benefits as the element "Other	2.0	1.8
	Meadow or dry meadow, depth of growing medium 0.15–0.3 m	Meadows and dry meadows are a more natural option (less need for maintenance) and have a more	2.0	The benefits of meadows to microclimate are comparable to those of perennials. However, a	1.0	The opinion on the perceived landscape value is divided.	1.5	After taking root (desired a few times during the summer), meadow	2.0	Planted meadows or ground vegetation have the same benefits	1.8	1.9
	Cultivation plots (depth of growing medium depends on species, at least 0.3 m)	Cultivation plots often comprise annual plant species, meaning that their ecological significance	1.0	Cultivation plots are very significant for functionality due to providing the opportunity	3.0	Potential flowering, berries and fruit increase landscape value and	1.5	Areas suitable for cultivation often require frequent maintenance, but it	2.0	Moderate significance for stormwater management.	1.5	2.1
	Lawn, depth of growing medium 0.15–0.2 m	Lawns have significance for stormwater management and biodiversity, only on a smaller	0.5	Lawns provide excellent opportunities for play. However, lawns play a minor role in	1.5	A manicured lawn is tidy; landscape value reduces significantly if	1.0	Maintenance need more than once a month. Lawns typically require	0.5	Lawns have significance for stormwater management, only on a	1.5	1.2
	Perennial vines, depth of growing medium 0.6 m, vertical area (2 m² each)	The ecology of perennial vines is comparable to that of other perennial plants. However, when	1.0	The benefits of vines to the microclimate and the energy consumption of buildings are	1.0	Vines add greenery to areas normally covered by impermeable	2.0	The estimated maintenance need corresponds to that of shrubs.	1.5	Vines add significance for stormwater management to some extent.	1.5	1.5
	Green wall, vertical area	The ecological value of a green wall depends on its location and implementation method. A green wall	0.5	Same estimated benefit as from vines.	1.0	A well-planned green wall has the same estimated benefit as vines.	2.0	Experience with the functionality of green walls in Finland are not	0.5	Due to the vertical alignment, only small significance for stormwater	0.3	0.9
Pavements	Semipermeable pavements (e.g. grass stones, growing medium 0.3 m)	A semipermeable surface that also contains vegetation capable of transpiration and carbon	0.5	Same functionality as with lawns, with less possibility to regulate the microclimate. A	1.0	A semipermeable grass stone pavement is tidy – its landscape	1.0	Maintenance need more than 3 times a year. The water maintenance	1.0	Semipermeable surfaces have a direct impact on reducing the	1.0	1.0
	Permeable pavements (e.g. gravel sod road surfaces, stone silt)	Better stormwater permeability compared to grass stones, but fewer other ecological benefits.	0.5	Same functionality as with lawns, without the possibility to regulate the microclimate. A	1.0	Permeable sand, grind or stone silt surfaces look crisp and clean, and	1.0	Maintenance need is less than once a year.	3.0	Generally high significance for stormwater control.	3.0	1.8
	Rain garden (biofiltration area, no permanent pool of water) with a broad range of layered vegetation	Highly significant for stormwater management and the biodiversity of species; well suited to	2.5	Significance for microclimate regulation and learning from nature due to abundant	2.0	A well-planned rain garden can be a presentable landscape element	2.5	A well-planned rain garden does not suffer from occasional dryness	1.5	Highly significant for stormwater management, so both quantity and	3.0	2.8
	Intensive green roof / roof garden, depth of substrate 20 – 100 cm	In stormwater management, green roofs are comparable to low vegetation such as lawns.	1.5	The functionality aspect of green roofs is comparable to low vegetation such as lawns.	1.5	Green roofs have significance for the cityscape, because they add	2.0	Maintenance need more than 3 times a year. Maintenance of the	1.0	Highly significant for stormwater management, so both quantity and	2.5	2.0
	Semi-intensive green roof, depth of substrate 15 – 30 cm	A green roof with a 0.15 – 0.3 m deep growing medium has the same ecological benefits as a green	1.0	A green roof with a 0.15 – 0.3 m deep growing medium has the same functional benefits as a	1.0	The landscape value is the same as with a thicker green roof, only on a	1.5	Maintenance need is slightly smaller than of a thicker green roof.	1.0	Well significant for stormwater management, but with less	2.0	1.5

Scale (ecology, functionality, cityscape – Note: maximum score for bonus elements is 1)
3 = Major significance
2 = Moderate significance
1 = Minor significance
0 = No significance

Scale (Maintenance – Note: Maximum score for bonus elements is 1)
3 = Maintenance need is less than once a year.
2 = Maintenance need 1–2 times a year
1 = Maintenance need more than 3 times a year
0 = Maintenance need more than once a month

Overall weighting of categories calculated from specialist interviews		
Categories	**Overall weighting (1–3)**	***Category functions***
Ecology	**1.59**	*Quantitative and qualitative management of stormwater*
		Carbon sequestration and storage
		Biodiversity of species and habitats, the ecological network
Functionality	**1.51**	*Microclimate regulation (cooling, sequestration of air pollutants, reduction of noise and wind conditions, visual screen)*
		Food production by urban farming, learning from nature, play
		Safety
Cityscape	**0.84**	*Link to the surrounding cityscape, effect on the scenery (e.g. flowers and berries)*
Maintenance	**0.70**	*Low-maintenance solutions (how many times)*
Stormwater	**1.25**	*Capture and treatment of stormwater*

Note. Costs have not been taken into account in the scoring (e.g. need for manual labour).

Note. There is a reducing effect on the scoring due to lack of experience with the maintenance of the element in Finland.

Figure 5. Information sheet containing weightings and descriptions for each element.

NB. The scaling/scoring factors are fixed and cannot be changed. By pressing the "Back" button, the sheet is closed and the "Green Factor" sheet is activated again.

2.3.3. Step 3: Checking and printing the results

The "Results" sheet (Figure 6) offers a pre-defined summary of the calculation and its results designed for a standard DIN-A4 sheet printout. It contains information about all important settings and results in numerical and graphical form, such as the Target Level and Green Factor, the share of each element group and elements within a group or the shares of weighted areas.

As part of the updated version, this section now also contains specific information from the stormwater management point of view: the blue-coloured section provides data on the total estimated amount of stormwater originating from the site (a) and its average runoff-coefficient (b) as well as the share of Total Impervious Area or TIA (c). Depending on the given option of a certain percentage of the stormwater that can be handled outside of the lot, the total volume will be reduced to a final amount that needs to be taken care of on the lot itself (d). Based on the user-defined detention volume (e), this results in a remaining retention demand (f), which should be minimised.

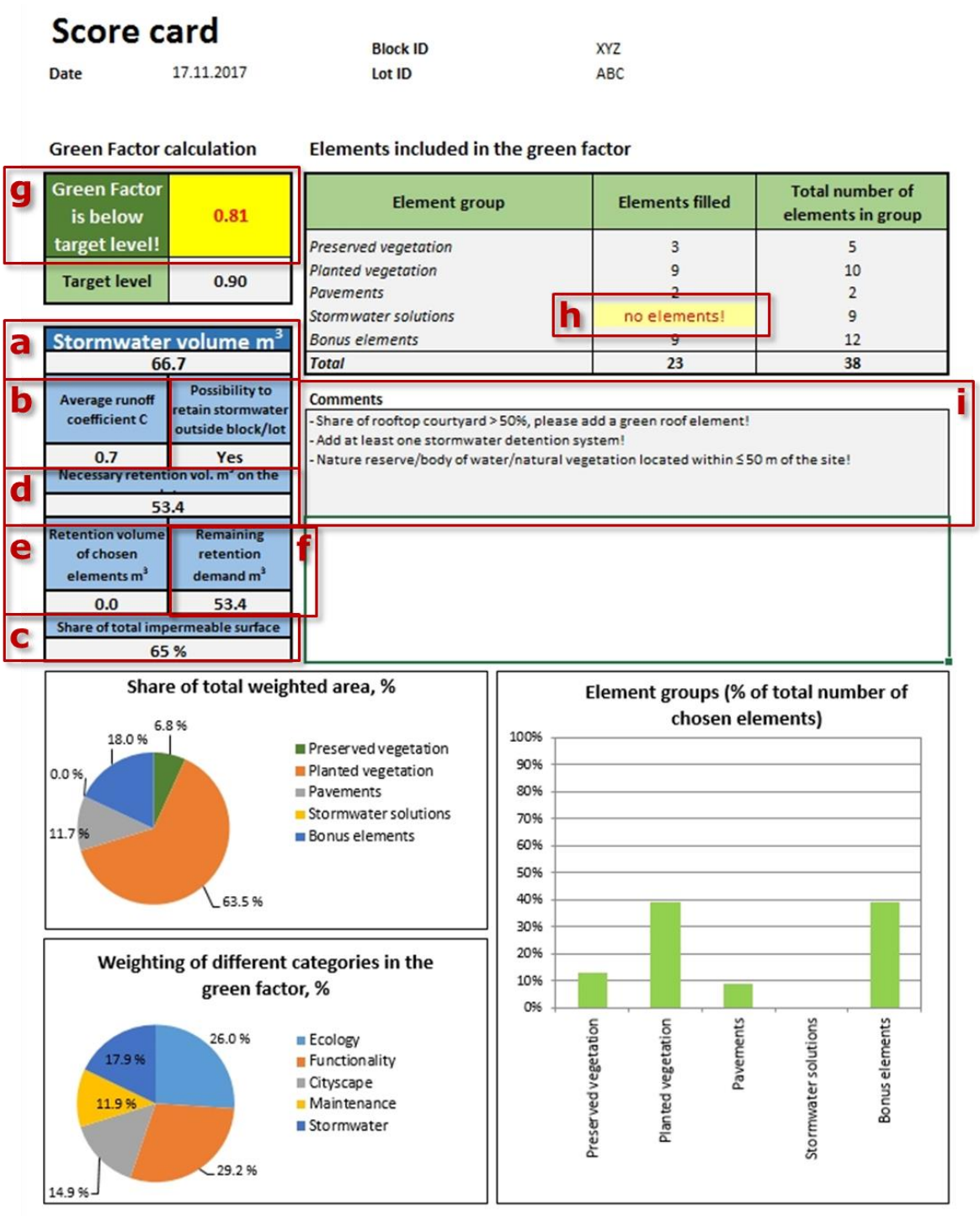


Figure 6. Results sheet.

Additionally, the user will now be visually warned, if for instance the Target Level has not been reached (g) or certain elements are missing (h). Furthermore, all important notifications resulting from automatic internal checks will be listed in the top section of the “Comments” field (i). This part cannot be manually changed and adjusts itself automatically depending on the settings within the tool.

For printing out the results sheet, make sure you define the Scaling and Print Area correctly within the Excel settings for Print and Page Setup (Figure 7). The table should be scaled to fit one page (wide and tall) and the “Print Area” should be set to A1:I46, which represents the extent of the results sheet.

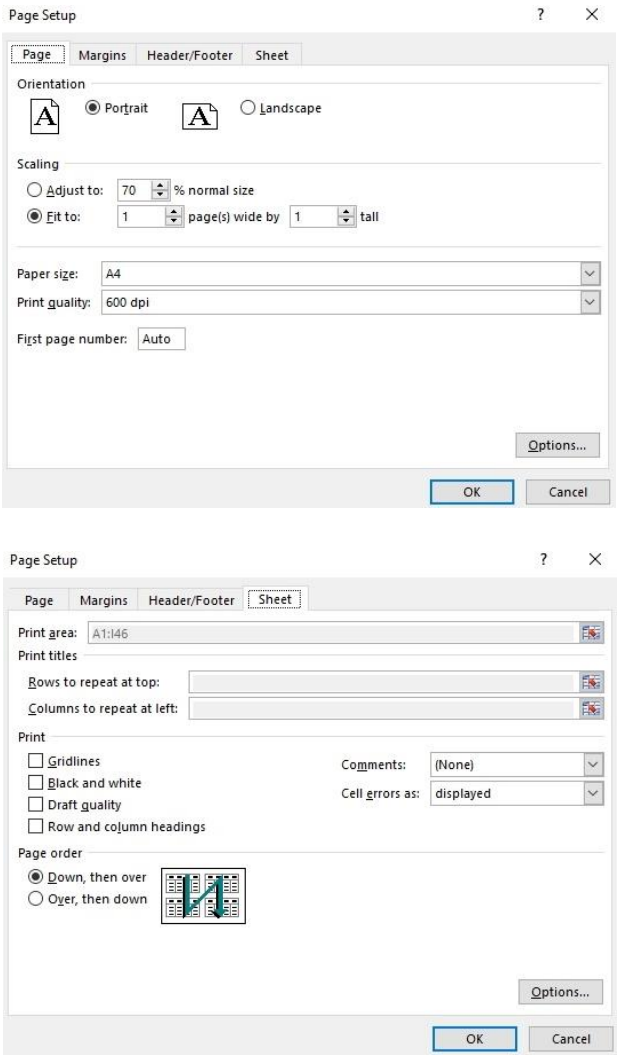


Figure 7. Page and printing setup.

This manual was developed within the iWater - Integrated Storm Water Management project (2015–2018).

iWater aims at improving the urban planning in the cities of the Baltic Sea Region through development of integrated storm water management system. Project provides new approaches and tools for urban planning – for greener, safer, more sustainable and attractive cities.

For more details please visit project website at **www.integratedstormwater.eu**

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